INTERNATIONAL SPACE STATION

Expedition 13

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Overview

Expedition 13: Station Assembly Resumes

A veteran crew will fly aboard the International Space Station this spring, working to set the stage for the resumption of assembly of new components at the complex as well as the return to a three-person crew on board.

Attired in Russian Sokol launch and landing suits, the next crew to launch to the International Space Station pauses from its training schedule in Star City, Russia, to pose for a crew portrait. From the left are Brazilian Space Agency astronaut Marcos C. Pontes; cosmonaut Pavel V. Vinogradov, Expedition 13 commander, representing Russia's Federal Space Agency, and NASA astronaut Jeffrey N. Williams, Expedition 13 Flight Engineer and Science Officer.

Making his second flight into space, Russian cosmonaut Pavel Vinogradov (**Pah'**-vuhl Vee-nah-**grah'**-dawf), 52, will command the 13th Expedition to the station and serve as Soyuz Commander for launch, landing and on-orbit operations. NASA astronaut Jeffrey Williams, 48, an Army colonel, will serve as Flight Engineer and Science Officer. He is also making his second flight into space.

Vinogradov and Williams will launch on the ISS Soyuz 12, or TMA-8, spacecraft on March 29, CST, from the Baikonur

Cosmodrome in Kazakhstan for a two-day flight to link up to the Zvezda Service Module on the station. They will be joined on the Soyuz by Brazilian Space Agency astronaut Marcos Pontes (**Mar**'-kuss **Pahn**'-tess), 43, a lieutenant colonel in the Brazilian Air Force, who will spend eight days on the complex under a contract signed with the Russian Federal Space Agency (Roscosmos).

Pontes will return to Earth on the ISS Soyuz 11, or TMA-7, capsule with Expedition 12 Commander and NASA Science Officer William McArthur and Russian Flight Engineer and Soyuz Commander Valery Tokarev (Vuh-**lair'-**ee **Toe'-**kuh-reff) in the pre-dawn hours of April 9, Kazakhstan time. McArthur and Tokarev have been aboard the station since October, 2005.

European Space Agency (ESA) Astronaut Thomas Reiter

Vinogradov and Williams will be joined on the station during Expedition 13 by European Space Agency (ESA) Astronaut Thomas Reiter (Toe-**mahs**' **Rye**'-turr) of Germany, 47, who will launch to the outpost on the STS-121 shuttle mission. Reiter is expected to be a station crewmember during both the Expedition 13 and 14 missions, and is scheduled to return on a future shuttle or Soyuz mission. He would be the first non-American or Russian long-duration crew member on the station under a commercial agreement between ESA and Roscosmos.

Once on board, Vinogradov and Williams will conduct more than a week of handover activities with McArthur and Tokarev, familiarizing themselves with station systems and procedures. They will also receive proficiency training on the Canadarm2 robotic arm from McArthur and will engage in safety briefings with the departing Expedition 12 crew as well as payload and scientific equipment training.

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Vinogradov and Williams will assume formal control of the station at hatch closure for the Expedition 12 crew members shortly before they and Pontes undock the ISS Soyuz 11 craft from their docking port at the Zarya Module. With Tokarev at the controls of Soyuz, he, McArthur and Pontes will land in the steppes of Kazakhstan to wrap up their mission. Pontes' mission will span 10 days.

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

Vinogradov and Williams are expected to spend about six months aboard the station. After the Columbia accident on Feb. 1, 2003, the station program and the international partners determined that the complex would be occupied by only two crewmembers until the resumption of shuttle flights because of limitations on consumables. Once Reiter arrives on board, the station will operate with a three-person crew for the first time since May, 2003.

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

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

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During their six months aloft, Vinogradov and Williams will 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. If all goes as planned, they will also greet two visiting shuttle crews.

On STS-121, Discovery will deliver Reiter to the complex as well as logistical supplies and a new umbilical cable system for the station's Mobile Transporter rail car. The new system will replace a unit that incurred a mechanical failure last December, resulting in the severing of one of two redundant cables that enable the car to move along the station's truss.

STS-115, on Atlantis, will deliver the next pair of segments for the port side of the truss. The P3 and P4 trusses will also add a new set of photovoltaic solar arrays to increase the power capability of the station.

The ISS Progress 21 cargo ship is scheduled to reach the station in late April and ISS Progress 22 is earmarked to fly to the complex in late June. The first Progress craft will link up to the aft port of Zvezda and the second will arrive at the Pirs Docking Compartment.

U.S. and Russian specialists are reviewing tasks that will be included in two spacewalks scheduled for Expedition 13. The first would be staged by Williams and Reiter out of the Quest airlock wearing U.S. suits to install a variety of external equipment for future assembly work. The second would be conducted by Vinogradov and Williams in Russian Orlan suits out of the Pirs airlock to install a new vent nozzle for the Elektron oxygen-generation system and to retrieve experiments.

Vinogradov is a veteran of five spacewalks on the Mir Space Station. Reiter conducted a pair of spacewalks on Mir. Williams would be conducting his second spacewalk. His first was during a shuttle assembly mission to the International Space Station.

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

Expedition 13 Crew

Pavel Vinogradov, commander

Russian Cosmonaut Pavel Vinogradov will command Expedition 13 and serve as the Soyuz commander for launch, landing and on-orbit operations. This will be the second long-duration mission for Vinogradov. He joined the RSC-Energia cosmonaut corps in May 1992 and conducted his first spaceflight in August 1997, launching on a Russian Soyuz for a 198-day spaceflight on board the Mir space station as the Expedition 24 flight engineer. During the mission, he conducted five spacewalks. He plans to conduct one spacewalk during Expedition 13.

Jeffrey Williams, flight engineer-1 and NASA science officer

This will be the second visit to the International Space Station for NASA astronaut Jeffrey Williams, an Army colonel, who will serve as the flight engineer. He'll also serve as the NASA station science officer for the six-month mission, overseeing a diverse range of U.S. experiments. His previous spaceflight experience includes STS-101 in May 2000, the third shuttle mission devoted to space station construction. During the flight, Williams performed his first spacewalk lasting nearly seven hours as he worked on station assembly tasks. He is scheduled to conduct two spacewalks during Expedition 13.

Thomas Reiter, Expedition 13 flight engineer-2

As the first astronaut from the European Space Agency to conduct a long-duration mission on the International Space Station, Thomas Reiter is scheduled to join Expedition 13 in progress, launching on Discovery on the STS-121 mission. Once on board, Reiter will return the station to a three-man crew for the first time since May 2003. Reiter is flying under a commercial agreement between ESA and the Russian Federal Space Agency.

Reiter will launch with Discovery's crew, scheduled for liftoff no earlier than July 2006. Shortly after docking to the outpost, Reiter will transfer his custom-made Soyuz capsule seat liner from the shuttle to the station to officially join Expedition 13. He is scheduled to return to Earth aboard shuttle mission STS-116 or aboard a Russian Soyuz.

This will be Reiter's second long-duration spaceflight, having served as a flight engineer on a mission aboard the Russian Mir Space Station in 1995 and 1996. During that flight, he performed 40 European scientific experiments and participated in the maintenance of Mir. He did two spacewalks to install and later retrieve cassettes of the European Space Exposure Facility experiment.

Marcos Pontes, Brazilian Space Agency astronaut

Brazilian Space Agency astronaut Marcos Pontes, a lieutenant colonel in the Brazil Air Force, will join the Expedition 13 crew for its launch to the International Space Station. He will remain aboard the complex for eight days of docked operations, and then return to Earth in with the Expedition 12 crew, Commander Bill McArthur and Flight Engineer Valery Tokarev.

While on board, Pontes will perform research and science experiments on behalf of the Brazilian Space Agency under a commercial agreement with the Russian Federal Space Agency.

Mission Milestones

(Dates are subject to change.)

March 30…………..Launch of ISS Soyuz 12/TMA-8 with Expedition 13 / Pontes

April 1..……………..Docking of ISS Soyuz 12/TMA-8 with Expedition 13 / Pontes (docks to Zarya nadir aft; 3 Russian vehicles at ISS)

March 31 - April 9……….Expedition 13 / 12 Handover

April 9……………..Undocking of ISS Soyuz 11/TMA-7 and landing of Expedition 12 / Pontes (undocks from Zvezda aft; 2 Russian vehicles at ISS)

April 12……………45th anniversary of Yuri Gagarin's flight; 25th anniversary of STS-1

April 24…………....Launch of ISS Progress 21

April 26…………....Docking of ISS Progress 21 (to Zvezda aft)

June 19……………Undocking of ISS Progress 20 (from Pirs Docking Compartment)

June 28…………..Launch of ISS Progress 22

June 30…………..Docking of ISS Progress 22 (to Pirs)

July 1 - 19……….STS-121/ULF1.1 space shuttle mission planning launch window

July……………….U.S. spacewalk by Williams and Reiter

Aug……………….Russian spacewalk by Vinogradov and Williams

Aug……………….STS-115/12A space shuttle mission planning launch window

Sept. 13…………Undocking of ISS Progress 21

Sept. 14…………Launch of Expedition 14 in ISS Soyuz 13/TMA-9

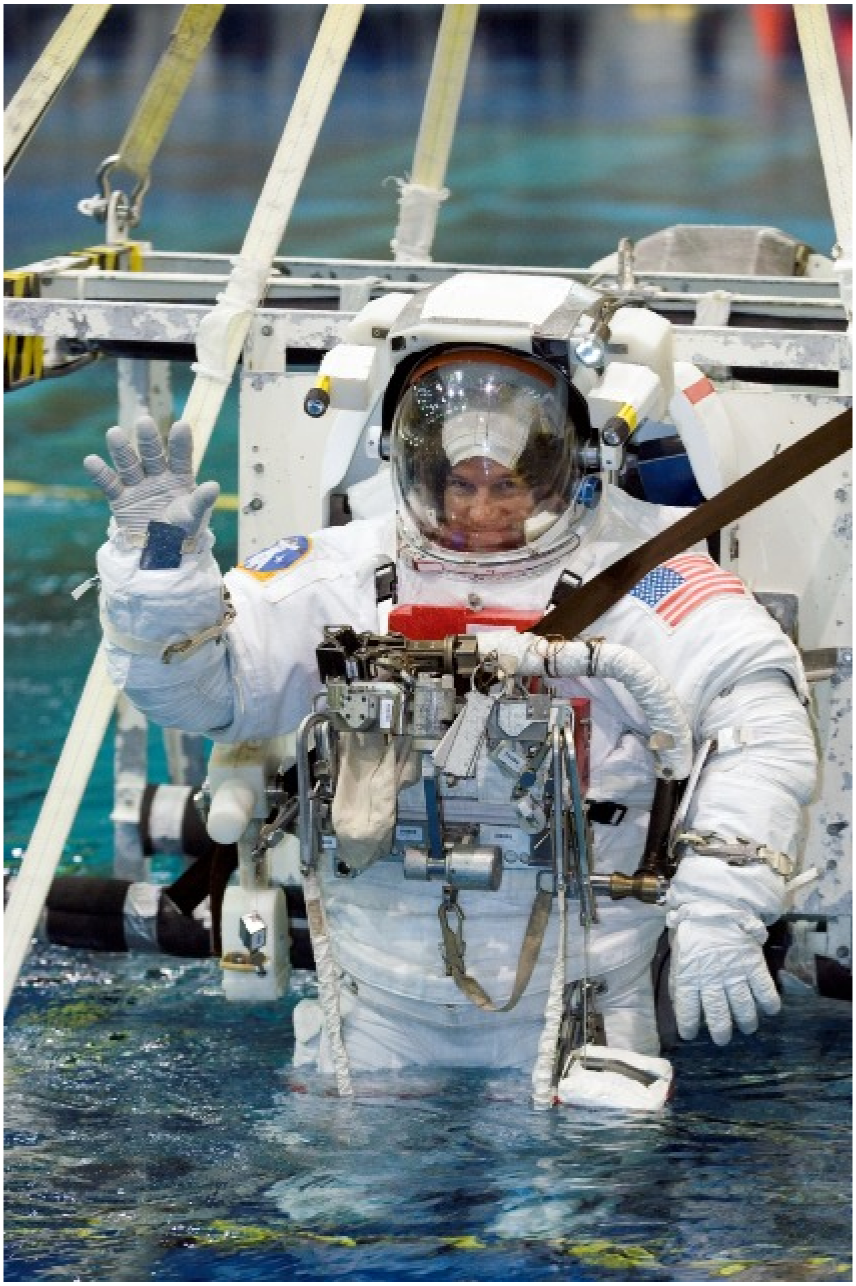
Sept. 16…………Docking of Expedition 14 to ISS

Sept. 24…………Undocking from ISS and landing of Expedition 13 in ISS Soyuz 12/TMA-8

Expedition 13 Spacewalks

Cosmonaut Pavel V. Vinogradov, Expedition 13 commander representing the Russian Federal Space Agency, participates in an Extravehicular Mobility Unit (EMU) spacesuit fit check in the Space Station Airlock Test Article (SSATA) in the Crew Systems Laboratory at the Johnson Space Center.

Two spacewalks are planned during Expedition 13. The first spacewalk, staged from the Quest airlock, is scheduled in July and the second, staged from the Pirs airlock, is scheduled in August. Jeff Williams and Thomas Reiter will perform the spacewalk from Quest. Pavel Vinogradov and Williams will perform the spacewalk from Pirs.



Astronaut Jeffrey N. Williams, Expedition 13 NASA science officer and flight engineer, is submerged in the waters of the Neutral Buoyancy Laboratory at Johnson Space Center.

All three crewmembers are spacewalk veterans. Vinogradov has made five, Williams has made one and Reiter has made two.

The following activities are to be accomplished during the Expedition 13 spacewalks:

U.S. Spacewalk No. 5
Williams (EV1) and Reiter (EV2)

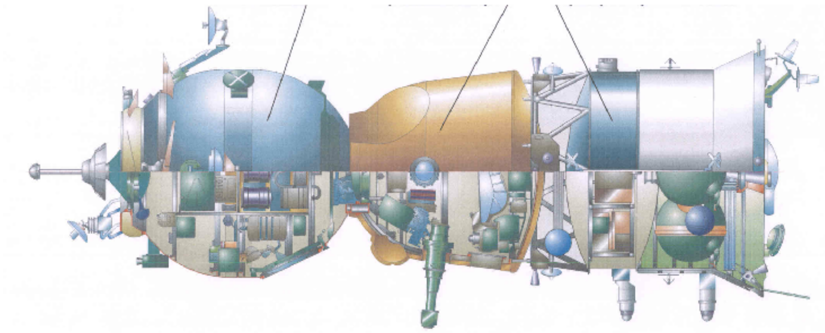
- Install Video Stanchion Support Assembly and Floating Potential Measurement Unit on the S1 truss
- Deploy materials on the ISS Experiment 3 and 4
- Install Thermal Radiator Rotary Joint Rotary Joint Motor Controller on S1 truss
- Remove and replace Thermal Radiator Multiplexer/Demultiplexer on S1 truss
- Remove and replace Node 2 Shunt Jumper in S0 truss
- Install four Spool Positioning Devices (SPDs) on the S0 truss
- Complete infra-red camera Detailed Test Objective 851 Objective 2 for the Space Shuttle Program to test shuttle heat shield inspection techniques
- A variety of get-ahead tasks for future shuttle assembly mission to the station are under consideration, including:
  - Install a light on the Crew Equipment Translation Aid cart on the S1 truss
  - Install a Non-Propulsive Valve on the Destiny Laboratory
- Remove Global Positioning Satellite antenna No. 4

Russian Spacewalk No. 16
Vinogradov (EV1) and Williams (EV2)

- Elektron vent nozzle (hydrogen relief valve) installation
- Retrieve third Biorisk container from DC-1
- Perform Golf Project
- Retrieve Pressure Control and Exposure Monitor Sensor
- Retrieve Kromka No. 3

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

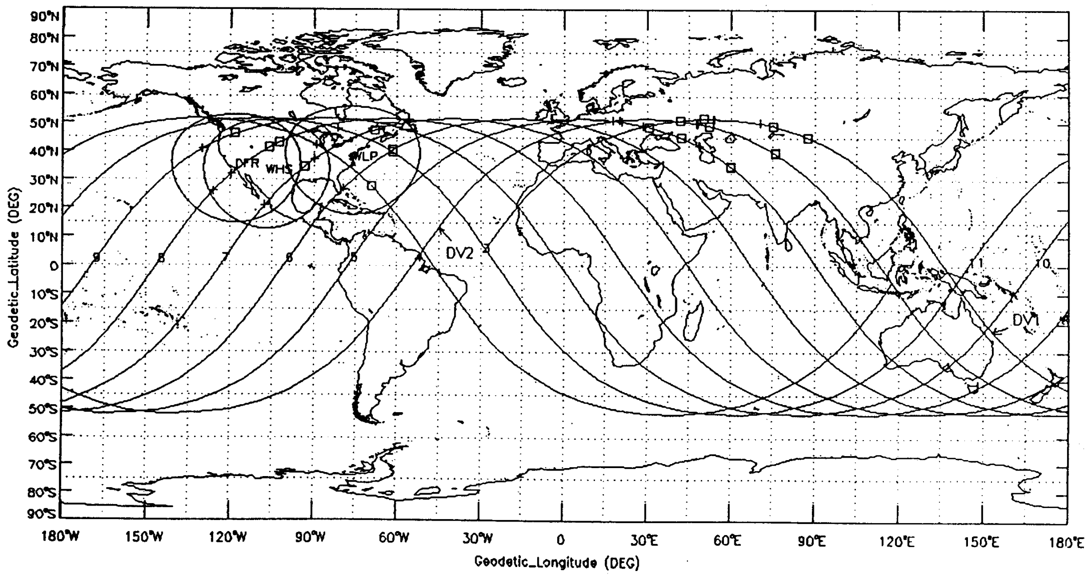
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital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



Expedition 12/ISS Soyuz 11 (TMA-7) Landing

For the seventh time, an American astronaut will return to Earth from orbit in a Russian Soyuz capsule. Expedition 12 Commander and Science Officer William McArthur will be aboard the Soyuz TMA-7 capsule as he, Soyuz Commander Valery Tokarev and Brazilian Space Agency astronaut Marcos Pontes touch down in the steppes of Kazakhstan to complete their mission. McArthur and Tokarev will be wrapping up six months in orbit while Pontes will return after a brief commercially-sponsored 10-day flight.

The grounding of the Space Shuttle fleet following the Columbia accident on Feb. 1, 2003, necessitated the landing of expedition crews in Soyuz capsules. The Expedition 6, 7, 8, 9, 10 and 11 crews rode the Soyuz home in May and October 2003, April and October 2004 and April 2005 and October. The Soyuz also provides a lifeboat capability for residents aboard the ISS.

The Expedition 7, 8, 9,10 and 11 crews landed on target, but as a precaution against any possibility that the Soyuz could land off course as did Expedition 6, Tokarev, McArthur and Pontes will have a satellite phone and Global Positioning System locator for instant communications with Russian recovery teams.

About three hours before undocking, Tokarev, McArthur and Pontes will bid farewell to the new Expedition 13 crew, Russian Commander Pavel Vinogradov and Flight Engineer and NASA Science Officer Jeffrey Williams. The departing crew will climb into the Soyuz vehicle, closing the hatch between Soyuz and Zvezda.

McArthur will be in the Soyuz' left seat for entry and landing and on-board engineer. Tokarev will be in the center commander's seat, and Pontes will occupy the right seat.

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

Tokarev will fire the Soyuz thrusters to back away from Zvezda. Five minutes after undocking and with the Soyuz about 20 meters away from the station, he will conduct a separation maneuver, firing the Soyuz jets for about 15 seconds to move away from the complex.

A little less than 2½ hours later, at a distance of about 19 kilometers from the station, Soyuz computers will initiate a deorbit burn braking maneuver of about 4½ minutes in duration to slow the spacecraft and enable it to drop out of orbit to begin its reentry to Earth.

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

The descent module's computers will orient the capsule with its ablative heat shield pointing forward to repel the buildup of heat as it plunges into the atmosphere. The crew will feel the first effects of gravity in almost six months at the point called entry Interface, when the module is about 400,000 feet above the Earth, about 3 minutes after module separation.

About 8 minutes later at an altitude of about 10 kilometers, traveling at about 220 meters per second, the Soyuz' computers will begin a commanded sequence for the deployment of the capsule's parachutes. First, two "pilot" parachutes will be deployed, extracting a larger drogue parachute, which stretches out over an area of 24 square meters. Within 16 seconds, the Soyuz's descent will slow to about 80 meters per second.

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

At this point, the drogue chute is jettisoned, allowing the main parachute to be deployed. Connected to the descent module by two harnesses, the main parachute covers an area of about 1,000 meters. Initially, the descent module will hang underneath the main parachute at a 30 degree angle with respect to the horizon for aerodynamic stability, but the bottommost harness will be severed a few minutes before landing, allowing the descent module to hang vertically through touchdown. The deployment of the main parachute slows down the descent module to a velocity of about 7 meters per second.

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

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

At an altitude of about 12 meters, cockpit displays will tell Tokarev to prepare for the soft-landing engine firing. Just one meter above the surface, and just seconds before touchdown, the six solid propellant engines are fired in a final braking maneuver, enabling the Soyuz to land to complete its mission, settling down at a velocity of about 1.5 meters per second.

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

Within minutes of landing, a portable medical tent will be set up nearby in which the crew can change out of its launch and entry suits. Russian technicians will open the module's hatch and begin to remove the crew, one-by-one. They will be seated in special reclining chairs near the capsule for initial medical tests and to provide an opportunity to begin readapting to Earth's gravity.

About two hours after landing, the crew will be assisted to the helicopters for a flight 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 adjacent to the Gagarin Cosmonaut Training Center in Star City, Russia, where their families will meet them. In all, it will take at around eight hours between landing and the return to Star City.

Assisted by a team of flight surgeons, the crew will undergo more than two weeks of medical tests and physical rehabilitation before McArthur and Tokarev return to the U.S. for additional debriefings and follow-up exams. Pontes' acclimation to Earth's gravity will be a much shorter.

Key Times for Expedition 13/12 International Space Station Event

Expedition 13 / Pontes Launch:

8:30 p.m. CST on March 29, 230:18 GMT on March 30, 6:30:18 a.m. Moscow time on March 30, 8:30:18 a.m. Baikonur time on March 30.

Expedition 13 / Pontes Docking to the ISS:

10:19 p.m. CST on March 31, 419 GMT on April 1, 8:19 a.m. Moscow time on April 1.

Expedition 13 / Pontes Hatch Opening to the ISS:

11:30 p.m. CST on March 31, 530 GMT on April 1, 9:30 a.m. Moscow time on April 1.

Expedition 12 / Pontes Hatch Closure to the ISS:

12:12 p.m. CST on April 8, 1712 GMT on April 8, 9:12 p.m. Moscow time on April 8, 11:12 p.m. Kazakhstan time on April 8.

Expedition 12 / Pontes Undocking from the ISS:

3:28 p.m. CST on April 8, 2028 GMT on April 8, 12:28 a.m. Moscow time on April 9, 2:28 a.m. Kazakhstan time on April 9.

Expedition 12 / Pontes Deorbit Burn:

5:55:43 p.m. CST on April 8, 2255:43 GMT on April 8, 2:55:43 a.m. Moscow time on April 9, 4:55:43 a.m. Kazakhstan time on April 9.

Expedition 12 / Pontes Landing:

6:46:06 p.m. CST on April 8, 2346 GMT on April 8, 3:46:06 a.m. Moscow time on April 9, 5:46:06 a.m. Kazakhstan time on April 9 (about 1 hour, 4 minutes before sunrise)

Launch on March 29 / 30 puts Houston 10 hours behind Moscow, which would be 2 hours behind Baikonur, with Moscow having moved to Daylight Savings Time on March 26. Same spread for docking April 1. For landing on April 8 / 9, Houston would again be 9 hours behind Moscow, only 11 hours behind Kustanai / Arkalyk / Karaganda / Dzhezkazgan.

Soyuz Entry Timeline

Separation Command to Begin to Open Hooks and Latches:

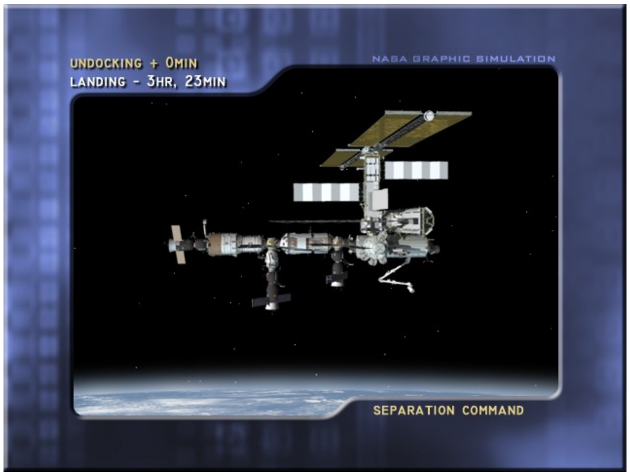
Undocking Command + 0 mins.

3:25 p.m. CST on April 8

2025 GMT on April 8

12:25 a.m. Moscow time on April 9

2:25 a.m. Kazakhstan time on April 9.



Hooks Opened / Physical Separation of Soyuz from Zvezda aft port at .12 meter/sec:

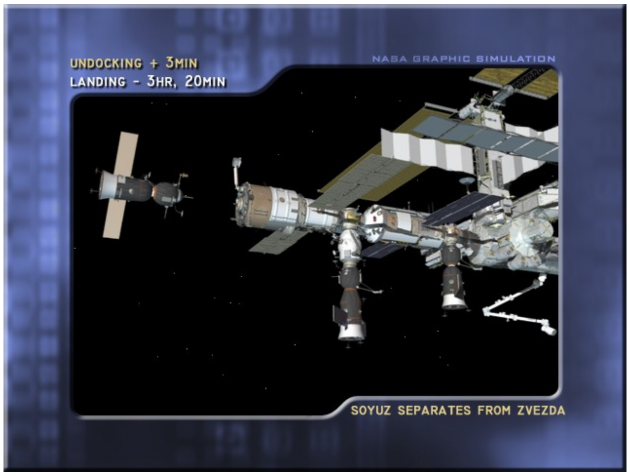
Undocking Command + 3 mins.

3:28 p.m. CST on April 8

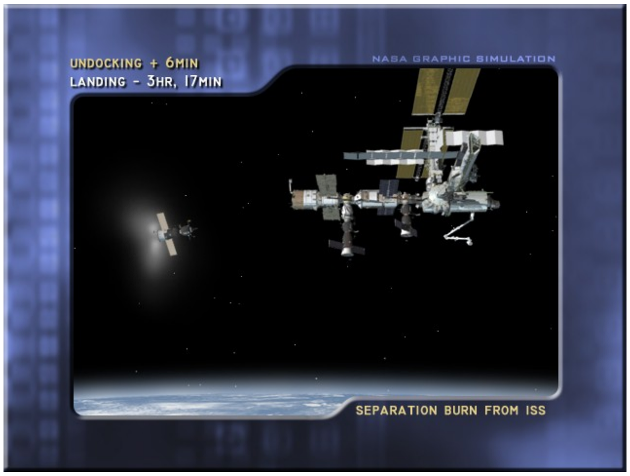
2028 GMT on April 8

12:28 a.m. Moscow time on April 9

2:28 a.m. Kazakhstan time on April 9



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



Undocking Command + 6 mins.

3:31 p.m. CST on April 8

2031 GMT on April 8

12:31 a.m. Moscow time on April 9

2:31 a.m. Kazakhstan time on April 9

Deorbit Burn (appx 4:24 in duration, 115.2 m/sec; Soyuz distance from the ISS is ~12 kilometers):

Undocking Command appx + ~2 hours, 30 mins.

5:55:43 p.m. CST on April 8

22:55:43 GMT on April 8

2:55:43 a.m. Moscow time on April 9

4:55:43 a.m. Kazakhstan time on April 9

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

Undocking Command + ~2 hours, 57 mins.

6:19:54 p.m. CST on April 8

2319:54 GMT on April 8

3:19:54 a.m. Moscow time on April 9

5:19:54 a.m. Kazakhstan time on April 9

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

Undocking Command + ~3 hours

6:22:45 p.m. CST on April 8

2322:45 GMT on April 8

3:22:45 a.m. Moscow time on April 9

5:22:45 a.m. Kazakhsatan time on April 9

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

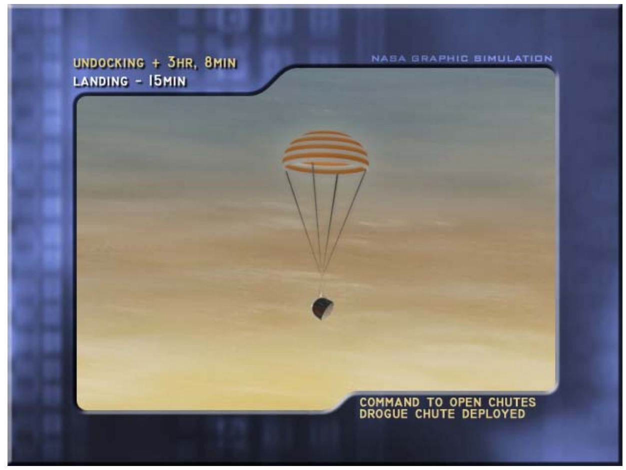
Undocking Command + ~3 hours, 8 mins.

6:31:06 p.m. CST on April 8

2331:06 GMT on April 8

3:31:06 a.m. Moscow time on April 9

5:31:06 a.m. Kazakhstan time on April 9



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

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

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

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

Landing - appx. 2 seconds

Landing (~47 mins. after Deorbit Burn):

Undocking Command + ~3 hours, 24 mins.

6:46:06 p.m. CST on April 8

2346:06 GMT on April 8

3:46:06 a.m. Moscow time on April 9

5:46:06 a.m. Kazakhstan time on April 9 (1 hour, 4 minutes before sunrise at the landing site)

International Space Station: Expedition 13 Science Overview

Many Expedition 13 research activities will be carried out using scientific facilities and samples already on board the space station, along with new research facilities transported during the next shuttle mission, STS-121. NASA's second Return to Flight test flight, a Space Shuttle Discovery mission, is scheduled for launch in July 2006.

During Expedition 13, two Russian Progress cargo flights – called ISS 21P and 22P for the 21st and 22nd Progress vehicles – are scheduled to dock with the space station in April and June 2006, respectively. The re-supply ships will transport scientific equipment and supplies to the station.

The research agenda for the expedition remains flexible. The Expedition 13 crew has scheduled about 170 hours for U.S. payload activities. Space station science also will be conducted remotely by the team of controllers and scientists on the ground, who will continue to plan, monitor and operate experiments from control centers across the United States.

A team of controllers for Expedition 13 will work in the Payload Operations Center – the science command post for the space station – at NASA's Marshall Space Flight Center in Huntsville, Ala. Controllers work in three shifts around the clock, seven days a week in the Payload Operations Center, which links researchers around the world with their experiments and the station crew.

Experiments Related to Spacecraft Systems

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

Dust Aerosol Measurement Feasibility Test (DAFT) will test the effectiveness of a device that counts ultra-fine dust particles in a microgravity environment, a precursor to the next generation of fire detection equipment for exploration vehicles.

Materials on the International Space Station Experiment (MISSE – 3/4 and 5) are suitcase-sized test beds attached to the outside of the space station. The beds expose hundreds of potential space construction materials and different types of solar cells to the harsh environment of space. After spending about a year mounted to the space station, the equipment will be returned to Earth for study. Investigators will use the resulting data to design stronger, more durable 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 control algorithms for spacecraft by performing autonomous rendezvous and docking maneuvers. The results are important for designing constellation and array spacecraft configurations.

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

Space Experiment Module (SEM) allows students to research the effects of microgravity, radiation and space flight on various materials. This encourages students to probe into the physics of radiation, microgravity and space flight through planning, performing and analyzing materials experiments on board the station.

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

Human Life Science Investigations

Measurements of Expedition 13 crewmembers will be used to study changes in the body caused by exposure to the microgravity environment. Continuing and new experiments include:

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

Chromosomal Aberrations in Blood Lymphocytes of Astronauts 2 (Chromosome-2), a European Space Agency payload, is a continuation of the Chromosome investigation performed on earlier expeditions. It will study the incidence aberrations in chromosomes following long duration spaceflight. By improving the knowledge genetic risks faced by astronauts in space, the study seeks to optimize radiation shielding.

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

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

Anomalous Long Term Effects in Astronauts' Central Nervous System (ALTEA) integrates several diagnostic technologies to measure the exposure of crewmembers to cosmic radiation. It will further our understanding of the impact of radiation on the human central nervous and visual systems. It also will provide an assessment of the radiation environment in the station.

Other Biological Experiments

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

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.

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

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

<u>Experiments Using On-board Resources</u>

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.

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.

<u>Space Shuttle Experiments</u>

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

Fungal Pathogenesis, Tumorigenesis, and Effects of Host Immunity in Space (FIT) studies the susceptibility to fungal infection, progression of radiation-induced tumors and changes in immune function in sensitized *Drosophila, or* fruit fly lines.

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

Bioavailablity and Performance Effects Of Promethazine During Spaceflight (PMZ) will examine the bioavailability and performance impacting side-effects of this medication. Promethazine is a medication taken by the astronauts to prevent motion sickness.

Effect of Space Flight on Microbial Gene Expression and Virulence (Microbe) will investigate the effects of the space flight environment on the infectiousness of three model microbial pathogens identified during previous space flight missions as potential threats to crew health.

Maui Analysis of Upper Atmospheric Injections (MAUI) observes the exhaust plume of the space shuttle from the ground, leading to an assessment of spacecraft plume interactions with the upper atmosphere.

Ram Burn Observations (RAMBO) is a Department of Defense experiment that observes Shuttle Orbital Maneuvering System engine burns by satellite for the purpose of improving plume models. Understanding the spacecraft engine plume flow could be significant to the safe arrival and departure of spacecraft on current and future exploration missions.

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

New Space Station Facilities

Two new space station facilities are scheduled to be launched on STS-121.

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

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

Destiny Laboratory Facilities

Several research facilities are in place on board the station to support Expedition 13 science investigations.

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

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

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

The Destiny lab also is outfitted with five **EXPRESS** Racks. EXPRESS, or Expedite the Processing of Experiments to the Space

Station, racks are standard payload racks designed to provide experiments with utilities such as power, data, cooling, fluids and gasses. The racks support payloads in disciplines including biology, chemistry, physics, ecology and 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 13 experiments and payload operations, click on **http://www.nasa.gov**

The Payload Operations Center

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

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

The Payload Operations Center continues the role Marshall has played in management and operation of NASA's on-orbit science research. In the 1970s, Marshall managed the science program for Skylab, the first American space station.

Spacelab -- the international science laboratory carried to orbit in the '80s and '90s by the space shuttle for more than a dozen missions -- was the prototype for Marshall's space station science operations.

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

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

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

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

- Marshall Space Flight Center**,** managing microgravity (materials sciences, microgravity research experiments, space partnership development program research)
- John Glenn Research Center in Cleveland, managing microgravity (fluids and combustion research)
- Johnson Space Center in Houston, managing human life sciences (physiological and behavioral studies, crew health and performance)

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

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

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

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

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

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

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

Russian Research Objectives (Increment 13)

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Commercial	КНТ-1	GTS	Electronics unit; Antenna assembly with attachment mechanism	Global time system test development	
Commercial	КНТ-20	GCF-JAXA	GCF-02 kit	Protein crystallization	
Commercial	КНТ-29	ROKVISS	"Rokviss" equipment Universal Working Place УРМ-Д	Hinge joints operation working-off	
Commercial	КНТ-34	"Golf" project	Golf-clubs (2 items) Golf-balls (4 items)	Imagery activities on ISS RS and in outer space	EVA
Technology & Material Science	ТХН-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	ТХН-9	Kristallizator (Crystallizer)	"Crystallizer" complex	Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions	
Geophysical	ГФИ-1	Relaksatsiya	"Fialka-MB-Kosmos" - Spectrozonal ultraviolet system High sensitive images recorder	Study of chemiluminescent chemical reactions and atmospheric light phenomena that occur during high-velocity interaction between the exhaust products from spacecraft propulsion systems and the Earth atmosphere at orbital altitudes and during the entry of space vehicles into the Earth upper atmosphere	Using OCA
Geophysical	ГФИ-8	Uragan	*Nominal hardware:* Kodak 760 camera; Nikon D1 LIV video system	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery	Using OCA
Biomedical	МБИ-5	Kardio-ODNT	*Nominal Hardware:* "Gamma-1M" equipment; "Chibis" countermeasures vacuum suit	Comprehensive study of the cardiac activity and blood circulation primary parameter dynamics	Will need help from US crewmember
Biomedical	МБИ-9	Pulse	Pulse set, Pulse kit; *Nominal Hardware:* Computer	Study of the autonomic regulation of the human cardiorespiratory system in weightlessness	

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	МБИ-15	Pilot	Right Control Handle Left Control Handle Synchronizer Unit (БС) ULTRABUOY-2000 Unit *Nominal hardware:* Laptop №3	Researching for individual features of state psychophysiological regulation and crewmembers professional activities during long space flights.	
Biomedical	БИО-2	Biorisk	"Biorisk-KM" set "Biorisk-MSV" containers "Biorisk-MSN" kit	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem	EVA
Biomedical	БИО-4	Aquarium	“Rasteniya (Plants)” kit (with “Aquarium” packs - 2 items)	Study of stability of model closed ecological system and its parts under microgravity conditions, both as microsystem components and as perspective biological systems of space crews life support	Crewmembers involvement is taken into account in Rasteniya-2 experiment
Biomedical	БИО-5	Rasteniya-2	"Lada" greenhouse Module of substratum research *Nominal Hardware:* Water container; Sony DVCam; Computer	Study of the space flight effect on the growth and development of higher plants	
Biomedical	БИО-11	Statoconia	"Ulitka" (Snail) incubating container "ART" (Autonomous Recorder of Temperature) kit	Statoconia growing potency research in organ of equilibrium of mollusca gasteropods under microgravity conditions	
Biomedical	БИО-12	Regeneratciya (Regeneration)	"Planariya" incubating container "ART" (Autonomous Recorder of Temperature) kit Thermostat	Study of microgravity influence on regeneration processes for biological objects by electrophysiological and morphological indices	During ISS-13, ISS-14 crews rotation
Biomedical	РБО-1	Prognoz	*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

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	РБО-3	Matryeshka-R	Passive detectors unit "Phantom" set "MOSFET-dosimeter" scientific equipment "Bubble-dosimeter" hardware	Study of radiation environment dynamics along the ISS RS flight path and in ISS compartments, and dose accumulation in antroph-amorphous phantom, located inside and outside ISS	Will need help from US crewmember
Study of Earth natural resources and ecological monitoring	Д33-2	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	
Study of Earth natural resources and ecological monitoring	Д33-11	Volny (Waves)	LSO hardware	Observation of wave disturbances (of man-caused and natural origins) in intermediate atmosphere	
Biotechnology	БТХ-1	Glikoproteid	"Luch-2" biocrystallizer "Kriogem-03M" freezer	Obtaining and study of E1-E2 surface glycoprotein of α-virus	
Biotechnology	БТХ-2	Mimetik-K		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	Biotrek	"Bioekologiya" kit	Studying influence of flows of heavy charged particles of space radiation on genetic properties of cells-producers of biological active substances	
Biotechnology	БТХ-10	Kon'yugatsiya (Conjugation)	"Rekomb-K" hardware TBK "Biocont-T" Thermo-vacuum container "Kriogem-03M" freezer *Nominal hardware:* "Kriogem-03" freezer	Working through the process of genetic material transmission using bacteria conjugation method	During ISS-12, ISS-13 crews rotation

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biotechnology	БТХ-11	Biodegradatsiya	"Bioproby" kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	
Biotechnology	БТХ-12	Bioekologiya (Bioecology)	"Bioekologiya " kit "ART" (Autonomous Recorder of Temperature) kit	Generation of high-efficiency strains of microorganisms to produce petroleum biodegradation compounds, organophosphorus substances, vegetation protection agents, and exopolysaccharides to be used in the petroleum industry	
Biotechnology	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 ISS-11, ISS-12 crews rotation
Biotechnology	БТХ-31	Antigen	"Antigen" kit	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-5 (SDTO 16002-R)	Meteoroid	Nominal micrometeoroid monitoring system: MMK-2 electronics unit; Stationary electrostatic sensors КД1, КД2, КД3, and КД4; Removable electrostatic sensor КДС	Recording of meteoroid and man-made particles on the ISS RS Service Module exterior surface	Unattended
Technical Studies	ТЕХ-14 (SDTO 12002-R)	Vektor-T	*Nominal Hardware:* ISS RS СУДН sensors; ISS RS orbit radio tracking [РКО] system; Satellite navigation; equipment [АСН] system GPS/GLONASS satellite systems	Study of a high-precision system for ISS motion prediction	Unattended

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technical Studies	TEX-15 (SDTO 13002-R)	Izgib	*Nominal Hardware:* ISS RS onboard measurement system (СБИ) accelerometers; ISS RS motion control and navigation system GIVUS (ГИВУС СУДН) Nominal temperature-sensing device for measures inside “Progress” vehicle modules	Study of the relationship between the onboard systems operating modes and ISS flight conditions	Unattended
Technical Studies	TEX-20	Plazmennyi Kristall (Plasma Crystal)	"PC-3 Plus" experimental unit "PC-3 Plus" telescience *Nominal hardware* “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	Telemetric monoblock with transmit-receive antenna from "Rokviss" scientific equipment	Working-off method of high-speed data transfer from ISS Service Module board to Earth	Unattended
Complex Analysis. Effectiveness Estimation	КПТ-3	Econ	"Econ" kit High Resolution Equipment Set (HRE) *Nominal Hardware:* Nikon D1 digital camera, Laptop №3	Experimental researching of ISS RS resources estimating for ecological investigation of areas	
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
Space energy systems	ПКЭ-1В	Kromka	Tray with materials to be exposed	Study of the dynamics of contamination from liquid-fuel thruster jets during burns, and verification of the efficacy of devices designed to protect the ISS exterior surfaces from contamination	EVA
Pre/Post Flight		Motor control	Electromiograph, control unit, tensometric pedal, miotometer «Miotonus», «GAZE» equipment	Study of hypo-gravitational ataxia syndrome;	Pre-flight data collection is on L-60 and L-30 days; Post-flight: on 1, 3, 7, 11 days Total time for all 4 tests is 2.5 hours
Pre/Post Flight		MION		Impact of microgravity on muscular characteristics.	Pre-flight biopsy (60 min) on L-60, and L-30 days; Post-flight: 3-5 days
Pre/Post Flight		Izokinez	Isocinetic ergometer «LIDO», electromiograph, reflotron-4, cardiac reader, scarifier	Microgravity impact on voluntary muscular contraction; human motor system re-adaptation to gravitation.	Pre-flight: L-30; Post-flight: 3-5, 7-9, 14-16, and 70 days. 1.5 hours for one session
Pre/Post Flight		Tendometria	Universal electrostimulator (ЭСУ-1); bio-potential amplifier (УБП-1-02); tensometric amplifier; oscilloscope with memory; oscillograph	Microgravity impact on induced muscular contraction; long duration space flight impact on muscular and peripheral nervous apparatus	Pre-flight: L-30; Post-flight: 3, 11, 21, 70 days; 1.5 hours for one session
Pre/Post Flight		Ravnovesie	"Ravnovesie" ("Equilibrium") equipment	Sensory and motor mechanisms in vertical pose control after long duration exposure to microgravity.	Pre-flight: L-60, L-30 days; Post-flight: 3, 7, 11 days, and if necessary on 42 or 70 days; Sessions: pre-flight data collection 2x45 min, post-flight: 3x45 min
Pre/Post Flight		Sensory adaptation	IBM PC, Pentium 11 with 32-bit s/w for Windows API Microsoft.	Countermeasures and correction of adaptation to space syndrome and of motion sickness.	Pre-flight: L-30, L-10; Post-flight: 1, 4, and 8 days, then up to 14 days if necessary; 45 min for one session.
Pre/Post Flight		Lokomotsii	Bi-lateral video filming, tensometry, miography, pose metric equipment.	Kinematic and dynamic locomotion characteristics prior and after space flight.	Pre-flight: L-20-30 days; Post-flight: 1, 5, and 20 days; 45 min for one session.

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 anti-g-force countermeasures development	In-flight: 60 min; instructions and questionnaire familiarization: 15 min; Post-flight: cosmonauts checkup – 5 min; debrief and questionnaire – 30 min for each cosmonauts.
Pre/Post Flight		Polymorphism	No hardware is used in-flight	Genotype parameters related to human individual tolerance to space flight conditions.	Pre-flight: blood samples, questionnaire, anthropometrical and anthroposcopic measurements – on early stages if possible; blood samples could be taken during preflight medical checkups on L-60, L-30 days. 30 min for one session.

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

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

Overview

Astronauts in orbit are exposed to cosmic radiation that is of sufficient frequency and intensity to cause effects on the central nervous system, such as the perception of flashes of light. Anomalous Long-Term Effects in Astronauts' Central Nervous System (ALTEA) will measure details about the cosmic radiation passing through a crewmember's head, while measuring the brain electrophysiological activity and the performance of the visual system. Furthermore, ALTEA will measure the particle flux in the U.S. lab, discriminating the type of particles, to measure their trajectories and the delivered energies.

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

Research Operations

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

Flight History/Background

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

Web Site:

For more information on ALTEA, visit:

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

Capillary Flow Experiment (CFE)

Overview

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

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

History

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

The CFE Contact Line (CL2) experiment was presented an opportunity to run on Dec. 20, 2005. The axial and push tests were performed by Increment 11 crew member, William McArthur. The 'axial mode' disturbances were imparted to the CFE CL2 vessel interfaces by deflecting and releasing the MWA like a cantilever (diving board), at first very lightly, and increasing in amplitude with each disturbance until just before the interfaces eject fluid drops. The push disturbances required a series of simple lateral 'pushes' to the vessel of increasing amplitude. The dampened sloshing motion of the interfaces were recorded for comparison with theory and numerical analysis on the ground. All tests were performed successfully, with additional requests to perform the Axial tests with the camcorder mounted separately from the MWA to gain disturbance knowledge of the CFE CL2 test units smooth and pinned cylinder test chambers.

Benefits

The CFE data to be obtained will be crucial to the space exploration Initiative, particularly pertaining to fluids management systems such as fuel and cryogenic storage systems, thermal control systems (e.g. water recycling), and materials processing in the liquid state. Technologies for liquid management in space use capillary forces to position and transport liquids, since the hydrostatic pressure is absent which gives the liquid a defined surface and enables easy withdrawal from the tank bottom. But the effect of capillary forces is limited on earth to a few millimeters. In space these forces affect free surfaces that extend over meters.

NASA's plans for exploration missions assume the use of larger liquid propellant masses than have ever flown on interplanetary missions. Under low gravity conditions, capillary forces can be exploited to control fluid orientation so that such large mission-critical systems perform predictably. This knowledge will assist spacecraft designers to decrease system mass, and reduce overall system complexity.

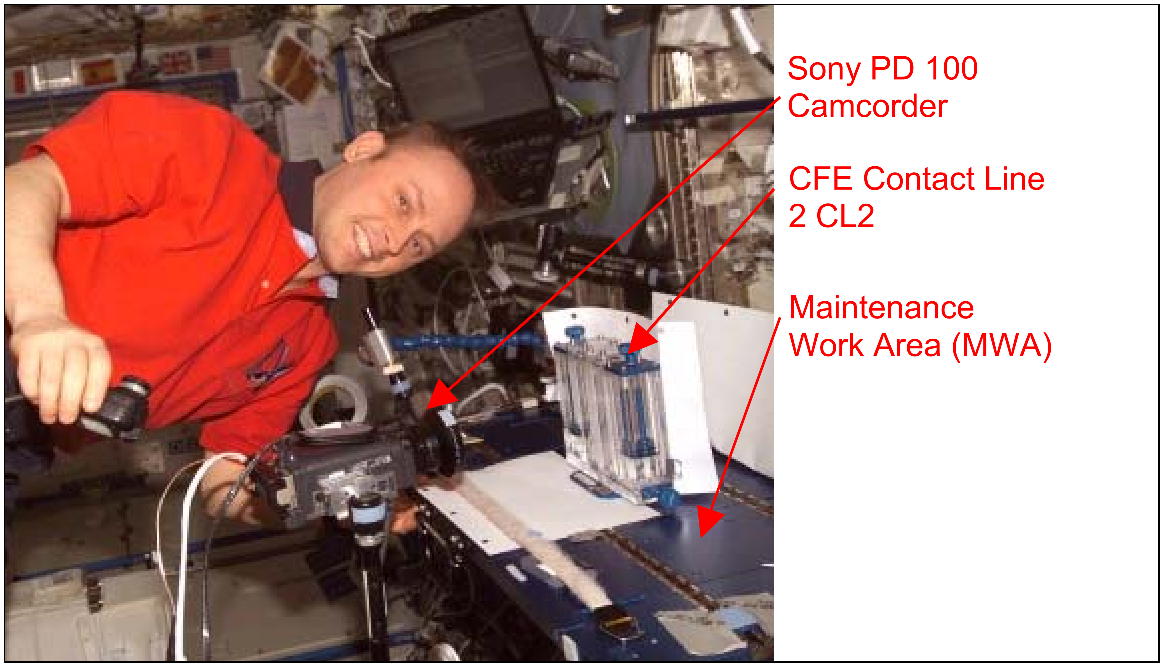
This work is performed as a collaborative effort through NASA Glenn Research Center, ZIN Technology and Portland State University.

Websites:

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

NASA
http://microgravity.grc.nasa.gov/expr2/ice-mir.htm

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



Mike Fincke during Increment 9, operating Contact Line 2 with various pieces of ISS equipment.

Chromosomal Aberrations in Blood Lymphocytes of Astronauts -2 (Chromosome-2)

Principal Investigator: Christian Johannes, Ph.D.
University of Duisburg-Essen, Essen, Germany

Overview

This study will assess changes in the morphology of chromosomes, particularly chromosomal aberrations, by taking into account the sensitivity to radiation by each crewmember. The frequency and the type of chromosomal aberrations depend on characteristics and doses of ionizing radiation the crewmembers are exposed to while in orbit.

Chromosomes collected from blood lymphocytes are analyzed for different types of abnormalities before and after a stay on the space station. Some of the analysis methods are new and will provide a new way of visualizing all changes, particularly those increasing the risk of cancer.

Research Operations

Two heparinized blood samples (samples are treated with heparin to prevent blood clotting) are taken (one preflight and one postflight). The blood is shipped to the principal investigator's laboratory in Essen, Germany, for analysis.

Flight History/Background

Chromosome, the precursor to this investigation, was operated on Expeditions 6-11.

Web Site:

For more information on Chromosome-2, visit:

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

Crew Earth Observations (CEO)

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

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

Overview

By allowing photographs to be taken from space, the Crew Earth Observations (CEO) experiment provides people on Earth with image data needed to better understand our planet. The photographs—taken by crewmembers using handheld cameras—record observable Earth surface changes over a period of time, as well as more fleeting events such as storms, floods, fires and volcanic eruptions.

Orbiting 220 miles or more above the Earth, the International Space Station offers an ideal vantage point for crewmembers to continue observational efforts that began in the early 1960s when space crews first photographed the Earth. This experiment on the space station began during Expedition 1, STS-97 (ISS Assembly Flight 4A), and is planned to continue throughout the life of the space station.

History/Background

This experiment has flown on every crewed NASA space mission beginning with Gemini in 1961. Since that time, astronauts have photographed the Earth, observing the world's geography and documenting events such as hurricanes and other natural phenomena. This database of astronaut-acquired Earth imagery is a national treasure for both the science community and general public. As a precursor to this space station experiment, crews conducted Earth observations on long-duration NASA-Mir missions and gained experience that is useful on board the International Space Station.

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

Benefits

Today, images of the world from 10, 20 or 30 years ago provide valuable insight into Earth processes and the effects of human developments. Photographic images taken by space crews serve as both primary data on the state of the Earth and as secondary data to be combined with images from other satellites in orbit. Worldwide more than five million users log on to the Astronaut Earth Photography database each year. Through their photography of the Earth, space station crewmembers will build on the time series of imagery started 35 years ago—ensuring this record of Earth remains unbroken. These images also have tremendous educational value. Educators use the image database to help make future generations of children "Earth-smart."

For more information, visit the "Gateway to Astronaut Photography" at:

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

Dust and Aerosol Measurement Feasibility Test (DAFT)

Overview

The Dust and Aerosol measurement Feasibility Test (DAFT) was designed to ensure that a modified P-Trak®—a key component of the forthcoming NASA Smoke Aerosol Measurement Experiment (SAME)—will perform properly in the unique environment of microgravity. If the P-Trak® performs as expected, the device will be used in SAME to provide data that will help scientists design better fire detectors for future, long-duration, manned missions.

The P-Trak® is a commercial device that counts ultrafine particles (it can recognize particles as small as 0.02 micrometers in diameter) in an aerosol source. It works by passing particulate-laden air through a heated chamber of vaporous isopropyl alcohol. The individual particles serve as “seeds” around which the alcohol condenses when cooled, forming droplets large enough to be detected and counted when they break a laser beam (see the included diagram). The P-Trak® must be tested in microgravity prior to its use in SAME because its alcohol condenser was redesigned to work properly in microgravity. (The original smooth-walled P-Trak® condenser—meant for Earth-based use—depends on gravity.) NASA scientists modified the unit’s condenser by forming microgrooves in its wall to increase the alcohol flow back to the wick. This modification was based on the knowledge gained from previous microgravity fluids physics experiments conducted by NASA GRC researchers.

History

Due to limited upmass allocations aboard the Russian Progress vehicles, DAFT was divided into four separate packages (DAFT-1 through -4) which could be delivered to the International Space Station (ISS) aboard successive flights. Each package would add functional capability to the previous package(s). DAFT-1 and -2 were delivered to the ISS in December 2004 aboard Russian Progress Flight 16P, and the main components of DAFT—the P-Trak® and the DustTrak® aerosol monitoring devices—were included in this delivery. (The DustTrak® uses a sensor to determine the percentage of light being scattered by particles—like dust in a sunbeam—and translates that number into the mass of particles per unit volume. It is being used to test the accuracy of the P-Trak® because it is insensitive to gravitational forces. This is accomplished by correlating the measurements from the two devices after they have simultaneously sampled from a characterized particulate source.) The first set of tests were conducted in February and March 2005 and the results were encouraging; the P-Trak provided reasonable readings with no detectable failure modes observed. The tests were conducted in the US laboratory module Destiny in front of EXPRESS Rack 4; in the modules’s aft end and port side; and in Node 1. (The EXPRESS Rack is a standardized payload rack system that transports, stores, and supports experiments aboard the ISS; Node 1 is a hub to which various modules are attached.) Three of the tests sampled undisturbed cabin air; the other test validated the instruments at high particulate levels by having an astronaut create airborne debris at the PTrak® and DustTrak® inlets by repeatedly separating pieces of Velcro®.

The three tests that sampled the undisturbed environment in the ISS showed very low levels of airborne particulates, averaging fewer than 0.005 mg/m3 from the DustTrak® and fewer than 15 particles/cm3 from the P-Trak® (these are typical readings at the baseline). These numbers are dramatically lower than the values recorded in the space shuttle in an earlier experiment (~.050 mg/m3). Lower levels are to be expected because the ISS U.S. Lab has HEPA filtration for the cabin air as compared to merely a fine screen on the shuttle air handler. Furthermore, the typical shuttle crew of seven astronauts generates more airborne particulate than an ISS crew of two astronauts.

Benefits

The second set of tests will be conducted after the balance of the DAFT components (including a calibrated aerosol source and an unmodified P-Trak®) are delivered to the ISS aboard shuttle flight ULF1.1. These tests will be performed with Arizona Road Dust (ARD)—a standard aerosol test material of known particle size and distribution—and nitrogen aerosol inside 15-liter Mylar® bags. Testing a known particulate will allow scientists to establish quantitatively how well the P-Trak® works in microgravity. The results will build assurance that the P-Trak® instrument will function properly as a key diagnostic for SAME and ultimately lead to the design of better fire detectors for future, long-duration, manned missions.

Website:

http://microgravity.grc.nasa.gov/combustion/daft/daft_index.htm.

Earth Knowledge Acquired by Middle School Students (EarthKAM)

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

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

Operations Manager: Sally Ride, Ph.D., University of California, San Diego

Overview

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

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

Experiment Operations

Funded by NASA, EarthKAM is operated by the University of California, San Diego, and NASA field centers. It is an educational payload that allows middle school students to conduct research from the International Space Station as it orbits 220 miles above the Earth. Using the tools of modern technology – computers, the Internet and a digital camera mounted at the space station's laboratory window – EarthKAM students are able to take stunning, high-quality digital photographs of our planet.

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

EarthKAM photographs are taken by remote operation from the ground. When the middle school students target the images of terrestrial features they choose to acquire, they submit the image request to the Mission Operation Center at UCSD. Image requests are collected and compiled into a "Camera Control File" for each ISS orbit that the payload is operational. This camera control file is then uplinked to a Station Support Computer (laptop) aboard the space station that controls when the digital camera captures the image. The Station Support Computer activates the camera at the specified times and immediately transfers these images to a file server, storing them until they are downlinked to Earth. With all systems performing nominally, a picture can be requested, captured and posted to the EarthKAM website in as little as four hours.

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

Flight History/Background

In 1994, Sally Ride, a physics professor and former NASA astronaut, started what is now EarthKAM with the goal of integrating education with the space program. EarthKAM has flown on five shuttle flights. Its first flight was aboard space shuttle Atlantis in 1996, with three participating schools taking a total of 325 photographs. Since 1996, EarthKAM students have taken more than 25,407 publicly accessible images of the Earth.

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

Benefits

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

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

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

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

www.earthkam.ucsd.edu

www.spaceflight.nasa.gov

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

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

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

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

Operations: Pre- and Post-flight

Previous Missions

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

Objective

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

Brief Summary

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

Space Applications

In the United States, approximately 90% of adults have been infected with EBV, one of the most common human viruses. It establishes a lifelong dormant infection inside the body after primary infection, but can be reactivated by illness or stress. Once reactivated, it is associated with diseases such as posttransplant lymphoproliferative disease and Hodgkin’s disease. Decreased cellular immune function is observed during and after human space flight. With longer-duration space missions, latent viruses are more likely to become reactivated, placing the crew at risk of developing and spreading infectious illness. If this is the case, drug therapies must be created to protect crewmembers during long-term and interplanetary missions (i.e. trips to Mars). This study will help provide information related to immune function and virus activity in space to develop such remedies and ensure future exploratory space missions.

Results

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

Fungal Pathogenesis, Tumorigenesis and Effects of Host Immunity in Space (FIT)

Principal Investigator: Sharmila Bhattacharya, Ph.D., Ames Research Center, Moffett Field, Calif., and Deborah Kimbrell, Ph.D., University of California Davis, Davis, Calif.

Payload Developer(s): Ames Research Center

Increment(s) Assigned: 13

Research Summary

This study will investigate the susceptibility to fungal infection, progression of radiation-induced tumors, and changes in immune function in sensitized *Drosophila* (fruit fly) lines.

- This experiment will study the growth of cancerous and benign tumors in sensitized genetic lines (breeds) of *Drosophila melanogaster* (fruit flies) that show an increase in the incidence of tumor formation. The effect of radiation exposure will be coupled to this study.
- In addition, samples of a fungal pathogen that infects flies will be exposed to radiation and the space environment. Space-flown samples will be used post-flight to infect *Drosophila* on the ground and assess changes in the pathogen.
- These studies will provide more information on the interaction between elements of the space environment (space radiation, microgravity) and immune function and tumor growth.

Research Operations

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

Flight History/Background

The STS-121 mission will be the first flight for this experiment.

Web Site

For more information on FIT, visit:

http://exploration,nasa.gov/prorgams/station/list.html

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

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

Operations: In-flight

Manifest Status: Ongoing

Objective

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

Brief Summary

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

Description

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

Space Applications

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

Latent Virus Incidence of Latent Virus Shedding During Space Flight

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

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

Increment(s) Assigned: 11, 12, 13, 14

Overview

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

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

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

Benefits

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

The viral-specific saliva DNA test currently used for space flight investigations may be applied to the rapid diagnosis of herpes virus disease in clinics. These studies of latent virus reactivation in the very healthy, superbly conditioned flight crews may provide new insight into stress, immunity, and viral disease in the general population.

Web Site

For more information on this experiment, visit:

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

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

Principal Investigator: Cheryl A. Nickerson, Ph.D., Tulane University Medical Center, New Orleans

Overview

Harmful microbes carried to spacecraft on the human body, or in water or food, could cause crewmembers to become sick and put a long-duration mission at risk. The combination of radiation and microgravity in the space environment may impact the growth and mutation of microbes and increase their virulence. The Microbe experiment will study three prevalent microbes (Salmonella typhimurium, Pseudomonas aeruginosa, and Candida albicans) that have been identified previously in the spacecraft environment in human flora, water and food. Data on their growth and mutation will identify whether risks of microbial contamination are increased for lunar and Martian missions compared to conditions on Earth.

Research Operations

The three microbes, Salmonella typhimurium, Pseudomonas aeruginosa, and Candida albicans, will be activated, grown for 24 hours and terminated. Once the samples have been recovered, the live cells and stabilized cells will be examined.

Flight History/Background

Microbe complements the nominal space station environmental monitoring payloads by providing a comparison of analyses from current media-based and advanced molecular-based technologies.

Benefits

Results from this single-flight experiment will provide important information on the threat of pathogens in the space environment, which will assist with development of diagnostic tools to monitor the atmosphere, water and surfaces for the presence of these microbes. Understanding the molecular responses of these organisms to spaceflight is a necessary step that will significantly contribute to development of systems that meet requirements for supplying and storing potable water that is free of microbial contaminants. Furthermore, identification of the changes caused by spaceflight to genes and proteins will provide novel targets for pharmacological intervention to prevent and control infectious disease, which will ultimately facilitate safe and productive long-term exploration of the moon and Mars.

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

Web Site

For more information on Microbe, visit:

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

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

Overview

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

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

History/Background

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

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

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

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

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

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

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

Benefits

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

Bioavailability and Performance Effects of Promethazine During Spaceflight (PMZ)

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

Overview

Promethazine (PMZ) is used to treat space motion sickness (SMS) 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 crewmembers 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 SMS are essential for determining optimal dosage and route of administration of PMZ in flight.

Research Operations

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.

Flight History/Background

This experiment began in 2001 and will be continued on STS-1212/ULF1.1.

Benefits

This study will lead to a better understanding of how Promethazine is handled by the body in space. This will also help determine the side effects of Promethazine. By understanding these aspects of Promethazine, scientists will be able to 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/list.html

Passive Observatories for Experimental Microbial Systems in Microgravity (POEMS)

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

Overview

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

Research Summary

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

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

Research Operations

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

Flight History/Background

POEMS will be launched on ULF1.1 (STS-121).

Web Sites

For more information on POEMS, visit:

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

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

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

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

Project Manager: Michelle Kamman, NASA Johnson Space Center

Operations: Inflight

Objective

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

Brief Summary

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

Strategic Objective Mapping

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

Space Applications

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

Earth Applications

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

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

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

Research Leads: Richard DeLombard, NASA Glenn Research Center
Kenol Jules, NASA Glenn Research Center

Overview

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

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

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

Space Acceleration Measurement System II (SAMS-II)

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

The Space Acceleration Measurement System II (SAMS-II) began operations on International Space Station Mission 6A. It measures vibrations that affect nearby experiments. SAMS-II uses small remote triaxial sensor systems that are placed directly next to experiments throughout the laboratory module. In EXPRESS (Expedite the Processing of Experiments to the Space Station) Racks 1 and 4, it will remain on board the Station permanently.

As the sensors measure accelerations electronically, they transmit the measurements to the interim control unit located in an EXPRESS rack drawer.

SAMS-II is designed to record accelerations for the lifetime of the Space Station. As larger, facility-size experiments fill entire space station racks in the future, the interim control unit will be replaced with a more sophisticated computer control unit. It will allow on-board data analysis and direct dissemination of data to the investigators' telescience centers at university laboratories and other locations around the world.

Microgravity Acceleration Measurement System (MAMS)

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

The Microgravity Acceleration Measurement System (MAMS) measures accelerations that affect the entire Space Station, including experiments inside the laboratory. It fits in a double middeck locker, in the U.S. Laboratory Destiny in EXPRESS Rack No.1. It was preinstalled in the rack, which was placed in the laboratory during Expedition 2, ISS Flight 6A. It will remain on board the Station permanently.

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

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

History/Background

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

Space Experiment Module (SEM)

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

Increment(s) Assigned: 10, 11, 13

Overview

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

Students select the items that will be contained inside the vials. Some of the items include seeds, such as corn, watermelon, cucumber, beans, peas and several other vegetable seeds. Additional items include materials such as wool, Kevlar, silk, ultraviolet beads, chicken bones, copper, plastic, dextrose, yeast, over-the-counter medications, human hair, mineral samples, light bulbs and brine shrimp eggs. Many students will test for seed growth after microgravity exposure; other students test how materials protect against radiation exposure and survival rates of microscopic life forms.

Flight History/Background

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

Benefits

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

Web Site

For more information on SEM, visit:

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

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

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

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

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

Overview

The success and effectiveness of manned spaceflight depends on the ability of crewmembers to maintain a high level of cognitive performance and vigilance while operating and monitoring sophisticated instrumentation. Astronauts during short space flights, however, commonly experience sleep disruption and may experience misalignment of circadian phase during spaceflight. Both of these conditions are associated with insomnia, and impairment of alertness and cognitive performance. Relatively little is known of the prevalence or cause of spaceflight induced insomnia in short duration missions. This experiment will use state of the art ambulatory technology to monitor sleep-wake activity patterns and light exposure in crewmembers aboard the space shuttle. Subjects will wear a small, light-weight activity and light recording device (Actiwatch) for the entire duration of their mission. The sleep-wake activity and light exposure patterns obtained in-flight will be compared with baseline data collected on Earth before and after spaceflight. These data should help us better understand the effects of spaceflight on sleep as well as aid in the development of effective countermeasures for short duration spaceflight.

Benefits

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

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

Web Site

For more information on this experiment, visit:

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

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

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

Overview

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

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

Flight History/Background

The MIT Space Systems Laboratory is developing the SPHERES formation flight test bed to provide the Air Force and NASA with a long-term, replenishable and upgradeable test bed for the validation of high-risk metrology, control and autonomy technologies. The technologies are critical to the operation of distributed satellite and docking missions such as TechSat 21, Starlight, Terrestrial Planet Finder and Orbital Express.

Expedition 8 and 9 crews worked with this experiment.

Benefits

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

For more information on SPHERES visit:

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

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

A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft (SWAB)

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

Overview

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

Research Summary

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

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

Research Operations

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

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

Objectives

The objectives are:

- A thorough analysis for microbial pathogens and allergens that may come into contact with the crew of the Station.
- An evaluation of the environmental ecology to assess potential threats to the ISS crew, its systems and spacecraft integrity.

Benefits

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

Flight History/Background

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

More Information

For more information on SWAB, visit:

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

Tropi
Analysis of a Novel Sensory Mechanism in Root Phototropism

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

Payload Developer: Ames Research Center, Moffett Field, Calif.

Increment(s) Assigned: 13

Research Summary

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

The primary objectives of Tropi are:

- To understand the mechanisms by which plant roots respond to varying levels of both light and gravity.
- To determine how plants organize multiple sensory inputs, like light and gravity.
- To gain insight into how plants grow in space to help create sustainable life support systems for long-term space travel.

Research Description

Tropi consists of dry *Arabidopsis thaliana* (thale cress) seeds stored in small seed cassettes. *Arabidopsis thaliana* is a rapidly growing, flowering plant in the mustard family. The seed cassettes will be flown inside the European Modular Cultivation System (EMCS). The seeds will remain dry and at ambient temperature until hydrated by an automated system of the EMCS. At specified times during the experiment, the plants will be stimulated by different light spectrums and by different gravity gradients. The only work required by the crew is to replace videotapes and harvest the plants when they are grown. Once the plants are harvested, they will be stored in the Minus Eighty-degree Laboratory Freezer for ISS (MELFI) until their return to Earth.

Web Site

For more information on Tropi, visit:

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

The New Digital NASA Television

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

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

Digital NASA TV has four digital channels:

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

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

Internet Information

Information is available through several sources on the Internet. The primary source for mission information is the NASA 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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