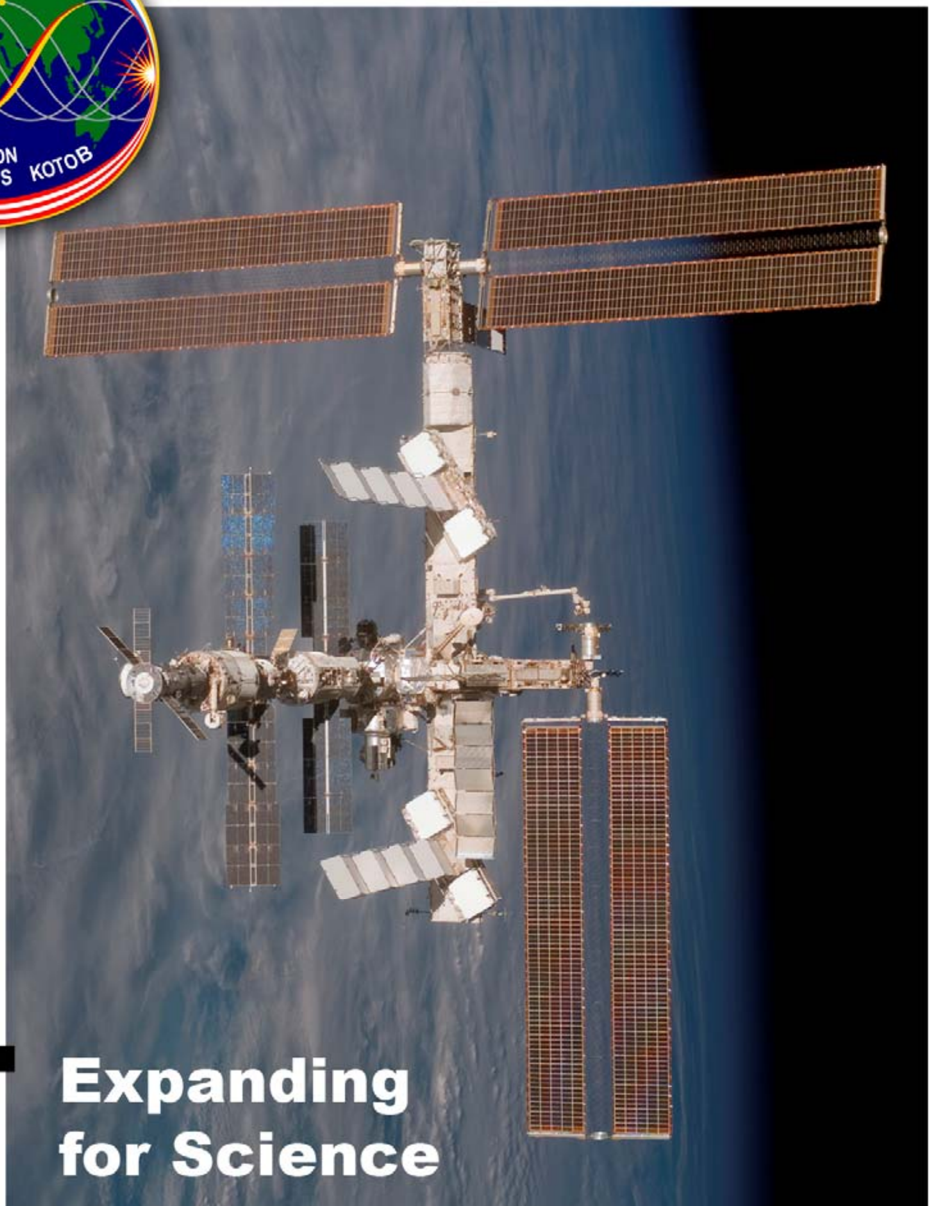
INTERNATIONAL SPACE STATION

Expedition 15



Expanding for Science

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Mission Overview

Expedition 15: Expanding for Science

On April 7, two Russian cosmonauts aboard the Soyuz TMA-10 will launch to the International Space Station, joining an American astronaut for one of the most complex expeditions since permanent human occupancy of the complex began almost seven years ago.

Making his second flight into space, Fyodor Yurchikhin (Fee-OH'-dur YOUR'-cheek-in), 48, will command the Expedition 15 mission. He is an engineer for RSC-Energia who flew on the STS-112 mission that delivered the starboard one (S1) truss to the outpost.

Cosmonaut Fyodor Yurchikhin of Russia's Federal Space Agency, Expedition 15 commander.

Cosmonaut Oleg Kotov, representing Russia's Federal Space Agency, has been assigned as Expedition 15 flight engineer and Soyuz commander.

Joining Yurchikhin is fellow Russian cosmonaut Oleg Kotov (AH'-leg KO'-tuff), 41, who will serve as flight engineer and Soyuz commander for launch, landing and on-orbit operations. This is Kotov's first flight. He is a cosmonaut-researcher and medical doctor for the Gagarin Cosmonaut Training Center in Star City, Russia. Their stay aboard the station is expected to last approximately six months.

Yurchikhin and Kotov will join NASA astronaut and Navy Cmdr. Sunita (Suni) Williams, 41, who flew to the station on shuttle Discovery's STS-116 mission in December 2006. She will return to Earth aboard shuttle Endeavour's mission STS-118. That flight will carry Expedition 15 crew member and NASA astronaut Clayton Anderson, 48, to the complex. He will return home aboard Atlantis on mission STS-120.

The Soyuz TMA-10 spacecraft will launch from the Baikonur Cosmodrome in Kazakhstan for a two-day flight to link up to the Zvezda Service Module on the station. Joining them on the Soyuz is U.S. businessman Charles Simonyi, 58, a former executive with Microsoft Corp., who will spend 10 days on the station under a contract signed with the Russian Federal Space Agency (Roscosmos).

Charles Simonyi will fly as a space flight participant on the Expedition 15 mission.

Simonyi will return to Earth on the Soyuz TMA-9 capsule with Expedition 14 Commander Mike Lopez-Alegria (Ah-luh-GREE'-uh), 48, and Flight Engineer and Soyuz Commander Mikhail Tyurin (Tee-YOUR'-in), 47, landing in central Kazakhstan. Lopez-Alegria and Tyurin have been aboard the station since September 2006.

Once on board, Yurchikhin and Kotov will conduct more than a week of handover activities with Lopez-Alegria, Tyurin and Williams, familiarizing themselves with station systems and procedures. They also will receive proficiency training on the Canadarm2 robotic arm from the resident crew and engage in safety briefings as well as payload and scientific equipment training.

The change of command ceremony marks the formal control of the station by Yurchikhin and Kotov just days before the Expedition 14 crew members and Simonyi depart the station. Tyurin, at the controls of Soyuz, Lopez-Alegria and Simonyi will land in the steppes of Kazakhstan to conclude their mission. Simonyi's mission will span 12 days.

After landing, the trio will be flown from Kazakhstan to the Gagarin Cosmonaut Training Center in Star City, for approximately two weeks of initial physical rehabilitation. Due to the brevity of his fight, Simonyi will spend significantly less time acclimating himself to Earth's gravity than Tyurin and Lopez-Alegria.

The crew will work with experiments across a wide variety of fields, including human life sciences, physical sciences and Earth observation, as well as education and technology demonstrations. Many experiments are designed to gather information about the effects of long-duration spaceflight on the human body, which will help with planning future exploration missions to the moon and Mars. The science team at the Payload Operations Integration Center at NASA's Marshall Space Flight Center in Huntsville, Ala., will operate some experiments without crew input and other experiments are designed to function autonomously.

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Backdropped by a sprinkling of small clouds over a blue Earth, an unpiloted Progress supply vehicle approaches the International Space Station.

The station crew is expected to greet the arrival of two Russian Progress resupply cargo ships filled with food, fuel, water and supplies that will augment the delivery of supplies on visiting shuttles. The ISS Progress 25 cargo is targeted to reach the station in May, and ISS Progress 26 is slated for August. If all goes as planned, the Expedition 15 crew also will greet two visiting shuttles.

During the STS-117 mission, Atlantis will deliver the starboard three and four (S3/S4) truss and a new set of solar arrays to the station. The mission was scheduled for Expedition 14, but was postponed due to hail damage to Atlantis' external fuel tank on Feb 26.

The next shuttle mission, Endeavour's STS-118, will bring the starboard five (S5) truss segment to the station and replace a failed control moment gyroscope. Additionally, the shuttle will fly Anderson to the complex, replacing Williams. Further, the mission will highlight the first flight of Educator Astronaut and Mission Specialist Barbara Morgan, who will be part of Endeavour's crew and will handle crucial robotics work throughout the flight.

Other mission tasks include using the Canadarm2 robotic arm in August to move one of the station's docking ports, the Pressurized Mating Adapter-3 (PMA-3), from the port side of the Unity module to the nadir side, clearing the port side for the temporary installation of Harmony (Node 2) during the STS-120 mission targeted for later this year.

Astronaut Clayton C. Anderson (left), Expedition 15 flight engineer; cosmonauts Fyodor N. Yurchikhin and Oleg V. Kotov, commander and flight engineer, respectively, representing Russia's Federal Space Agency, participate in a training session in the Neutral Buoyancy Laboratory (NBL) near Johnson Space Center.

U.S. and Russian specialists are reviewing the tasks expected to be included in as many as three spacewalks planned for Expedition 15. Yurchikhin and Kotov will do the first two spacewalks out of the Pirs airlock on the station's Russian segment. They will wear Russian Orlan suits and install micrometeoroid debris shields on the Zvezda module that were delivered to the complex in December on the STS-116 shuttle mission. Yurchikhin, Kotov and Anderson will conduct their first spacewalks during Expedition 15.

The third spacewalk will feature Anderson and Yurchikhin in U.S. suits exiting from the Quest airlock. They will jettison an ammonia reservoir tank, the Early Ammonia Servicer, which was attached to the P6 truss to replenish ammonia for cooling lines for the early thermal control system for the station. That temporary system has been shut down in favor of the station's permanent cooling system, and the ammonia reservoir is no longer required.

Anderson and Yurchikhin also will disconnect electrical connections between PMA-3 and Unity in advance of its relocation and install equipment for additional video hardware that will accompany future station assembly missions.

Also on the crew's agenda is work with Canadarm2 that will support the spacewalks and observe the station's exterior.

Expedition 15 Crew

Fyodor Yurchikhin, Ph.D., Expedition 15 commander

Since graduating from the Sergei Ordzhonikidze Moscow Aviation Institute in 1983, Yurchikhin, 48, has worked at the Russian Space Corporation-Energia. He began working as a flight controller in the Russian Mission Control Center in Korolev, Russia, eventually becoming a lead engineer for the Shuttle-Mir and NASA-Mir Programs. In August 1997, he began training as a cosmonaut and in October 2002, flew aboard STS-112 as a mission specialist, logging a total of 10 days, 19 hours, and 58 minutes in space.

Oleg Kotov, M.D., Lt. Col., Russian Air Force, Expedition 15 flight engineer and Soyuz commander

After serving as a backup crew member to the Mir-26 mission, and backup flight engineer and Soyuz commander on Expedition 6 and 13, Dr. Kotov is the flight engineer and the Soyuz commander for Expedition 15. A 1988 graduate of the Kirov Military Medical Academy, he was selected as a cosmonaut candidate in 1996. Since completing his initial training, has served as a cosmonaut-researcher and test-cosmonaut of the Cosmonaut Office and also worked as a CAPCOM (Capsule or Spacecraft Communicator) for Expedition 3 and 4 in Mission Control Center in Moscow, as well as the Moscow Support Group in Houston.

Sunita Williams, Cmdr., USN, Expedition 15 flight engineer

Williams, who arrived on the space station in December 2006 on shuttle Discovery during the STS-116 mission, will remain as a flight engineer for part of Expedition 15. Although this is her first spaceflight mission, Williams holds the spacewalk duration world record for females with a total extra-vehicular activity time of 29 hour, 17 minutes over four spacewalks. Her first spacewalk was with veteran spacewalker Bob Curbeam during STS-116. The other three spacewalks were conducted with Expedition 14 Commander Michael Lopez-Alegria. Williams was selected by NASA in June 1998. She worked in Moscow with Russian space officials on Russian segment systems development for the station and with the first Expedition crew to the station. Williams is scheduled to wrap up her long-duration spaceflight midway through Expedition 15 and return to Earth via the space shuttle Endeavour on the STS-118 mission.

Clayton Anderson, flight engineer

Replacing Williams as the Expedition 15 flight engineer, Anderson will join the crew during the STS-118 shuttle mission. Anderson is a graduate of Hastings College in Nebraska and Iowa State University. He joined NASA in 1983 in the Mission Planning and Analysis Division, before moving on to the Mission Operations Directorate where he progressed to chief of the Flight Design Branch. He was selected to join NASA's astronaut corps in 1998. He most recently was back-up flight engineer for Expeditions 12, 13 and 14 to the station. He is scheduled to return to Earth on shuttle mission STS-120.

Daniel Tani

A veteran of a prior space shuttle flight, Tani will also serve as Flight Engineer for a brief time during Expedition 15. Tani is slated to arrive to the station on STS-120, and stay onboard with Expedition 16. He is scheduled to return to Earth on Discovery on STS-122. A Massachusetts Institute of Technology graduate, Tani joined NASA in 1996. He served in numerous roles, including the EVA Branch and as a Crew Support Astronaut for Expedition-4. Tani flew on STS-108 in 2001, and has logged more 11 days in space, including a space walk to wrap thermal blankets around ISS Solar Array Gimbals. He also trained and qualified as the backup flight engineer for Expedition 11.

Charles Simonyi, spaceflight participant

Born in Budapest, Hungary but a naturalized American citizen, Charles Simonyi will serve as the fifth spaceflight participant to visit the International Space Station and the third U.S. spaceflight participant. He will travel to the orbital outpost with Yurchikhin and Kotov and spend 11 days aboard before returning with Expedition 14 crew members, Michael Lopez-Alegria and Mikhail Tyurin. Simonyi came to the United States in 1968 and is a graduate of the University of California at Berkeley and Stanford University. He has an extensive career in software development including work at Xerox Corp. and Microsoft, Inc. and founded Intentional Software Corp., a software engineering firm. Simonyi gained his American citizenship in 1982.

Expedition 15 Spacewalks

During three planned spacewalks, Expedition 15 crew members will install 17 debris panels designed to shield the station's Zvezda service module from micrometeorites and remove and jettison the space station's Early Ammonia Servicer, or EAS.

The servicer, a reservoir for the initial cooling system used on the complex, is on the station's P6 integrated truss segment. The EAS held reserve ammonia for the station's early external thermal control system. It is about the size of a large refrigerator weighing 1,400 pounds.

Cosmonaut Fyodor N. Yurchikhin, Expedition 15 commander, dons a training version of the Extravehicular Mobility Unit (EMU) space suit prior to being submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near the Johnson Space Center.

The early external thermal control system was a temporary cooling system for the space station and its equipment. That system is no longer used because the station's permanent external thermal control system was activated during the STS-116 mission in December 2006 and during Expedition 14.

Two of the Expedition 15 spacewalks are designated as Russian spacewalks because the astronauts will exit from the Pirs airlock and use Russian Orlan spacesuits. The third spacewalk will be a U.S. spacewalk conducted from the station's Quest airlock using U.S. spacesuits.

The spacewalks will be the first for all three crew members.

The Russian Spacewalks

The first spacewalk -- also known as an extravehicular activity or EVA -- is slated for June 1 and is designated Russian EVA 18. The second spacewalk is scheduled for June 7 and will be Russian EVA 19. Both spacewalks will be conducted by Expedition 15 Commander Fyodor Yurchikhin and Flight Engineer Oleg Kotov.

During the first spacewalk, Yurchikhin and Kotov will leave the station, extend the manually operated Strela, a 45-foot Russian crane attached to the Pirs airlock, to Pressurized Mating Adapter 3 (PMA-3) located on the Unity Node and then move to the adapter. Once in place, the spacewalkers will use the Strela to retrieve the three bundles of debris panels stowed on the pressurized mating adapter during STS-116. The panel bundles are mounted on a holder called a “Christmas tree." Each bundle includes six or seven shields.

The spacewalkers will use the Strela to grasp the “Christmas tree” adapter and then move it to the Zvezda service module to again temporarily stow the bundles.

Next, the two spacewalkers will move the Strela back to the Pirs docking compartment and begin to install the debris panels on the handrails of the module's cone shaped section. This section is located between the small and large diameters of Zvezda.

Each panel is hollow and about 1 meter tall, 0.5 meters wide, and 10 centimeters thick.

The spacewalkers will install one set of panels during the first EVA and leave two sets for the second spacewalk. Installation of the shields will complete the additional protection required on that section. Six similar shields were installed on an earlier Expedition. The debris panels will protect the service module against micrometeroid impacts.

During the second Russian spacewalk, Yurchikhin and Kotov will again leave the Pirs docking compartment, move to where the debris panel bundles are stowed and complete installation of the panels on the service module. After the panels are installed, the crew will photograph the panels. These photographs will give the ground crew a close-up view of the panel installation.

If time permits, the crew will also install a computer network cable on the Russian segment modules which, once attached on the U.S. segment, will enable commands to be sent from the U.S. modules to the Russian portion of the outpost.

Cosmonaut Oleg V. Kotov (left), Expedition 15 flight engineer, participates in an EMU spacesuit fit check in the Space Station Airlock Test Article (SSATA) in the Crew Systems Laboratory at Johnson Space Center. Yurchikhin assisted Kotov.

The U.S. Spacewalk

The third Expedition 15 spacewalk, designated U.S. EVA 9, will be performed by Flight Engineer Clayton Anderson and Yurchikhin. Kotov will maneuver the station's robotic arm, the Canadarm2. The primary task for the crew will be to jettison two items that are no longer needed on the station. This also will be the first time the station's robotic arm will be controlled by a Russian cosmonaut.

During the spacewalk, operators in the station's Mission Control Center at the Johnson Space Center in Houston will serve as Kotov's robotic arm assistant, verifying control of the arm and its position. Because there will be fewer camera views without the shuttle present, Kotov may also call upon Yurchikhin to help him judge clearances between structures.

Kotov's operation of the robotic arm will demonstrate the crew's ability to perform a one-man robotic operation during a spacewalk without a shuttle present, also known as a stage spacewalk. This will lay the foundation for future undertakings, including the possible need to replace orbital replacement units stowed on the station's exterior.

The first task for Anderson and Yurchikhin will be to jettison a stanchion, a support post, for an exterior video camera. It needs to be cleared for future additions to the station.

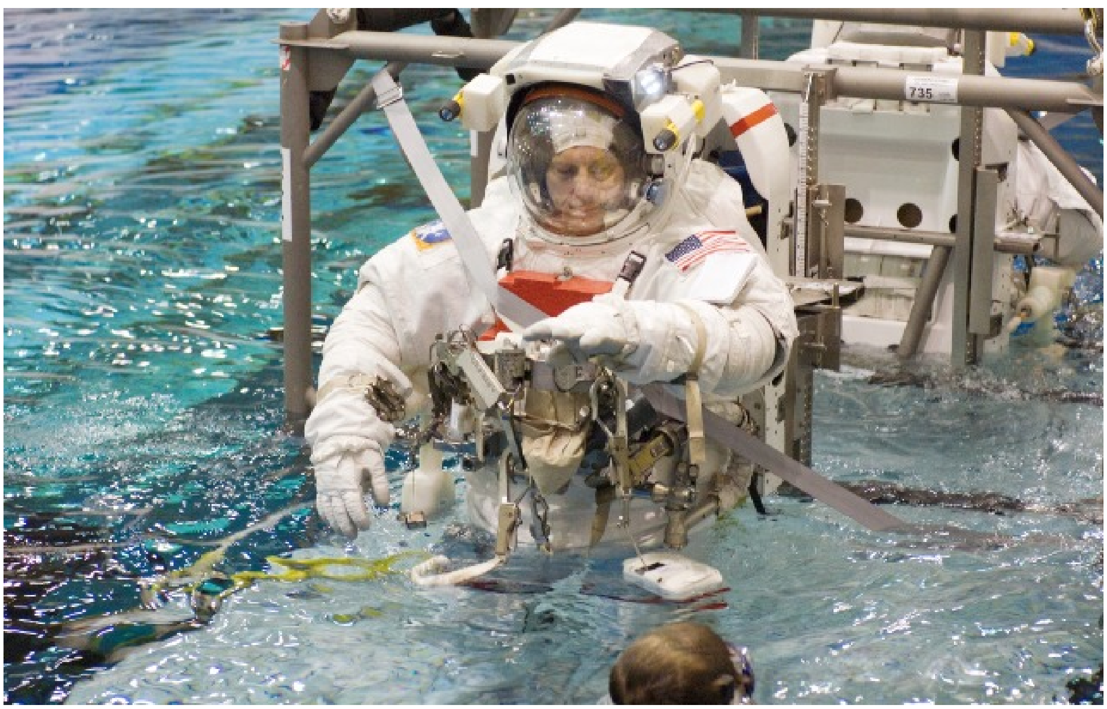
However, the most important task during EVA 9 is the removal and jettison of the Early Ammonia Servicer. Originally, a shuttle was expected to return the servicer to Earth. But, because it is nearing its structural life expectancy, engineers were concerned an ammonia leak could occur in the shuttle's payload bay during return and place the shuttle crew at risk.

Once the cables have been removed from the servicer, Anderson will jettison it by simply pushing it away. Valves on the servicer were secured by Expedition 14 spacewalkers Mike Lopez-Alegria and Suni Williams in February during Expedition 14.

As the servicer moves away from the station, it will begin to sink because trace amounts of atmosphere that exist at the station's altitude create drag, or resistance to motion. Because the servicer's relative drag is similar to the space station's relative drag, flight controllers plan to fire thrusters to boost the station the day after the spacewalk to insure the servicer is cleared from station's orbit.

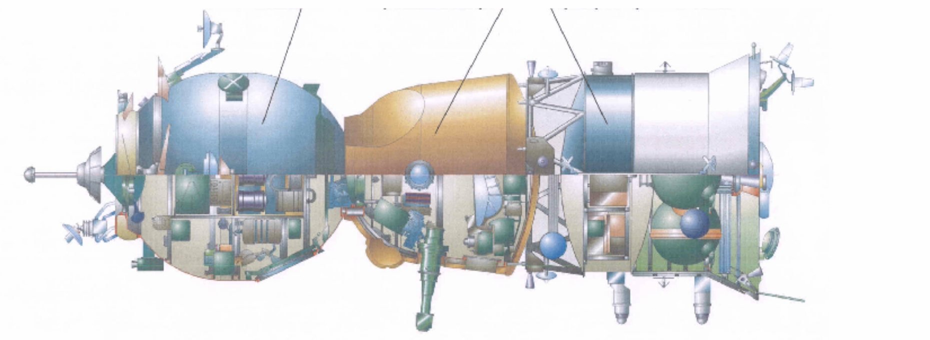
The spacewalkers will have spent more than 100 hours training for the two jettisons, including time in NASA's underwater Neutral Buoyancy Laboratory (NBL) and Virtual Reality (VR) Laboratory, and work in robotics simulators and on an air bearing floor that works much like an air-hockey table.

Other scheduled tasks for the spacewalkers are being finalized.



Astronaut Clayton C. Anderson, Expedition 15 flight engineer and Yurchikhin are submerged in the waters of the NBL.

Russian Soyuz TMA



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

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

Orbital Module

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

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

Descent Module

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

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

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

Instrumentation/Propulsion Module

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

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

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

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

TMA Improvements and Testing

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

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

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

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

New components and the entire TMA were rigorously tested on the ground, in hangar-drop tests, in airdrop tests and in space before the spacecraft was declared flight-ready. For example, the accelerometer and associated software, as well as modified boosters (incorporated to cope with the TMA's additional mass), were tested on flights of Progress 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 in the cone-shaped portion and the kerosene tank in the cylindrical portion.

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

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

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

Second Stage

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

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

Third Stage

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

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

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

Launcher Telemetry Tracking & Flight Safety Systems

Soyuz launcher tracking and telemetry is provided through systems in the second and third stages. These two stages have their own radar transponders for ground tracking. Individual telemetry transmitters are in each stage. Launcher health status is downlinked to ground stations along the flight path. Telemetry and tracking data are transmitted to the mission control center, where the incoming data flow is recorded. Partial real-time data processing and plotting is performed for flight following and initial performance assessment. All flight data is analyzed and documented within a few hours after launch.

Baikonur Cosmodrome Launch Operations

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

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

Final Launch Preparations

The assembled launch vehicle is moved to the launch pad on a railcar. Transfer to the launch zone occurs two days before launch. The vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

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

Rendezvous to Docking

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

Soyuz Booster Rocket Characteristics

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

Prelaunch Countdown Timeline

T- 34 Hours	Booster is prepared for fuel loading
T- 6:00:00	Batteries are installed in booster
T- 5:30:00	State commission gives go to take launch vehicle
T- 5:15:00	Crew arrives at site 254
T- 5:00:00	Tanking begins
T- 4:20:00	Spacesuit donning
T- 4:00:00	Booster is loaded with liquid oxygen
T- 3:40:00	Crew meets delegations
T- 3:10:00	Reports to the State commission
T- 3:05:00	Transfer to the launch pad
T- 3:00:00	Vehicle 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

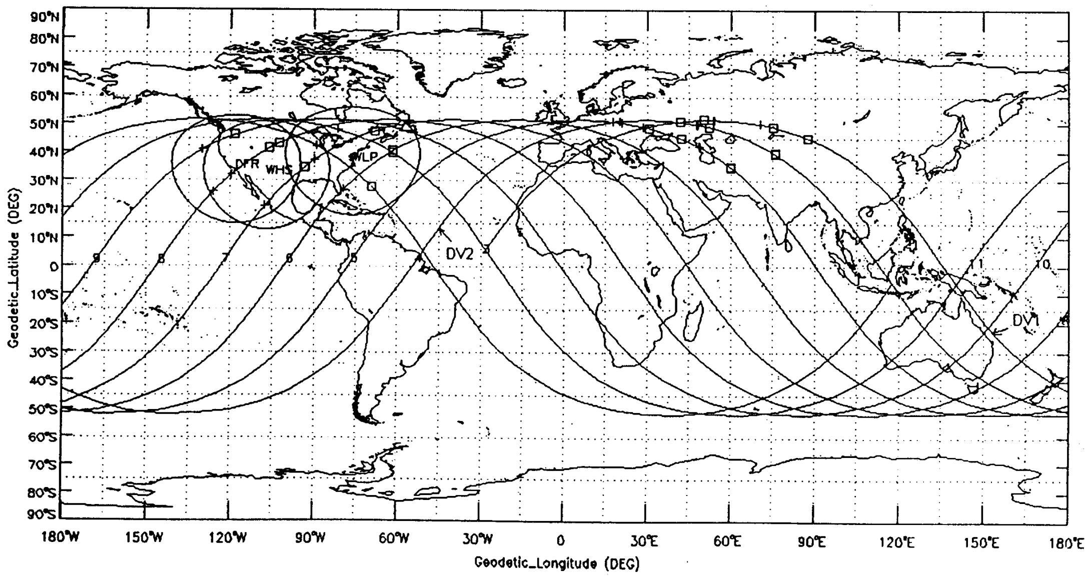
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital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



Key Times for Expedition 15/14 International Space Station Events

Expedition 15/Simonyi Launch

12:31:03 p.m. CT on April 7

17:31:03 GMT on April 7

21:31:03 p.m. Moscow time on April 7

23:31:03 p.m. Baikonur time on April 7.

Expedition 15/Simonyi Docking to the ISS

2:15 p.m. CT on April 9

19:15 GMT on April 9

23:15 p.m. Moscow time on April 9.

Expedition 15/Simonyi Hatch Opening to the ISS

3:30 p.m. CT on April 9

20:30 GMT on April 9

00:30 a.m. Moscow time on April 10.

Expedition 14/Simonyi Hatch Closure to the ISS

2:05 a.m. CT on April 20

7:05 GMT on April 20

11:05 a.m. Moscow time on April 20

13:05 p.m. Kazakhstan time on April 20.

Expedition 14/Simonyi Undocking from the ISS

5:20 a.m. CT on April 20

10:20 GMT on April 20

14:20 p.m. Moscow time on April 20

16:20 p.m. Kazakhstan time on April 20.

Expedition 14/Simonyi Deorbit Burn

7:40 a.m. CT on April 20

12:40 GMT on April 20

16:40 p.m. Moscow time on April 20

18:40 p.m. Kazakhstan time on April 20

Expedition 14/Simonyi Landing

8:36:36 a.m. CT on April 20

13:36:36 GMT on April 20

17:36:36 p.m. Moscow time on April 20

19:36:36 p.m. Kazakhstan time on April 20 (57minutes before sunset)

EXPEDITION 14/ISS SOYUZ 13 (TMA-9) LANDING

For the ninth time in history, an American astronaut will return to Earth from orbit in a Russian Soyuz capsule. Expedition 14 Commander Mike Lopez-Alegria will be aboard the International Space Station Soyuz 13 (TMA-9) capsule as he, Soyuz Commander Mikhail Tyurin and U.S. Spaceflight Participant Charles Simonyi touch down on the steppes of Kazakhstan to complete their mission. Lopez-Alegria and Tyurin will be concluding seven months in orbit, while Simonyi will return after a 12-day commercial flight.

The grounding of the space shuttle fleet following the Columbia accident on Feb.1, 2003, necessitated the landing of Expedition crews in Soyuz capsules. The Expedition 6 through 13 crews rode the Soyuz home starting in May 2003. Some Americans will continue to return from space in Soyuz capsules while others fly home on space shuttles, depending on the timing of crew rotation activities. The Soyuz provides an assured crew return capability for residents aboard the station.

Lopez-Alegria, Tyurin and Simonyi will be equipped with a satellite phone and Global Positioning System locator hardware for instant communications with Russian recovery teams.

Three hours before undocking, Lopez-Alegria, Tyurin and Simonyi will bid farewell to Expedition 15 crew members Commander Fyodor Yurchikhin and flight engineers Oleg Kotov and Suni Williams, who arrived at the station in December 2006. Williams will return to Earth on shuttle Endeavour's STS-118 mission, targeted for launch in summer 2007.

The departing crew will climb into the Soyuz, closing the hatch between Soyuz and the station's Zarya module where the vehicle is linked. Lopez-Alegria, the on-board engineer, will sit in the Soyuz' left seat for entry and landing. Tyurin will sit in the center commander's seat with Simonyi occupying the right seat.

After activating Soyuz systems and getting approval from Russian flight controllers at the Russian Mission Control Center outside Moscow, Tyurin will send commands to open hooks and latches between the Soyuz and Zarya module.

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

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

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

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

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

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

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

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

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

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

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

Within minutes of landing, a portable medical tent will be set up near the capsule so the crew can change out of its launch and entry suits. Russian technicians will open the module's hatch and begin to remove the crew one at a time. The three crew members will sit in special reclining chairs near the capsule for initial medical tests and an opportunity to begin readapting to Earth's gravity.

Two hours after landing, the crew, assisted to the helicopters, will fly back to a staging site in Kazakhstan, where local officials will welcome them. The crew will then board a Russian military transport plane to be flown back to the Chkalovsky Airfield, which is adjacent to the Gagarin Cosmonaut Training Center in Star City, Russia, where their families will meet them. In all, it will take approximately eight hours between landing and the return to Star City.

Assisted by a team of flight surgeons, Lopez-Alegria and Tyurin will undergo several weeks of medical tests and physical rehabilitation before returning to the United States for additional debriefings and follow-up exams. Simonyi's acclimation to Earth's gravity will take a much shorter period of time due to the brevity of his flight.

Soyuz Entry Timeline

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

5:17 a.m. CT on April 20

10:17 GMT on April 20

14:17 p.m. Moscow time on April 20

16:17 p.m. Kazakhstan time on April 20

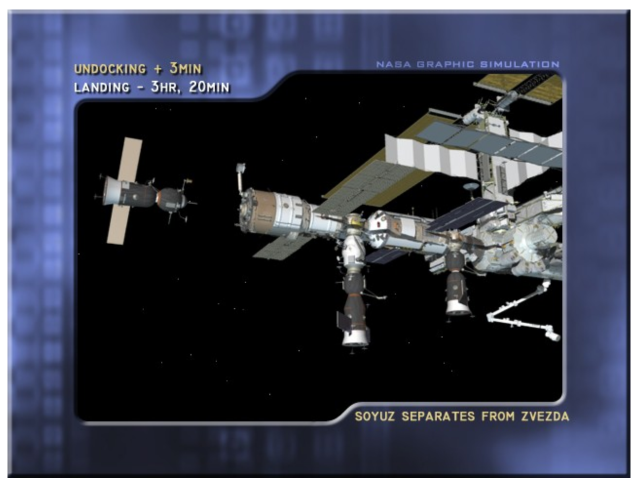
Hooks Opened/Physical Separation of Soyuz from Zarya Module nadir port at .12 meter/sec. (Undocking Command + 3 mins.)

5:20 a.m. CT on April 20

10:20 a.m. GMT on April 20

14:20 a.m. Moscow time on April 20

16:20 p.m. Kazakhstan time on April 20



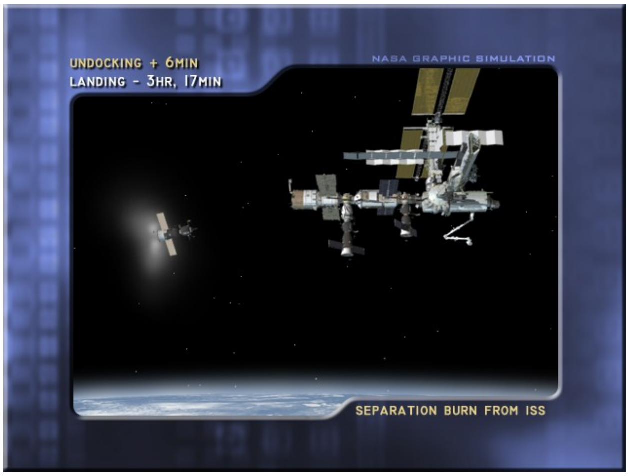
Separation Burn from ISS (8 second burn of the Soyuz engines, .56 meters/sec; Soyuz distance from the ISS is ~20 meters)

5:23 a.m. CT on April 20

10:23 GMT on April 20

14:23 p.m. Moscow time on April 20

16:23 p.m. Kazakhstan time on April 20



Deorbit Burn (appx 4:20 in duration, 115.2 m/sec; Soyuz distance from the ISS is ~12 kilometers; Undocking Command appx + ~2 hours, 30 mins.)

7:40 a.m. CT on April 20

12:40 GMT on April 20

16:40 p.m. Moscow time on April 20

18:40 p.m. Kazakhstan time on April 20

Separation of Modules (~23 mins. after Deorbit Burn; Undocking Command + ~2 hours, 57 mins.)

8:03 a.m. CT on April 20

13:03 GMT on April 20

17:03 p.m. Moscow time on April 20

19:03 p.m. Kazakhstan time on April 20

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

8:06 a.m. CT on April 20

13:06 GMT on April 20

17:06 p.m. Moscow time on April 20

19:06 p.m. Kazakhstan time on April 20

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

8:15 a.m. CT on April 20

13:15 GMT on April 20

17:15 p.m. Moscow time on April 20

19:15 p.m. Kazakhstan time on April 20

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 from a descent rate of 230 meters/second to 80 meters/second.

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

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

Landing - appx. 2 seconds

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

8:36:36 a.m. CT on April 20

13:36:36 GMT on April 20

17:36:36 p.m. Moscow time on April 20

19:36:36 p.m. Kazakhstan time on April 20 (57 minutes before sunset at the landing site)

European Space Agency's Automated Transfer Vehicle Debuts

The Automated Transfer Vehicle

The International Space Station depends on regular deliveries of food, water, air, experimental equipment and spare parts for its crew. Beginning in the second half of 2007, the European Space Agency's Automated Transfer Vehicle (ATV) will join the station's fleet of supply craft.

Equipped with its own propulsion and navigation systems, the maiden ATV is a multi-functional spaceship, combining the automatic capabilities of a robotic vehicle with human spacecraft safety requirements. Its mission will resemble that of a tug boat re-supplying and pushing a river barge—the space station.

Named "Jules Verne" after the visionary 19th-century science fiction writer, the maiden ATV will carry up to nine tons of cargo from Europe's spaceport in Kourou, French Guiana, to the International Space Station. An on-board, high-precision optical navigation system will be used during the last 250 meters to guide the ATV on a rendezvous trajectory toward the space station where it will automatically dock to the station's Russian Zvezda Service Module. From launch until the final 250 meters, a Global Positioning System-based system is used to guide the ATV.

It will remain there as a pressurized component of the complex for up to six months until a controlled re-entry into the Earth's atmosphere, where it will burn up and, in the process, dispose (for Jules Verne) 6 340 kg of items no longer needed on the space station.

Externally, the ATV is covered with an insulating foil layer on top of meteorite protection panels. Its X-shaped solar arrays resemble metallic blue wings.

Although people will not be launched in an ATV, crew members on the station will be able to access cargo and systems during the time it is docked. There is room inside for up to eight standard racks designed to store equipment and transfer bags.

The ATV also will carry several tanks containing drinking water, refueling propellant for the station's propulsion system and air (air, oxygen and nitrogen) for the crew. The forward end cone of the cargo section contains the Russian-made docking equipment and the rendezvous sensors.

The ATV uses four main engines and 28 thrusters for orbit and attitude control. After docking, it can perform space station attitude control and debris avoidance maneuvers. It also can desaturate the space station gyroscopic attitude system and boost the complex's orbit to overcome the effects of residual atmospheric drag.

The ATV has about three times the payload capability of its Russian counterpart, the Progress cargo craft.

Mission Profile

The ATV launches on an Ariane 5 rocket.

The Jules Verne ATV mission will begin when the craft is launched into orbit by an Ariane 5 from the European launch site in Kourou, French Guiana, on the northern coast of South America.

After separation from Ariane, the ATV's navigation systems are activated and engines are fired to boost it into the transfer orbit. These activities will be monitored by ESA's ATV Control Center in Toulouse, France.

The cargo craft will come in sight of the International Space Station after more than two weeks in orbit during which time onboard systems, rendezvous and collision avoidance systems are tested. Its computers will control final approach maneuvers over the final two orbits, closing with the space station at a relative speed of a few centimeters per second while both vehicles fly at 17,500 mph.

Docking will be automatic. If there are any last-minute problems, either the ATV's computers or the space station crew can trigger a pre-programmed sequence of anti-collision maneuvers, which would be independent of the main navigation system. The avoidance maneuvers can be done on a main computer or on an independent system. The ESA ATV Control Center also can initiate the avoidance maneuvers.

The ATV remains docked with the ISS for up to six months

With the ATV securely docked, space station crew members can enter the cargo section and remove its payloads. The ATV's fuel and water supply tanks will be connected to the space station's plumbing system and crew members will manually release air, oxygen or nitrogen directly into the space station.

ATVs will remain at the space station for about six months to allow crew members to fill them with unwanted material.

Once its re-supply mission is complete, the ATV hatch will be closed by the crew and later separated automatically. Its engines will de-orbit the spacecraft on a steep flight path to perform a controlled re-entry under deliberately high forces of atmospheric drag, causing it to break up and burn high above the Pacific Ocean.

ATV Control and Rendezvous

The maiden ATV flight, tentatively scheduled for the second half of 2007, will mark the first rendezvous and docking ever of a European spacecraft in orbit. It also will be the first European re-supply mission to the space station.

The maiden voyage will take up to 17 days to allow engineers to perform a series of tests. It must be demonstrated that the cargo ship is capable of halting its rendezvous maneuver at any time by stopping and flying away from the space station.

During the highly critical phases of an ATV flight—from launch to docking and from departure to re-entry—a 60-person team at the new ESA ATV Control Center in Toulouse, France, will work in three adjacent control rooms monitoring closely the automatic approach procedures. Working in concert with NASA flight controllers in Houston and Russian flight controllers in Korolev, outside Moscow, the team will use European and U.S. relay satellites to control ATV phasing, automatic approach and docking, attached phase operations and safe re-entry into the Earth's atmosphere. The French space agency CNES has responsibility for management of the Toulouse center and will coordinate and support all ATV operations on behalf of the European Space Agency.

Star trackers, able to recognize different constellations in the sky to calculate its own orientation in space, and GPS, able to measure angles between orbiting satellites to give positional information, are the modern-day equivalents of centuries-old navigation equipment, such as a sextant.

The ATV uses these instruments to draw closer to the space station over a period of days before switching to a different system for the high-precision docking, using a videometer's eye-like sensors combined with separate parallel measurements systems.

The videometer will analyze images of its emitted laser beam reflected by passive retro-reflectors on the space station next to the Russian docking port where the ATV will be attached to calculate distance from the docking target and rate of closure.

During the last 250 meters of the final approach, the videometer will automatically recognize the retro-reflector's target patterns and then calculate the distance and direction to the docking port.

To add a safety margin, a secondary sensor, called a telegoniometer, will emit laser pulses at a different wavelength to the retro-reflectors. The travel time of the pulses gives the distance and direction as given by the orientation of two built-in mirrors.

The telegoniometer's radar-like pulses provide 10,000 hits per second, whereas the camera-like videometer illuminates its objective from once per second to 10 times per second as it approaches the target.

During its final approach, the ATV will set up a direct link with the space station, allowing it to initiate relative and accurate navigation as well as providing the station crew with critical monitoring capabilities. As it gets closer to its objective, the ATV ground controllers in Toulouse will direct it on a step-by-step predefined approach. This will require authorization from the Mission Control Center in Korolev, Russia (because the ATV docks to the Russian Zvezda module) and overall coordination with Mission Control, Houston.

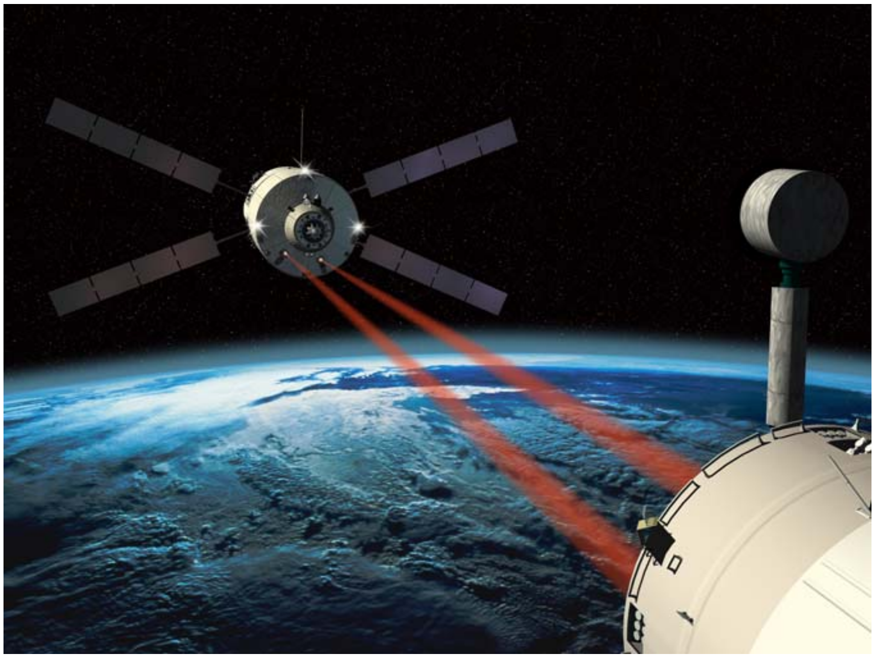
The first ATV flight will take 17 days from launch to docking. The second flight, planned a year or so later, will take only three to five days.

ATV Statistics

Length:	10.3 meters
Maximum Diameter:	4.51 meters
Launch Mass:	up to 20,750 kilograms
Pressurized Volume:	14 cubic meters

ATV is capable of carrying:

- up to 5,500 kg of equipment and food
- up to 840 kg of water
- up to 100 kg of air/oxygen/nitrogen
- up to 860 kg of propellant for refueling the Zvezda fuel tanks
- up to 4,700 kg of propellant for reboosts



The ATV will automatically dock with the ISS

Ariane 5 Launch Vehicle

An Ariane 5 rocket clears the launch tower as it climbs out under the power of its Vulcain main engine and its two solid rocket motors.

Ariane 5 is a European expendable launch system designed to deliver satellites into geostationary transfer orbit and to send payloads to low-Earth orbit. It is manufactured under authority of the European Space Agency (ESA) with EADS Astrium Space Transportation as the prime contractor, leading a consortium of subcontractors.

The rocket is operated and marketed by Arianespace as part of the Ariane program. EADS Astrium Space Transportation builds the rockets in Europe and Ariancespace launches them from a spaceport at Kourou in French Guiana.

Ariane 5 succeeded Ariane 4, but does not derive from it directly. The ESA originally designed Ariane 5 to launch the crewed mini shuttle Hermes, and thus intended it to be human rated from the beginning. After the ESA cancelled Hermes, the rocket became a purely commercial launcher.

Two satellites can be mounted using a Sylda carrier. Three main satellites are possible depending on size. Up to eight secondary payloads, usually small experiment packages or minisatellites, can be carried with an ASAP (Ariane Structure for Auxiliary Payloads) platform.

Components

An Ariane 5 rocket waits on its mobile launch table at the ELA-3 launch zone of Europe's Spaceport in French Guiana

Ariane 5's cryogenic H158 main stage (H173 for Ariane 5 ECA) is called the EPC (Étage Principal Cryotechnique/Cryogenic First Stage). It consists of a large tank 30.5 meters high with two compartments, one for 130 tons of liquid oxygen and one for 25 tons of liquid hydrogen, and a Vulcain engine at the base with thrust of 115 tons-force (1.13 meganewtons). This part of the first stage weighs about 15 tons when empty.

Attached to the sides are two solid propellant boosters, P238 (P241 for Ariane 5 ECA), each weighing about 277 tons full. Each delivers a thrust of about 630 tons-force (6.2 MN). These boosters can be recovered with parachutes, like the space shuttle Solid Rocket Boosters. They may have been retrieved for examination on early missions, but are not reused.

The second stage is on top of the main stage and below the payload. The Ariane 5G uses the EPS (Étage à Propergols Stockables/Storable Propellant Stage), which is fueled by monomethylhydrazine (MMH) and nitrogen tetroxide, where the Ariane 5 ECA uses the ESC (Étage Supérieur Cryotechnique/Cryogenic Upper Stage), which is fueled by liquid hydrogen and liquid oxygen. The payload and all upper stages are covered at launch by the fairing, which splits off once sufficient altitude has been reached.

Statistics on Ariane 5 ES version to launch ATV

Height:	53 m
EPC & fairing diameter:	5.4 m
Overall lift-off weight:	770 tons
Thrust at lift-off:	1,200 tons
Cargo carrying ability:	up to 21 tons

Stages:

Two EAP (solid boosters) side-by-side to the EPC central cryotechnical stage) with its Vulcain2 engine, topped by the EPS re-ignitable upper stage using hypergolic propellants) with its Aestus engine, the vehicle equipment bay (avionics) & the long fairing protecting the ATV.

International Space Station: Expedition 15 Science Overview

Cosmonaut Fyodor N. Yurchikhin (center), Expedition 15 commander representing Russia's Federal Space Agency; cosmonaut Oleg V. Kotov (right), flight engineer representing Russia's Federal Space Agency; and astronaut Sunita L. Williams, flight engineer.

Expedition 15—the 15th science research mission on the International Space Station—is scheduled to begin in April 2007, when the 15th crew launches to the space station aboard a Russian Soyuz spacecraft.

Russian cosmonaut Fyodor Yurchikhin will command the 14S mission, named for the 14th Soyuz to visit the station. Russian cosmonaut Oleg Kotov will serve as flight engineer. The crew will join NASA astronaut Sunita Williams, who has been living and working at the station since her arrival in December 2006 aboard the space shuttle Discovery during the STS-116 mission. The three-person station crew will work with teams on the ground to operate experiments, collect data and maintain the space station.

NASA astronaut Clayton Anderson will join Expedition 15 in progress and serve as a flight engineer after traveling to the station on shuttle mission STS-118, targeted for launch in summer 2007. NASA astronaut Daniel Tani will join Expedition 15 as flight engineer after launching to the station on mission STS-120.

Astronaut Clayton C. Anderson, Expedition 15 flight engineer, dons a training version of the Extravehicular Mobility Unit (EMU) space suit prior to being submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near the Johnson Space Center.

Expedition 14 crew members Michael Lopez-Alegria and Mikhail Tyurin are scheduled to return home in April 2007 on another Soyuz spacecraft—13S—now docked at the station.

During Expedition 15, two Russian Progress cargo flights are scheduled to dock with the space station, the first in May and the second in September. The resupply ships will transport scientific equipment and supplies to the station.

The Expedition 15 crew is scheduled for approximately 119 hours of U.S. payload activities. The team of controllers and scientists on the ground also will conduct space station science remotely. They will continue to plan, monitor and operate experiments from control centers throughout the United States.

A team of controllers for Expedition 15 will staff the Payload Operations Center at NASA's Marshall Space Flight Center in Huntsville, Ala. The center is the science command post for the space station, which links researchers around the world with their experiments and the station crew. Controllers in the Payload Operations Center work in three shifts around the clock, seven days a week.

Experiments Related to Spacecraft Systems

Many experiments are designed to help develop technologies, designs and materials for future spacecraft and exploration missions. These include:

Analyzing Interferometer for Ambient Air (ANITA) will monitor 32 potentially gaseous contaminants, including formaldehyde, ammonia and carbon monoxide, in the atmosphere on the station. The experiment will test the accuracy and reliability of this technology as a potential next-generation atmosphere trace-gas monitoring system for the station.

Elastic Memory Composite Hinge (EMCH) will study the performance of a new type of composite hinge to determine its suitability for use in space. The experiment uses elastic memory hinges to move an attached mass at one end. Materials tested in this experiment are stronger and lighter than current materials used in space hinges and could be used in the design of future spacecraft.

Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 2 (InSPACE - 2) will obtain data on magnetorheological fluids—fluids that change properties in response to magnetic fields—that can be used to improve or develop new brake systems and robotics.

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

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

Microgravity Acceleration Measurement System (MAMS) and Space Acceleration Measurement System – II (SAMS-II) measure vibration and quasi-steady accelerations that result from vehicle control burns, docking and undocking activities. The two different equipment packages measure vibrations at different frequencies. These measurements help investigators characterize the vibrations and accelerations that may influence space station experiments.

Smoke and Aerosol Measurement Experiment (SAME) will measure the smoke properties, or particle size distribution, from typical spacecraft fire smokes to identify ways to improve smoke detectors on future spacecraft.

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) are bowling-ball sized spherical satellites. They will be used inside the space station to test a set of well-defined instructions for spacecraft performing autonomous rendezvous and docking maneuvers. Three free-flying spheres will fly within the cabin of the station, performing flight formations. Each satellite is self-contained with power, propulsion, computers and navigation equipment. The results are important for satellite servicing, vehicle assembly and formation flying spacecraft configurations.

Human Life Science Investigations

Physical measurements of Expedition 15 crew members will be used to study changes in the body caused by exposure to the microgravity environment. Continuing and new experiments include:

Anomalous Long Term Effects in Astronauts' Central Nervous System (ALTEA) integrates several diagnostic technologies to measure the exposure of crew members to cosmic radiation. It will further our understanding of radiation's impact on the human central nervous and visual systems, especially the phenomenon of crew members seeing phosphenes, or flashes of light, while in orbit. This experiment is a cooperative effort with the Italian Space Agency, ASI.

Cardiovascular and Cerebrovascular Control on Return from ISS (CCISS) will study the effects of long-duration spaceflight on crew members' heart functions and their blood vessels that supply the brain. Learning more about the cardiovascular and cerebrovascular systems could lead to specific countermeasures that might better protect future space travelers.

ELaboratore Immagini Televisive - Space 2 (ELITE-S2) studies the connection between brain, visualization and motion in the absence of gravity. By recording and analyzing the three-dimensional motion of astronauts, this study will help engineers apply ergonomics into future spacecraft designs and determine the effects of weightlessness on breathing mechanisms for long-duration missions. This experiment is a cooperative effort with the Italian Space Agency, ASI.

Validation of Procedures for Monitoring Crew Member Immune Function (Integrated Immune) will assess the clinical risks resulting from the adverse effects of spaceflight on the human immune system. It will validate a flight-compatible immune monitoring strategy by collecting and analyzing blood, urine and saliva samples from crew members before, during and after spaceflight to monitor changes in the immune system.

Behavioral Issues Associated with Isolation and Confinement: Review and Analysis of Astronaut Journals (Journals), using journals kept by the crew and surveys, is studying the effect of isolation. By quantifying the importance of different behavioral issues in long-duration crews, the study will help NASA design equipment and procedures to allow astronauts to cope effectively with isolation and long-duration spaceflight.

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

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

Nutritional Status Assessment (Nutrition) is NASA's most comprehensive in-flight study to date of human physiologic changes during long-duration spaceflight; this includes measures of bone metabolism, oxidative damage, nutritional assessments and hormonal changes. This study will impact both the definition of nutritional requirements and development of food systems for future space exploration missions to the moon and Mars. This experiment also will help to understand the impact of countermeasures—exercise and pharmaceuticals—on nutritional status and nutrient requirements for astronauts.

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

Streptococcus pneumoniae Gene Expression and Virulence Potential in the Space Environment (SPEGIS) will examine the behavior and growth of bacteria in microgravity. The data collected will give insight on what types of bacterial infections may occur during long-duration space missions and the risks to crew members.

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

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

Other Biological Experiments

Studies of the responses of microbes in the space environment will help evaluate risks to human health. Plant growth experiments give insight into the effects of the space environment on living organisms. These experiments include:

Molecular and Plant Physiological Analyses of the Microgravity Effects on Multigeneration Studies of Arabidopsis thaliana (Multigen) will grow *arabidopsis thaliana*—a small flowering plant related to cabbage and mustard—in orbit for three generations. The results of this investigation will support future plans to grow plants on the long-duration transit to Mars. This is a cooperative investigation with the European Space Agency, ESA.

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

Education and Earth Observation

Many experiments from earlier expeditions remain on board the space station and will continue to benefit from the long-term research platform 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, along with more fleeting events such as storms, floods, fires and volcanic eruptions. Together, they provide researchers on Earth with vital, continuous images to better understand the planet.

Crew Earth Observations - International Polar Year (CEO-IPY) is an international collaboration of scientists for the observation and exploration of Earth's Polar Regions from 2007 to 2009. Space station crew members will photograph polar phenomena, including auroras and mesospheric clouds, in response to a daily message from the scientists on the ground.

Commercial Generic Bioprocessing Apparatus Science Insert - 02 (CSI-02) is an educational payload designed to interest middle school students in science, technology, engineering and math by participating in near real-time research conducted on board the station. Students will observe three experiments through data and imagery downlinked and distributed directly into the classroom via the Internet. The first is a seed germination experiment through which students will learn how gravity affects plant development. Small seeds will be developed on orbit in a garden habitat. The second experiment will examine crystal growth formation using specific types of proteins and enzymes, and the third experiment will examine crystal formation using silicates—compounds containing silicon, oxygen and one or more metals. For the two crystal growth experiments, students will grow crystals in their classrooms and analyze growth of those compared to the crystals grown in space.

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. Photos are made available on the Web for viewing and study by participating schools around the world. Educators use the images for projects involving Earth Science, geography, physics and technology.

Education Payload Operations (EPO) includes curriculum-based educational activities that will demonstrate basic principles of science, mathematics, technology, engineering and geography. These activities are videotaped then used in classroom lectures. EPO is designed to support the NASA mission to inspire the next generation of explorers.

Education Payload Operations - Kit C (EPO - Kit C) is an on-orbit plant growth investigation using basil seeds. The still and video imagery captured will be used as part of a national engineering design challenge for students in kindergarten through 12th grade. On the ground, students will grow basil seeds—control and flown seeds—in growth chambers to conduct their own science experiments on plant growth.

Space Shuttle Experiments

Many other experiments are scheduled to be performed during upcoming space shuttle missions that are part of Expedition 15. These experiments include:

Commercial Biomedical Test Module - 2 (CBTM-2) will use a proven mouse model to examine the effectiveness of an investigational therapeutic drug designed to limit muscle loss in microgravity. Combined with exercise, this drug could form the basis for a treatment that will maintain a high level of physical fitness in future flight crews.

Cell Culture Module – Immune Response of Human Monocytes in Microgravity (CCM – Immune Response) is Department of Defense Space Test Program research directed at understanding the effects of microgravity on living systems, concentrating on compromised immune systems. This investigation will examine the human immune response in microgravity and study effects of recently discovered natural antibacterials that may improve immune response during spaceflight.

Cell Culture Module – Effect of Microgravity on Wound Repair: In Vitro Model of New Blood Vessel Development (CCM – Wound Repair) is Department of Defense Space Test Program research directed at understanding the effects of microgravity on living systems, concentrating on wound healing. This investigation is directed at the use of adipose-derived adult stem cells for use in injury repair. It will examine how the microgravity alters new blood vessel development, which is a key component of wound and tissue repair.

Education Payload Operations - Educator (EPO - Educator) will use video and still photography to capture data of experiment activities in space. Students also will be designing and completing ground-based investigations developed by the NASA Education Office, focusing on kindergarten through 12th grade students. The activities will support educator astronauts in their missions. An educator astronaut is a full-time astronaut who has experience teaching in elementary, middle school, or high school classrooms.

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

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

Bioavailablity and Performance Effects of Promethazine during Spaceflight (PMZ) will examine the performance-impacting side-effects of promethazine and its bioavailability—the degree to which a drug can be absorbed and used by the parts of the body on which it is intended to have an effect. Promethazine is a medication taken by astronauts to prevent motion sickness.

Ram Burn Observations (RAMBO) is an experiment in which the Department of Defense uses a satellite to observe space shuttle orbital maneuvering system engine burns. The study's purpose is to improve plume models, which predict the direction of the plume, or rising column of exhaust, as the shuttle maneuvers on orbit. Understanding this flow direction could be significant to the safe arrival and departure of spacecraft on current and future exploration missions.

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

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

Destiny Laboratory Facilities

Several research facilities are in place on the station to support Expedition 15 science investigations:

The **Human Research Facility-1** 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 in astronauts induced by spaceflight.

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

Minus Eighty-degree Laboratory Freezer for ISS (MELFI) provides refrigerated storage and fast-freezing of biological and life science samples. It can hold up to 300 liters of samples ranging in temperature from -80 C, -26 C, or 4 C throughout a mission.

The **Microgravity Science Glovebox (MSG)** provides a safe environment for research with liquids, combustion and hazardous materials on board the International Space Station. Without the glovebox, many types of hands-on investigations would be impossible or severely limited on the station.

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 medicines. The racks stay in orbit, while experiments are changed as needed. EXPRESS Racks 2 and 3 are equipped with the **Active Rack Isolation System (ARIS)** for countering minute vibrations from crew movement or operating equipment that could disturb delicate experiments.

On the Internet

For fact sheets, imagery and more on Expedition 15 experiments and payload operations, visit:

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

The Payload Operations Center

A team of controllers for Expedition 15 will staff the Payload Operations Center at NASA's Marshall Space Flight Center in Huntsville, Ala.

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, NASA's roadmap for returning to the moon and exploring our solar system.

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

The Payload Operations Center continues the role Marshall has played in management and operation of NASA's on-orbit science research. In the 1970s, Marshall managed the science program for Skylab, the first American space station. Spacelab—the international science laboratory that the space shuttle carried to orbit in the 1980s and 1990s for more than a dozen missions—was the prototype for Marshall's space station science operations.

Today, the POC team 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, 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 around-the-clock reports from science outposts around the United States to systems controllers and science experts. 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. Experiments are in cycle constantly as the shuttle or launch vehicles, provided by our international partners, deliver new payloads and the shuttle returns completed experiments and samples to Earth.

The POC is the science command post for the space station, which links researchers around the world with their experiments and the station crew.

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

- Marshall Space Flight Center, managing microgravity (materials sciences, microgravity research experiments, space partnership development program research)
- 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 these centers into a U.S. payload operations master plan, which is delivered to Johnson's Space Station Control 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 science experiments and operations in orbit.

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

The payload operations director leads the POC's main flight control team, the "cadre." The payload operations director 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 station crew conducting payload operations and the researchers whose science the crew is conducting. 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 television 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 and 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

ISS 15 Russian Research Objectives

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	KHT-20	GCF-JAXA	GCF-02 kit	Protein crystallization	
Commercial	KHT-32	JAXA 3DPC	3DPCU 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	GTS	GTS-2	Electronics unit-2; Antenna assembly with attachment mechanism	Global time system test development	
Commercial	ALC	ALTCRISS	AST Spectrometer	Taking measurements of radiation field onboard the ISS	
Commercial	CAR-2	Cardiocog-2	“Cardio science” kit *Nominal hardware:* Laptop	Acquisition of new scientific data to deepen knowledge about mechanisms of cardiorespiratory system adaptation to spaceflight conditions	
Commercial	IMM	Immuno	Kit for blood sampling “ M-priemniki" (“M-Collectors”) kit ”Saliva-Immuno” kit “Zaschita MBI” (“Protection BMI”) kit KB-03 returning container Crew procedure questionnaire *Nominal hardware:* "Kriogem-03" freezer "Plazma-03" centrifuge	Study of human neuroendocrine and immunologic changes in and after a spaceflight aboard the ISS	
Commercial	NOA-2	NOA-2	“Platon” analyzer “Platon” power supply unit	Monitoring of nitrogen oxide exhaled by a cosmonaut to detect the pulmonary function alterations in a long-term spaceflight	
Commercial	SAM-LDM	Sample-LDM	SAMPLE Collection Kit KUBIK TOPAZ container	Taking samples from different surfaces on board the Russian segment of the station	
Technology &Material Science	TXH-7	SVS (CBC)	"CBC" researching camera "Telescience" hardware from "ПК-3" *Nominal hardware:* “Klest” (“Crossbill”) TV-system Picture monitor (ВКУ)	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	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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's upper atmosphere	Using OCA
Geophysical	ГФИ-8	Uragan	*Nominal hardware:* Kodak 760 camera; Nikon D1X LIV video system	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery	Using OCA
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	
Biomedical	МБИ-8	Profilaktika	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-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABUOY-2000 Unit *Nominal hardware:* Laptop RSE-Med	Researching for individual features of state psychophysiological regulation and crew members' professional activities during long spaceflights.	
Biomedical	МБИ-18	Dykhanie	“Dykhanie-1” set *Nominal hardware:* Laptop RSE-Med	Study of respiration regulation and biomechanics under spaceflight conditions	
Biomedical	МБИ-21	Pneumocard	“Pneumocard” set “Pneumocard-KPM” kit “Pneumocard-Data” kit	Study of space flight factors impacts on vegetative regulation of blood circulation, respiration and contractile heart function during long space flights	
Biomedical	МБИ-22	BIMS (Board Informational Medical System)	TBK-1 hardware *Nominal Hardware:* RSE-Med laptop	Study of dataware processes for flight medical support using TBK-1 telemedicine equipment	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	БИО-2	Biorisk	"Biorisk-KM" set "Biorisk-MSV" containers "Biorisk-MSN" kit	Study of spaceflight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	EVA
Biomedical	БИО-5	Rasteniya	"Lada" greenhouse Module of substratum research *Nominal Hardware:* Water container; Sony DVCam; Computer	Study of the spaceflight effect on the growth and development of higher plants	
Biomedical	БИО-8	Plazmida	Thermal container Biocont-T, including: Hybridizers Recomb-K Kit with tubes "Kriogem-03M" freezer "Kubik-Amber"	Investigation of microgravity effect on the rate of transfer and mobilization of bacteria plasmids	
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	Study of microgravity influence on regeneration processes for biological objects by electrophysiological and morphological indices	During Expedition 15 and 16 crews rotation
Biomedical	РБО-1	Prognoz	*Nominal Hardware for the radiation monitoring system:* P-16 dosimeter; ДБ-8 dosimeters “Pille-ISS” dosimeter “Lyulin-ISS” complex	Development of a method for real-time prediction of dose loads on the crews of manned spacecraft	Unattended
Biomedical	РБО-3	Matryeshka-R	Passive detectors unit "Phantom" set "MOSFET-dosimeter” scientific equipment “Bubble-dosimeter” hardware	Study of radiation environment dynamics along the International Space Station Russian segment flight path and in ISS compartments and dose accumulation in antroph-amorphous phantom, located inside and outside the ISS	
Study of Earth natural resources and ecological monitoring	ДЗЗ-2	Diatomea	"Diatomea" kit *Nominal hardware:* Nikon F5 camera; DSR-PD1P video camera; Dictaphone; Laptop No. 3;	Study of the stability of the geographic position and form of the boundaries of the World Ocean biologically active water areas observed by space station crews	
Biotechnology	БТХ-1	Glykoproteid	"Luch-2" biocrystallizer	Obtaining and study of E1-E2 surface glycoprotein of α-virus	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
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-8	Biotrack	"Bioekologiya " kit	Study of space radiation heavy charged particles fluxes influence on genetic properties of bioactive substances cells-producers	
Biotechnology	БТХ-10	Kon'yugatsiya (Conjugation)	"Rekomb-K" hardware "Kriogem-03M" freezer	Working through the process of genetic material transmission using bacteria conjugation method	During Expedition 14 and 15 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 " 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)	Changeable bioreactor Thermostat with drive control unit with stand and power supply cable in cover ТВК "Biocont-T" Thermo-vacuum container	Study and improvement of closed-type autonomous reactor for obtaining biomass of microorganisms and bioactive substance without additional ingredients input and metabolism products removal	During Expedition 14 and 15 crews rotation
Biotechnology	БТХ-31	Antigen	"Bioekologiya " kit Autonomous Recorder of Temperature	Comparative researching heterologous expression of acute viral hepatitis HbsAg in S.cerevisiae yeast under microgravity and Earth conditions and determining synthesis optimization methods	
Technical Studies	ТЕХ-1 (SDTO 15001-R)	Infrazvuk-M (Infrasound)	Fan 17КС.53Ю 5009-0 *Nominal hardware:* Board sound analyzer 2260 Laptop	Complex study of electromagnetic and acoustic fields of the lowest frequency diapason inside International Space Station Russian segment modules	

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 “Dakon” hardware	Study of the relationship between the onboard systems operating modes and ISS flight conditions	
Technical Studies	TEX-20	Plazmennyi Kristall (Plasma Crystal)	"PC-3 Plus" experimental unit "PC-3 Plus" telescience *Nominal hardware* “Klest” (“Crossbill”) TV-system БСПН – Payload Server Block	Study of the plasma-dust crystals and fluids under microgravity	
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	*Nominal Hardware:* ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unattended
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 (TBD)	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 *Nominal Hardware:* Nikon D1 digital camera, Laptop №3	Experimental researching of ISS RS resources estimating for ecological investigation of areas	
Complex Analysis. Effectiveness Estimation	КПТ-6	Plazma-MKS (Plasma-ISS)	“Fialka-MB-Kosmos” - Spectrozonal ultraviolet system	Study of plasma environment on ISS external surface by optical radiation characteristics	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Complex Analysis. Effectiveness Estimation	КПТ-14	Ten' -Mayak (Shadow – Beacon)	Complex of amateur packet radio communication set with 145/430 MHz frequency range: - receiver-transmitter; - 4 antenna-feeder devices; - 2 power supply units; - controlling computer	Working-out of the method for radio probing of board-ground space for supporting preparation of "Ten'" ("Shadow") plasma experiment on ISS RS	
Study of cosmic rays	ИКЛ-2В	BTN-Neutron	Detection Block Electronic Equipment Block Mechanical interface	Study of fast and thermal neutrons fluxes	
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 spaceflight impact on muscular and peripheral nervous apparatus	Pre-flight: L-30; Post-flight: 3, 11, 21, 70 days; 1.5 hours for one session
Pre/Post Flight		Ravnovesie	"Ravnovesie" (""Equilibrium") equipment	Sensory and motor mechanisms in vertical pose control after long-duration exposure to microgravity.	Pre-flight: L-60, L-30 days; Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days; Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min
Pre/Post Flight		Sensory adaptation	IBM PC, Pentium 11 with 32-bit s/w for Windows API Microsoft.	Countermeasures and correction of adaptation to space syndrome and of motion sickness.	Pre-flight: L-30, L-10; Post-flight: 1, 4, and 8 days, then up to 14 days if necessary; 45 min for one session.
Pre/Post Flight		Lokomotsii	Bi-lateral video filming, tensometry, miography, pose metric equipment.	Kinematic and dynamic locomotion characteristics prior to and after spaceflight.	Pre-flight: L-20-30 days; Post-flight: 1, 5, and 20 days; 45 min for one session.

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Pre/Post Flight		Peregruzki	Medical monitoring nominal equipment: Alfa-06, Mir 3A7 used during descent phase.	G-forces on Soyuz and recommendations for 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 spaceflight conditions.	Pre-flight: blood samples, questionnaire, anthropometrical and anthropo-scopic 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

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

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

Increments Assigned: 13, 14 and 15.

Overview

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

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

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

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

Applications

Space Applications: The tests conducted using the ALTEA hardware will help scientists characterize how the heavy ion radiation of space impacts the brain and whether or not that radiation causes any temporary or permanent abnormalities in the brain function and the visual system in particular.

Earth Applications: Data provided from ALTEA can lead to further understanding of how radiation may affect brain function on Earth as well as in space. While the levels of heavy ion radiation are much higher in space that on Earth, any understanding into the way radiation may alter brain function is extremely useful to neuroscientists of these studies. Ion therapies to treat brain tumors will also benefit from the ALTEA results.

Web Site

For more information on ALTEA, visit:

http://exploration.nasa.gov/programs/station/ALTEA.html

Analyzing Interferometer for Ambient Air (ANITA)

Principal Investigator: Gijsbert Tan, European Space Research and Technology Center, Noordwijk, Netherlands

Increments Assigned: 15, 16

Overview

Analyzing Interferometer for Ambient Air (ANITA) will monitor 32 potentially gaseous contaminants—including formaldehyde, ammonia and carbon monoxide - in the atmosphere on the station. The experiment will test a technology novel to spaceflight for monitoring the atmosphere on the station.

The ANITA flight experiment is a trace gas monitoring system based on Fourier Transform Infrared (FTIR) technology. The initial flight of ANITA will test the accuracy and reliability of the FTIR technology as a potential next generation atmosphere trace gas monitoring system for the space station.

ANITA will analyze air samples from local and remote areas on the space station. Data will be down-linked daily to the ground team.

No experiment like ANITA has been flown in space before.

Applications

This will lead to new atmospheric monitoring systems for future spaceflight. The ANITA application of FTIR technology provides an improved multi-component gas measurement system for various purposes, such as workplace monitoring (including airplanes and submarines), environmental monitoring, and control of industrial processes.

Web Site

For more information on ANITA, visit:

http://exploration.nasa.gov/programs/station/ANITA.html

Binary Colloidal Alloy Test-3 (BCAT-3)

For Expedition 15, the Binary Colloidal Alloy Test-3 (BCAT-3) is in reserve operations, awaiting crew time to homogenize and photograph the final samples. There are two types of samples. The first is an experiment of the long-duration phase separation of two mild solvents. The second category is an experiment studying how colloidal networks form when the effect of gravity (sedimentation) is eliminated.

Scientists will use this information to improve models for a wide range of everyday products including cosmetics, paints and fabric softener. For long-duration spaceflight to the moon or Mars, NASA needs to understand the "shelf life" of polymers, solvents and colloids.

BCAT-3, operated during Expeditions 8, 9, 10, 12 and 13, is scheduled to run during Expeditions 14, 15 and 16.

A follow-on experiment, the Binary Colloidal Alloy Test-4 (BCAT-4), is a small payload to be launched in winter 2007. BCAT-4 will study 10 colloidal samples to determine phase separation rates and properties of a model critical fluid system to add needed points to the phase diagram. The BCAT-4 hardware includes a newly fabricated Slow Growth Sample Module, Magnet, and Magnet Keeper (identical in design to BCAT-3 hardware) and will use the Maintenance Work Area (MWA) DCS760 Camera and EarthKAM software for manual and automated time-lapse photography during six sessions of homogenizing and photographing the 10 samples.

Expedition 12 astronaut Bill McArthur photographing BCAT samples

Increment 15 astronaut Dan Tani being trained by Cathy Frey of ZIN Technologies on the BCAT experiment

Increment 10 astronaut Leroy Chiao photographing BCAT

Increment 18 astronaut Greg Chamitoff being trained on photographing the BCAT-4

Cardiovascular and Cerebrovascular Control On Return from ISS (CCISS)

Principal Investigator: Richard Lee Hughson, Ph.D., University of Waterloo, Ontario, Canada

Co-Investigators: Joel Kevin Shoemaker, Ph.D., University of Western Ontario, London, Ontario, Canada; Andrew Philip Blaber, Ph.D., Simon Fraser University, Burnaby, British Columbia, Canada; Philippe Arbeille, Ph.D., M.D., University of Tours, France; Danielle Kathleen Greaves, M.Sc., University of Waterloo, Ontario, Canada.

Increments Assigned: 15, 16

Overview

Cardiovascular and Cerebrovascular Control on Return from ISS (CCISS) will study the effects of long-duration spaceflight on crew members' heart functions and their blood vessels that supply the brain. Learning more about the cardiovascular and cerebrovascular systems could lead to specific countermeasures that might protect future space travelers more effectively.

For crew members' health, the need to maintain blood pressure immediately after returning to Earth is essential. To obtain information on the baroreflex stability (blood pressure regulation) of space station crews, an electrocardiogram and blood pressure data will be gathered before flight, in flight and after flight.

The data gathered during this investigation will lead to countermeasures to help crew members maintain sufficient blood pressure after long-duration missions. This study will provide a basis for studies of individuals who are susceptible to fainting in the upright posture.

Expedition 15 will be the first mission for CCISS.

Applications

Space Applications: The information derived from this study will help to better understand the effects of spaceflight on cardiovascular and cerebrovascular functions. By gaining increased knowledge of the specific components of the cardiovascular and cerebrovascular systems that deviate from the normal Earth-baseline responses, it will be possible to recommend specific countermeasures that might better protect future space travelers from complications that could put them at risk on return to the effects of gravity as will occur on re-entry to Earth or landing on the moon or Mars.

Earth Applications: The risk of fainting and falling is increased in older adults. Falls are very serious because they often cause fracture of the hip which is a major cause of prolonged disability, loss of independence and unfortunately for a high percentage of individuals the complications from the fracture will lead to death. Gaining improved knowledge of the mechanisms of loss of blood pressure and the warning signs that might predict risk will reduce the incidence of fainting and falls in the elderly.

Web Site

For more information on CCISS, visit:

http://exploration.nasa.gov/programs/station/CCISS.html

Crew Earth Observations (CEO)

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

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

Overview

By allowing photographs to be taken from space, the Crew Earth Observations (CEO) experiment provides people on Earth with image data needed to understand our planet. The photographs—taken by crew members 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 crew members 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.

During Expeditions 15 through 18, a new activity will begin in collaboration with International Polar Year activities. International Polar Year is an international collaboration of scientists for the observation and exploration of Earth's Polar Regions from March 2007 to March 2009. International Space Station crew members will photograph polar phenomena, including auroras and mesospheric clouds, in response to requests made from the scientists on the ground.

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 the International Space Station.

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

Benefits

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

Earth Photography database each year. Through their photography of the Earth, space station crew members 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 future generations of children become “Earth-smart.”

Web Site

For more information on CEO, visit:

http://exploration.nasa.gov/programs/station/CEO.html

More information about the station's participation in the International Polar Year can be found on “The Gateway to Astronaut Photography of Earth” at:

http://eol.jsc.nasa.gov/ipy

IPY science investigators also can request imagery from the station using a form found on that Web site.

International Polar Year (IPY) from the International Space Station

What is the International Polar Year (IPY)?

The IPY is an international effort to collect relevant scientific data of the Earth's polar regions from March 2007 to March 2009. Scientists will analyze IPY data to answer fundamental questions about the Earth's changing climate, the effects of space weather and Earth processes recorded from the far reaches of upper atmosphere to deep in polar ice cores. Today's IPY celebrates the 50th anniversary of the 1957-58 International Geophysical Year (IGY), the remarkable international collaboration that provided many new findings about the Earth system. Results from the IGY sparked the next 50 years of interdisciplinary studies in Earth science, geophysics, atmospheric science and oceanography. Building from IGY's successes, IPY's focused research of the Earth's polar regions is intended to provide a better understanding of how these hard-to-reach places of the Earth affect the global system.

ISS Involvement in IPY

Don Pettit, space station crew member on Expedition 6 in 2003, realized the vantage point astronauts have for repeatedly observing polar features like the moving boundaries of sea ice, the glowing aurora and the occurrence of Polar Mesospheric Clouds. His proposal to the International IPY committee was accepted (see http://www.ipy.org/development/eoi/proposal-details.php?id=78), and NASA's Space Operations Mission Directorate endorsed the participation of the station for IPY observations.

The Crew Earth Observations (CEO) Payload will be the venue for supporting International Polar Year activities aboard the space station. Expedition crew members will photograph polar phenomena including auroras and polar mesospheric clouds, sea ice, plankton blooms in the arctic and southern oceans, and high latitude terrestrial features in response to requests made from the scientists on the ground.

The IPY kick-off occurred during Expedition 14, but the crews of Expeditions 15 through 18 will be the prime participants in the ISS-IPY activity.

More information about the station's participation in IPY can be found on "The Gateway to Astronaut Photography of Earth" at:

http://eol.jsc.nasa.gov/ipy

IPY science investigators can request imagery from the station using a form found on the Web site. All IPY-designated imagery acquired by station astronauts will be posted on the Web site in a special collection of imagery.

Benefits

Imagery of polar phenomena from the International Space Station will support several ground or sea-based IPY experiments. Investigators are invited to request observations from the station, and efforts will be made to coordinate those observations with field experiments or campaigns. At a minimum, the IPY imagery collected from the station will provide contextual information for regional studies and help researchers visualize and communicate their work. We anticipate more rigorous applications of the imagery data for some IPY investigators.

Aurora at sunset over the south Indian Ocean, Feb 16, 2003. Image ISS006-E-28961

Web Site

For more information on CEO-IPY, visit:

http://exploration.nasa.gov/programs/station/CEO-IPY.html

Commercial Generic Bioprocessing Apparatus (CGBA) Science Insert – 02 (CSI-02)

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

Expedition Assigned: 15

Overview

Commercial Generic Bioprocessing Apparatus Science Insert—02 (CSI-02) is an educational payload designed to interest middle school students in science, technology, engineering and math by participating in near real-time research conducted on board the station.

Students will observe three experiments through data and imagery downlinked and distributed directly into the classroom via the internet. The first is a seed germination experiment, where students will learn how gravity affects plant development. Small seeds will be developed on orbit in a garden habitat. The second experiment will examine crystal growth formation using specific types of proteins and enzymes, and the third experiment will examine crystal formation using silicates—compounds containing silicon, oxygen and one or more metals.

For the two crystal growth experiments, students will grow crystals in their classrooms and analyze growth of those compared to the crystals grown in space.

A similar investigation, Space Technology and Research Students (STARS™), flew on STS-93 and STS-107. CSI-01 began during Expedition 14.

Applications

Space Applications: Influences children to continue their education in the science, technology, engineering and math areas and pursue related careers. This will promote education of the next generation of scientists, engineers and astronauts for the space program. In addition, scientific research with the three experiments is expected to provide a greater understanding of the effects of spaceflight on different biological systems, which could support future plans for the human exploration of the solar system.

Earth Applications: Provides a unique educational opportunity to encourage students to pursue careers in the scientific and technical fields. Approximately 15,000 students will conduct ground controls and observe these experiments while on board the space station, influencing these students to further their education in the fields of science, technology, engineering and math.

Web Site

For more information on CSI-02, visit:

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

Earth Knowledge Acquired by Middle School Students

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

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

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

Overview

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

Using the Internet, working through the EarthKAM Mission Operations Center located at the University of California at San Diego (UCSD), middle school students can control a camera mounted at the science-grade window in the station's Destiny science module to capture high-resolution digital images of features around the globe. Students use these images to enhance their study of geography, geology, botany, history and earth science and to identify changes occurring on the Earth's surface, all from the unique vantage point of space. Using the station's high-speed digital communications capabilities 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 periodically is setup 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. Once the station crew mounts the camera at the window, the payload requires no further crew interaction for nominal operations.

EarthKAM photographs are taken via 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 station orbit that the payload is operational. This camera control file is then uplinked to a Station Support Computer (laptop) aboard the space station that controls when the digital camera captures the image. The Station Support Computer activates the camera at the specified times and immediately transfers these images to a file server, storing them until they are downlinked to Earth. With all systems performing nominally, a picture can be requested, captured and posted to the EarthKAM Web site in as little as four hours.

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

Flight History/Background

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

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

Benefits

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

No other NASA program gives students such direct control of an instrument flying on a spacecraft orbiting Earth. As a result, 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 can use the images alongside suggested curriculum plans for studies in physics, computers, geography, math, earth science, botany, biology, art, history, cultural studies and more.

Web Site

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

http://exploration.nasa.gov/programs/station/EarthKAM.html

www.earthkam.ucsd.edu

www.spaceflight.nasa.gov

ELaboratore Immagini Televisive - Space 2 (ELITE-S2)

Principal Investigator: Francesco Lacquaniti, M.D., Università of Roma Tor Vergata, Italy

Overview

ELaboratore Immagini Televisive - Space 2 (ELITE-S2) studies the connection among the brain, visualization and motion in the absence of gravity. By recording and analyzing the three-dimensional motion of astronauts, this study will help engineers apply ergonomics into future spacecraft designs and determine the effects of weightlessness on breathing mechanisms for long-duration missions. This experiment is a cooperative effort with the Italian Space Agency, ASI.

On Earth, our ability to catch a ball depends on a mental model of the physical behavior of that object, a model that includes gravity. In a microgravity environment, astronauts adjust their motor control strategies to respond to new rules but still show evidence that the old gravity-based rules are hard-wired into their brains through neural networks.

This experiment will evaluate differences in the way the brain controls conscious and unconscious motions such as breathing, sitting and standing in environments with and without gravity.

The predecessor to this investigation, ELITE-S, was flown on EUROMIR in 1995. A similar experiment, KINELITE, flew on STS-90.

Applications

This study will allow the application of ergonomics in the design of future spacecraft and determine the effects of weightlessness on breathing mechanisms for long-duration missions. This study has important implications not only for understanding basic mechanisms of motor control but also for rehabilitative training of neurological patients with impaired motor control. New rehabilitation techniques are based on virtual reality and mental rehearsal of motor actions.

Web Site

For more information on ELITE-S2, visit:

http://exploration.nasa.gov/programs/station/ELITE-S2.html

Elastic Memory Composite Hinge (EMCH)

Principal Investigator: Lt. Corey Duncan, Air Force Research Laboratory, Kirtland Air Force Base, N.M.

Increments Assigned: 14, 15, 16

Overview

The Elastic Memory Composite Hinge (EMCH) experiment will study the performance of a new type of composite hinge and see if it is suitable for use in space. The EMCH investigations conducted aboard the space station are the first ever performed in space.

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

The study will measure the force and torque on the hinge and the accuracy of the deployment. New materials that are reliable, light and strong will be important building blocks of future exploration spacecraft.

Applications

Space Applications: EMC materials tested in this experiment are stronger and lighter than current material used in space hinges and could be used in the design of future spacecraft.

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

Web Site

For more information about EMCH, visit:

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

Educational Payload Operations (EPO)

Principal Investigator: Jonathan Neubauer, Johnson Space Center, Houston

Co-Investigator: Matthew Keil, Johnson Space Center, Houston

Overview

Education Payload Operations (EPO) refers to 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 crew member operating EPO hardware while on orbit will achieve EPO goals and objectives. The overall goal for every expedition is to facilitate education opportunities that use the unique environment of human spaceflight.

EPO - Kit C

EPO Kit C is an education payload consisting of two small collapsible plant growth chambers and the associated hardware to conduct a 20-day plant germination investigation. During the investigation, crew members will maintain the plants and will capture still images of plant growth. All images will be incorporated into a comprehensive set of education activities planned in association with STS-118 and Expedition15.

EPO - Education Demonstration Activities (EDAs)

EPO Education Demonstration Activities (EDAs) may be scheduled during Expedition 15. An EDA is an educational demonstration designed to use only hardware already on board the International Space Station (ISS). No educational payloads are associated with these activities. These demonstrations 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.

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

Applications

Space Applications: EPO introduces the next generation of explorers to the environment of space.

Earth Applications: EPO is part of NASA's continuing effort to use space as a unique educational tool for K-12 students. Everyday items, such as toys and tools, are given a new twist by combining them with the allure of space flight and the unusual weightless environment to produce educational materials that inspire interest in science and technology and encourage curiosity and creativity.

Web Sites

http://exploration.nasa.gov/programs/station/EPO.html

http://exploration.nasa.gov/programs/station/EPO-Educator.html

http://exploration.nasa.gov/programs/station/EPO-Kit-C.html

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

Principal Investigator and Payload Developer: Raymond Stowe, Ph.D., Microgen Labs, La Marque, Texas.

Increments Assigned: 5, 6, 11, 12, 13, 14, 15 and 16

Overview

Earlier studies of the Epstein-Barr virus (EBV), the virus that causes mononucleosis, began on STS-108. These studies paved the way for the current experiment. Stowe and his team discovered from their shuttle research that stress hormones released before and during flight decreased the immune system's ability to keep the virus deactivated. That discovery was the basis for the continuing research. Epstein-Barr was performed during Expeditions 5, 6 and 11-14.

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

Decreased immune system response has been observed in spaceflight. This experiment determines how spaceflight reactivates EBV from latency, which results in increased viral replication. This investigation provides insight into the magnitude of human immunosuppression as a result of spaceflight. The effects of stress and other acute or chronic events on EBV replication are evaluated.

Applications

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

Web Site

For more information on the Epstein-Barr experiment, visit:

http://exploration.nasa.gov/programs/station/Epstein-Barr.html

Integrated Immune:
Validation of Procedures for MonitoringCrew Member Immune Function

Principal Investigator: Clarence Sams, Ph.D, Johnson Space Center, Houston

Increments Assigned: 15, 16

Overview

Validation of Procedures for Monitoring Crew Member Immune Function (Integrated Immune) will assess the clinical risks resulting from the adverse effects of spaceflight on the human immune system. It will validate a flight-compatible immune monitoring strategy by monitoring changes in the immune system through analysis of blood, urine and saliva samples collected from crew members before, during and after spaceflight.

Evidence suggests spaceflight has a negative effect on the immune system. Scientists have identified several possible causes ranging from microgravity to stress to radiation. Complications arising from an immune system deficiency have the potential to negatively impact long-duration space missions. To develop a countermeasure to prevent immune dysfunction, a valid monitoring technique must be developed.

The objective of this study is to validate a monitoring technique that will allow future countermeasures to be developed. Expedition 15 will be the first mission for Integrated Immune.

Applications

Space Applications: The study will result in the validation of a monitoring strategy that will allow the development of effective countermeasures, which, when implemented, will safeguard the health of the crew during long duration space missions.

Earth Applications: The data collected during this investigation may lead to a greater understanding of how different factors—from stress to the environment—affect the immune system. These data potentially could be used to develop new treatments and preventative measures for immune dysfunctions.

Web Site

http://exploration.nasa.gov/programs/station/Integrated-Immune.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.

Increments Assigned: 8, 9, 10, 11, 12, 13, 14, 15, 16

Overview

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 long-duration space expeditions. The method used in the experiment is analyzing the content of journals the International Space Station crews maintain for this purpose.

Crew members' in-flight journals are studied to gain an understanding of factors that may play a role in the stress crews experience 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.

Studies conducted on Earth have shown that analyzing the content of journals and diaries is an effective method for identifying the issues 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. The content analysis of the studies conducted 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.

Applications

Space Applications: 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 International Space Station, moon, Mars and beyond.

Web Site

For more information on Journals, visit:

http://exploration.nasa.gov/programs/station/Journals.html

Latent Virus: Incidence of Latent Virus Shedding during Spaceflight

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

Co-Investigator: Satish K. Mehta, Ph.D., Enterprise Advisory Services, Inc., Houston

Increments Assigned: 1, 2, 4, 5, 11, 13, 14, 15

Overview

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

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

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

Applications

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

Web Site

For more information on Latent Virus, visit:

http://exploration.nasa.gov/programs/station/Latent-Virus.html

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

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

Co-Investigator: Jake Maule, Ph.D., Carnegie Institution of Washington, Washington, D.C.

Increments Assigned: 14, 15, 16

Overview

Shuttle mission STS-116 in December 2006 transported a unique, state-of-the-art science instrument to the International Space Station. It will help astronauts perform biological studies necessary for an extended human presence in space, from crew health and spacecraft environmental studies to the search for life on other worlds.

The Lab-on-a-Chip Application Development Portable Test System, or LOCAD-PTS, is a handheld diagnostic reader and set of instruments small enough to fit into a compact ice cooler. On the space station, crew members will test the hand-portable detection unit. They will conduct experiments, taking samples from their own environment, to determine the system's effectiveness at acquiring samples in a weightless environment and to quantify levels of bacterial contamination. The results will help researchers refine the technology for future moon and Mars missions.

Lab-on-a-chip technology allows chemical and biological processes – previously requiring large pieces of laboratory equipment – to be performed on small plates etched with fluid channels called capillaries. Using these channels, chemicals and fluid samples can be mixed, diluted, separated and controlled for study.

The compact system, which incorporates interchangeable cartridges, is driven by technology that Charles River Laboratories of Wilmington, Mass., developed and Marshall Space Flight Center, Huntsville, Ala., modified for space applications. Designed to use minimal resources, the handheld unit is a self-contained mobile laboratory that weighs a mere six pounds.

This unique tool is small, lightweight and portable, allowing it to be placed directly in astronauts' hands, reducing the speed at which they can receive data from days to minutes. Crew members on the space station, for example, will be able to rapidly assess microorganisms found on the orbiting science facility, helping to maintain a clean research environment and monitor the quality of air and water supplies.

Applications

Lab-on-a-chip technology is important for future exploration missions. The Portable Clinical Blood Analyzer is used to examine crew members' blood on orbit. A crew member draws blood and places the sample in the analyzer, which returns results on potassium, sodium and glucose levels in the blood. The size of the test units make them key technologies for a variety of tests that crew members may need to conduct on a long-duration lunar or Mars mission.

The LOCAD technology also is being tested at analog sites for planetary surface operations. In future missions, a rapid scan for the presence of microbes can be used to ensure that planetary surfaces are protected from the microbes humans carry.

Web Site

For more information about NASA's LOCAD project, visit:

http://exploration.nasa.gov/programs/station/LOCAD-PTS.html

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

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

Increments Assigned: 5, 14, 15, 16

Overview

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

On Earth, and in studies that simulate weightlessness, the drug midodrine has been used extensively to treat low blood pressure. This experiment was flown as a Detailed Supplementary Objective on STS-108 and aboard the space station during Expedition 5.

Applications

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

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

Web Site

For more information on Midodrine, visit:

http://exploration.nasa.gov/programs/station/Midodrine.html

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

Principal Investigator: William H. Kinard, Ph.D., Langley Research Center, Hampton, Va.

Increments Assigned: 13, 14, 15

Overview

The Materials on the International Space Station Experiment (MISSE) Project is a cooperative endeavor to fly materials and other types of space exposure experiments on the station and is managed by NASA Langley Research Center, Hampton, Va. 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.

Flown to the space station in 2001, the MISSE experiments were the first externally mounted experiments conducted on the 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 in orbit and clamped to the host spacecraft, the PECs are opened and serve as racks to expose experiments to the space environment.

The first two MISSE PECs (MISSE 1 and 2) were transported to the space station on STS-105 (ISS Assembly Flight 7A.1) in August 2001. About 1,500 samples were tested on MISSE 1 and 2. The samples included ultra-light membranes, composites, ceramics, polymers, coatings and radiation shielding. Seeds, plant specimens and bacteria, furnished by students at the Wright Patterson Air Force Research Laboratory, Ohio, also were flown in specially designed containers.

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

MISSE PECs 3 and 4 were launched on STS-121 in July 2006. MISSE 5 was retrieved, and MISSE PECs 3 and 4 were placed outside during a spacewalk conducted during the STS-115 space shuttle mission in September 2006.

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, Houston. This work, relevant to the environmental durability of the Crew Exploration Vehicle and other exploration mission systems, is supported through the Exploration Systems Research and Technology Program and other programs.

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

Applications

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

Web Site

For more information on MISSE, visit:

http://exploration.nasa.gov/programs/station/MISSE-3-and-4.html

Myofibers - Cell Culture Module (M-CCM)

Principal Investigator: Herman Vandenburgh, Ph.D., Brown University, Providence, R.I.

Increment Assigned: 15

Overview

Exposure to microgravity has adverse effects on living systems. Muscle loss in astronauts is a major concern for future spaceflights to the moon and Mars. Myofibers - Cell Culture Module (M-CCM) investigates the effects of microgravity on muscle deterioration to develop a successful countermeasure for astronauts on long-duration missions.

Myofibers are the primary cells in skeletal muscle mass. Studies have shown that astronauts experience significant loss of muscle mass during space exploration due to the stresses of microgravity on the physiology of living systems.

Bio-Artificial Muscles (BAMs), collagen scaffolds seeded with myofiber cells, derived from avian myoblasts (bird) and C2C12 cells (mouse) will be used in the M-CCM investigation to test the efficacy of insulin growth factor - I (IGF-I) in vitro to prevent muscle atrophy caused by long-duration space exploration. The cells will be split into two groups, control and experimental. The control group will not be treated, whereas the experimental group of BAMs will be treated either with perfused rhIGF-1 or with cell-based delivery of IGF-1 through genetically-modified C2C12 cells. IGF-I promotes growth and proliferation of muscle mass. At the right concentrations, it is suspected that these hormones will be beneficial in maintaining muscle mass for space explorers.

BAMs have previously flown in the CCM on STS-66, STS-72 and STS-77.

Applications

Space Applications: Astronauts traveling to the moon or Mars will experience muscle atrophy as a result of weightlessness. The results of this experiment will help determine a potential treatment to minimize the progression of muscle atrophy in microgravity.

Earth Applications: Investigation of the effects of muscle loss may help improve the treatments for similar conditions suffered by patients on Earth, especially in the elderly population.

Web Site

For more information on M-CCM, visit:

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

Nutrition:
Nutritional Status Assessment

Principal Investigator: Scott M. Smith, Ph.D., Johnson Space Center, Houston

Increments Assigned: 14, 15, 16

Overview

The Nutrition protocol will help the Human Research Program gain a better understanding of the time course of nutrition-related changes during flight and will help define the nutritional requirements for space travelers. This likely will impact food system development for future space exploration programs to the moon and Mars. This experiment also will help us understand the impact of countermeasures (for example, exercise or pharmaceuticals) on nutritional status. Ensuring that we send the right nutrient balance for long-duration missions is critical for crew health and mission success.

Although this experiment was initiated on Expedition 14, a similar protocol, Clinical Nutritional Status Assessment Medical Requirement, has been performed on two Mir missions and all International Space Station increments to date.

Applications

Space Applications: Pre- and post-flight assessment of nutritional status is part of the routine medical testing for station crews. The inclusion of in-flight blood and urine collections and inclusion of additional parameters to monitor nutritional status is required to understand better the role of nutrition in bone health, changes in body composition, oxidative damage and, ultimately, in defining nutritional requirements for space crews. Maintaining and monitoring nutritional status are important for ensuring crew health during spaceflight and will be critical as we begin to embark on the longer-duration missions.

Earth Applications: Increased understanding of the connections between nutrition and disease (for example, bone loss) has potential value for patients on Earth.

Web Site

For more information on Nutrition, visit:

http://exploration.nasa.gov/programs/station/Nutrition.html

The Optimization of Root Zone Substrates (ORZS) for Reduced Gravity Experiments Program

Principal Investigator: Gail Bingham, Ph.D., Utah State University, Space Dynamics Laboratory, North Logan, Utah

Increments Assigned: 14, 15

Overview

Optimization of Root Zone Substrates (ORZS) was developed to provide direct measurements and models for plant rooting media that will be used in future Advanced Life Support (ALS) plant growth experiments. The goal of this investigation is to develop and optimize hardware and procedures to allow optimal plant growth to occur in microgravity.

Many long-term spaceflight life-support scenarios assume the use of regenerating green plants to provide food supplies for crew members, as well as to recycle waste products. To date, Brassica Rapa and Apogee wheat and four species of salad plants have grown in microgravity throughout their useful life cycles, with wheat and Brassica producing viable seeds in nearly normal amounts and quality. These successes came at the end of nearly a decade of repeated efforts using the same equipment to arrive at the best settings for substrate moisture and oxygen.

ORZS for Reduced Gravity Experiments is managed at the Space Dynamics Laboratory (SDL) as part of SDL's Space Plant Technology program and was developed to provide direct measurements and models for plant rooting media that will be used in future ALS plant growth experiments. The goal of this program is to develop hardware and procedures to allow optimum plant growth to occur in microgravity.

Key to this effort is validating wet substrate oxygen diffusion calculations. While the measurements appear simple and well studied in agricultural soils on Earth, collecting repeatable results at high water contents in the coarse-textured growth media necessary for microgravity requires a modified approach. Collecting accurate data under both 1g and microgravity conditions and correctly interpreting these data at reasonable cost requires careful management and organization and expert technical microgravity experience. Only a few microgravity substrate water management experiments have been conducted. ORZS will be the first experiment to directly measure oxygenation parameters in wet substrates.

ORZS is a new investigation for microgravity research.

Applications

Space Applications: The experiment will develop hardware and procedures to allow optimum plant growth to occur in microgravity (µg). This growth will support long-term spaceflight life-support scenarios, assuming the use of regenerating green plants to provide food supplies for crew members and to recycle waste products.

Earth Applications: As less fertile land becomes available to grow food, alternative agricultural systems that efficiently produce greater quantities of high-quality crops will be increasingly important. Data from the operation of the ORZS will advance greenhouse and controlled-environment agricultural systems and will help farmers produce better, healthier crops in a small space using the optimum amount of nutrients.

Web Site

For more information on ORZS, visit:

http://exploration.nasa.gov/programs/station/ORZS.html

Periodic Fitness Evaluation with Oxygen Uptake Measurement (PFE-OUM)

Principal Investigators: Sean K. Roden, M.D., Johnson Space Center, Houston, and Simon Evetts, Ph.D., European Astronaut Centre, Cologne, Germany

Increments Assigned: 13, 14, 15, 16, 17

Overview

The Periodic Fitness Evaluation with Oxygen Uptake Measurement (PFE-OUM) will demonstrate the capability of crew members to perform periodic fitness evaluations (PFE) with continuous oxygen consumption measurements. The evaluation will take place within 14 days after arrival on the International Space Station and once a month during routine PFEs. When the capability of the pulmonary function system (PFS) to perform PFEs is verified, crew members will be able to integrate their monthly PFE with oxygen consumption measurements to fulfill the requirement for cardiovascular fitness evaluations during long-duration spaceflight.

The PFE-OUM is a collaborative effort between the European Space Agency (ESA) and NASA. NASA Medical Operations require an evaluation of crew aerobic capacity. Currently, the crew aerobic capacity on board is calculated using heart rates while the crew goes through a set exercise protocol.

The PFS upgrade hardware that ESA developed for the Human Research Facility-2 provides the necessary hardware to measure oxygen consumption directly when the crew member breathes through a mouthpiece during the performance of the routine evaluation.

The project is designed to be completed in three phases. Phase I, proof of concept, was demonstrated during Expedition 13/14. Phase II, initial implementation for crew members and hardware check-out, will start as soon as additional interface hardware is available on orbit, and Phase III will be the migration to PFE-OUM for crew fitness evaluation.

Expedition 13 was the first mission for the PFE-OUM.

Applications

Space Applications: The PFE-OUM measurements will help flight surgeons to understand better the decline in cardiovascular function that occurs during long-duration stays in microgravity.

Earth Applications: Little information is currently available on the effects of long-term exposure to a closed life control system microgravity environment on aerobic capacity of humans. This information is important to maintain crew health during long-duration exploration. The data also will provide valuable insight into the aerobic capacity of teams in closed environments on Earth, such as arctic bases and submarines.

Web Site

For more information on PFE-OUM, visit:

http://exploration.nasa.gov/programs/station/PFE-OUM.html

Perceptual Motor Deficits in Space (PMDIS)

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

Increments Assigned: 14, 15

Overview

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

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

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

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

Applications

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

Earth Applications: Understanding how the brain adapts to physiological changes that the space station crew members undergo will be applicable on Earth as well as space. The results from this experiment will give insight to how the brain overcomes stresses that are not normally part of the day-to-day life. This new information can be applied in many areas of research for neurological diseases, providing improved treatments.

Web Site

For more information on PMDIS, visit:

http://exploration.nasa.gov/programs/station/PMDIS.html

Bioavailability and Performance Effects of Promethazine During Spaceflight (PMZ)

Principal Investigator: Lakshmi Putcha, Ph.D., Johnson Space Center, Houston

Increments Assigned: 11, 13, 15 and 16

Overview

Promethazine (PMZ) is used to treat space motion sickness during shuttle missions. However, side effects associated with PMZ when used on Earth include dizziness, drowsiness, sedation and impaired psychomotor performance, which could impact crew performance or mission operations. Early anecdotal reports from crew members indicate that these central nervous system side effects of PMZ are absent or greatly attenuated in microgravity. Systematic evaluation of PMZ bioavailability, effects on performance, side effects and efficacy in the treatment of space motion sickness are essential for determining optimal dosage and route of administration of PMZ in flight.

All participants don an Actiwatch activity monitor as soon as possible on orbit. The watches record light levels and accelerations from motion. Participants also record sleep times throughout the mission.

Before the first PMZ dose, participants collect a saliva sample; thereafter, saliva samples are collected at 1, 2, 4, 8, 24, 36 and 48 hours post-PMZ. This protocol is repeated each time PMZ is taken. Participants who do not take PMZ wear the Actiwatch and record sleep times throughout the mission.

This experiment began in 2001 and has flown on five shuttle missions.

Applications

This study will lead to a better understanding of how Promethazine is handled by the body in space. This also will help determine the side effects of Promethazine. By understanding these aspects of Promethazine, scientists can optimize treatment of motion sickness in space and on the ground with Promethazine. This study may lead to more effective treatment for motion sickness.

Web Site

For more information on this experiment, visit:

http://exploration.nasa.gov/programs/station/PMZ.html

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

The International Space Station microgravity acceleration environment consists of two regimes: the quasi-steady environment and the vibratory/transient environment; therefore, the measurement of the microgravity acceleration environment is best accomplished by two accelerometer systems. In the U.S. Laboratory Module, the measurement of these two regimes is accomplished by the Space Acceleration Measurement System (SAMS) and the Microgravity Acceleration Measurement System (MAMS).

It is necessary to measure the microgravity environment on board the station to provide this data to the scientists and researchers of the payload experiments. SAMS and MAMS provide acceleration data to fluid physics, material science and combustion experiments on board the station that study phenomena that are isolated by the microgravity environment. Acceleration data would be requested by the researcher of any experiment where the effects of gravity are important to the results of the research and affect the outcome of the scientific data.

The vibratory/transient environment, consisting of vehicle, crew and equipment disturbances and covering the frequency range of 0.01 to 400 Hz, will be measured by SAMS. Due to the localized nature of these vibrations, this frequency requires measurement of the environment near the experiment hardware of interest. SAMS provides this distributed measurement system through the use of Remote Triaxial Sensor systems (RTS). An individual RTS consists of an Electronics Enclosure (EE) and two Sensor Enclosures (SE). A SAMS Interim Control Unit (ICU) housed in an International Subrack Interface Standard (ISIS) drawer collects data from all active EE's and prepares the data for downlink. SAMS was launched on shuttle mission STS-100 and installed on board the station during Expedition 1 in April 2001.

During Expedition 15, SAMS will be in stand by mode until Glenn Research Center (GRC) payloads Boiling Experiment Facility (BXF) and Fluids and Combustion Facility (FCF) arrive on the station on board a shuttle mission scheduled for October 2008. If SAMS is requested to support station vehicle test at the .01 to 400 Hz frequency range, SAMS could be activated to support a vehicle test before the GRC payloads fly in Increment 18.

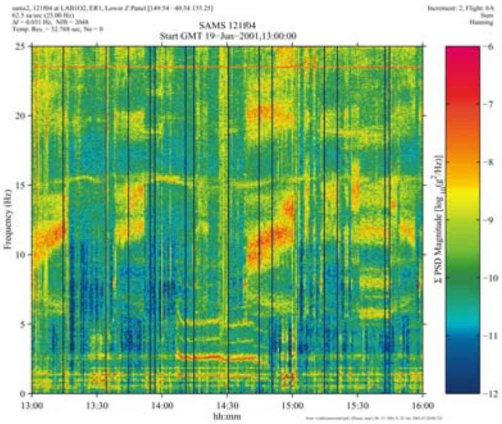
The MAMS will record the quasi-steady microgravity environment (f< 0.01 Hz), including the influences of aerodynamic drag, vehicle rotation and venting effects. The MAMS unit is located in the U.S. Laboratory Module in a double middeck locker enclosure in EXPRESS Rack 1. MAMS was launched on shuttle mission STS-100 and installed on board the International Space Station during Expedition 1 in April 2001.

During Expedition 15, MAMS will support data collection for station reboost and docking and undocking of shuttle and progress flights.

MAMS is used by the station vehicle structures and dynamics group to collect acceleration data during reboost. The reboost of the International Space Station is used to maintain the in the station's orbit. After the reboost the MAMS data is sent to the vehicle structures and dynamics group for analysis.

MAMS front panel

SAMS Interim Control Unit to left,
SAMS ICU with laptop on right



SAMS data spectrograph – showing the vibratory environment on board the International Space Station

Streptococcus Pneumoniae Expression of Genes in Space (SPEGIS)

Ames Research Center

Payload Overview

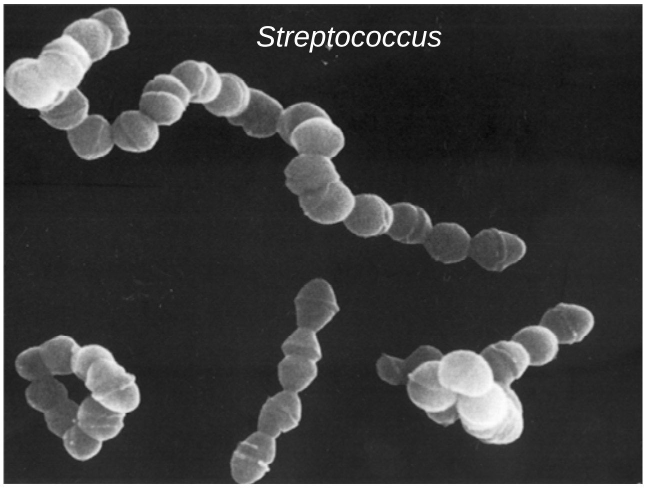
During the flight of STS-118/13A.1, the SPEGIS payload will carry a microbiological experiment. The payload is supporting the research of Dr. David Niesel. His experiment will investigate the effects of the space environment on the gene expression, protein production and virulence of the bacteria *Streptococcus pneumoniae (S. pneumoniae).*

Vials containing bacterial cultures will be loaded into the SPEGIS Canister Assembly. A total of three canisters will be flown on the space shuttle. Each Canister contains three 8 ml polypropylene vials. The vials are inserted into vial jackets that will aid in the temperature transition of the bacteria.

While on-orbit, the bacteria will be incubated in the Microgravity Environment Research Locker/INcubator (MERLIN). After incubation the canisters will be transferred to the Minus Eighty Laboratory Freezer for ISS (MELFI) for sample preservation. The samples will be returned to Earth in the Double Coldbag, which will maintain the frozen sample integrity for later analysis by the investigator.

Experiment Relevance

S. pneumoniae is a respiratory microbe that is normally found in the upper respiratory tract of approximately 40% of the healthy human population. This experiment will lead to an increased understanding of S. pneumoniae, which is an opportunistic human pathogen. It is anticipated that the results from this study will advance our understanding of the virulence mechanism of this bacteria and how it adapts to different environments. The identification of specific S. pneumoniae virulence factors and cellular and molecular processes may aid scientists in furthering the understanding of how this bacteria causes infection. This data may aid in the design and development of new antimicrobial drugs.



(N Engl J Med. 1993 Aug 12; 329(7): 477)

SPEGIS Canister

SPEGIS Canister

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

Principal Investigator: David Miller, Ph.D., Massachusetts Institute of Technology, Cambridge, Mass.

Expeditions Assigned: 8, 13, 14, 15 and 16.

Overview

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

SPHERES consists of three self-contained, bowling ball-sized "satellites" or free-flyers, which perform the various algorithms. Each satellite is self-contained with power (AA batteries), propulsion (CO_2 gas), computers and navigation equipment. As the satellites fly through the station, they will communicate with each other and an International Space Station laptop via a low-power, 900 MHz wireless link.

Preliminary signal testing to support SPHERES operations was performed during Expedition 8. Testing with one satellite was performed early during Expedition 13. The second satellite was delivered to the space station on STS-121, enabling testing of the two-satellite configuration beginning in August 2006. The third satellite was flown on STS-116.

Applications

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

Web Sites

For more information on SPHERES, visit:

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

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

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

Surface, Water and Air Biocharacterization: A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft Environment (SWAB)

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

Expeditions Assigned: 13, 14, 15 and 16

Overview

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

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

This study will use modern molecular techniques to identify microorganisms and allergens. Direct sampling of the space station allows identification of the microbial communities present and determination of whether these change over time.

Applications

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

Web Site

For more information on SWAB, visit:

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

Sleep-Wake Actigraphy and Light ExposureDuring Spaceflight-Long (Sleep-Long)

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

Expeditions Assigned: 14, 15, 16

Overview

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

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

Space Applications

The information derived from this study will help to better understand the effects of spaceflight on sleep-wake cycles. The countermeasures that will be developed will improve sleep cycles during missions that, in turn, will help maintain alertness and lessen fatigue of the crew during long-duration spaceflights.

Earth Applications

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

Web Site

For more information on Sleep-Long, visit:

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

Sleep-Wake Actigraphy and Light ExposureDuring Spaceflight-Short (Sleep-Short)

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

Expeditions Assigned: 11, 13, 14, 15

Overview

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

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

Applications

Space Applications: The information derived from this study will help to better understand the effects of spaceflight on sleep-wake cycles. The countermeasures that will be developed will improve sleep cycles during missions that, in turn, will help maintain alertness and lessen fatigue of the space shuttle astronauts.

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

Web Site

For more information on Sleep-Short, visit:

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

Stability of Pharmacotherapeutic and Nutritional Compounds (Stability)

Principal Investigators: Scott M. Smith, Ph.D., and Lakshmi Putcha, Ph.D., Johnson Space Center, Houston

Expeditions Assigned: 13, 14, 15, 16

Overview

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

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

Applications

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

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

Web Site

For more information on Stability, visit:

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

Test of Reaction and Adaptation Capabilities (TRAC)

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

Expeditions Assigned: 14, 15

Overview

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

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

Applications

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

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

Web Site

For more information on TRAC, visit:

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

The Digital NASA Television

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

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

Digital NASA TV has four digital channels:

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

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

Internet Information

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

http://spaceflight.nasa.gov

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

http://www.nasa.gov

or

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

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