

National Aeronautics and Space Administration



INTERNATIONAL SPACE STATION EXPEDITION 18



Gearing Up for a Crew of Six



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EXPEDITION 18

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Mission Overview

Expedition 18: Setting the Stage for Six-Person Crew



Russian Federal Space Agency cosmonaut Yury Lonchakov (left), Expedition 18 flight engineer; NASA astronaut E. Michael Fincke, commander; Sandra Magnus, flight engineer; Japan Aerospace Exploration Agency astronaut Koichi Wakata, flight engineer; and American spaceflight participant Richard Garriott following an Expedition 18/Soyuz 17 preflight press conference at NASA's Johnson Space Center.

On Oct. 12, an American astronaut, a Russian cosmonaut and an American spaceflight participant will be launched aboard the Soyuz TMA-13 spacecraft to the International Space Station from the Baikonur Cosmodrome in Kazakhstan. The crew will replace two Russians, who have been in space for six months, while a NASA astronaut remains onboard for another month awaiting his ride home on the space shuttle Endeavour. The arrival of the Expedition 18 crew marks the beginning of a testing period of equipment that

will support the expansion of the station to six people next spring.

Making his second flight into space, NASA astronaut E. Michael Fincke, 41, an Air Force colonel, will become the first American to launch for a second time on a Soyuz vehicle. He was a flight engineer and NASA science officer during the Expedition 9 mission to the complex in 2004, spending 188 days in space, 186 days aboard the orbital outpost. Joining Fincke is veteran Russian cosmonaut Yury Lonchakov (pron: LAHN'-chuh-coff), 43, a



Russian Air Force colonel, who will serve as flight engineer and Soyuz commander for launch, landing and in-orbit operations. This is Lonchakov's third flight and third trip to the station, having served as a mission specialist on the STS-100 mission on Endeavour in 2001 that delivered the Canadarm2 robotic arm to the complex and a flight engineer aboard Soyuz TMA-1 in 2002 that brought a new Soyuz return craft to the space station for its resident crew.

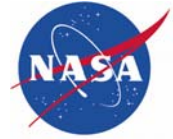
Fincke and Lonchakov will be joined for launch by Richard Garriott (GAH'-ree-ott), 47, an American computer game developer and the son of veteran NASA astronaut Owen Garriott.

He will spend nine days on the station under a commercial agreement with the Russian Federal Space Agency, returning to Earth in the Soyuz TMA-12 spacecraft on Oct. 24 with Expedition 17 Commander Sergey Volkov (SIR'-gay VOHL'-koff), 35, and Oleg Kononenko (AH'-leg Ko-no-NEN'-ko) 44, who have been aboard the station since April 10.

For launch, Fincke will be in the left seat of the Soyuz as board engineer while Lonchakov occupies the center seat as Soyuz commander. Lonchakov's call sign for launch, docking and landing in April 2009 will be "Titan". Garriott will be in the right seat of the Soyuz.



From the left, spaceflight participant Richard Garriott, along with cosmonaut Yury Lonchakov and astronaut E. Michael Fincke, flight engineer and commander, respectively, for the Expedition 18 mission of the International Space Station, listen to a briefing during a day of fit checks and rehearsals at the site of their scheduled Oct. 12 launch from the Baikonur launch complex in Kazakhstan. Photo Credit: NASA/Victor Zelentsov.



Two days after launch, the Soyuz TMA-13 craft will dock to the Zarya module of the Russian segment of the station. That will occur just five weeks before the commemoration of the 10th anniversary of Zarya's launch Nov. 20, 1998, as the first component to arrive in orbit for the International Space Station.

Once hatches are opened, Fincke and Lonchakov will join NASA flight engineer and science officer Greg Chamitoff (SHAM'-uh-toff), 46, who arrived at the station on the shuttle Discovery in June. Chamitoff will be replaced in November by NASA astronaut Sandra Magnus, 44, during shuttle Endeavour's STS-126 mission to the station that will bring Chamitoff home.

Endeavour's crew will deliver new hardware and supplies to the space station from the Leonardo Multi-Purpose Logistics Module that will be berthed to the Earth-facing port of the Harmony connecting module for the duration of the shuttle's visit. The hardware will include new environmental systems to support the expansion of the station to six crew members next year, including a second toilet, a new treadmill, a water regeneration system, additional sleeping quarters and an additional oxygen generation system.

Fincke, Lonchakov and Magnus will spend a good portion of their increment testing and activating the new systems.

Before Endeavour's arrival, one of the three External Stowage Platforms (ESP-3) on the station will be robotically detached from the P3 truss by Fincke and Chamitoff and temporarily located to an attachment device on the Mobile Transporter railcar. This will facilitate the movement of items from Endeavour's payload bay to the station during STS-126. After Endeavour's logistics resupply and delivery mission, Fincke and Magnus will return the stowage platform to its parking place on the truss.

Fincke and Lonchakov will see another partial crew rotation during their six months in space. Magnus will be replaced by Japan Aerospace Exploration Agency (JAXA) astronaut Koichi Wakata (Koh-EE'-chee Wah-KAH'-tah), 45, in February 2009 on the STS-119 mission that delivers the final set of U.S. solar arrays, the S6 truss, to the station. Wakata, who will become the first Japanese long-duration crew member on the station, will return to Earth on the STS-127 mission next spring after the arrival of the Expedition 19 crew, which will succeed Fincke and Lonchakov in late March.

Once on board, Fincke and Lonchakov will conduct more than a week of handover activities with Volkov, Kononenko and Chamitoff, familiarizing themselves with station systems and procedures. They also will receive proficiency training on the Canadarm2 robotic arm from the resident crew and engage in safety briefings as well as payload and scientific equipment training.



Expedition 18 crew members participate in a space station emergency scenarios training session in the Space Vehicle Mockup Facility at NASA's Johnson Space Center. Pictured are Japan Aerospace Exploration Agency (JAXA) astronaut Koichi Wakata (foreground), flight engineer; NASA astronaut E. Michael Fincke (center, partially obscured), commander; Sandra Magnus, and Russian Federal Space Agency cosmonaut Yuri V. Lonchakov (left, partially obscured), both flight engineers.

The change of command ceremony during the docked operations between crews will mark the formal handover of the station to Fincke and Lonchakov, just days before the Expedition 17 crew members and Garriott depart the station.

After landing, Volkov, Kononenko and Garriott will be flown from Kazakhstan to the Gagarin Cosmonaut Training Center in Star City for about two weeks of initial physical rehabilitation. Due to the brevity of his flight, Garriott will spend significantly less time acclimating himself to Earth's gravity than his Russian colleagues.

Taking advantage of the new Columbus and Kibo science modules, the Expedition 18 crew will work with experiments across a wide variety of fields, including human life sciences, physical sciences and Earth observation, as well as education and technology demonstrations. Many experiments are designed to gather information about the effects of long-duration spaceflight on the human body, which will help with planning future exploration missions to the moon and Mars. Science teams at the Payload Operations Integration Center at NASA's Marshall Space Flight Center in Huntsville, Ala., ESA's Columbus Control Center in Oberpfaffenhofen, Germany, and



JAXA's Space Station Integration and Promotion Facility in Tsukuba, Japan, will oversee the operation of experiments and consult with the crew, when required, to ensure the best scientific data return possible.

In addition to the two shuttle missions that will arrive with supplies for the station during Expedition 18, the resident crew is expected to greet the arrival of two Russian Progress resupply cargo ships filled with food, fuel, water and supplies. The ISS Progress 31 cargo is targeted to reach the station shortly after Thanksgiving, and ISS Progress 32 is slated to arrive in February.

After four spacewalks on Expedition 9, Fincke is scheduled to don a Russian Orlan spacesuit shortly before Christmas and venture outside the Pirs Docking Compartment with Lonchakov. They will install a navigation antenna on Zvezda for next year's docking of a new Russian research module, called the Mini-Research Module 2 (MRM2), the first of two such modules that also will serve as docking ports and airlocks for spacewalks for six-person crew operations. The pair also will install scientific equipment on the hull of Zvezda. The spacewalk will be the first for Lonchakov.

Starting in late January 2009, Fincke and Magnus will begin extensive testing of the Japanese robotic arm attached to the forward end of Kibo that arrived at the station last June. All of the new arm's joints, brakes and software will be checked out over a two-month period. During STS-127 in May 2009, Wakata will use the arm to move experiments from a Japanese platform that will be temporarily attached to the new Exposed Section of Kibo, a "front porch," to JAXA's lab. The lab will house a variety of biological, materials sciences and fluids experiments.



Astronauts Sandra H. Magnus, Expedition 18 flight engineer, and E. Michael Fincke (partially obscured), commander, are about to be submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near NASA's Johnson Space Center. Magnus and Fincke are attired in training versions of their Extravehicular Mobility Unit (EMU) spacesuits.

In late March, Expedition 19 Commander Gennady Padalka and flight engineer and NASA science officer Michael Barratt will arrive at the station on Soyuz TMA-14. Fincke and Lonchakov will board the Soyuz TMA-13 and depart the complex after six months in orbit, bringing Expedition 18 to a close with a landing in north central Kazakhstan.



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Expedition 18 Crew



Expedition 18 Patch

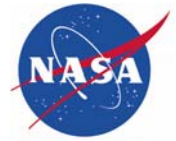
This emblem represents the 18th expedition to the International Space Station. Featured prominently is the Roman numeral XVIII. The “X” evokes exploration, which is at the core of the indivisible cooperation of the International Space Station partners. “V” is for victory and for the five space agencies in the ISS Program.

“III” stands for the hope that this crew will help evolve the station from supporting the last three-person crew to crews of six explorers and researchers. The moon, sun and stars symbolize the efforts of the entire space station team, which will lead to the human exploration of the moon, our solar system and beyond.



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From top left Japan Aerospace Exploration Agency astronaut Koichi Wakata; NASA astronauts Sandra Magnus, flight engineer; Greg Chamitoff, flight engineer; E. Michael Fincke, commander (bottom left); and Russian Federal Space Agency cosmonaut Yuri Lonchakov.

Short biographical sketches of the crew follow with detailed background available at:

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



E. Michael Fincke

Astronaut E. Michael Fincke, a colonel in the U.S. Air Force, will command the Expedition 18 mission. He holds master's degrees in aeronautics and astronautics and physical sciences. He previously served as flight engineer and NASA space station science officer on Expedition 9 in 2004. Fincke's first mission to the International Space Station

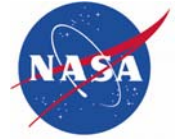
lasted 187 days, 21 hours and 17 minutes. He also logged 15 hours, 45 minutes and 22 seconds of spacewalking time in four spacewalks. Before being named commander of Expedition 18, he served as backup commander for Expeditions 13 and 16. He will return to Earth in March 2009.



Yury Lonchakov

Cosmonaut Yury Lonchakov, a colonel in the Russian Air Force, will serve as a flight engineer and Soyuz commander for Expedition 18. He was selected as a test-cosmonaut candidate of the Gagarin Cosmonaut Training Center Cosmonaut Office in 1997. This will be his third trip to the International Space Station. Lonchakov was a

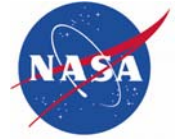
mission specialist on STS-100, which visited the complex in 2001, and he returned to the station in 2002 as part of the Soyuz TMA-1 crew. He has logged 22 days, 16 hours and 23 minutes in space from his two previous spaceflight missions. He will return to Earth in March 2009.



Greg Chamitoff

Astronaut Greg Chamitoff made his first spaceflight aboard STS-124 and joined Expedition 17 in progress. He holds a doctorate in aeronautics and astronautics. Selected by NASA in 1998, Chamitoff has worked in the Astronaut Office robotics branch. He also served as the lead CAPCOM for Expedition 9 and as the crew support astronaut

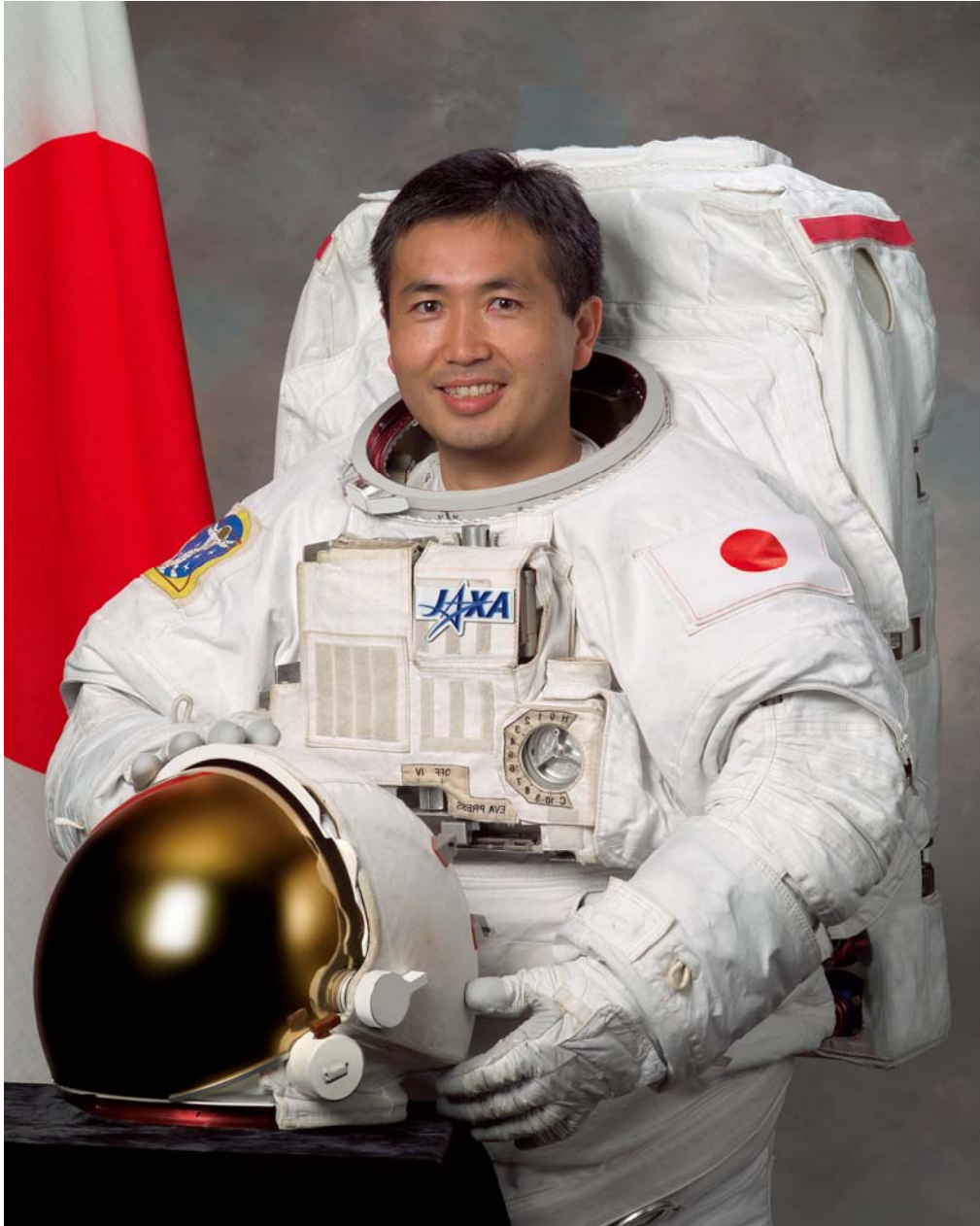
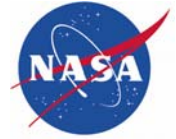
for Expedition 6. He was part of the NEEMO 3 mission, living on the bottom of the sea in the Aquarius habitat for nine days. He is serving as a flight engineer and science officer for Expedition 17 and will continue his duties during the transition to Expedition 18 aboard station. He is scheduled to return on shuttle mission STS-126, targeted for November 2008.



Sandra Magnus

Astronaut Sandra Magnus will fly to the International Space Station on shuttle mission STS-126 and will return to Earth on STS-119. She holds a doctorate in material science and engineering. Selected by NASA in 1996, Magnus previously served as a mission specialist on STS-112, which visited the station in 2002. During STS-112, Magnus operated

the space station's robotic arm during the three spacewalks the crew performed to continue the assembly of the station. She has been training for long-duration missions to the space station since 2005. She will serve as a flight engineer and NASA space station science officer for Expedition 18.



Koichi Wakata

Japan Aerospace Exploration Agency (JAXA) astronaut Koichi Wakata will fly to the International Space Station on shuttle mission STS-119 and join the Expedition 18 crew as a flight engineer. He holds a doctorate in aerospace engineering. He was selected as an astronaut candidate by the National Space Development Agency of Japan (NASDA) in

1992. Wakata has logged 21 days, 19 hours, 41 minutes and 5 seconds in space from his two previous spaceflights on STS-72 and STS-92. He has been training for a long-duration expedition on the station since 2001. He will be the first resident station crew member from JAXA. He will return to Earth on the STS-127 mission.



Richard Garriott
Spaceflight Participant

American Richard Garriott is a video game pioneer, entrepreneur and son of astronaut Owen Garriott. He is best known for creating the longest running role-playing game series, Ultima, which has been produced since the

1980's. Garriott will launch to the International Space Station as a spaceflight participant on a Soyuz spacecraft with the Expedition 18 crew and will return on a Soyuz spacecraft with the Expedition 17 crew.



Expedition 18 Mission Milestones

(Dates are subject to change)

2008:

- Oct. 12 Expedition 18 launch from the Baikonur Cosmodrome, Kazakhstan on Soyuz TMA-13 with U.S. spaceflight participant
- Oct. 14 Expedition 18 docks to the International Space Station's Zarya module on Soyuz TMA-13 with U.S. spaceflight participant
- Oct. 21 Change of command ceremony with departing Expedition 17 crew
- Oct. 23 Undocking and landing of Expedition 17 crew from Pirs Docking Compartment and landing in Kazakhstan on Soyuz TMA-12 with U.S. spaceflight participant
- Nov. 14 Launch of Endeavour on the STS-126/ULF-2 mission from the Kennedy Space Center
- Nov. 28 Docking of Endeavour to ISS Pressurized Mating Adapter-2 (PMA-2); Magnus and Chamitoff swap places as Expedition 18 crew members
- TBD Undocking of ISS Progress 30 from Zvezda Service Module aft port
- Nov. 26 Launch of ISS Progress 31 from the Baikonur Cosmodrome in Kazakhstan
- Nov. 29 Undocking of Endeavour from ISS PMA-2
- Nov. 30 Docking of ISS Progress 31 to the Pirs Docking Compartment
- Dec. 1 Landing of Endeavour to complete STS-126/ULF-2
- Dec. 18 Russian spacewalk No. 21 by Lonchakov and Fincke Out of Pirs Docking Compartment

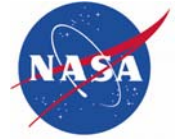
2009:

- Feb. 9 Undocking of ISS Progress 31 from the Pirs Docking Compartment
- Feb. 10 Launch of ISS Progress 32 from the Baikonur Cosmodrome in Kazakhstan
- Feb. 12 Docking of ISS Progress 32 to the Pirs Docking Compartment; launch of Discovery on the STS-119/15A mission from the Kennedy Space Center
- Feb. 14 Docking of Discovery to ISS Pressurized Mating Adapter-2 (PMA-2); Wakata and Magnus swap places as Expedition 18 crew members



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Feb. 23	Undocking of Discovery from PMA-2
Feb. 26	Landing of Discovery to complete STS-119/15A
March 25	Launch of the Expedition 19 crew and an Australian spaceflight participant on the Soyuz TMA-14 from the Baikonur Cosmodrome in Kazakhstan
March 27	Docking of the Expedition 19 crew and an Australian spaceflight participant on the Soyuz TMA-14 to the aft port of the Zvezda Service Module
April 5	Undocking of the Expedition 18 crew and an Australian spaceflight participant from the Zarya Module and landing in Kazakhstan on Soyuz TMA-13



Expedition 18 Spacewalks

There are no U.S.-based spacewalks currently scheduled for Expedition 18; however, Commander E. Michael Fincke and Flight Engineer Yury Lonchakov plan to venture outside the Russian segment's Pirs Docking

Compartment in December for the station's 21st Russian spacewalk.

It will be Fincke's fifth time to don one of the Russian Orlan spacesuits and Lonchakov's first.



Astronaut E. Michael Fincke, Expedition 18 commander, gets help donning a training version of the Extravehicular Mobility Unit (EMU) spacesuit before being submerged in the waters of the Neutral Buoyancy Laboratory (NBL) near the Johnson Space Center.

The plans for the spacewalk are still in work, but several tasks have already been identified. Fincke and Lonchakov will be installing the Expose-R and Impuls experiments on the exterior of the Zvezda Service Module. Expose-R is a European Space Agency experiment that will arrive on a Progress vehicle scheduled to launch in November. It is

designed to expose organic material to the extreme environment of space. Impuls explores the ionosphere plasma environment.

As part of a continuing experiment, the spacewalkers also will be removing a container from the Russian Biorisk experiment. Biorisk studies how changes in solar activity affect the



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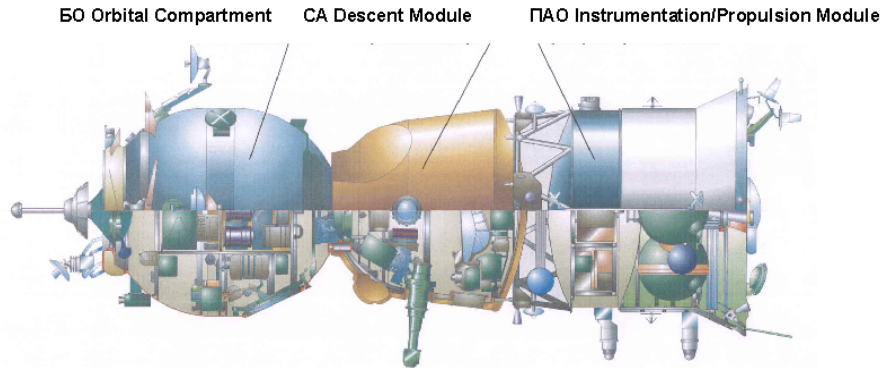


growth of microbial bacteria and fungi on materials used to build spacecraft. The container Fincke and Lonchakov remove will be returned to Earth for examination.

They'll also take advantage of their time outside to close a multilayer insulation flap on the Zvezda module opened during the last Russian spacewalk and reorient the SKK experiment, which was moved accidentally during a previous spacewalk.



Russian Soyuz TMA



The Soyuz TMA spacecraft is designed to serve as the ISS'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 crew member, individually molded to fit each person's body – this ensures a tight, comfortable fit when the module lands on the Earth. When crew members are brought to the station aboard the space shuttle, their seat liners are brought with them and transferred to the 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 crew members 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.

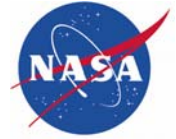
TMA Improvements and Testing

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 crew member 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 crew members 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 uncrewed supply spacecraft, while the new



cooling system was tested on two Soyuz TM flights.

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

Soyuz Launcher

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

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

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

First Stage Boosters

The first stage's four boosters are assembled 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.



A Soyuz launches from the Baikonur Cosmodrome, Kazakhstan.



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



Prelaunch Countdown Timeline (concluded)

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

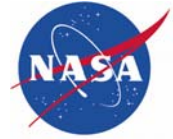
Ascent/Insertion Timeline

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

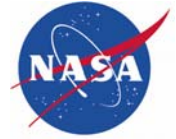
FLIGHT DAY 1 OVERVIEW	
Orbit 1	Post insertion: Deployment of solar panels, antennas and docking probe
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital insertion 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
Orbit 4	DV1 phasing burn while LOS
	- Crew monitor only, no manual action nominally required
	DV2 phasing burn while LOS
	- Crew monitor only, no manual action nominally required



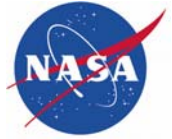
FLIGHT DAY 1 OVERVIEW (CONTINUED)	
Orbit 4 (continued)	Crew report on burn performance upon AOS
	- HM and DM pressure checks read down
	- Post burn Form 23 (AOS/LOS pad), Form 14 and "Globe" corrections voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	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.



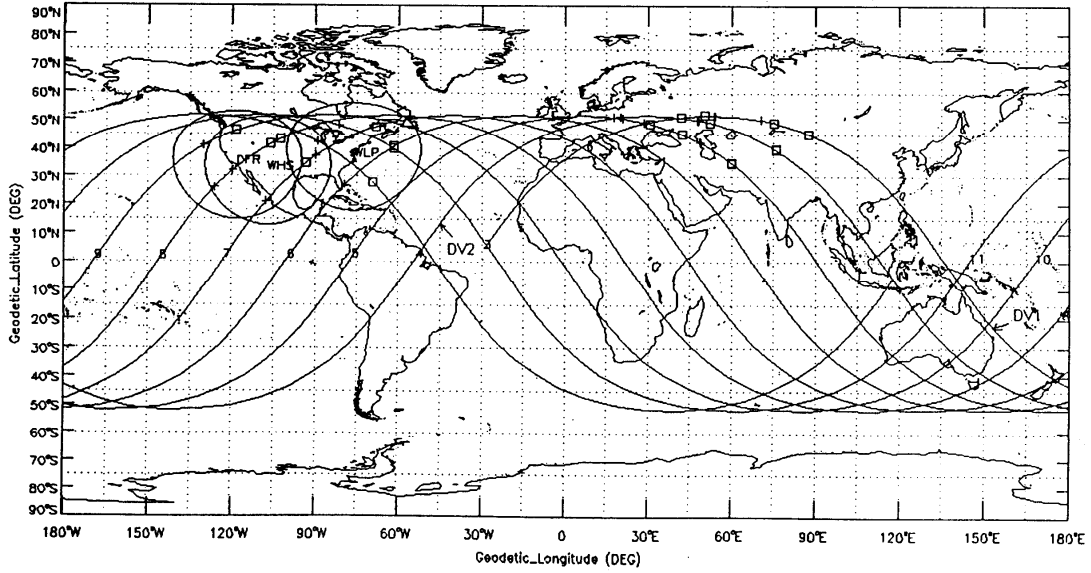
FLIGHT DAY 2 OVERVIEW (CONTINUED)	
Orbit 18 (2)	Post burn and manual maneuver to +Y Sun report when AOS
	- HM/DM pressures read down
	- Post burn Form 23, Form 14 and Form 2 (Globe correction) voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 19 (3)	- Radar and radio transponder tracking
	CO2 scrubber cartridge change out
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 20 (4)	- Radar and radio transponder tracking
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 21 (5)	- Radar and radio transponder tracking
	Last pass on Russian tracking range for Flight Day 2
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
Orbit 22 (6) - 27 (11)	- Radar and radio transponder tracking
	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 (CONCLUDED)	
Orbit 32 (16)	Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)
	Begin auto rendezvous sequence
	- Crew monitoring of LVLH reference build and auto rendezvous timeline execution
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radio transponder tracking
FLIGHT DAY 3 FINAL APPROACH AND DOCKING	
Orbit 33 (1)	Auto Rendezvous sequence continues, flyaround and station keeping
	- Crew monitor
	- Comm relays via SM through Altair established
	- Form 23 and Form 14 updates
	- Fly around and station keeping initiated near end of orbit
	- A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair)
	- Radio transponder tracking
Orbit 34 (2)	Final Approach and docking
	- Capture to "docking sequence complete" 20 minutes, typically
	- Monitor docking interface pressure seal
	- Transfer to HM, doff Sokol suits
	- A/G (gnd stations and Altair), R/T TLM (gnd stations), Display TV downlink (gnd stations and Altair)
	- Radio transponder tracking
FLIGHT DAY 3 STATION INGRESS	
Orbit 35 (3)	Station/Soyuz pressure equalization
	- Report all pressures
	- Open transfer hatch, ingress station
	- A/G, R/T and playback telemetry
	- Radio transponder tracking



Typical Soyuz Ground Track





Key Times for Expedition 18/17 ISS Events

Expedition 18/SFP Launch on Soyuz TMA-13

2:01:29 a.m. CT on Oct. 12

7:01:29 GMT on Oct. 12

11:01:29 a.m. Moscow time on Oct. 12

13:01:29 p.m. Baikonur time on Oct. 12

Expedition 18/SFP Docking to ISS on Soyuz TMA-13 (Zarya module nadir port)

3:33 a.m. CT on Oct. 14

8:33 GMT on Oct. 14

12:33 p.m. Moscow time on Oct. 14

Expedition 18/SFP Hatch Opening to ISS

5 a.m. CT on Oct. 14

10:00 GMT on Oct. 14

14:00 p.m. Moscow time on Oct. 14

Expedition 17/SFP Hatch Closing to ISS

4:15 p.m. CT on Oct. 23

21:15 GMT on Oct. 23

1:15 a.m. Moscow time on Oct. 24

3:15 a.m. Kazakhstan time on Oct. 24

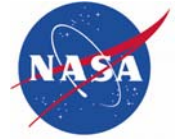
Expedition 17/SFP Undocking from ISS on Soyuz TMA-12 (Pirs Docking Compartment)

7:15 p.m. CT on Oct. 23

00:15 GMT on Oct. 24

4:15 a.m. Moscow time on Oct. 24

6:15 a.m. Kazakhstan time on Oct. 24



Expedition 17/SFP Deorbit Burn on Soyuz TMA-12

9:44:29 p.m. CT on Oct. 23

2:44:29 GMT on Oct. 24

6:44:29 a.m. Moscow time on Oct. 24

8:44:29 a.m. Kazakhstan time on Oct. 24

Expedition 17/SFP Landing in Soyuz TMA-12

10:36:07 p.m. CT on Oct. 23

3:36:07 GMT on Oct. 24

7:36:07 a.m. Moscow time on Oct. 24

9:36:07 a.m. Kazakhstan time on Oct. 24 (approximately 1:24 after sunrise at the landing site)



Expedition 17/Soyuz TMA-12 Landing

Following a nine-day handover with the newly arrived Expedition 18 crew, Expedition 17 and Soyuz Commander Sergei Volkov, Flight Engineer Oleg Kononenko and U.S. spaceflight participant Richard Garriott will board their Soyuz TMA-12 capsule for undocking and a one-hour descent back to Earth. Volkov and Kononenko will complete a six-month mission in orbit, while Garriott will return after an 11-day flight.

About three hours before undocking, Volkov, Kononenko and Garriott will bid farewell to the new Expedition 18 crew, Commander E. Michael Fincke, Flight Engineer Yury Lonchakov and Flight Engineer Greg Chamitoff, who arrived at the station in June on the shuttle Discovery. The departing crew will climb into the Soyuz vehicle, closing the hatch between Soyuz and the Pirs Docking Compartment. Kononenko will be seated in the Soyuz' left seat for entry and landing as on-board engineer. Volkov will be in the center seat as Soyuz commander as he was for the April launch, and Garriott will occupy the right seat.

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

Volkov will fire the Soyuz thrusters to back away from Pirs. Six minutes after undocking, with the Soyuz about 66 feet away from the station, Volkov will conduct a separation maneuver, firing the Soyuz jets for about 15 seconds to begin to depart the vicinity of the complex.

About 2.5 hours after undocking, at a distance of about 12 miles from the station, Soyuz computers will initiate a deorbit burn braking maneuver. The 4.5-minute maneuver to slow

the spacecraft will enable it to drop out of orbit and begin its re-entry to Earth.

About 30 minutes later, just above the first traces of the Earth's atmosphere, computers will command the pyrotechnic separation of the three modules of the Soyuz vehicle. With the crew strapped in the middle descent module, the uppermost orbital module containing the docking mechanism and rendezvous antennas, and the instrumentation and propulsion module at the rear, which houses the engines and avionics, will 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 about three minutes after module separation at the point called entry interface, when the module is about 400,000 feet above the Earth.

About eight minutes later, at an altitude of about 33,000 feet, traveling at about 722 feet 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 79 square feet. Within 16 seconds, the Soyuz's descent will slow to about 262 feet per second.

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

A few minutes before touchdown, 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 3,281 feet. The



deployment of the main parachute slows down the descent module to a velocity of about 23 feet per second. Initially, the descent module will hang underneath the main parachute at a 30-degree angle with respect to the horizon, for aerodynamic stability. The bottommost harness will be severed a few minutes before landing, allowing the descent module to right itself to a vertical position through touchdown.

At an altitude of a little more than 16,000 feet, 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 dissipation of any residual propellant from the Soyuz. Computers also will arm the module's seat shock absorbers in preparation for landing.

When the capsule's heat shield is jettisoned, the Soyuz altimeter is exposed to the surface of the Earth. 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 39 feet, cockpit displays will tell Volkov to prepare for the soft landing engine firing. Just 3 feet above the surface, and just seconds before touchdown, the six solid propellant engines are fired in a final braking maneuver. This enables the Soyuz to settle down to a velocity of about 5 feet per second and land to complete its mission.

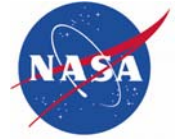
The last two Soyuz entries involving the Expedition 15 and 16 crews resulted in "ballistic" landings, safe but off-course landings that brought the Soyuz vehicles to landing sites

in Kazakhstan about 250 miles short of their intended target zones. It is believed that a problem with a pyrotechnic separation mechanism between the descent and instrumentation and propulsion modules triggered both "ballistic" entries. As is always the case, teams of Russian engineers, flight surgeons and technicians in fleets of MI-8 helicopters will be poised near the nominal and "ballistic" landing zones to perform the swift recovery of Volkov, Kononenko and Garriott once the capsule touches down.

A portable medical tent will be set up near the capsule in which the crew can change out of its launch and entry suits. Russian technicians will open the module's hatch and begin to remove the crew members. They will be seated in special reclining chairs near the capsule for initial medical tests and to have a chance to begin readapting to Earth's gravity.

About two hours after landing, the crew will be assisted to the recovery helicopters for a flight back to a staging site in northern Kazakhstan, where local officials will welcome them. The crew then will board a Russian military 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 around eight hours between landing and the return to Star City.

Assisted by a team of flight surgeons, Volkov and Kononenko will undergo several weeks of medical tests and physical rehabilitation. Garriott's acclimation to Earth's gravity will take a much shorter period of time due to the brevity of his flight.



Soyuz Entry Timeline

This is the entry timeline for Soyuz TMA-12.

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

7:12 p.m. CT on Oct. 23

00:12 GMT on Oct. 24

4:12 a.m. Moscow time on Oct. 24

6:12 a.m. Kazakhstan time on Oct. 24

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

7:15 p.m. CT on Oct. 23

00:15 GMT on Oct. 24

4:15 a.m. Moscow time on Oct. 24

6:15 a.m. Kazakhstan time on Oct. 24

Separation Burn from ISS (15 second burn of the Soyuz engines, .65 meters/sec; Soyuz distance from the ISS is ~20 meters)

7:18 p.m. CT on Oct. 23

00:18 GMT on Oct. 24

4:18 a.m. Moscow time on Oct. 24

6:18 a.m. Kazakhstan time on Oct. 24

Deorbit Burn (appx 4:19 in duration, 115.2 m/sec; Soyuz distance from the ISS is ~12 kilometers; Undocking Command appx + ~2 hours, 30 mins.)

9:44:29 p.m. CT on Oct. 23

2:44:29 GMT on Oct. 24

6:44:29 a.m. Moscow time on Oct. 24

8:44:29 a.m. Kazakhstan time on Oct. 24



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

~10:08 p.m. CT on Oct. 23

~3:08 GMT on Oct. 24

~7:08 a.m. Moscow time on Oct. 24

~9:08 a.m. Kazakhstan time on Oct. 24

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

10:12:35 p.m. CT on Oct. 23

3:12:35 GMT on Oct. 24

7:12:35 a.m. Moscow time on Oct. 24

9:12:35 a.m. Kazakhstan time on Oct. 24

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

10:21:07 p.m. CT on Oct. 23

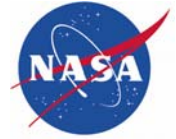
3:21:07 GMT on Oct. 24

7:21:07 a.m. Moscow time on Oct. 24

9:21:07 a.m. Kazakhstan time on Oct. 24

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

10:36:07 p.m. CT on Oct. 23

3:36:07 GMT on Oct. 24

7:36:07 a.m. Moscow time on Oct. 24

9:36:07 a.m. Kazakhstan time on Oct. 24 (~1:24 after sunrise at the landing site)



EXPEDITION 18

Gearing Up for a Crew of Six



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International Space Station: Expedition 18 Science Overview

Expedition 18, the 18th science research mission on the International Space Station, includes the operation of 40 NASA-managed experiments in human research, exploration technology testing, biological and physical sciences, and education. An additional 33 experiments are planned for operation by the international partners – the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA).

During Expedition 18, the scientific work of more than 300 scientists will be supported through U.S.-managed experiments. The team of controllers and scientists on the ground will continue to plan, monitor and remotely operate experiments from control centers across the United States.

A team of controllers for Expedition 18 will staff 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.

The Payload Operations Center also coordinates the payload activities of NASA's international partners. While the partners are responsible for the planning and operations of their space agencies' modules, NASA's Payload Operations Center is chartered to synchronize the payload activities among the partners and optimize the use of valuable in-orbit resources.

Human Life Science Investigations

Sampling and testing of crew members will be used to study changes in the body caused by

living in microgravity. Continuing and new experiments include:

Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss (Bisphosphonates) will determine whether antiresorptive agents, or those that help reduce bone loss on Earth, in conjunction with the routine in-flight exercise program, will protect station crew members from the bone loss documented on previous missions.

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

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

Nutritional Status Assessment (Nutrition) is NASA's most comprehensive in-flight study to date of human physiologic changes during long-duration spaceflight. This study will impact both the definition of nutritional requirements and development of food systems for future space exploration missions to the moon and beyond. This experiment also will help researchers understand the impact of countermeasures, such as exercise and pharmaceuticals, on nutritional status and nutrient requirements for astronauts.



The National Aeronautics and Space Administration Biological Specimen Repository (Repository) is a storage bank used to maintain biological specimens over extended periods of time and under well-controlled conditions. Samples from the station, including blood and urine, will be collected, processed and archived during the preflight, in-flight and postflight phases of the missions. This investigation has been developed to archive biological samples for use as a resource for future spaceflight research.

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

Experiments Related to Spacecraft Systems

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

JPL Electronic Nose (ENose) is a full-time, continuously operating event, or incident monitor designed to detect air contamination from spills and leaks in the crew habitat inside the station. It is envisioned to be one part of a distributed system for automated monitoring and control of the breathing atmosphere in inhabited spacecraft in microgravity.

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

Multi-User Droplet Combustion Apparatus – Flame Extinguishment Experiment (MCDA-FLEX) will assess the effectiveness of fire suppressants in microgravity and quantify the effect of different possible crew exploration atmospheres on fire suppression. This will provide definition and direction for large-scale fire suppression tests and selection of the fire suppressant for next-generation crew exploration vehicles.

Materials on the International Space Station Experiment 6 A and B (MISSE-6A and 6B) is a test bed for materials and coatings attached to the outside of the space station that are being evaluated for the effects of atomic oxygen, direct sunlight, radiation and extremes of heat and cold. This experiment allows the development and testing of new materials to better withstand the rigors of space environments. Results will provide a better understanding of the durability of various materials in space, leading to the design of stronger, more durable spacecraft components.

Pico-Satellite Solar Cell Experiment (PSSC) is designed to test the space environment effects on new solar cell technologies for applications in the design of future spacecraft. It will provide a better understanding of the durability of various solar cell materials when they are exposed to the space environment.

Shuttle Exhaust Ion Turbulence Experiments (SEITE) will use space-based sensors to detect turbulence inferred from the radar observations from a previous space shuttle Orbital Maneuvering System burn experiment using ground-based radar. The research will enhance detection, tracking and timely surveillance of high interest objects in space.

Smoke Point In Co-flow Experiment (SPICE) determines the point at which gas-jet flames, similar to a butane-lighter flame, begin to emit soot in microgravity. Studying a soot-emitting



flame is important in understanding the ability of fires to spread in microgravity.

Biological and Physical Science Experiments

Plant growth experiments give insight into the effects of the space environment on living organisms. Physical science experiments explore fundamental processes – such as phase transitions or crystal growth – in microgravity. These experiments include:

Validating Vegetable Production Unit (VPU) Plants, Protocols, Procedures and Requirements (P³R) Using Currently Existing Flight Resources (Lada-VPU-P3R) is a study to advance the technology required for plant growth in microgravity and to research related food safety issues. It also investigates the non-nutritional value to the flight crew of developing plants in orbit.

The Optimization of Root Zone Substrates (ORZS) for Reduced Gravity Experiments Program was developed to provide direct measurements and models for plant rooting instructions that will be used in future advanced life support plant growth experiments. The goal is to develop and enhance hardware and procedures to allow optimal plant growth in microgravity.

Shear History Extensional Rheology Experiment (SHERE) is designed to investigate the effect of preshearing, or rotation on the stress and strain response of a polymer fluid – a complex fluid containing long chains of polymer molecules – being stretched in microgravity. The fundamental understanding and measurement of these complex fluids is important for fabrication of parts on future exploration missions.

Education and Earth Observation

Many experiments aboard the space station continue to teach the next generation of

explorers about living and working in space. 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 dynamic events such as storms, floods, fires and volcanic eruptions. These images provide researchers on Earth with key data to better understand the planet.

Crew Earth Observations – International Polar Year (CEO-IPY) supports an international collaboration of scientists studying the Earth's polar regions from 2007 to 2009. Space station crew members photograph polar phenomena including icebergs, auroras and mesospheric clouds in response to daily correspondence from the scientists on the ground.

Commercial Generic Bioprocessing Apparatus Science Insert – 02 (CSI-02) is an educational payload designed to interest middle school students in science, technology, engineering and math by participating in near real-time research conducted aboard the station. Students will observe four experiments through data and imagery downlinked and distributed directly into the classroom via the Internet. The first experiment will examine seed germination and plant development in microgravity. It will be followed by an experiment to examine yeast cells' adaptation to the space environment; another will examine plant cell cultures; and the final experiment, a silicate garden, will examine crystal growth formation using silicates, or compounds containing silicon, oxygen and one or more metals.

Commercial Generic Bioprocessing Apparatus Science Insert – 03 (CSI-03) provides K-12 teachers opportunities to use the unique microgravity environment of the space station as part of the regular classroom to encourage learning and interest in science,



technology, engineering and math. CSI-03 will examine the complete life cycle of the painted lady butterfly and the ability of an orb-weaving spider to spin a web, eat and remain healthy in space.

Earth Knowledge Acquired by Middle School Students (EarthKAM), an education experiment, allows middle school students to program a digital camera aboard the station to photograph a variety of geographical targets for study in the classroom. Photos are made available on the Web for viewing and study by participating schools around the world. Educators use the images for projects involving Earth science, geography, physics and technology.

Space Shuttle Experiments

Many other experiments are scheduled to be performed during upcoming space shuttle missions that are part of Expedition 18. These experiments include:

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

National Lab Pathfinder – Cells (NLP-Cells) comprises two experiments conducted by the U.S. Department of Agriculture aimed at understanding the effects of microgravity on living systems. One experiment will assess the effects of spaceflight on cattle cells. The other experiment examines the effects of spaceflight on liver cells.

National Lab Pathfinder – Vaccine 2 (NLP-Vaccine 2) is a commercial payload

serving as a pathfinder for use of the space station as a National Laboratory after station assembly is complete. This payload contains a pathogenic, or disease-carrying organism, and tests whether the organism changes in microgravity in a way that allows it to become a viable base for a potential vaccine against infections on Earth and in microgravity.

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

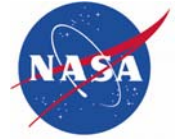
Shuttle Ionospheric Modification with Pulsed Localized Exhaust Experiments (SIMPLEX) will investigate plasma turbulence driven by rocket exhaust in the ionosphere using ground-based radars.

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

Reserve Payloads

Several additional experiments are ready for operation, but designated as “reserve” and will be performed if crew time becomes available. They include:

Agricultural Camera (AgCam) takes frequent images, in visible and infrared light, of vegetated areas on Earth, such as growing crops, rangeland, grasslands, forests and



wetlands in the northern Great Plains and Rocky Mountain regions of the United States. Images will be delivered within two days directly to requesting farmers, ranchers, foresters, natural resource managers and tribal officials to help improve environmental stewardship.

Binary Colloidal Alloy Test – 3 and 4: Critical Point (BCAT-3-4-CP) continues to investigate the long-term behavior of colloids – a system of fine particles suspended in a fluid – in a microgravity environment, where the effects of sedimentation and convection are removed. Results will help scientists develop fundamental physics concepts previously masked by the effects of gravity.

Binodal Colloidal Aggregation Test – 4: Polydispersion (BCAT-4-Poly) will use model hard-spheres to explore seeded colloidal crystal nucleation and the effects of polydispersity, providing insight into how nature brings order out of disorder. Crew members photograph samples of polymer and colloidal particles, tiny nanoscale spheres suspended in liquid, that model liquid/gas phase changes. Results will help scientists develop fundamental physics concepts previously cloaked by the effects of gravity.

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

Education Payload Operations – Demonstrations (EPO-Demos) are recorded video education demonstrations performed on the space station by crew members using hardware already on board the station. EPO-Demos are videotaped, edited and used to enhance existing NASA education resources and programs for educators and students in grades K-12. EPO-Demos are designed to

support the NASA mission to inspire the next generation of explorers.

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

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

Lab-on-a-Chip Application Development-Portable Test System – Exploration (LOCAD-PTS – Exploration) is a handheld device for rapid detection and quantification of biological substances aboard the space station. LOCAD-PTS-Exploration will test procedures that will ultimately support scientific activities during the human exploration of the moon and Mars. It will mark the first time that external surfaces of a spacecraft have been sampled for biological material during spacewalks, followed by analysis within the cabin environment.



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

Sleep-Wake Actigraphy and Light Exposure During Spaceflight – Long (Sleep-Long) examines the effects of spaceflight and ambient light exposure on the sleep-wake cycles of the crew members during long-duration stays on the space station. Results are vital to treating insomnia in space.

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

Vehicle Cabin Atmosphere Monitor (VCAM) identifies gases that are present in small quantities in the space station breathing air that could be harmful to crew health. If successful, instruments like this could accompany crew members during long-duration exploration missions to the moon or Mars.

Research Facilities

The space station is equipped with state-of-the-art research facilities to support science investigations:

The **Combustion Integrated Rack (CIR)** is used to perform combustion experiments in microgravity. It is designed to be easily reconfigured in orbit to accommodate a wide variety of combustion experiments.

The **General Laboratory Active Cryogenic ISS Experiment Refrigerator (GLACIER)** will serve as an in-orbit cold stowage facility as well as carry frozen scientific samples to and from the station and Earth via the space shuttle. This facility is capable of thermal control of the samples between 4° C and -185° C.

The **Human Research Facility-1 (HRF-1)** is designed to house and support life sciences experiments. It includes equipment for lung function tests, ultrasound to image the heart and many other types of computers and medical equipment.

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

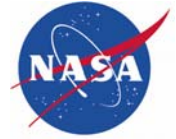
Minus Eighty-Degree Laboratory Freezer for ISS (MELFI) provides refrigerated storage and fast-freezing of biological and life science samples. It can hold up to 300 liters of samples ranging in temperature from -80° C, -26° C, or 4° C throughout a mission.

Expedite the Processing of Experiments to the Space Station (ExPRESS) Racks are standard payload racks designed to provide experiments with utilities such as power, data, cooling, fluids and gases. 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.



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

The **European Modular Cultivation System (EMCS)** is a large incubator that provides control over the atmosphere, lighting and

humidity of growth chambers used to study plant growth.

On the Internet

For fact sheets, imagery and more on Expedition 18 experiments and payload operations, click on

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



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The Payload Operations Center



From the Payload Operations Center at NASA's MSFC in Huntsville, Ala., scientists and engineers operate all the U.S. experiments located 225 miles above Earth on the ISS. The best technology of the 21st century monitors and stores several billion bits of data from the space station, while saving NASA millions of dollars and serving a diverse community of research scientists located around the globe.

The Payload Operations Center, or POC, at Marshall Space Flight Center in Huntsville, Ala., is NASA's primary science command post for the International Space Station. Space station scientific research plays a vital role in NASA's roadmap for returning to the moon and exploring our solar system.

The space station accommodates dozens of experiments in fields as diverse as medicine, human life sciences, biotechnology, agriculture, manufacturing and Earth observation. Managing these science assets, as well as the time and space required to accommodate

experiments and programs from a host of private, commercial, industry and government agencies nationwide, makes the job of coordinating space station research critical.

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



1990s, was the prototype for Marshall's space station science operations.

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

State-of-the-art computers and communications equipment deliver around-the-clock reports to and from science outposts across the United States to POC systems controllers and science experts. Other computers stream information to and from the space station itself, linking the orbiting research facility with the science command post on Earth.

The payload operations team also synchronizes the payload time lining among international partners, ensuring the best use of valuable resources and crew time. NASA's partners are the Russian Space Agency, European Space Agency, Japan Aerospace and Exploration Agency and Canadian Space Agency.

NASA's partners' control centers are:

- Center for Control of Spaceflights ("TsUP" in Russian) in Korolev, Russia;
- Space Station Integration and Promotion Center (SSIPC) in Tskuba, Japan; and
- Columbus Control Center (Col-CC) in Oberpfaffenhofen, Germany

Once launch schedules are finalized, the POC oversees delivery of experiments to the space station. Experiments are rotated in and out periodically as the shuttle or other launch vehicle makes deliveries and returns completed experiments and samples to Earth.

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 10 to 40 or more experiments simultaneously.

The payload operations director leads the POC's main flight control team, known as the "cadre." The payload operations director approves all science plans in coordination with Mission Control at Johnson, the station crew and the international partner control centers. The payload communications manager, the voice of the POC, coordinates and manages real-time voice responses between the station crew conducting payload operations and the researchers whose science the crew is conducting. The operations controller oversees station science operations resources such as tools and supplies and assures support systems and procedures are ready to support planned activities. The data management coordinator is responsible for station video systems and high-rate data links to the POC. The payload rack officer monitors rack integrity, power and temperature control, and the proper working conditions of station experiments.

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



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Orbiting 250 miles above the Earth, the space station crew works together with science experts at the POC at the MSFC and researchers around the world to perform cutting-edge science experiments in the unique microgravity environment of space. (NASA)

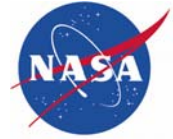


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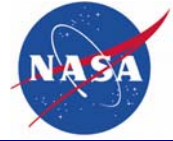
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ISS-18 Russian Research Objectives

ROSCOSMOS Research Objectives

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technology & Material Science	ТХН-7	SVS (CBC)	"CBC" researching camera "Telescience" hardware from "ПК-3" <i>Nominal hardware:</i> "Klest" ("Crossbill") TV-system Picture monitor (BKY)	Self-propagating high-temperature fusion in space	N/A
Geophysical	ГФИ-1	Relaksatsiya	"Fialka-MB-Kosmos" - Spectrozoal 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	<i>Nominal hardware:</i> Camera Nikon D2X Laptop	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery	Using OCA
Geophysical	ГФИ-16	Vsplesk (Burst)	"Vsplesk" hardware Mechanical adapter Conversion board	Seismic effects monitoring. Researching high-energy particles streams in near-Earth space environment	N/A
Biomedical	МБИ-15	Pilot	Right Control Handle Synchronizer Unit (BC) ULTRABUOY-2000 Unit "Neyrolab" set <i>Nominal hardware:</i> Laptop RSE-Med	Researching for individual features of state psycho-physiological regulation and crewmembers professional activities during long space flights	N/A
Received from RSC Energia Payload Division January 31, 2008					
Biomedical	МБИ-18	Dykhanie	"Dykhanie-1" set "Dykhanie-1 - Data" kit <i>Nominal hardware:</i> Laptop RSE-Med	Study of respiration regulation and biomechanics under space flight conditions	N/A
Biomedical	БИО-1	Poligen	"Drozophila-3" kit	Detection of genotypic features (experimental object – Drozophila midge), determining individual characteristics of resistance to the long-duration flight factors	During ISS-17, ISS-18 crews rotation
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



ROSCOSMOS Research Objectives (continued)

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Biomedical	БИО-12	Regeneratsiya (Regeneration)	"Ulitka" (Snail) incubating container "Planariya" incubating container	Study of microgravity influence on regeneration processes for biological objects by electrophysiological and morphological indices	N/A
Study of Earth natural resources and ecological monitoring	Д33-2	Diatomea	"Diatomea" kit <i>Nominal hardware:</i> Nikon F5 camera; DSR-PD1P video camera; Dictaphone; Laptop RSK1	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	N/A
Biotechnology	БТХ-2	Mimetik-K	"Luch-2" biocrystallizer "Kriogem-03M" freezer (to be determined)	Anti-idiotypic antibodies as adjuvant-active glycoprotein mimetic	N/A
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	N/A
Biotechnology	БТХ-4	Vaktsina-K (Vaccine)		Structural analysis of proteins-candidates for vaccine effective against AIDS	N/A
Biotechnology	БТХ-20	Interleukin-K		Obtaining of high-quality 1 α , 1 β interleukins crystals and interleukin receptor antagonist – 1	N/A
Received from RSC Energia Payload Division January 31, 2008					
Biotechnology	БТХ-10	Kon'yugatsiya (Conjugation)	"Rekomb-K" hardware <i>Nominal Hardware:</i> "Kriogem-03M" freezer (to be determined)	Working through the process of genetic material transmission using bacteria conjugation method	During ISS-17, ISS-18 crews rotation
Biotechnology	БТХ-11	Biodegradatsiya	"Bioprobly" kit	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials	N/A
Biotechnology	БТХ-14	Bioemulsiya (Bioemulsion)	Changeable bioreactor thermostat with drive control unit with stand and power supply cable in cover TBK "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-17, ISS-18 crews rotation



ROSCOSMOS Research Objectives (concluded)

Category	Experiment Code	Experiment Name	Hardware Description	Research Objective	Unique Payload Constraints
Technical Studies	TEX-14 (SDTO 12002-R)	Vektor-T	<i>Nominal Hardware:</i> ISS RS СУДН sensors; ISS RS orbit radio tracking [PKO] system; Satellite navigation; equipment [ACH] system GPS/GLONASS satellite systems	Study of a high-precision system for ISS motion prediction	Unattended
Technical Studies	TEX-15 (SDTO 13002-R)	Izhib	<i>Nominal Hardware:</i> ISS RS onboard measurement system (СБИ) accelerometers; ISS RS motion control and navigation system GIVUS (ГИБУС СУДН) Nominal temperature-sensing device for measures inside "Progress" vehicle modules "Dakon" hardware	Study of the relationship between the onboard systems operating modes and ISS flight conditions	N/A
Technical Studies	TEX-20	Plazmennyi Kristall (Plasma Crystal)	"PC-3 Plus" experimental unit "PC-3 Plus" telescience <i>Nominal hardware</i> "Klest" ("Crossbill") TV-system	Study of the plasma-dust crystals and fluids under microgravity	N/A
Technical Studies	TEX-22 (SDTO 13001-R)	Identifikatsiya	<i>Nominal Hardware:</i> ISS RS СБИ accelerometers	Identification of disturbance sources when the microgravity conditions on the ISS are disrupted	Unattended
Received from RSC Energia Payload Division January 31, 2008					
Technical Studies	TEX-44	Sreda-ISS (Environment)	<i>Nominal Hardware:</i> Movement Control System sensors; orientation sensors; magnetometers ; Russian and foreign accelerometers	Studying ISS characteristics as researching environment	Unattended
Complex Analysis. Effectiveness Estimation	КПТ-3	Econ	"Econ" kit <i>Nominal Hardware:</i> Nikon D1X digital camera, Laptop RSK1	Experimental researching of ISS RS resources estimating for ecological investigation of areas	N/A
Complex Analysis. Effectiveness Estimation	КПТ-6	Plazma-MKS (Plasma-ISS)	"Fialka-MB-Kosmos" - Spectrozonol ultraviolet system	Study of plasma environment on ISS external surface by optical radiation characteristics	N/A
Study of cosmic rays	ИКЛ-2В	BTN-Neutron	Detection Block Electronic Equipment Block Mechanical interface	Study of fast and thermal neutrons fluxes	N/A



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European Space Agency Experiment Program

During the Expedition 18 mission on the International Space Station, there will be a full European experiment program in a host of different scientific areas with many using the internal and external research facilities of the Columbus laboratory, which was attached to the station as part of the shuttle assembly flight in February 2008.

Internal Experiments: Biology

Kubik Incubator: Bio-4 Experiments

The following biology experiments will be carried out using three European incubators called Kubik, currently on the station. The samples for the experiments will be flown to the complex with the Expedition 18 crew on Soyuz 17S, with all samples except for the ROALD experiment being returned with the Expedition 17 crew on Soyuz 16S some 10 days later. As well as providing a thermally-controlled environment, two of the three incubators have a centrifuge, which provides the ability to run 1g control experiments while in orbit. All experiments apart from *Xenopus* will take place in one of the two incubators with centrifuges.

BASE-B and C – The Bacteria Adaptation to Space Environment (BASE) experiments will determine how several different bacterial species adapt to spaceflight conditions: weightlessness, cosmic radiation and electromagnetism, building on research from previous spaceflight experiments. Data from this study will be useful to determine if adaptation to spaceflight conditions may modify the ability of bacteria to deteriorate the spacecraft environment, act as pathogens or function in recycling systems. These experiments will take place at a temperature of 22° C.

Science Team:

M. Mergeay (BE), R. Wattiez (BE),
J. Mahillon (BE), P. Cornelis (BE), N. Leys (BE)

Xenopus – This experiment will study cellular modifications within the vestibulo-ocular system of a developing amphibian (*Xenopus laevis*) during adaptation to weightlessness. The vestibulo-ocular system is the system of the body responsible for maintaining balance. The main purpose of this project is to characterize the effect of weightlessness on development of this system in *Xenopus laevis* tadpoles at early and late development stages. This experiment will take place at a temperature of 22° C.

Science Team:

E.R. Horn (DE), L. Gualandris-Parisot (FR),
C. Dournon (FR), C.R. Phillips (US),
B. Fritsch (US)

ROALD - ROALD stands for the ROle of Apoptosis in Lymphocyte Depression and aims to determine the role that programmed cell death (apoptosis) plays in reduced immune response in weightlessness. Apoptosis is a normal function in human and animal cells and T-lymphocytes are a class of white blood cells important in immune response. Various aspects of the apoptotic process will be assessed using human T-lymphocytes. This experiment will take place at a temperature of 37° C.

Science Team:

M. Maccarrone (IT), M. Ranalli (IT), M. Bari (IT),
A. Finazzi-Agro (IT), M. Cogoli-Greuter (CH),
I. Walther (CH), A. Cogoli (CH),
M.A. Meloni (CH), P. Pippia (IT)



Internal Experiments: Human Physiology

3D-Space

This physiology study investigates the effects of weightlessness on the mental representation of visual information during and after spaceflight. Accurate perception is a prerequisite for spatial orientation and reliable performance of tasks in space. The experiment has different elements including investigations of perception of depth and distance carried out using a virtual reality headset and standard psychophysics tests. Runs of the experiment have already been undertaken during Expedition 17, and are scheduled to continue with a target total of 10 Expedition crew members as test subjects.

Science Team:

G. Clement (FR), C.E. Lathan (US)

Card

It has been observed that exposure to weightlessness increases cardiac output and lowers blood pressure (caused by dilated arteries) in the face of increased activity in the sympathetic nervous system (which normally constrict arteries). The Card experiment will examine these effects in order to provide a thorough picture of how the circulatory system changes during a prolonged stay in weightlessness. The experiment will consist of tests taken during a 24-hour period pre-flight, during the second half of the mission increment and postflight. This will include: two blood samples, 24-hour urine samples, hourly blood pressure measurements, and cardiac output measurements with rebreathing every four hours except during sleep using the ESA/NASA Pulmonary Function System. The blood and urine samples will be examined for hormonal activity and electrolyte levels.

Science Team:

P. Norsk (DK), N.J. Christensen (DK),
B. Pump (DK), A. Gabrielsen (DK),

J.G. Nielsen (DK), C. Drummer (DE),
M. Kentsch (DE), N. Gadsboll (DK).

EDOS

Early Detection of Osteoporosis in Space (EDOS) is a study into the mechanisms underlying the reduction in bone mass, which occurs in astronauts in weightlessness. The EDOS experiment will evaluate the structure of weight and non-weight bearing bones of cosmonauts/astronauts pre- and postflight using the method of computed tomography (pQCT) together with an analysis of bone biochemical markers in blood samples.

Science Team

C. Alexandre (FR), L. Braak (FR),
L. Vico (FR), P. Ruegsegger (CH),
M. Heer (DE)

Flywheel Exercise Device

The Flywheel Exercise Device was launched to the space station during the Columbus laboratory assembly mission in February 2008 in order to become an advanced exercise device for station astronauts and serving human physiology investigations. It will be removed from storage in the European Transport Carrier of the Columbus laboratory for deployment and first functional checkout in early 2009.

Matroshka 2B

The ESA Matroshka facility has been an ongoing experiment on the space station since February 2004 with the aim of studying radiation levels experienced by astronauts. It consists of a human shape (head and torso) called the Phantom, which is equipped with several active and passive radiation dosimeters. For the Matroshka 2B experiment, new passive radiation sensors uploaded on Soyuz 15S in October 2007 were installed inside the Phantom. The Matroshka facility is currently installed inside the Pirs docking



module on the station, taking measurements of the internal station radiation environment.

Science Team:

G. Reitz (DE), R. Beaujean (DE),
W. Heinrich (DE), M. Luszik-Bhadra (DE),
M. Scherkenbach (DE), P. Olko (PL),
P. Bilski (PL), S. Derne (HU), J. Palvalvi (HU),
E. Stassinopoulos (US), J. Miller (US),
C. Zeitlin (US), F. Cucinotta (US),
V. Petrov (RU).

Project Team:

ESA: J. Dettmann, DLR: G. Reitz,
J. Bossler,
Kayser Italia: M. Porciani, F. Granata

MOP

When entering weightlessness, astronauts suffer from a phenomenon called space motion sickness, which has symptoms comparable to seasickness. This disturbance in the body's orientation and balance is similar to the disturbances experienced by subjects who have undergone rotation in a human centrifuge, having experienced two to three times Earth's gravity for up to several hours. This experiment aims to obtain an insight into this process and could help in developing countermeasures to space motion sickness.

Science Team:

E. Groen (NL), J. Bos (NL), S. Nooij (NL),
W. Bles (NL), R. Simons (NL),
T. Meeuwsen (NL)

Muscle

The deep muscle corset plays an important role in posture when in the upright position. It is thought that this deep muscle corset atrophies during spaceflight leading to strain and hence pain in certain ligaments, in particular in the iliolumbar region in the back. The objective of this experiment is to assess the occurrence and characteristics of back pain. The results will be

correlated to data related to back pain and atrophy obtained in ground-based studies.

Science Team:

A. Pool-Goudzwaard (NL), C. Richardson (AU),
J. Hides (AU), L. Danneels (BE)

Portable Pulmonary Function System

The Portable Pulmonary Function System is an autonomous multi-user facility supporting a broad range of human physiological research experiments under weightless condition in the areas of respiratory, cardiovascular and metabolic physiology. The Portable Pulmonary Function System is an evolution to the existing Pulmonary Function System, (which is a joint ESA/NASA collaboration in the field of respiratory physiology instrumentation) currently on the station. The Portable Pulmonary Function System is currently scheduled to be transported to the complex in February 2009.

Otolith

The working of our balance system and our eyes are strongly interconnected and understanding their adaptation to weightlessness is important for maintaining an astronaut's capacity for carrying out tasks in space. The otoliths in the inner ear play an important role in our balance system as detectors of vertical and horizontal motion. This experiment will make an assessment of otolith function before and after short-term spaceflight. This includes an assessment of otolith-ocular response to determine neural pathway communication between the otoliths and the central nervous system; an indication of function of the saccule, which transmits neural impulses of head movements to the brain; and evaluating the symmetry of information generated by the otoliths using an estimation of the astronaut's subjective visual vertical.

Science Team:

A. Clarke (DE), S. Wood (US), F. Wuyts (BE)



Solo

The Solo experiment is carrying out research into salt retention in space and related human physiology effects. It is a continuation of extensive research into the mechanisms of fluid and salt retention in the body during bed rest and spaceflights and subsequent effect on bone metabolism. The astronaut subjects will participate in two study phases, five days each. Subjects follow a diet of constant either low or normal sodium intake, fairly high fluid consumption and isocaloric nutrition. This metabolically controlled study will make use of the European Physiology Modules Facility and Human Research Facility capabilities.

Science Team:

M. Heer (DE), N. Kamps (DE), F. Baisch (DE), P. Norsk (DK)

ZAG

ZAG, which stands for Z-axis Aligned Gravito-inertial force, is an investigation into the effect that weightlessness has on an astronaut's perception of motion and tilt as well as his level of performance before and immediately after spaceflight. Different tests will take place pre- and postflight including an analysis of the astronaut's motion perception and eye movements while using a track-and-tilt chair. It also will be evaluated whether a tactile vest improves perception and performance during these tests.

Science Team:

G. Clement (FR), S. Wood (US), M.F. Reschke (US), P. Denise (FR)

Internal Experiments: Physical Science and Technology

Fluid Science

Fluid Science Laboratory: Geoflow

Geoflow was the first experiment to take place within the Fluid Science Laboratory inside the European Columbus Laboratory, its first runs

starting in August during Expedition 17. The experiment will continue to investigate the flow of an incompressible viscous fluid (silicon oil) held between two concentric spheres rotating about a common axis. A temperature gradient is maintained from the inside to the outside sphere as is an electrical field. This geometrical configuration can be seen as a representation of a planet, with the electric field simulating its gravitational field. This research is of importance in such areas as flow in the atmosphere, the oceans and in the liquid nucleus of planets on a global scale.

Science Team:

Ch. Egbers (DE), P. Chossat (FR), F. Feudel (DE), Ph. Beltrame (DE), I. Mutabazi (FR), L. Tuckerman (FR), R. Hollerbach (UK)

Protein Crystallization

European Drawer Rack: Protein Crystallization Diagnostics Facility

The first configuration of the European Drawer Rack in the Columbus laboratory includes the Protein Crystallization Diagnostics Facility, which will tackle the problems of protein crystallization in space. The aim of this project is to understand to what extent various crystallization processes and conditions contribute to the formation of defects and imperfections in biomolecular crystals. The expected results from experiments in weightlessness will help to identify the growth conditions and stages that are responsible for these defects. This will hold benefits in various industrial applications.

Science Team:

F. Otalora (E), D. Maes (B), S. Weinkauf (D), E. Weckert (D), A. Chernov (USA), J. Martial (B), G. Nicolis (B), F. Dubois (B)

Radiation Dosimetry

DOSIS (See also DOBIES)

The Dose Distribution inside the International Space Station (DOSIS) experiment will



determine the nature and distribution of the radiation field inside the station. Measurements of energy, charge and LET spectra of heavy ions will be carried out using different nuclear track detectors. Average absorbed doses will be measured by thermoluminescent detectors and the neutron dose will be measured by different neutron dosimeters. This experiment is in combination with the DOBIES experiment.

Science Team:

G. Reitz (DE) et al.

DOBIES (See also DOSIS)

The aim of Dosimetry for Biological Experiments in Space (DOBIES) is to develop a standard method to measure the radiation dosage experienced by biological samples in specific areas of the space station using a combination of different dosimetric techniques. The areas of interest are the Columbus laboratory and specifically the European Physiology Modules Facility, and also in the EXPOSE-E and EXPOSE-R payloads (see EuTEF and EXPOSE-R, respectively). This experiment is in combination with the DOSIS experiment.

Science Team:

F. Vanhavere (BE) et al.

Technology Demonstrations

GTS-2 (Global Transmission Service)

The Global Transmission Service (GTS) is continuously on since early 2008 and will tentatively continue until spring 2009. This experiment is testing the receiving conditions of a time and data signal for dedicated receivers on the ground. The time signal distributed by the GTS has special coding to allow the receiver to determine the local time anywhere on the Earth without user intervention. The main scientific objectives of the experiment are to verify under real space operation conditions: the performance and accuracy of a time signal transmitted to the Earth's surface from low Earth orbit; the signal quality and data rates achieved on the ground; and measurement of

disturbing effects such as Doppler shifts, multi-path reflections, shadowing and elevation impacts.

Science Team:

F. Huber (DE)

Internal Experiments: Education Activities

Video Lesson ESA – I

The clips recorded during Video Lesson ESA - I will be edited on the ground and used in an educational video about nutrition and health (30 min.) fitting the basic European science curriculum. The video will be addressed to 16- to 18-year-old students and will be released in summer 2009. The clips are intended to provide European students with selected aspects of life on board the space station, focusing on the social and cultural value of food. The footage will help to directly compare and contrast food on Earth and in space. The recorded clips during the reserve activity will be used in an educational video about space design (6 min.) addressing 16- to 18-year-old students, to be released in autumn 2009.

Project Team:

C. Olivotto, (ESA, NL)

**External Experiments:
Astrophysics/Technology/
Exobiology/Earth Observation**

Solar

The Solar facility, located on the External Payload Facility of Columbus, is studying the sun with unprecedented accuracy across most of its spectral range. This study is currently scheduled to last for two years. Solar is expected to contribute to the knowledge of the interaction between the solar energy flux and the Earth's atmosphere chemistry and climatology. This will be important for Earth observation predictions. The payload consists



of three instruments complementing each other, which are:

SOL-ACES

The goal of the Solar Auto-Calibrating Extreme UV-Spectrometer (SOL-ACES) is to measure the solar spectral irradiance of the full disk from 17 to 220 nm at 0.5 to 2 nm spectral resolution. By an auto-calibration capability, it gains long-term spectral data with a high absolute resolution. In its center, it contains four extreme ultraviolet spectrometers.

Science Team:

G. Schmidtke (DE)

SOLSPEC

SOLSPEC (SOLar SPECtral irradiance measurements) measures the solar spectrum irradiance from 180 nm to 3,000 nm. The aims of this investigation are the study of solar variability at short- and long-term and the achievement of absolute measurements (2% in UV and 1% above). The SOLSPEC instrument was fully refurbished and improved with respect to the experience gained in the previous missions (Spacelab-1, Atlas-1, Atlas-2, Atlas-3, Eureca).

Science Team:

M.G. Thuillier (FR)

SOVIM

The Solar Variability and Irradiance Monitor (SOVIM) is a re-flight of the SOVA experiment aboard Eureca-1. The investigation is studying the irradiance of the sun, with high precision and high stability. The total irradiance is being observed with active cavity radiometers and the spectral irradiance measurement is being carried out by one type of sun-photometer.

Science Team:

C. Frohlich (CH)

EuTEF

The European Technology Exposure Facility (EuTEF) also is on the External Payload Facility of Columbus. Along with Solar, it is one of the first two external facilities attached outside the Columbus laboratory. EuTEF houses the following experiments requiring either exposure to the open space environment or a housing on the external surface of the station:

DEBIE-2

DEBIE, which stands for 'DEBris In orbit Evaluator' is a standard in-situ space debris and micro-meteoroid monitoring instrument that requires low resources from the spacecraft. It measures sub-mm sized particles and has 3 sensors facing in different directions. The scientific results from several DEBIE instruments aboard different spacecraft will be compiled into a single database for ease of comparison.

Science Team:

G. Drolshagen - ESA

Dostel

Dostel (DOSimetric radiation TELEscope) is a small radiation telescope that is measuring the radiation environment outside the space station.

Science Team:

G. Reitz - DLR (DE)

EXPOSE-E

EXPOSE-E is a subsection of EuTEF and consists of five individual exobiology experiments:

- **Life**
This experiment tests the limits of survival of lichens, fungi and symbionts.

Science Team:

S. Onofri (IT), L. Zucconi (IT),
L. Selbmann (DE), S. Ott (DE),
J.-P.de Vera (ES), R. de la Torre (ES)



- **Adapt**

This experiment concerns the molecular adaptation strategies of micro-organisms to different space and planetary UV climate conditions.

Science Team:

P. Rettberg (DE), C. Cockell (UK),
E. Rabbow (DE), T. Douki (FR), J. Cadet
(FR), C. Panitz (DE), R. Moeller (DE),
G. Horneck (DE), H. Stan-Lotter (AT)

- **PROCESS**

The main goal of the PROCESS (PREbiotic Organic ChEmistry on Space Station) experiment is to improve our knowledge of the chemical nature and evolution of organic molecules involved in extraterrestrial environments.

Science Team:

H. Cottin (FR), P. Coll (FR), D. Coscia (FR),
A. Brack (FR), F. Raulin (FR)

- **Protect**

The aim of this experiment is to investigate the resistance of spores, attached to the outer surface of spacecraft, to the open space environment. Three aspects of resistance are of importance: the degree of resistance, the types of damage sustained and the spores repair mechanisms.

Science Team:

G. Horneck (DE), J. Cadet (FR), T. Douki
(FR), R. Mancinelli (FR), R. Moeller (DE),
W. Nicholson (US), J. Pillinger (UK),
E. Rabbow (DE), P. Rettberg (DE),
J. Sprey (UK), E. Stackebrandt (DE),
K. Venkateswaren (US)

- **Seeds**

This experiment is testing the plant seed as a terrestrial model for a panspermia vehicle, i.e., a means of transporting life through the universe and as a source of universal UV screens.

Science Team:

D. Tepfer (DE), L. Sydney (FR),
S. Hoffmann (DK), P. Ducrot (FR),
F. Corbineau (FR), C. Wood (UK)

EVC

The Earth Viewing Camera (EVC) payload is a fixed-pointed Earth-observing camera. The main goal of the system is to capture color images of the Earth's surface, to be used as a tool to increase general public awareness of the station and promote the use of the complex to the potential user community for observation purposes.

Science Team:

M. Sabbatini (ESA, NL)

FIPEX

FIPEX is the Flux (Phi) Probe Experiment. It is important to build up a picture of the varying atmospheric conditions in low Earth orbit where orbiting spacecraft are still affected by atmospheric drag. The density of the atmosphere is the major factor affecting drag and this is affected by solar radiation and the Earth's magnetic and gravitational fields. The flux of atomic oxygen is important, as it shows different interactions with spacecraft surfaces, e.g., surface erosion. The FIPEX micro-sensor system is being used to measure the atomic oxygen flux as well as the oxygen molecules in the surrounding area of the International Space Station.

Science Team:

S. Fasoulas (DE)

MEDET

The aims of the Materials Exposure and Degradation Experiment (MEDET) are: to evaluate the effects of open space on materials currently being considered for utilization on spacecraft in low Earth orbit; to verify the validity of data from the space simulation currently used for materials evaluation; and to



monitor solid particles impacting spacecraft in low Earth orbit.

Science Team:

V. Inguibert (FR), A. Tighe – ESA

PLEGPAY

The scientific objective of PLEGPAY (PLasma Electron Gun PAYload) is the study of the interactions between spacecraft and the space environment in low Earth orbit, with reference to electrostatic charging and discharging. Understanding these mechanisms is very important as uncontrollable discharge events can adversely affect the functioning of spacecraft electronic systems.

Science Team:

G. Noci – Laben-Proel (IT)

Tribolab

This series of experiments covers research in tribology, (i.e., the science of friction and lubrication thereof. This is of major importance for spacecraft systems). The Tribolab experiments cover both experiments in liquid and solid lubrication, such as the evaluation of fluid losses from surfaces and the evaluation of wear of polymer and metallic cages in weightlessness.

Science Team:

R. Fernandez – INTA (ES)

EXPOSE-R

The EXPOSE-R facility is a European external facility that will be attached to the outside of the Russian Zvezda Service Module after being transported to the station on Progress flight 31P, currently due to launch at the end of November. It houses a number of experiments covering the areas of photochemistry, photobiology and astrobiology, requiring exposure to the open space environment.

The experiment package is as follows:

Amino

The main objective of the Amino experiment is to determine to what extent biologically active molecules (amino acids and peptides) are converted into a mixture of so-called L- and D-molecules when exposed to UV-C radiation. (Organic material is principally made up of L-molecules on Earth). The experiment also will determine to what degree the samples are protected by the porous material in which they are accommodated. Another experiment objective is to test whether photosensitive amino acids can use the energy from ultraviolet light from the sun to chain together under space conditions.

Science Team:

H. Cottin (FR)

Endo

This experiment will assess the impact of increased UV-B and UV-C radiation, due to ozone depletion, on algae and cyanobacteria from Antarctic sites under the ozone hole. It also will determine the probability for endolithic microbial communities, i.e., microbes embedded in rock surfaces, to survive in regions where exposed communities become extinct. The findings will contribute to our understanding of the potential for such communities to have survived UV-exposure in past times on Mars.

Science Team:

C.S. Cockell (UK), H.G.M. Edwards (UK)

IBMP Experiments

These experiments from the Institute for Biomedical Problems in Moscow are looking into the effect of exposing a diverse collection of terrestrial organisms in a resting stage of their life cycle to space conditions. Included are bacterial spores, fungal spores, plant seeds and eggs of lower crustacea.



Science Team:

V. Sychev (RU), N. Novikova (RU),
S. Poddubko (RU), M. Levenskikh (RU),
T. Agaptseva (RU)

Organic

The goal of the Organic experiment which concerns the evolution of organic matter in space is to study the effects of UV radiation, low pressure and heavy ion bombardment on organic molecules of interest in astrophysics and astrobiology. This includes polycyclic aromatic hydrocarbons, fullerenes, kerogens of different origin, and complex mixtures.

Science Team:

P. Ehrenfreund (NL), Z. Peeters (NL),
B. Foing (ESA, NL), F. Robert (FR),
E. Jessberger (DE), W. Schmidt (DE),
M. Mumma (US)

Osmo

This experiment aims to understand the response of microbes to the vacuum of space and to solar radiation. It will especially focus on bacteria that survive in environments of high osmotic pressure, in this case two bacteria (*Synechococcus* and *Haloarcula-G*) that survive in salt-rich environments. It will assess whether these salt-rich environments, as well as the high intracellular potassium concentration of the micro-organisms, plays a role in protecting their DNA from drying out in space.

Science Team:

R. Mancinelli (US)

Photo

This experiment is studying the effect of exposure of bacterial spores and samples of their DNA to solar UV radiation. The objective is to assess the quantity and chemistry of chemical products produced. The samples will be completely exposed, or protected by artificial meteorite materials, clays, and salt crystals.

Science Team:

J. Cadet (FR), T. Douki (FR), J.L. Ravanat (FR),
S. Sauvaigo (FR)

PUR

The Phage and Uracil Response (PUR) experiment is studying the effect of solar UV radiation on a type of virus (Phage T7) and an RNA compound (uracil) to determine their effectiveness as biological dosimeters for measuring UV dose in the space environment.

Science Team:

G. Rontó (HU), A. Fekete (HU), P. Gróf (HU)

Spores

This experiment will assess how meteorite material acts as a protection for bacterial (*Bacillus subtilis*), fungal (*Trichoderma koningii*) and ferny (*Athyrium filix-femina*, *Dryopteris filix-mas*) spores against space conditions, i.e., UV, vacuum and ionising radiation.

Science Team:

G. Horneck (DE), B. Hock (DE), F. Wänke (DE),
P. Rettberg (DE), D.P. Häder (DE),
G. Reitz (D), T. Dachev (BG), D. Mishev (BG)

Subtil

This experiment will determine the extent of mutation of spores and plasmid DNA of the model bacteria *Bacillus subtilis* induced by exposure to space vacuum and solar UV radiation. Plasmids are DNA segments capable of reproducing themselves independently of chromosomes. The experiment also will study the molecular differentiation in mutations brought about by principal exposure to space vacuum and mutations brought about by just UV exposure. The experiment will use two different strains of the bacteria, one of which is deficient in cellular repair.

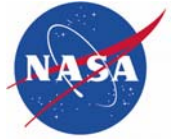
Science Team:

N. Munkata (JPN), K. Hieda (JPN)



EXPEDITION 18

Gearing Up for a Crew of Six



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Japan Aerospace Exploration Agency Science Operations

JAXA Kibo Utilization

The pressurized section of the Japanese Experiment Module (JEM), Kibo, was successfully assembled in orbit during the STS-124 mission. The Japan Aerospace Exploration Agency (JAXA) science operations began in the summer of 2008.

Kibo is now entering the utilization phase, and JAXA will conduct the first phase of Kibo programs for scientific research, application research, human spaceflight technology development, and education and culture.

Scientific research in fluid physics, crystal growth and cell biology experiments, which use Kibo's SAIBO and RYUTAI payload racks, are scheduled for Expedition 18. The first experiment performed on Kibo during Expedition 17 was a fluid physics experiment in the RYUTAI rack. This time, cell biology experiments using the SAIBO rack will begin.

Those experiments will be performed through ground teleoperations aided by the in-orbit crew. Some experiments will be preprogrammed or crew-manipulated. Scientists, research teams and Kibo utilization planners, all of whom have been involved in planning and arranging JAXA's science operation programs for Expedition 18, will monitor, check, replan or remotely operate those experiments from the ground.

For JAXA Education Payload Observations (JAXA EPO), an Expedition 18 crew member will perform demonstrations that reflect human culture using JAXA's payloads.

JAXA also will conduct human spaceflight technology development programs, focusing on the development of instruments that will be used in the risk assessment or crew health management for future human spaceflights.

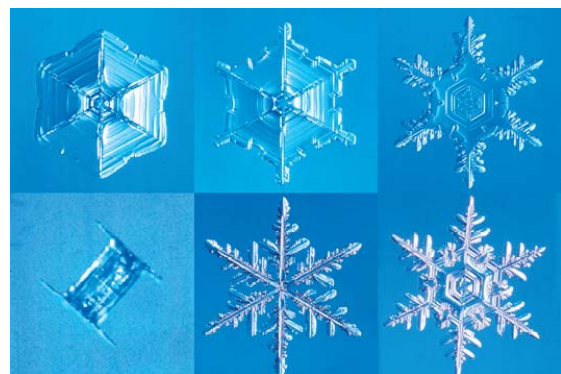
The following Kibo utilization programs are planned for Expedition 18.

Category	Experiment Program
Material Science	<ul style="list-style-type: none"> • Ice Crystal • Chaos, Turbulence and its Transition Process in Marangoni Convection (Marangoni Experiment)
Life Science	<ul style="list-style-type: none"> • Rad Gene • LOH • Control of cell differentiation and morphogenesis of amphibian culture cells (Dome Gene)
Human Space Flight Technology Development	<ul style="list-style-type: none"> • Area PADLES • JAXA Holter
JAXA EPO	<ul style="list-style-type: none"> • Spiral Top • Hiten Project • Space Clothing • Space Poem Chain

Material Science Experiments

Ice Crystal

The main objective of this experiment is to understand mechanisms that cause instability in ice crystal formation. The microgravity environment enables a convection-free experiment so that the factors concerning the pattern formation of crystal growth can be determined.



Ice crystal formation patterns



This experiment examines the pattern formation of ice crystals through in-situ growth observation. Three-dimensional patterns of ice crystals and the thermal diffusion field around the crystal will be analyzed using an interferometer. Experiment duration is approximately three months. Crystals will be grown in various super cooling conditions and will be repeated to increase the measurement accuracy. This experiment will use the Ice Crystal cell that will be installed in the Solution Crystallization Observation Facility (SCOF). It also will use the Image Processing Unit (IPU) for recording the growth process. The SCOF and the IPU are housed in the RYUTAI rack. The Ice Crystal cell will be launched on the STS-126 (ULF2) mission. Sample recovery is not planned for this experiment.



Ice Crystal cell flight model

Principal Investigator:

Y. Furukawa (Hokkaido University)

Chaos, Turbulence and its Transition Process in Marangoni Convection (Marangoni Experiment)

This experiment was started during Expedition 17 and seeks to understand Marangoni convection, a surface-tension-driven flow that occurs in a liquid. A liquid bridge of silicone oil is formed between a pair of disks. Convection is induced in the liquid bridge by imposing a temperature difference between the disks. Marangoni convection exhibits various flow patterns depending on its driving force. The flow and temperature fields in each stage

are observed using several visualization techniques to determine the transition process. The experiment is performed using the Fluid Physics Experiment Facility (FPEF). The experiment data and images are processed in the IPU for real-time downlink and also recorded on the IPU hard disks for detailed analysis.

The resulting data can be applied to various technologies, such as high-quality crystal growth, high-performance heat pipes and micro-fluid handling in the future.

Principal Investigator:

Hiroshi Kawamura (Tokyo University of Science)

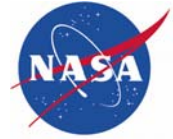
JAXA Co-Investigator:

Satoshi Matsumoto (ISS Science Project Office, JAXA)

Life Science Experiments

Rad Gene

This experiment investigates genetic alterations in mammalian cultured cells that have been exposed to cosmic radiation. The effects of radiation exposure in microgravity on the expression of p53-regulated genes will be evaluated based on the changes in gene expression of p53 (tumor suppressive protein) in mammalian cultured cells exposed to cosmic radiation. This experiment will use the Cell Biology Experiment Facility (CBEF) in the SAIBO rack and a station freezer, the Minus Eighty degree Celsius Laboratory Freezer for ISS (MELFI). Scheduled experiment duration is six days. The samples will be placed in culture bags and launched on the STS-126 (ULF2) mission. After the experiment, frozen samples will be returned to the ground on the STS-119 (15A) mission.



Cell Biology Experiments Facility (CBEF)



Culture bag

Principal Investigator:

Takeo Ohnishi (Dean, Nara Pref. Med School)

JAXA Co-Investigator:

Katsunori Omori (Associate Senior Researcher, ISS Science Project Office, JAXA),
Noriaki Ishioka (Prof. ISS Science Project Office, JAXA)

LOH

The LOH experiment investigates genetic alterations in immature immune cells that have been exposed to cosmic radiation. Potential changes in the chromosome of lymphoblastoid cells (immature immune cells) that have been exposed to cosmic radiation will be examined.

This experiment will use the CBEF and the MELFI. Scheduled experiment duration is six days. The samples will be placed in culture bags and launched on the STS-126 (ULF2) mission. After the experiment, frozen samples will be returned to the ground on the STS-119 (15A) mission. The effects of radiation on human cells will be evaluated based on the data obtained in this investigation. The experiment could lead to development of new measures to protect the health of future space travelers. The resulting data will be applied to the medical field in the areas of immunology and cancer research.

Principal Investigator:

Fumio Yatagai (Senior Scientist, Riken)

JAXA Co-Investigator:

Katsunori Omori (Associate Senior Researcher, ISS Science Project Office, JAXA),
Noriaki Ishioka (Prof. ISS Science Project Office, JAXA)

Control of Cell Differentiation and Morphogenesis of Amphibian Culture Cells (Dome Gene)

The main objective of this experiment is to understand effects of microgravity (weightlessness) on amphibian cultured cells (frog cells). Differences in cell formation between Earth gravity and microgravity will be examined with DNA array assay. Kidney cells and liver cells from frogs will be used for comparison of cell differences. This experiment will use the Clean Bench (CB) and the CBEF in the SAIBO rack, an experiment laptop, the MELFI and the IPU. The cells will be placed in Cell Experiment Units (CEUs) and launched on the STS-119 (15A) mission; control samples will be returned to the ground on the return flight. After the experiment, samples will be returned to the ground on the STS-127 (2J/A) mission, targeted to launch in May 2009. Scheduled experiment duration is approximately eight days.



Clean Bench (CB) in SAIBO rack

high-precision space radiation dosimeter developed by JAXA for measuring absorbed dose, equivalent dose and effective dose of space radiation. The ultimate goal is to support risk assessment and space radiation dose management, or to update radiation assessment models for the human spaceflight in the next generation.

PADLES dosimeters will measure space radiation inside Kibo in each space station increment. The PADLES dosimeters for Expedition 17 were delivered during the STS-124 (1J) mission and installed in Kibo's Pressurized Module (PM) during the 1J stage. The exposed dosimeters will be returned to the ground on the STS-119 (15A) mission.

The PADLES dosimeters for Expedition 18 will be delivered to the station on the STS-119 (15A) mission and will be installed in Kibo within a week after the STS-119 undocking. The Expedition 18 PADLES dosimeters will collect data in Kibo until the next dosimeters arrive for replacement.



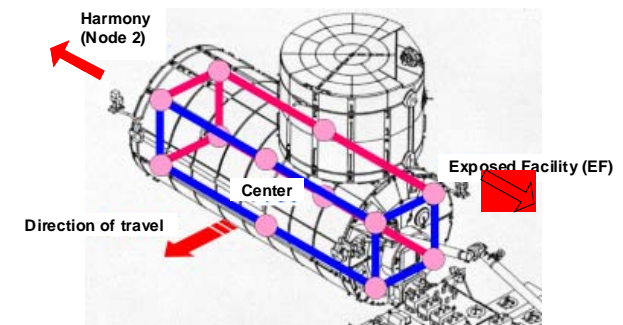
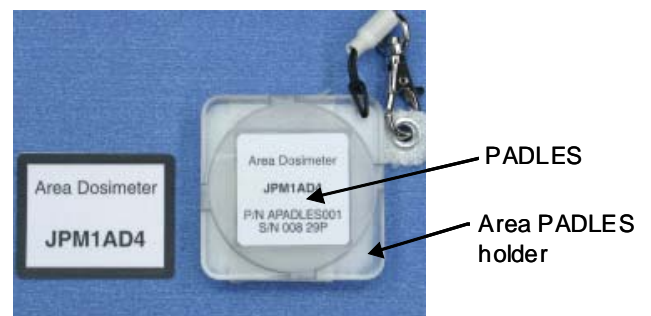
Cell Experiment Unit (CEU)

Principal Investigator:
M. Asashima (Prof., the University of Tokyo)

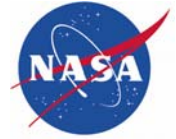
Human Spaceflight Technology Development Area

PADLES

This program surveys the space radiation environment inside Kibo using dosimeter, the Passive Dosimeter for Life science Experiments in Space (PADLES). PADLES is a



The above illustrates locations of the dosimeters (12 in total) installed in Kibo.



Science Team:

A. Nagamatsu, K. Murakami (JAXA)

JAXA Holter

This program tries to verify JAXA's Digital Holter ECG (Electrocardiograph), which was developed for monitoring circadian (24h) cardiovascular and autonomic functions of astronauts in orbit. The ultimate goal is to understand the effects of microgravity and long-duration spaceflight on the cardiovascular and autonomic systems of astronauts who stay in orbit for long durations. In this research, changes in skin condition before and after attaching the ECG electrodes also will be evaluated for crew health and safety. The ECG measurements will be conducted four times at different measuring points (once preflight, twice in-flight and once postflight). The ECG electrodes will be attached to the chest wall of an Expedition 18 crew member to monitor heart rate and arrhythmia (irregular heartbeat). After the 24h ECG measurement, the crew member's chest will be videoed by a High Definition Television (HDTV) camera to record the visual changes in skin condition where the ECG electrodes were attached.

One Digital Holter ECG will be launched on Progress M-67 (32P) (the HDTV camera was delivered on the STS-120 (10A) mission).



Digital Holter ECG



HDTV camera

Principal Investigator:

Chiaki Mukai (JAXA)

Project Lead:

Hiroshi Ohshima (JAXA)

Technical POC:

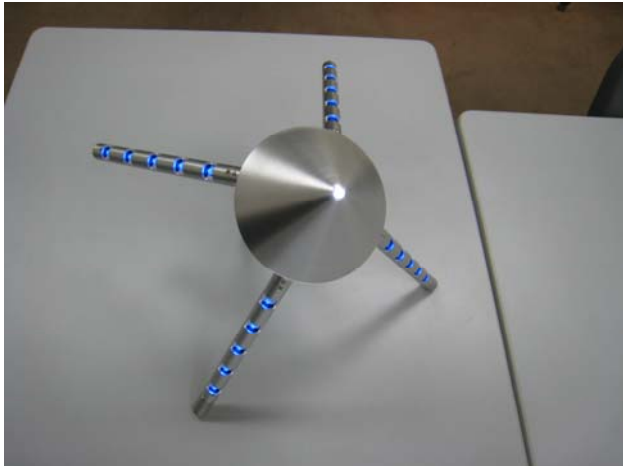
Ichiro Tayama (JAXA)

JAXA Education Payload Observations (JAXA EPO)

Spiral Top

This is a demonstration of light art in space. Light art is a kind of modern art object that optically varies its image along with some self-motions. Spiral Top is a moving light art object that will spin around in the air. An Expedition 18 crew member will use the HDTV camera to capture video images of the Spiral Top floating and spinning around in Kibo.

The Spiral Top will be launched aboard Progress M-67 (32P). The video imagery will return to the ground on the STS-127 (2J/A) mission.



Spiral top

Hiten Project

This project tries to demonstrate the “Hiten (flying deity)” dance painted on ancient murals, such as “Dun Huang Mural” in China and the “Horyuji Mural Painting” in Japan. An Expedition 18 crew member will wear a costume for the Hiten dance, and try to re-enact the dance as painted on ancient murals. Re-enacting the flying deities dance in microgravity may help us to realize the ancient people’s dreams and adoration of the celestial world. Items for the Hiten Project will be launched aboard Progress M-67 (32P) and the STS-119 (15A) mission. The video imagery will be returned to the ground on the STS-127 (2J/A) mission.



Video image

Space Clothing

The goal of this program is to obtain fundamental information for developing and designing mentally and emotionally comfortable clothing for astronauts living in a microgravity environment. An Expedition 18 crew member will take various different poses moving around in Kibo. The movements will be videoed using the HDTV. The video imagery will be returned to the ground on the STS-127 (2J/A) mission.

Space Poem Chain

The first series of Space Poem Chain (Space Poem Chain 1), in which 24 poems were compiled, was recorded on a DVD, launched to the station, and stored in Kibo’s Experiment Logistics Module-Pressurized Section (ELM-PS) during the STS-123 (1J/A) mission.

This time, the second series of Space Poem Chain (Space Poem Chain 2), which includes 24 poems written based on the theme “There are Stars,” recorded on a DVD. This second DVD will be launched to the space station aboard the Progress M-67 (32P). Astronaut Wakata will write verses for Space Poem Chain 3 during his stay aboard the station.



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.
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>



EXPEDITION 18

Gearing Up for a Crew of Six



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