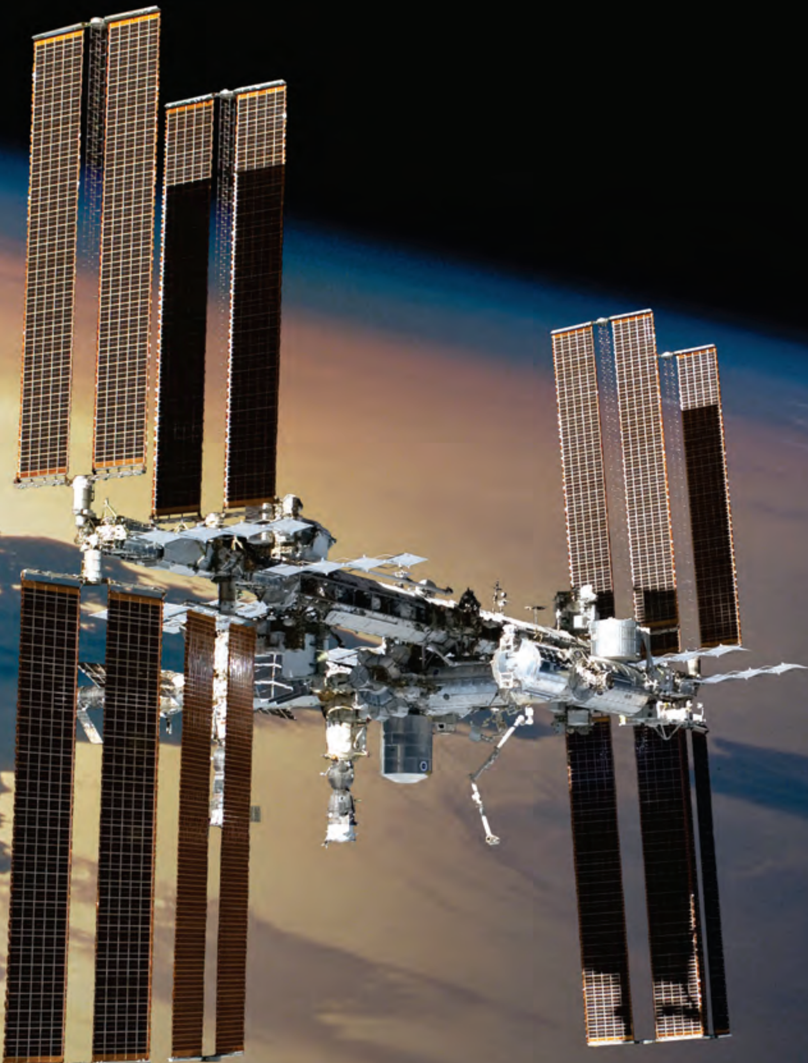
National Aeronautics and Space Administration

SPACE STATION MISSION

EXPEDITION 30-31

PRESS KIT/November 2011



A New Era of Research and Resupply Begins

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USA United Space Alliance

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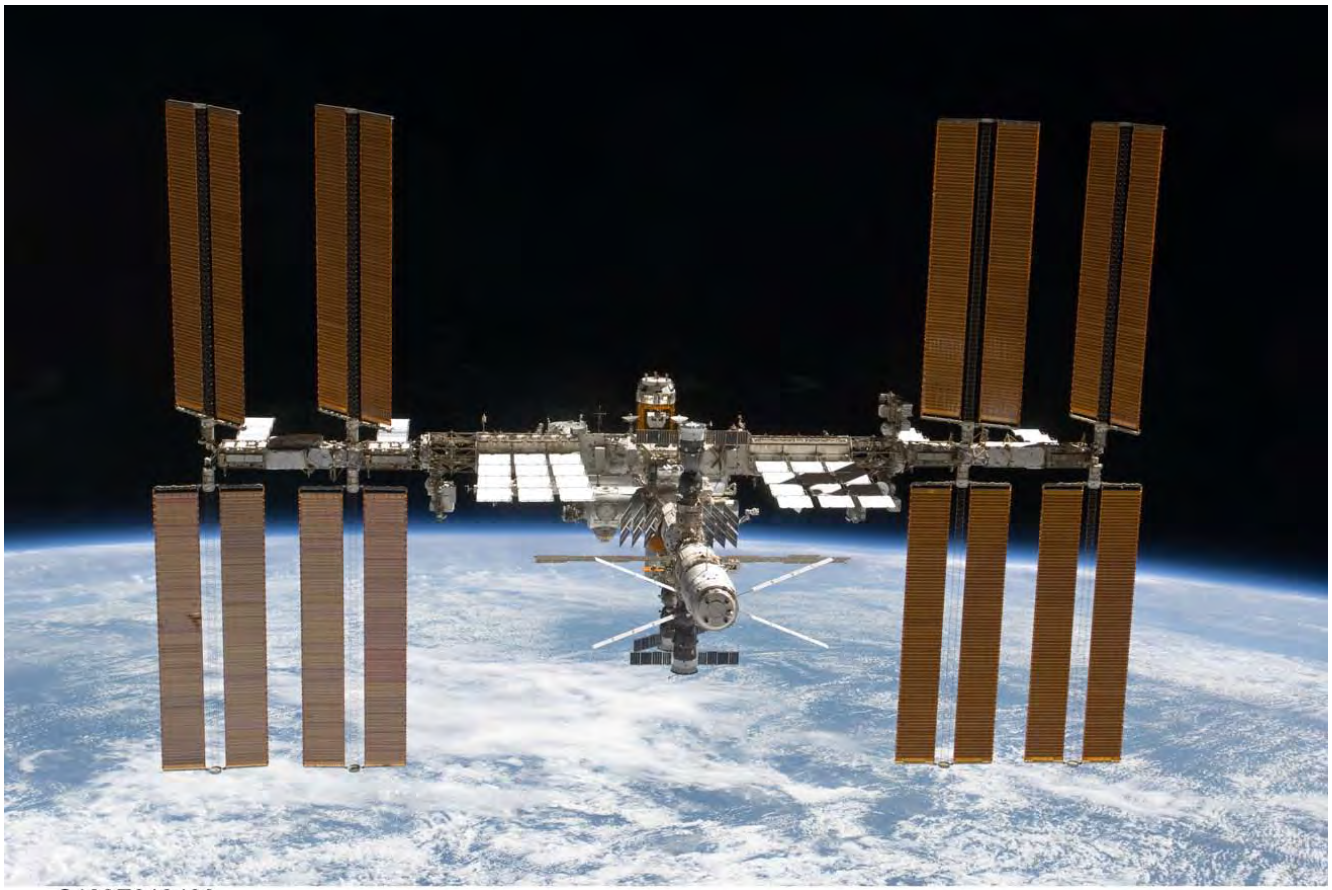
Mission Overview

Expeditions 30 and 31



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The International Space Station is featured in this image photographed by an STS-133 crew member on space shuttle Discovery after the station and shuttle began their post-undocking relative separation. Undocking of the two spacecraft occurred at 7 a.m. (EST) on March 7, 2011. Discovery spent eight days, 16 hours, and 46 minutes attached to the orbiting laboratory. Photo credit: NASA

The 30th and 31st expeditions aboard the International Space Station not only will be focused on cutting-edge science and research, but also welcome a new era of commercial resupply services from the United States.

NASA astronaut Dan Burbank will take over operations as commander of Expedition 30 when Mike Fossum, Sergei Volkov and Satoshi Furukawa depart and return to Earth. Burbank will be joined on Expedition 30 by Russian cosmonauts Anton Shkaplerov and Anatoly Ivanishin.

They will launch to the station on the Soyuz TMA-22 in November.

Completing the complement of Expedition 30 will be the addition of European Space Agency astronaut Andre Kuipers, NASA astronaut Don Pettit and Russian cosmonaut Oleg Kononenko. The three will launch to the station on the Soyuz TMA-03M in late December.

The crew will be busy with dozens of experiments during their time aboard the station. They will be continuing work that examines how the human body and different materials react to being in the weightless environment of space. How do the body's bones and muscles adapt? What kinds of materials are more suitable for the harsh environment of space travel? How can we build those materials, and what can space teach us about manufacturing processes here on Earth? All of these questions will be explored by the crew during the upcoming Expedition, all in the pursuit of helping humans venture farther into the solar system.

Expedition 30 has a spacewalk scheduled out of the Russian segment in early 2012. Shkaplerov and Kononenko will install new debris shields on parts of the Zvezda service module and a materials exposure experiment on the Poisk module. Shkaplerov will collect some surface samples from the station's exterior hull to examine what types of bacteria might be surviving in the vacuum of space and also what types of corrosion could be happening. This will give the ground teams excellent data on the station's structure.

The crew will see the arrival of the third Automated Transfer Vehicle (ATV-3) at the International Space Station. The ATV is the European Space Agency's cargo ship, bringing vital supplies to the station such as water, oxygen, food, spare parts and fuel, and acting as a means to remove old equipment and waste from the station. In addition, the ATV supports station activities by performing debris avoidance maneuvers, by controlling the station's attitude (e.g., during docking procedures of other visiting vehicles) and reboosting the station to a higher altitude to account for atmospheric drag in low Earth orbit or to place the station in the correct orbital profile for the arrival or departure of visiting spacecraft.

ATV-3, known as Edoardo Amaldi, will be launched by an Ariane 5 from Europe's Spaceport in Kourou, French Guiana, in March. According to current planning, Edoardo Amaldi will carry almost two-and-a-half tons of dry cargo, 285 kg (628 pounds) of water and about three tons of propellants. The ATV is the biggest cargo carrier servicing the space station and a vital element of station logistics. The ATV uses state-of-the-art systems to carry out autonomous rendezvous and docking with the Russian Zvezda module at the back of the station, with ATV maneuvers monitored and controlled from the ATV Control Center in Toulouse, France.

ATV-3 follows on from the mission of the first ATV, "Jules Verne" in 2008, and the mission of the second ATV, "Johannes Kepler" in 2011, the latter of which reboosted the station by more than 40 km (24.8 miles) in altitude, the biggest boost for human spaceflight since the Apollo missions to the moon.

The next Progress launch – Progress M-14M/46P – is planned for Jan. 25, 2012.

Expedition 30 is also expected to greet the arrival of Dragon, a commercial resupply ship being built by SpaceX. Dragon will perform a test flight and rendezvous with the station, soon followed by Cygnus (scheduled for flight during Expedition 31), another commercial resupply ship being built by Orbital Sciences. Both of these vehicles fly to the station, and then the crew uses the station's robotic arm to grapple the spacecraft and plug them into the bottom of the Harmony node. The successful test flights of both of these vehicles will set the stage for commercial cargo resupply of the station from these two companies, in addition to the current complement of Russian, European and Japanese vehicles.

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Expedition 30/31 Crew

Expedition 30

Expedition 30 Patch

The International Space Station Program is completing the transition from assembly to full utilization as humankind celebrates the golden anniversary of human space exploration. In recognition of these milestones and especially of the contribution of those whose dedication and ingenuity make spaceflight possible, a fully assembled station is depicted rising above a sunlit Earth limb. Eastward of the sunlit limb, the distinctive portrayal of Earth's surface illuminated by nighttime city lights is a reminder of mankind's presence on the planet, most readily apparent from space only by night, and commemorates how human beings have transcended their early bonds throughout the previous 50 years of space exploration. The station, a unique space-based outpost for research in biological, physical, space, and Earth sciences, in the words of the crew members, is an impressive testament to the tremendous teamwork of the engineers, scientists, and technicians from 15 countries and five national space agencies.

Expedition 30 crew members take a break from training at NASA's Johnson Space Center to pose for a crew portrait. Pictured on the front row from left are NASA astronaut Dan Burbank, commander; and Russian cosmonaut Oleg Kononenko, flight engineer. Pictured on the back row from left are Russian cosmonauts Anton Shkaplerov and Anatoly Ivanishin; along with European Space Agency astronaut Andre Kuipers and NASA astronaut Don Pettit, all flight engineers. Photo credit: NASA and International Space Station partners

The six crew members of Expedition 30, like those who have gone before them, have expressed that they are honored to represent their countries and the space station team in conducting research aboard the station and adding to the body of knowledge that will enable the world's spacefaring countries to live more safely and more productively, and work and explore outer space, paving the way for future missions beyond low Earth orbit, and inspiring young people to join in this great adventure.

Expedition 31

Expedition 31 Patch

Thin crescents along the horizons of Earth and its moon depict International Space Station Expedition 31. The shape of the patch represents a view of our galaxy. The black background symbolizes the research into dark matter, one of the scientific objectives of Expedition 31. At the heart of the patch are Earth, its moon, Mars, and asteroids, the focus of current and future exploration. The station is shown in an orbit around Earth, with a collection of stars for the Expedition 30 and 31 crews. The small stars symbolize the visiting vehicles that will dock with the complex during this expedition.

The Expedition 31 crew members take a break from training at NASA's Johnson Space Center to pose for a crew portrait. Pictured on the front row are Russian cosmonauts Oleg Kononenko (right), commander; and Gennady Padalka, flight engineer. Pictured on the back row from left are NASA astronaut Joe Acaba, Russian cosmonaut Sergei Revin, European Space Agency astronaut Andre Kuipers and NASA astronaut Don Pettit, all flight engineers. Photo credit: NASA

Short biographical sketches of the crew follow with detailed background available at the following Web site: http://www.jsc.nasa.gov/Bios/

Dan Burbank

This is the third spaceflight mission for NASA astronaut Dan Burbank, 50, a retired U.S. Coast Guard captain. Burbank and his crewmates launched to the space station Nov. 13, 2011. He will serve as commander for Expedition 30. Burbank has accumulated more than 23 days in space and more than seven hours of spacewalk experience.

Anton Shkaplerov

This will be the first spaceflight mission for Anton Shkaplerov, 39, a colonel in the Russian Air Force. Shkaplerov was selected as a test-cosmonaut candidate in May 2003 and will serve as the Soyuz commander.

Anatoly Ivanishin

A lieutenant colonel in the Russian Air Force, Anatoly Ivanishin, 42, will serve as a Soyuz flight engineer for the Expedition 30 crew. Like Shkaplerov, he began his training as a cosmonaut in 2003. He will serve as a flight engineer for the long-duration mission.

Oleg Kononenko

Oleg Kononenko, 47, will serve as a flight engineer for Expedition 30 and commander for Expedition 31. He first flew as a Soyuz and International Space Station commander for the Expedition 17 crew in 2008. He also performed two spacewalks during the increment, acquiring more than 12 hours of extravehicular experience.

Andre Kuipers

European Space Agency astronaut Andre Kuipers, 58, will return to space for his second spaceflight mission. A medical doctor, he flew aboard the Soyuz spacecraft in 2004 as part of the DELTA mission. During the flight, he performed 21 science experiments. He will serve as a flight engineer for this mission.

Donald Pettit

NASA astronaut Donald Pettit, 56, and his crewmates will launch to the station via a Soyuz spacecraft on Dec. 21. Pettit, who holds a doctorate in chemical engineering, will be embarking on his third spaceflight and second long-duration mission. He previously served as flight engineer during Expedition 6 in 2002 and 2003 and as mission specialist on STS-126 in 2008. He will again serve as flight engineer during the upcoming mission.

Gennady Padalka

This will be the fourth mission for Gennady Padalka, 53, whose first mission was as commander aboard the MIR space station in 1998. He returned to space in 2002 as commander of Expedition 9, and returned to the complex in 2009 to command Expedition 19. He will serve as flight engineer for Expedition 31.

Joseph Acaba

Former educator Joe Acaba, 44, will be returning to space for a second time. His first mission was in 2009 as a mission specialist on the STS-119 mission. Acaba accumulated nearly 13 hours of spacewalk experience during the mission. He will serve as a flight engineer during Expedition 31.

Sergei Revin

This will be the first spaceflight mission for cosmonaut Sergei Revin. He was selected to train as a cosmonaut in 1996, and completed spaceflight training in 1998. He will serve as a flight engineer for the Expedition 31 crew.

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Expedition 30/31 Spacewalks

There are no U.S.-based spacewalks currently scheduled for Expedition 30 or 31. However, cosmonauts Oleg Kononenko and Anton Shkaplerov will don Russian Orlan spacesuits for the station's 30th Russian spacewalk. Kononenko has 12 hours and 15 minutes of spacewalk experience from the two spacewalks he performed on Expedition 17. Shkaplerov will perform his first spacewalk.

Spacewalk 30 is currently planned for Feb. 14, and scheduled to last six hours.

Kononenko and Shkaplerov will conduct a variety of work, including installing five shields on the Zvezda service module to protect it from micrometeoroid orbital debris and moving the Strela1 crane from the Piers docking compartment to the Poist Mini Research Module 2. If time permits, they also will install struts on a ladder used by spacewalkers on Piers.

As another get-ahead, they may install an experiment called Vynoslivost – which means "Endurance" – on the Poisk Mini Research Module 2. As part of Vynoslivost, two trays of metal samples would be left exposed on the surface of the Poisk. One will be brought in after one year, and the other after three years, at which point the samples will be returned to Earth for study.

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H-II Transfer Vehicle-3

The H-II Transfer Vehicle "KOUNOTORI" (HTV), developed by Japan Aerospace Exploration Agency (JAXA) in Japan, is an unmanned cargo transfer spacecraft that delivers supplies to the International Space Station.

The HTV is launched from the Tanegashima Space Center aboard an H-IIB launch vehicle with up to 6,000 kg of supplies. When the HTV approaches close to the space station, the Space Station Remote Manipulator System (SSRMS), known as "Canadarm2," will grapple the HTV and berth it to the station. Then, crew items and internal and external equipment are carried into the station. After unloading the supplies, HTV will be loaded with waste materials, such as used experiment equipment and used clothes. The HTV will then undock and separate from the station and re-enter the atmosphere. While the HTV is berthed to the station, the station crew will be able to enter and remove the supplies from the HTV Pressurized Logistics Carrier.

Russia's Progress spacecraft, the European Space Agency's Automated Transfer Vehicle (ATV), and Japan's HTV are used for delivering supplies to the station. Among these cargo-carrying spacecraft, the HTV is the only vehicle that can carry large pressurized cargo, and also can accommodate unpressurized cargo to the station. These are unique special features of the HTV.

The HTV successfully completed its mission in 2009 and 2011, and its flight is scheduled once every year.

ISS026E020932

The station arm grapples the HTV-2

The H-IIB Launch Vehicle No. 2 with the KOUNOTORI2 (HTV2, a cargo transporter to the International Space Station) on board was launched from the Tanegashima Space Center at 2:37:57 p.m. on Jan. 22 (Sat., Japan Standard Time)

ISS026E020910

HTV-2 makes it voyage in space

The HTV was nicknamed “KOUNOTORI,” meaning “White Stork,” in 2010.

HTV Specifications

HTV is 4 meters across and about 10 meters long, the same size as a sightseeing bus. It consists primarily of three parts: (1) a propulsion module installed at the rear and composed of four main engines for orbital transfer, 28 Reaction Control System (RCS) thrusters for position and attitude control, fuel and oxidizing reagent tanks, and high-pressure air tanks; (2) an avionics module installed in the center part, with electronic equipment for guidance control, power supply, and telecommunications data processing; (3) and a logistics carrier that stores supplies.

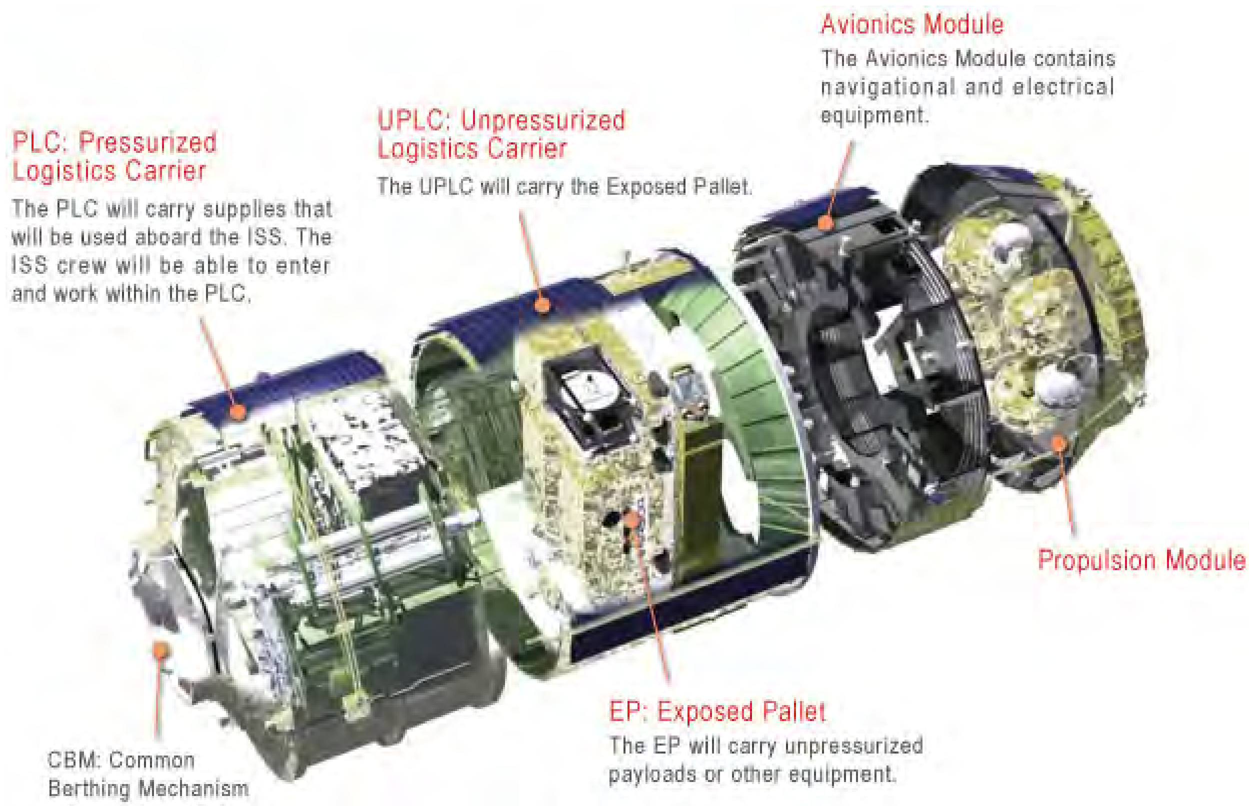


Diagram of HTV specifications

HTV specifications

Item	Specification
Length	Approx. 10 m (including thrusters)
Diameter	Approx. 4.4 m
Total Mass	Approx. 10,500 kg
Cargo capacity (supplies and equipment)	Approx. 6,000 kg -Pressurized cargo: Approx. 5,200 kg -Unpressurized cargo: Approx. 1,500 kg
Cargo capacity (waste)	Approx. 6,000 kg
Target orbit to International Space Station	Altitude: 350 km to 460 km Inclination: 51.6 degrees
Mission Duration (Nominal)	Rendezvous Flight: Approx. 5 days Berthed Operation: Approx. 30 days Reserve: Approx. 7 days

HTV3 Mission

The HTV3 is scheduled to be launched in 2012. Major objectives of the HTV3 mission are as follows:

1. Cargo Delivery

   (a) Pressurized carrier

   Cargo Transfer Bags (CTB) of food and experiment equipment will be transferred.

Cargo Transfer Bag (CTB)

   (b) Unpressurized carrier

   Two external cargo payloads will be transferred. One is a Japanese payload, Multi-mission Consolidated Equipment (MCE), which installs five pieces of equipment.

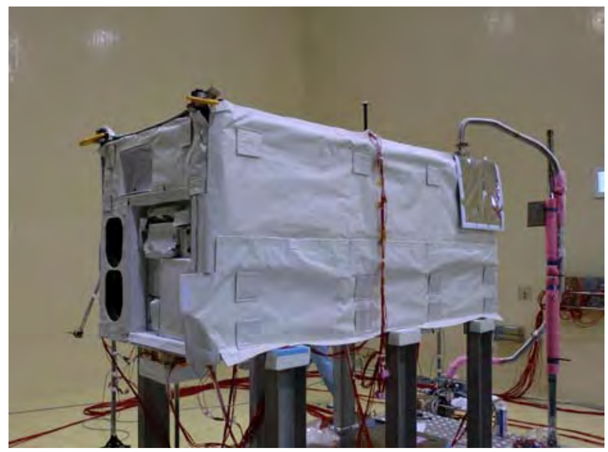
   (1) International Space Station Ionosphere, Mesosphere, Upper Atmosphere and Plasmasphere mapping (IMAP)

   (2) Global Lightning and Sprite Measurements (GLIMS)

   (3) Space Inflatable Membrane Pioneer Long-term Experiment (SIMPLE)

   (4) Robot EXperiment on JEM:REXJ

   (5) Commercial Off-The-Shelf High-Definition Television Camera System HDTV-EF



Multi-mission Consolidated Equipment (MCE)

The other is NASA`s in-orbit facility. The Space Communications And Navigation (SCAN) test bed will be an International Space Station-based experimental facility aimed at advancing communications, navigation and networking technology. The test bed includes three reconfigurable radios and five different antennas capable of S-band, Ka-band and L-band (GPS) communications. Experiments with the facility will include high-data rate transmission and reception, new data coding and modulation, real-time networking and precise navigation. The experiments will further these technologies and enable them to be used on future human and robotic space missions.

1. The SCAN testbed payload public Web site is http://spaceflightsystems.grc.nasa.gov/SpaceOps/CoNNeCT/

Space Communications And Navigation (SCAN) Testbed

2. Trash Loading

3. Major Modification

HTV’s four main engines and 28 Reaction Control System (RCS) thrusters were domestically produced for HTV3.

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Russian Soyuz

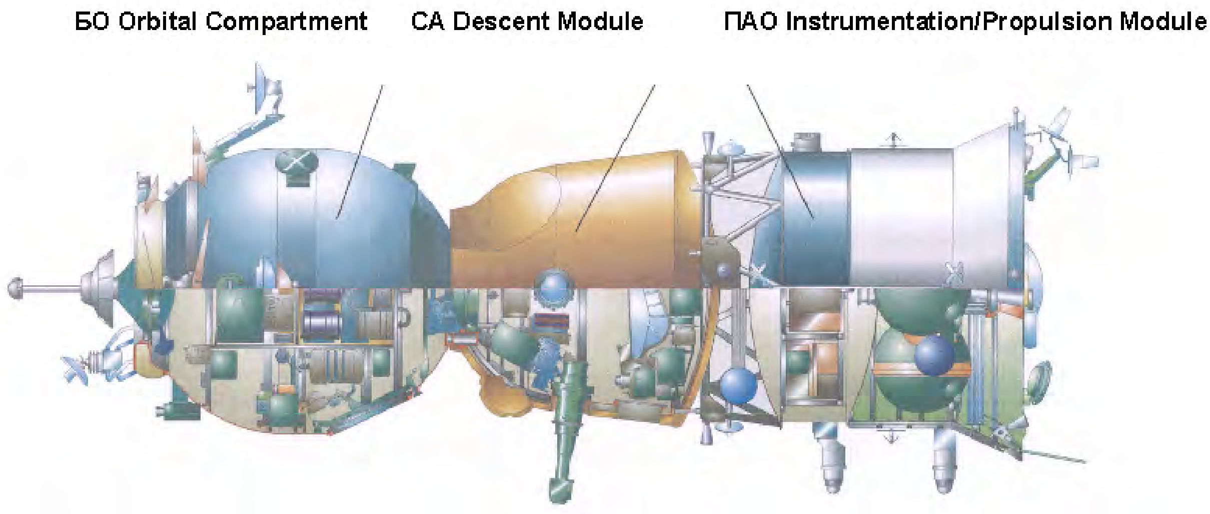


Diagram of the Soyuz-TMA spacecraft

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

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 in orbit during free flight. It has a volume of 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 antennae are used by the automated docking system – a radar-based system – to maneuver toward the station for docking. There is also a window in the module.

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

Descent Module

The descent module is where the cosmonauts and astronauts sit for launch, re-entry and landing. All the necessary controls and displays of the Soyuz are located here. The module also contains life support supplies and batteries used during descent, as well as the primary and backup parachutes and landing rockets. It also contains custom-fitted seat liners for each crew member's couch/seat, which are individually molded to fit each person's body – this ensures a tight, comfortable fit when the module lands on the Earth.

The module has a periscope, which allows the crew to view the docking target on the station or Earth below. The eight hydrogen peroxide thrusters 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 (GNC) system to maneuver the vehicle during the descent phase of the mission.

This module weighs 6,393 pounds, with a habitable volume of 141 cubic feet. Approximately 110 pounds of payload can be returned to Earth in this module and up to 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, which has a cooling area of 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 the atmosphere upon re-entry.

TMA Improvements and Testing

The Soyuz TMA-01M spacecraft is the first to incorporate both newer, more powerful computer avionics systems and new digital displays for use by the crew. The new computer systems will allow the Soyuz computers to interface with the onboard computers in the Russian segment of the station once docking is complete.

Both Soyuz TMA-15, which launched to the station in May 2009, and Soyuz TMA-18, which launched in April 2010, incorporated the new digital "Neptune" display panels, and seven Progress resupply vehicles have used the new avionics computer systems.

The Soyuz TMA-01M vehicle integrates those systems. The majority of updated components are housed in the Soyuz instrumentation module.

For launch, the new avionics systems reduce the weight of the spacecraft by approximately 150 pounds, which allows a small increase in cargo-carrying capacity. Soyuz spacecraft are capable of carrying a limited amount of supplies for the crew's use. This will increase the weight of supplies the spacecraft is capable of carrying, but will not provide any additional volume for bulky items.

Once Soyuz is docked to the station, the new digital data communications system will simplify life for the crew. Previous versions of the spacecraft, including both the Soyuz TM, which was used from 1986 to 2002, and the Soyuz TMA in use since 2002, required Mission Control-Moscow (MCC-M), to turn on the Soyuz computer systems periodically so that a partial set of parameters on the health of the vehicle could be downlinked for review. In addition, in the case of an emergency undocking and deorbit, crew members were required to manually input undocking and deorbit data parameters. The new system will eliminate the need for the crew to perform these checks and data updates, with the necessary data being automatically transferred from the space station to the Soyuz.

The updates required some structural modifications to the Soyuz, including the installation of cold plates and an improved thermal system pump capable of rejecting the additional heat generated by the new computer systems.

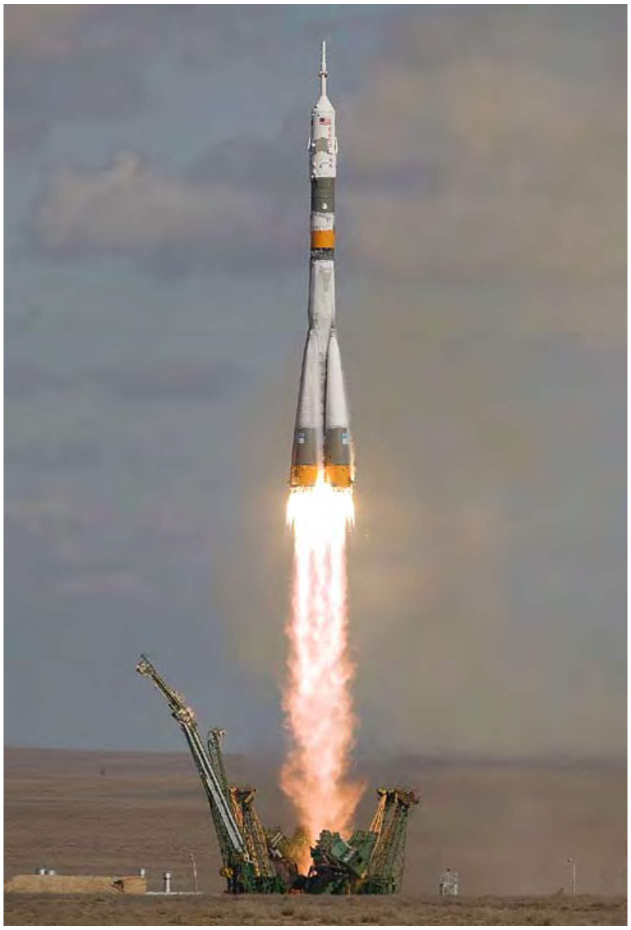
The majority of Soyuz TMA systems remain unchanged. In use since 2002, the TMA increased safety, especially in descent and landing. It has smaller and more efficient computers and improved displays. In addition, the Soyuz TMA accommodates individuals as large as 6 feet, 3 inches tall and 209 pounds, compared to 6 feet and 187 pounds in the earlier TM. Minimum crew member size for the TMA is 4 feet, 11 inches and 110 pounds, compared to 5 feet, 4 inches and 123 pounds for the TM.

Two new engines reduced 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 included 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, the unpiloted supply spacecraft, while the new cooling system was tested on two Soyuz TM flights.

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

Soyuz Launcher



A Soyuz TMA spacecraft launches from the Baikonur Cosmodrome in Kazakhstan on Oct. 12, 2008 carrying a new crew to the ISS. Photo Credit: NASA/Bill Ingalls

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 space flights.

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

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

First Stage Boosters

The first stage's four boosters are assembled laterally around the second stage central core. The boosters are identical and cylindrical-conic in shape with the oxygen tank in the cone-shaped portion and the kerosene tank in the cylindrical portion.

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

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

First stage booster separation occurs when the predefined velocity is reached, which is about 118 seconds after liftoff.

Second Stage

An NPO Energomash RD 108 engine powers the Soyuz second stage. This engine differs from those of the boosters by the presence of four vernier thrusters, which are necessary for three-axis flight control of the launcher after the first stage boosters have separated.

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

Third Stage

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

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

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

Launcher Telemetry Tracking & Flight Safety Systems

Soyuz launcher tracking and telemetry is provided through systems in the second and third stages. These two stages have their own radar transponders for ground tracking. Individual telemetry transmitters are in each stage. Launcher health status is downlinked to ground stations along the flight path. Telemetry and tracking data are transmitted to the mission control center, where the incoming data flow is recorded. Partial real-time data processing and plotting is performed for flight following an 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 horizontal railcar. Transfer to the launch zone occurs two days before launch, during which the vehicle is erected and a launch rehearsal is performed that includes activation of all electrical and mechanical equipment.

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

Rendezvous to Docking

A Soyuz spacecraft generally takes two days after launch to reach the space station. The rendezvous and docking are both automated, though once the spacecraft is within 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 onboard 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

Prelaunch Countdown Timeline (concluded)

T- 3:15	Combustion chambers of side and central engine pods purged with nitrogen
T- 2:30	Booster propellant tank pressurization starts
	Onboard measurement system activated by RUN 2 command
	Prelaunch pressurization of all tanks with nitrogen begins
T- 2:15	Oxidizer and fuel drain and safety valves of launch vehicle are closed
	Ground filling of oxidizer and nitrogen to the launch vehicle is terminated
T- 1:00	Vehicle on internal power
	Automatic sequencer on
	First umbilical tower separates from booster
T- :40	Ground power supply umbilical to third stage is disconnected
T- :20	Launch command given at the launch position
	Central and side pod engines are turned on
T- :15	Second umbilical tower separates from booster
T- :10	Engine turbopumps at flight speed
T- :05	First stage engines at maximum thrust
T- :00	Fueling tower separates
	Lift off

Ascent/Insertion Timeline

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

Orbital Insertion to Docking Timeline

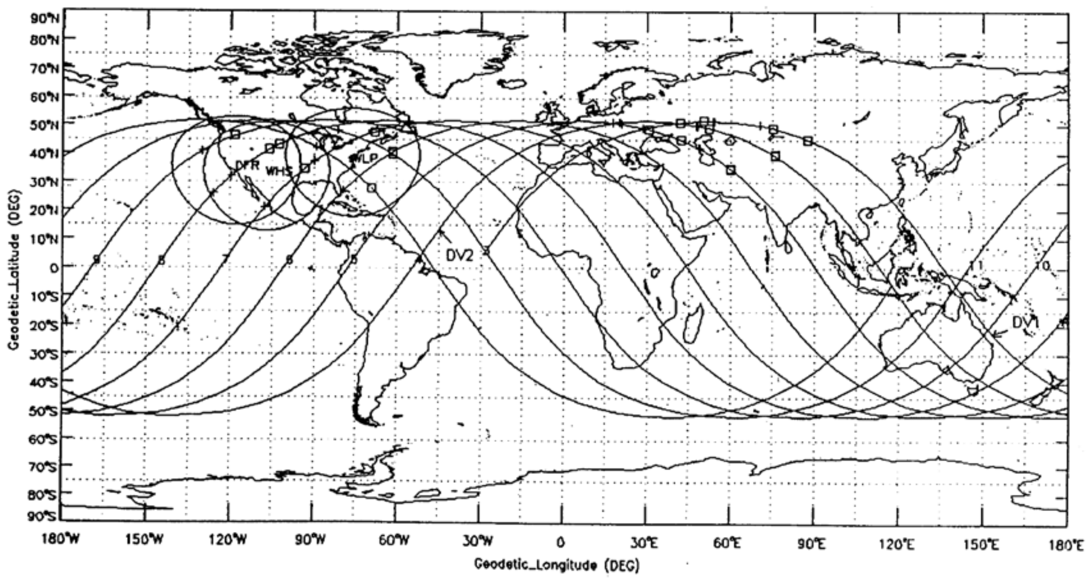
FLIGHT DAY 1 OVERVIEW	
Orbit 1	**Post insertion: Deployment of solar panels, antennas and docking probe**
	- Crew monitors all deployments
	- Crew reports on pressurization of OMS/RCS and ECLSS systems and crew health. Entry thermal sensors are manually deactivated
	- Ground provides initial orbital insertion data from tracking
Orbit 2	**Systems Checkout: IR Att Sensors, Kurs, Angular Accels, "Display" TV Downlink System, OMS engine control system, Manual Attitude Control Test**
	- Crew monitors all systems tests and confirms onboard indications
	- Crew performs manual RHC stick inputs for attitude control test
	- Ingress into HM, activate HM CO2 scrubber and doff Sokols
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Manual maneuver to +Y to Sun and initiate a 2 deg/sec yaw rotation. MCS is deactivated after rate is established
Orbit 3	**Terminate +Y solar rotation, reactivate MCS and establish LVLH attitude reference (auto maneuver sequence)**
	- Crew monitors LVLH attitude reference build up
	- Burn data command upload for DV1 and DV2 (attitude, TIG Delta Vs)
	- Form 14 preburn emergency deorbit pad read up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
	Auto maneuver to DV1 burn attitude (TIG - 8 minutes) while LOS
	- Crew monitor only, no manual action nominally required
	DV1 phasing burn while LOS
	- Crew monitor only, no manual action nominally required
Orbit 4	**Auto maneuver to DV2 burn attitude (TIG - 8 minutes) while LOS**
	- Crew monitor only, no manual action nominally required
	DV2 phasing burn while LOS
	- Crew monitor only, no manual action nominally required

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

FLIGHT DAY 2 OVERVIEW (CONTINUED)	
Orbit 18 (2)	**Post burn and manual maneuver to +Y Sun report when AOS**
	- HM/DM pressures read down
	- Post burn Form 23, Form 14 and Form 2 (Globe correction) voiced up
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 19 (3)	**CO2 scrubber cartridge change out**
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 20 (4)	**Free time**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 21 (5)	**Last pass on Russian tracking range for Flight Day 2**
	Free time
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 22 (6) - 27 (11)	**Crew sleep, off of Russian tracking range**
	- Emergency VHF2 comm available through NASA VHF Network
FLIGHT DAY 3 OVERVIEW	
Orbit 28 (12)	**Post sleep activity**
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 29 (13)	**Free time, report on HM/DM pressures**
	- Read up of predicted post burn Form 23 and Form 14
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
Orbit 30 (14)	**Free time, read up of Form 2 “Globe Correction,” lunch**
	- Uplink of auto rendezvous command timeline
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radar and radio transponder tracking
FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE	
Orbit 31 (15)	**Don Sokol spacesuits, ingress DM, close DM/HM hatch**
	- Active and passive vehicle state vector uplinks
	- A/G, R/T and Recorded TLM and Display TV downlink
	- Radio transponder tracking

FLIGHT DAY 3 AUTO RENDEZVOUS SEQUENCE (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



Soyuz Landing

The Soyuz TMA-20 spacecraft is seen as it glides to a landing with Russian cosmonaut Dmitry Kondratyev, Expedition 27 commander, and two flight engineer crewmates - Paolo Nespoli of the European Space Agency and Cady Coleman of NASA - in a remote area southeast of the town of Dzhezkazgan, Kazakhstan, May 24, 2011 (local time or May 23 in USA time zones). The three return from more than five months on board the International Space Station where they served as members of the Expedition 26 and 27 crews. Photo credit: NASA/Bill Ingalls

After about six months in space, the departing crew members from the International Space Station will board their Soyuz spacecraft capsule for undocking and a one-hour descent back to Earth.

About three hours before undocking, the crew will bid farewell to the other three crew members who will remain on the station awaiting the launch of a new trio of astronauts and cosmonauts from the

Baikonur Cosmodrome in Kazakhstan about 17 days later.

The departing crew will climb into its Soyuz vehicle and close the hatch between Soyuz and its docking port. The Soyuz commander will be seated in the center seat of the Soyuz' descent module, flanked by his two crewmates.

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

He will then fire the Soyuz thrusters to back away from the docking port. Six minutes after undocking, with the Soyuz about 66 feet away from the station, the Soyuz commander 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 centermost descent module, the uppermost orbital module, containing the docking mechanism and rendezvous antennas, and the lower 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 will begin a computer-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' 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 will be 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 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 will be followed by the termination of the aerodynamic spin cycle and the dissipation of any residual propellant from the Soyuz. Also, computers 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 the commander to prepare for the soft landing engine firing. Just three feet above the surface, and just seconds before touchdown, the six solid propellant engines will be fired in a final braking maneuver. This will enable the Soyuz to settle down to a velocity of about five feet per second and land, completing its mission.

As always is the case, teams of Russian engineers, flight surgeons and technicians in fleets of MI-8 helicopters will be poised near the normal and "ballistic" landing zones, and midway in between, to enact the swift recovery of the crew 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. The crew will be seated in special reclining chairs near the capsule for initial medical tests and 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 will then return to Chkalovsky Airfield adjacent to the Gagarin Cosmonaut Training Center in Star City, Russia, or to Ellington Field in Houston where their families can meet them.

Expedition 30/31 Science Overview

Expedition 30/31 will continue to expand the scope of research aboard the International Space Station now that assembly of the orbiting laboratory is complete.

Among the many educational activities planned will be a contest for students 14 to 18 years of age to have an experiment flown on the space station as part of a joint effort by NASA, the U.S. National Laboratory Office, YouTube and Lenovo. The YouTube Space Lab Global Science contest challenges students to design an experiment pertaining to biology or physics to be conducted on board the station by crew members, presenting their ideas with a two-minute YouTube video. The top 60 finalists will be announced, allowing for public voting along with evaluation by a panel of distinguished judges, after Jan. 3, 2012. The top six regional winners will be announced Jan. 31, with the final two global winners announced March 13. The deadline for submittals is Dec. 7, 2011. This event has the capacity to expose hundreds of thousands of students around the world to the excitement of space and to the unique scientific platform the station provides.

As with prior expeditions, many investigations are designed to gather information about the effects of long-duration spaceflight on the human body, which will help us understand complicated processes such as immune systems with plans for future exploration missions. The investigations cover human research; biological and physical sciences; technology development; Earth observation; and education.

The Japan Aerospace Exploration Agency's Monitor of All-sky X-ray Image (MAXI) investigation will be finishing up its stay on the station. MAXI has been installed on the Exposed Facility (EF) of the Japanese Kibo laboratory since Expedition 19-20, monitoring more than 1,000 X-ray sources in space once every 96 minutes using slit cameras, and has already produced significant results in the area of space science. In 2010, MAXI, along with the SWIFT spacecraft, found two new X-ray sources from its sky scans. Both instruments made the first observation of a relativistic (moving at a velocity approaching the speed of light) X-ray burst from a supermassive black hole destroying a star and creating a jet of X-rays.

The Alpha Magnetic Spectrometer (AMS-02), a state-of-the-art particle physics detector delivered during Expedition 27-28, is continuing to collect data on anti-matter, dark matter, and cosmic rays in an effort to provide highly developed knowledge, and a better understanding of the origin of the universe. As the largest and most advanced magnetic spectrometer in space, information is being collected from cosmic sources originating from stars and galaxies millions of light-years beyond the Milky Way, and at a much faster rate than anticipated. The foundations of modern physics will be explored, including the investigation of quark (elementary particle or fundamental particle considered to be one of the basic building blocks of the universe) types and strangelets (hypothetical particles) that could lead to the discovery of a totally new form of matter.

The Commercial Generic Bioprocessing Apparatus Science Insert – 05 (CSI-05) Directional Plant Growth (also referred to as Plants in Space) investigation is continuing, comparing plant growth on the ground (by thousands of students in classrooms around the world) to plant growth in microgravity on board the station. Results from this investigation will continue to expand the knowledge base regarding how plants react in a microgravity environment, using this information to support long-duration deep space missions providing food and oxygen generation. This also allows students to work essentially side-by-side with scientists and astronauts.

Space radiation exposure is always a concern, and must be protected against. The European Space Agency's Dose Distribution Inside the International Space Station - 3D (DOSIS-3D) investigation will employ various active and passive radiation detector devices to assemble a three-dimensional dose distribution map, of all segments of the station, to determine the radiation field parameters dose and dose equivalent to assist in assessing radiation safe exposure limits and exposure health risks. This investigation will provide important information regarding devices used for data collection and real-time data monitoring, proving valuable to commercial crews and military flight crews regarding radiation monitoring.

As part of U.S. National Laboratory activities on the station, Nanoracks modules provide autonomous, self-contained experiments that can be flown quickly and inexpensively by students, companies and other U.S. government agencies. Nanorack investigations during this timeframe will look at exploring the use of readily available commercial-off-the-shelf products and technologies (a smart phone and an electronic book) in microgravity, remote control mechanisms and mechanical devices, the behavior of 18S Ribosomal Ribonucleic Acid (RNA), and the MC3T3 mouse bone cell line, along with several student-based investigations.

Earth science is also on the list of topics that generates much interest, and there are many investigations involving this aspect. AuroraMax (simultaneous photography of the aurora borealis from the space station and ground-based observatories), Crew Earth Observations (CEO) (photography of natural and man-made surface changes), HREP-HICO (coastal imagery), and Geoflow-2 (studying heat and flow currents in the Earth's mantle to better understand and predict volcanic eruptions, plate tectonics and earthquakes) are all recording images, many never seen before.

The Burning and Suppression of Solids (BASS) investigation examines burning and extinction characteristics of a wide variety of fuel samples in microgravity. Results from this investigation will assist in devising strategies for extinguishing accidental fires in microgravity, along with contributing to advances in fire detection and suppression in microgravity and on Earth. Crew members will observe the burning process, noting flame shape (as a function of flow speed), flame spread rate, and flame dynamics, along with extinction data to be used for comparison to modeling data. A nitrogen suppressant system is used as the means for flame extinction.

Checkout and testing of hand motions for Robonaut 2, installed in the U.S. Destiny Laboratory, are planned for later this year.

Managing the international laboratory's scientific 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. Teams of controllers and scientists on the ground continuously plan, monitor, and remotely operate experiments from control centers around the globe. Controllers staff payload operations centers around the world, effectively providing for researchers and the station crew around the clock, seven days a week.

State-of-the-art computers and communications equipment deliver up-to-the-minute reports about experiment facilities and investigations between science outposts across the United States and around the world. The payload operations team also synchronizes the payload timelines among international partners, ensuring the best use of valuable resources and crew time.

The control centers of NASA and its partners are

- NASA Payload Operations Center (POC), Marshall Space Flight Center in Huntsville, Ala.
- RSA Center for Control of Spaceflights ("TsUP" in Russian) in Korolev, Russia
- JAXA Space Station Integration and Promotion Center (SSIPC) in Tskuba, Japan
- ESA Columbus Control Center (Col-CC) in Oberpfaffenhofen, Germany
- CSA Payloads Operations Telesciences Center, St. Hubert, Quebec, Canada

NASA's POC serves as a hub for coordinating much of the work related to delivery of research facilities and experiments to the space station as they are rotated in and out periodically when vehicles make deliveries and return completed experiments and samples to Earth.

The payload operations director leads the POC's main flight control team, known as the "cadre," and approves all science plans in coordination with Mission Control at NASA's Johnson Space Center in Houston, the international partner control centers and the station crew.

On the Internet

For fact sheets, imagery and more on Expedition 30/31 experiments and payload operations, visit the following Web site: http://www.nasa.gov/mission_pages/station/science/

Expedition 30/31 Science Table

Research Experiments

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
AuroraMax	Coordinated Aurora Photography from Earth and Space (AuroraMAX)	CSA	Earth and Space Sciences	This joint public engagement and science activity aims to enhance the public's awareness of the science of the aurora and the Sun-Earth relationship. AuroraMax consists of simultaneous photography of the *aurora borealis* from the station and ground-based observatories during periods of peak solar activity	Ruth Ann Chicoine, Canadian Space Agency; Dr Emma Spanswick, University of Calgary, Calgary, Alberta, Canada	USOS
BCAT-C1	Binary Colloidal Alloy Test – Canadian 1	CSA	Physical Science	BCAT will study binary colloidal alloys with time lapse photography. Samples are initially homogenized and allowed to evolve over 10 to 20 days to reveal their structure. Samples 1-7 from Simon Fraser University (SFU) will focus on phase competing processes. Samples 8-10 from New York University (NYU) will study seeded growth	Dr. Barbara Frisken, SFU; Dr. Art Bailey, Scitech Instruments; Dr. Paul Chaikin and Dr. Andrew Hollingsworth, NYU	JEM
TOMATOSPHERE III	TOMATOSPHERE III	CSA	Education Activity	TOMATOSPHERE III primary objectives are to increase student interest in space science and horticultural technology and to increase student familiarity and experience with research methodology. Following exposure of the tomato seeds to weightlessness, they will be distributed to approximately 13,000 classrooms across Canada and the United States. Students in grades 3-10 will plant the seeds, make observations, record data and investigate the effect of spaceflight on seed germination rate, seedling vigor and other growth parameters	Dr. Michael Dixon, University of Guelph, Ontario, Canada	None
VASCULAR	Cardiovascular Health Consequences of Long-Duration Space Flight	CSA	Human Research and Counter-measures Development	Health Consequences of Long-Duration Flight (VASCULAR) will conduct an integrated investigation of mechanisms responsible for changes in blood vessel structure with long-duration space flight, which are similar to changes that occur during the aging process. Space flight accelerates the aging process requiring a better understanding to determine the need for specific countermeasures. Data will be collected before, during, and after spaceflight to assess inflammation of the artery walls, and changes in blood vessel properties and cardiovascular fitness	Richard Lee Hughson, Ph.D., University of Waterloo, Waterloo, Ontario, Canada	Columbus

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
ALTEA-SHIELD	Anomalous Long-Term Effects in Astronauts – Central Nervous System Radiation Shielding	ESA	Technology Development and Demonstration	ALTEA-SHIELD aims at obtaining a better understanding of the light flash phenomenon (perception of seeing light flashes when eyes are closed), and more generally the interaction between cosmic rays and brain function, as well as testing different types of shielding material. Also provides an assessment of the radiation environment inside the space station	Italy: L. Narici, F. Ballarini, G. Battistoni, M. Casolini, A. Ottolenghi, P. Picozza, W. Sannita, S. Villari USA: E. Benton, J. Miller, M. Shavers Switzerland: A. Ferrari Germany: H. Iwase, D. Schardt Japan: T. Sato Sweden: L. Sihver	Destiny
CARD	Long Term Microgravity: A Model for Investigating Mechanisms of Heart Disease with New Portable Equipment	ESA	Human Research and Counter-measures Development	CARD aims to understand how weightlessness affects the regulation of blood pressure and establish how some hormones responsible for regulating the cardiovascular system are affected by long-term exposure to weightlessness	Denmark: P. Norsk, N.J. Christensen, B. Pump, A.Gabrielsen, J.G. Nielsen, N. Gadsboll Germany: C. Drummer, M. Kentsch	Columbus
CARD -(Sympatho)	Sympatho-Adrenal Activity in Humans During Spaceflight	ESA	Human Research and Counter-measures Development	SYMPATHO, which forms part of the CARD experiment, is an ongoing study of adrenal activity of the sympathetic nervous system in weightlessness	Denmark: N.J. Christensen, P. Norsk	Merged protocol with CARD
DOSIS-3D	Dose Distribution Inside the International Space Station - 3D	ESA	Technology Development and Demonstration	DOSIS-3D determines the radiation field parameters absorbed dose and dose equivalent inside the station with various active and passive radiation detector devices, aiming for a concise three dimensional dose distribution (3D) map of all the segments of the space station	Germany: T. Berger	
EDOS	Early Detection of Osteoporosis	ESA	Human Research and Counter-measures Development	EDOS will study the mechanisms underlying the reduction in bone mass, which occurs in astronauts in weightlessness, and will test the ability of XtremeCT technology to evaluate bone structure pre- and post-flight	France: C. Alexandre, L. Braak, L. Vico Switzerland: P. Ruegsegger Germany: M. Heer	Ground-based
EKE	Assessment of Endurance Capacity by Gas Exchange and Heart Rate Kinetics During Physical Training.	ESA	Human Research and Counter-measures Development	EKE will make an assessment of endurance capacity and heart rate kinetics during physical training of station expedition crew members	Germany: U. Hoffman, S. Fasoulas, D. Essfeld, T. Drager	Data sharing with NASA VO2max protocol
ENERGY	Astronaut's Energy Requirements for Long-Term Spaceflight.	ESA	Human Research and Counter-measures Development	ENERGY measures changes in energy balance/expenditure due to long-term spaceflight; and derive an equation for astronaut's energy requirements	France: S. Blanc, A. Zahariev, M. Caloin, F. Crampes USA: D. Schoeller	Columbus

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
EPO - CONVECTION	EPO Convection	ESA	Education	Introducing the concept of convection to European children age 10-18. School children will be able to operate identical experiment on the ground and witness how convection differs under gravity compared to the space station microgravity environment	Netherlands: J. van Loon, S. de Vet, A. Adawy E. Celton, ESA/ESTEC	Columbus
EPO - FOAM S2	EPO Foam-Stability	ESA	Education	Introducing the concept of foams to European children age 10-18. School children will be able to operate identical experiment on the ground and witness how foams differ under gravity compared to the space station microgravity environment	Netherlands: E. Celton, N. Savage, C. Hartevelt, ESA/ESTEC	Columbus
EPO - MISSION X	Mission-X Train Like an Astronaut	ESA	Education	NASA-led project using strict astronaut training and diets to emphasise importance of exercise and healthy eating to children aged 8-14 from around the world	Netherlands: E. Celton, N. Savage, C. Hartevelt ESA/ESTEC	Node 3 /Columbus
EPO - SCRIPTS	SpaceShip Earth Scripts	ESA	Education	Aims to record educational photography and video related to the subthemes of the SpaceShip education project: human life, biodiversity and climate	Netherlands: E. Celton, N. Savage, C. Hartevelt ESA/ESTEC	Cupola
EPO – SPHERES	ZeroRobotics	ESA/NASA	Education	NASA/MIT-led project using Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) aboard the station to test formation flying algorithms written by European students	Netherlands: N. Savage, ESA/ESTEC	Kibo
ERB-2	Erasmus Recording Binocular 2	ESA	Technology Demonstration	The ERB-2 is a high definition 3D stereoscopic video camera to be used for taking footage inside the space station to develop narrated video material for promotional and educational purposes. It will be used in the future for live 3D public affairs events	Netherlands: M. Sabbatini, ESA/ESTEC	Columbus
Geoflow-2	Simulation of Geophysical Fluid Flow Under Microgravity - 2	ESA	Physical Science	Geoflow-2 studies heat and fluid flow currents within the Earth's mantle, in an attempt to improve computational methods that scientists and engineers use to understand and predict the processes in the Earth's mantle that lead to volcanic eruptions, plate tectonics and earthquakes	Germany: Ch. Egbers, P. Beltrame, F. Feudel, D. Breuer France: P. Chossat, L.Tuckerman, I. Mutabazi, J. Srulijes U.K.: R. Hollerbach	Columbus
IMMUNO	Neuroendocrine and Immune Responses in Humans During and After a Long-Term Stay on the ISS	ESA	Human Research and Counter-measures Development	IMMUNO aims to determine changes in hormone production and immune response during and after a space station mission	Germany: A. Chouker, F. Christ, M. Thiel, I. Kaufmann, Russia: B. Morukov	Russian Segment

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
MARES - SARCOLAB	Myotendinous and Neuromuscular Adaptation to Long-Term Spaceflight: Determinants and Time Courses	ESA	Human Research and Counter-measures Development	Sarcolab will study loss of muscle mass, function and motor control by determining the contractile characteristics of muscles particularly affected, i.e., the plantar flexor muscles in the lower leg, during static and dynamic contractions	Italy: P. Cerretelli, M. Narici, R. Bottinelli, C. Gelfi France: C. Pérot, C. Marque, F. Canon, D. Gamet, S. Boudaoud, D. Lambertz UK: M. Fluck, C. Maganaris, J. Rittweger, O. Seynnes	Ground-based
METERON	Multi-Purpose End-To-End Robotic Operation Network	ESA/DLR	Technology Demonstration	METERON is a technology experiment/architecture aiming to validate future human-robotic operations from space using the space station to carry out future mission simulations with real-time mission operations and communications	Netherlands: A. Schiele, P.Schoone-jans, W. Carey, J. Dettmann, C. Taylor (ESA) Germany: K. Nergaard, F. B. De Frescheville, J.Grenouilleau (ESA) K. Landzettel (DLR) US: K. Laurini, T. Fong, A. Hooke (NASA)	Destiny
MSL CETSOL-2 (Batch-2A)	Columnar-to- Equiaxed Transition in Solidification Processing	ESA	Physical Sciences in Microgravity	CETSOL-2 researches the formation of microstructures during the solidification of metallic alloys, specifically the transition from columnar growth to equiaxed growth when crystals start to nucleate in the melt. Results will help to optimize industrial casting processes. (See also MSL Batch-2A MICAST-2 and SETA-2)	France: C.-A. Gandin, B. Billia, Y. Fautrelle Germany: G. Zimmerman Ireland: D. Browne USA: D. Poirier, C. Beckermann	Destiny
MSL MICAST-2 Batch-2A)	Microstructure Formation in Casting of Technical Alloys Under Diffusive and Magnetically Controlled Convective Conditions	ESA	Physical Sciences in Microgravity	MICAST researches the formation of microstructures during the solidification of metallic alloys under diffusive and magnetically controlled convective conditions. (See also MSL Batch-2A CETSOL-2 and SETA-2)	Germany: L. Ratke, G. Zimmerman France: Y. Fautrelle, J. Lacaze Hungary: A. Roosz Canada: S. Dost USA: D. Poirier	Destiny
NEUROSPAT: NEUROCOG-2	Effect of Gravitational Context on Brain Processing: A Study of Sensori-Motor Integration Using Event Related EEG Dynamics	ESA	Human Research and Counter-measures Development	NEUROCOG-2 will study brain activity that underlies cognitive processes involved in four different tasks that humans and astronauts may encounter on a daily basis. The roles played by gravity on neural processes will be analyzed by different methods such as Electroencephalogram (EEG) during virtual reality stimulation	Belgium: G. Cheron, C. Desadeleer, A. Cebolla, A. Bengoetxea France: A. Berthoz	Columbus

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
NEUROSPAT: PRESPAT	Prefrontal Brain Function and Spatial Cognition	ESA	Human Research and Counter-measures Development	Prespat will use physiological and behavioral measures to assess changes in general activation, prefrontal brain function and perceptual reorganization. It is funded as part of the European Commission The International Space Station: a Unique REsearch Infrastructure (SURE) project	Hungary: L. Balazs, I. Czigler, G. Karmos, M. Molnar, E. Nagy Poland: J.Achimowicz	Columbus
NIGHT POD NODDING MECHANISM	Nodding Mechanism	ESA	Technology Demonstration	A 2-direction "nodding" mechanism positioned in Cupola on the space station to support camera in taking high-definition pictures of a particular point on Earth. Will also be used to teach children and students about Earth Observation using the station resources. The nodding mechanism will compensate for the speed of the orbiting outpost to take pictures of poorly illuminated targets on Earth and long sequences of photographs using a Nikon 3DS camera mounted to it. Its use shall be part of ESA outreach and education programs	Netherlands: M. Sabbatini, ESA/ESTEC	Cupola
PASSAGES	Scaling Body-Related Actions in the Absence of Gravity	ESA	Human Research and Counter-measures Development	PASSAGES will test how astronauts interpret visual information due to exposure to weightlessness with a focus on a specific neurological strategy	France: M. Luyat, J. McIntyre	Columbus
ROALD 2	Role of Anandamide in Lymphocyte Depression-2	ESA	Biological Sciences in Microgravity	Studies gene expression of proteins involved in metabolic control of the neurotransmitter Anandamide. Scientists want to find out the role of this lipid in regulation of immune processes and in the cell cycle under weightless conditions	Italy: N. Battista, M. Maccarrone, C. Rapino, M. DiTommaso, M. Bari, V. Gasperi, A. Finazzi-Agrò	Columbus
SODI-COLLOID 2	SODI-Advanced Photonic Devices in Microgravity	ESA	Physical Sciences in Microgravity	With the fabrication of photonic devices being a very promising application in colloidal engineering, COLLOID will study the growth and properties of advanced photonic materials grown in weightlessness	USA: D. Weitz, P. Segre, W. V. Meyer, Netherlands: A. Lagendijk, G. Wegdam	Destiny
SODI-DSC	Selectable Optical Diagnostics Instrument - Diffusion and Soret Coefficient Measurement for Improvement of Oil Recovery	ESA	Physical Science	SODI-DSC will study diffusion in six different liquids over time in the absence of convection induced by the gravity field, refining relevant models related to petroleum reservoir evaluation	France: G. Galliero, M. Azaiez, J.L. Daridon Canada: Z. Saghir Denmark: A. Shapiro Belgium: S. Van-Vaerenbergh	Destiny
SOLAR: SOLSPEC	SOLSPEC	ESA	Solar Physics	SOLSPEC will measure the solar spectrum irradiance from 207 miles (333 kilometers) to 3454 Miles (5556 kilometers). The goals of this investigation are the study of solar variability at short and long term and the achievement of absolute measurements	France: G. Thuillier	Columbus

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SOLAR: SOLACES	Solar Auto-Calibrating Extreme UV-Spectrometer	ESA	Solar Physics	The goal of the experiment is to measure the solar spectral irradiance of the full disk from 20 miles (31 kilometers) to 253 miles (407 kilometers) at 0.6 miles (0.9 kilometers) to 2.3 miles (3.7 kilometers) spectral resolution	Germany: G. Schmidtke	Columbus
SOLO	Sodium Loading in Microgravity	ESA	Human Research and Counter-measures Development	SOdium LOading in Microgravity (SOLO) studies the mechanisms of fluid and salt retention in the body during space flight	Germany: P. Frings-Meuthen, M. Heer, N. Kamps, F. Baisch Denmark: P. Norsk	Columbus
SPACE HEADACHES	Space Headaches	ESA	Human Research and Counter-measures Development	Studies the incidence and prevalence of headaches during a stay on orbit. Headache characteristics are analyzed and classified according to International Classification of Headache Disorders	Netherlands: A. Vein, M. Terwindt, M.D. Ferrari	Columbus
SPIN	SPIN	ESA	Human Research and Counter-measures Development	SPIN is a comparison between pre-flight and post-flight testing of astronaut subjects using a centrifuge and a standardized tilt test to link orthostatic tolerance with otolith-ocular function	Belgium: F. Wuyts, N. Pattyn USA: S. Moore, B. Cohen, A. Diedrich Australia: H. MacDougall France: G. Clement	Ground-based
THERMOLAB	Thermoregulation in Humans During Long-Term Spaceflight	ESA	Human Research and Counter-measures Development	THERMOLAB is investigating core temperature changes in astronauts performed before, during and after exercise on the station to investigate thermoregulatory and cardiovascular adaptations during long-duration spaceflight	Germany: H.C. Gunga, K. Kirsch, E. Koralewski, J. Cornier, H.V. Heyer, P. Hoffman, J. Koch, F. Sattler France: P. Arbeille	Destiny
Vessel ID System	Vessel ID System	ESA	Technology Demonstration	The Vessel ID System demonstrates the space-based capability of identification of maritime vessels and also tests the ability of an external grappling adaptor to accommodate small passive equipment and payloads	Norway: R.B. Olsen, O. Helleren, A. Nordmo Skauen, T. Eriksen, S. Christiansen, H. Rosshaug, F. Storesund	Columbus
Vessel Imaging	Vascular Echography	ESA	Human Research and Counter-measures Development	Vessel Imaging will evaluate changes in the peripheral blood vessel wall properties (thickness and compliance) and cross sectional areas during long-term spaceflight	France: P. Arbeille	Columbus
2D-NanoTemplate	Production of Two Dimensional NanoTemplate in Microgravity	JAXA	Physical Science	2D-NanoTemplate fabricates large and highly oriented nano-scale two-dimensional arranged peptide arrays by suppressing convection, sedimentation and buoyancy	Takatoshi Kinoshita, Ph.D., Nagoya Institute of Technology, Nagoya, Aichi, Japan	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Alloy Semiconductor	Crystal Growth of Alloy Semiconductor Under Microgravity	JAXA	Physical Science	Alloy Semiconductor aims to develop a clear understanding of how semiconductor materials crystallize in microgravity. The materials that are being studied are known to be useful as devices which convert heat into electricity (thermoelectrics). These studies may also shed light on how higher quality crystals may be obtainable in other materials and for other devices such as solar cells	Yuko Inatomi, Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Area PADLES	Passive Dosimeter for Life Science Experiments in Space	JAXA	Technology Development and Demonstration	Area PADLES will measure the space radiation environment inside the KIBO module. The dosimeters, having been exposed to the space environment for six months, are returned to the ground for analysis. The measured data will be used for planning future life science experiments and updating radiation assessment models for human spaceflight in the next generation	Keiji Murakami, Akiko Nagamatsu, JAXA	Kibo
Biological Rhythms	The Effect of Long-term Microgravity Exposure on Cardiac Autonomic Function by Analyzing 24-Hours Electrocardiogram	JAXA	Human Research	Biological Rhythms examines the effect of long-term microgravity exposure on cardiac autonomic function by analyzing 24-hour electrocardiogram of long-duration space station crew members	Chiaki Mukai, M.D., Ph.D., Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
CsPINs	Dynamism of Auxin Efflux Facilitators, CsPINs, Responsible for Gravity-Regulated Growth and Development in Cucumber	JAXA	Biology and Biotechnology	CsPINs uses cucumber seedlings to analyze the effect of gravity on gravimorphogenesis (shape change in response to a change in gravity direction) (peg formation) in cucumber plants	Hideyuki Takahashi, Ph.D., Tohoku University, Sendai, Japan	Kibo
Dynamic Surf	Experimental Assessment of Dynamic Surface Deformation Effects in Transition to Oscillatory Thermo- capillary Flow in Liquid Bridge of High Prandtl Number Fluid	JAXA	Physical Science	Marangoni convection is the flow driven by the presence of a surface tension gradient which can be produced by temperature difference at a liquid/gas interface. The convection in liquid bridge of silicone oil is generated by heating the one disc higher than the other. Scientists are observing flow patterns of how fluids move to learn more about how heat is transferred in microgravity	Yasuhiro, Kamotani, Case Western Reserve University, Cleveland, OH	Kibo
Hair	Biomedical Analyses of Human Hair Exposed to a Long-Term Space Flight	JAXA	Human Research	Hair examines the effect of long-duration space flight on gene expression and trace element metabolism in the human body by analyzing human hair. Hair root cells actively divide in a hair follicle, and they sensitively reflect physical conditions. The hair shaft has an advantage in that it records the metabolic conditions of the environment where the subject is	Chiaki Mukai, M.D., Ph.D., Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Hicari	Growth of Homogeneous SiGe Crystals in Microgravity by the TLZ Method	JAXA	Physical Science	Hicari aims to verify the crystal-growth theory, and to produce high-quality crystals of silicon-germanium semiconductor. Once this method is established, it is expected to be applied for developing more efficient solar cells and semiconductor-based electronics	Kyoichi Kinoshita, JAXA	Kibo

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Ice Crystal 2	Crystal Growth Mechanisms Associated With the Macromolecules Adsorbed at a Growing Interface - Microgravity Effect for Self-Oscillatory Growth - 2	JAXA	Physical Science	Ice Crystal-2 uses an Antifreeze Protein (AFP) that suppresses the growth of ice crystals in a supercooled water because the adsorption of AFP molecules occurs at the ice/water interface. To precisely observe this phenomena and clarify the principle of the oscillatory growth mechanism, this experiment examines the growth of the ice crystals in microgravity where gravity-based convection cannot interfere with the results	Yoshinori Furukawa, Ph.D, Hokkaido University, Sapporo, Japan	Kibo
JAXA EPO 8	Japan Aerospace Exploration Agency Education Payload Observation 8	JAXA	Educational Activity and Outreach	JAXA EPO 8 activities demonstrate educational events and artistic activities on board the space station/Japanese Experiment Module (JEM) to enlighten the general public about microgravity research and human space flight		Kibo
JAXA PCG	Japan Aerospace Exploration Agency Protein Crystal Growth	JAXA	Biology and Biotechnology	JAXA PCG is aimed at the growth of crystals of biological macromolecules by the counter-diffusion technique. The main scientific objective is to make the fine quality protein crystals under microgravity environment; the space-grown crystals will be applied to structural biology and pharmaceutical activity	Ohta Kazuo, Japan Aerospace Exploration Agency, Japan)	Kibo
Marangoni-Exp	Chaos, Turbulence and Its Transition Process in Marangoni Convection-Exp	JAXA	Physical Science	Marangoni convection is the flow driven by the presence of a surface tension gradient, which can be produced by temperature difference at a liquid/gas interface. The convection in liquid bridge of silicone oil is generated by heating the one disc higher than the other. Scientists are observing flow patterns of how fluids move to learn more about how heat is transferred in microgravity	Koichi Nishino, Yokohama National University, Yokohama, Japan	Kibo
MAXI	Monitor of All-sky X-ray Image	JAXA	Earth and Space Science	MAXI is a highly sensitive X-ray slit camera for the monitoring of more than 1000 X-ray sources in space over an energy band range of 0.5 to 30 kiloelectron volt (keV)	Masaru Matsuoka, Ph.D., Institute of Space and Astronautical Science (ISAS) ISS Science Project Office, Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
MCE	Multi-Mission Consolidated Equipment	JAXA	Earth and Space Science	IMAP: Observes the rim of atmosphere, between space and the earth, with visible light spectrometer for no less than one continuous year GLIMS: Observes lightning and plasma phenomena during night time for no less than one continuous year SIMPLE: Demonstrates the usefulness of the inflatable space structures in orbit in different manners. Inflatable structures include extendable mast, space terrarium and material panel REXJ: Demonstrates the robot manipulation in orbit from ground. The robot moves around within an envelope by adjusting length of tethers and a telescopic arm HDTV: Demonstrates use of Commercial-off-the-Shelf (COTS)-HDTV in an exposed environment in orbit	Hirohisa Oda, Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Myco-3	Mycological Evaluation of Crew Exposure to ISS Ambient Air - 3	JAXA	Biology and Biotechnology	Myco-3 identifies what kinds of fungi proliferate on the space station and evaluates the risk of microorganisms via inhalation and adhesion to the skin to determine which fungi act as allergens on the space station	Chiaki Mukai, M.D., Ph.D., Japan Aerospace Exploration Agency, Tsukuba, Japan	Kibo
Nano Step	In-situ Observation of Growth Mechanisms of Protein Crystals and Their Perfection Under Microgravity	JAXA	Biology and Biotechnology	NanoStep aims to clarify the relationship between crystal growth and mechanism and the perfection of crystals. Crystallization of proteins in microgravity yields crystals with better perfection than crystallization on Earth. The reason for this phenomenon has not been explained from a viewpoint of crystal growth mechanism	Professor Katsuo Tsukamoto, Tohoku University	Kibo
Onboard Diagnostic Kit	Evaluation of Onboard Diagnostic Kit	JAXA	Human Research	Onboard Diagnostic Kit is a system capable of measuring, storing and analyzing crew's medical data while on orbit. Medical data is downlinked to the ground in real time, whereby doctors will have the capability to diagnose disorders	Japan Aerospace Exploration Agency (JAXA)	Kibo
Resist Tubule	Mechanisms of Gravity Resistance in Plants From Signal Transformation and Transduction to Response	JAXA	Biology and Biotechnology	Resist Tubule clarifies the mechanisms of gravity resistance, in particular the processes from signal transformation and transduction to response. Gravity resistance is a principal gravity response in plants, comparable to gravitropism, and has played an important role in the transition of plant ancestors from an aquatic environment to a terrestrial environment about 450 million years ago and in the consequent establishment of land plants. Nevertheless, only limited information has been obtained for the mechanism of gravity resistance	Takayuki Hoson, Ph.D., Osaka City University, Osaka, Japan	Kibo

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SEDA-AP	Space Environment Data Acquisition Equipment - Attached Payload	JAXA	Technology Development and Demonstration	SEDA-AP will measure space environment data at the Exposed Facility (EF) of Japanese Experimental Module (JEM) "Kibo" on the station. SEDA-AP is composed of common bus equipment that support launch, Remote Manipulator System (RMS) handling, power/communication interface with JEM-EF, an extendible mast that extends the neutron monitor sensor into space (1m), and equipment that measure space environment data. SEDA-AP has seven measurement units as follows, (1) Neutron Monitor (NM),(2) Heavy Ion Telescope (HIT),(3) Plasma Monitor (PLAM),(4) Standard Dose Monitor (SDOM),(5) Atomic Oxygen Monitor (AOM),(6) Electronic Device Evaluation Equipment (EDEE),(7) Micro-Particles Capture (MPAC) and Space Environment Exposure Device (SEED)	Kiyokazu Koga, Japan Aerospace Exploration Agency, Japan	Kibo
SMILES	Superconducting Submillimeter-Wave Limb-Emission Sounder	JAXA	Earth and Space Science	SMILES is aimed at global mappings of stratospheric trace gases by means of the most sensitive submillimeter receiver. Although SMILES has stopped atmospheric observation due to instrumental failures since April 2010, sensitive data obtained for a half year will provide accurate global datasets of atmospheric minor constituents related to ozone chemistry. SMILES is still continuing operations for instrumental calibration and cooling of mechanical cooler, as well as brush-up of retrieval algorithms for atmospheric constituents	Masato Shiotani, Kyoto University, Kyoto, Japan	Kibo
SS-HDTV	Super-Sensitive High Definition TV	JAXA	Technology Development and Demonstration	SS-HDTV system records Super Sensitive High Definition video for TV program production. During orbital nights, Earth nights, lightning, auroras, cosmic showers and other interesting events, images are recorded either by crew members or automatically, and downlinked by Ku-Band and/or Inter-Satellite Communication System link	Akiyoshi Ohmori, Japan Aerospace Exploration Agency	
TEM	Transport Environment Monitor Packages	JAXA	Technology Development and Demonstration	TEM will monitor temperatures inside cargo vehicles bound for the station. Environmental conditions during transportation are very important for biological specimens and reagents for life-science experiments. This investigation uses temperature data loggers to record the environmental conditions near investigations launched on cargo vehicles. The TEM is planned for use to record the temperature data aboard the Space-X Demo flight (SPX-D)	Dr. Keiji Murakami, Japan Aerospace Exploration Agency, Tsukuba, Japan M. Masukawa	SPX-D

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
3DA1 Camcorder	Panasonic 3D Camera	NASA	Technology Development and Demonstration	3D HDTV Camcorder (3DA1 Camcorder) is a unique all-in-one design three-dimensional high-definition television (3D HDTV) camcorder that records video as files on standard definition (SD) memory cards. The camera tests the performance of a file-based video camcorder versus recording on tapes, and provides useful data regarding the performance of the camera's complementary metal oxide semiconductor (CMOS) imaging sensors. The 3D HD video also provides a unique virtual experience for outreach to the public. As part of a Fully Reimbursable Space Act Agreement with Panasonic Solutions Company, the camera provides a unique outlet for outreach about the space station		
ACE-1	Advanced Colloids Experiment-1	NASA	Physical Science	This is the first in a series of microgravity experiments using microscopy to pursue fundamental science studies with colloids and to lay the foundations for colloidal engineering. Data acquired on this length-scale will allow scientists to remove the need to macroscopically model images to couple observations with the underlying physics. This experiment will also help refine the time scales (that is the optimal particle sizes) for the follow-on ACE 3-D confocal experiments	P. Chaikin, Ph.D., New York University, New York, NY; Matthew Lynch, Ph.D., Procter and Gamble, Cincinnati, OH; David A. Weitz, Ph.D., Harvard University, Cambridge, MA; Arjun Yodh, Ph.D., University of Pennsylvania, University Park, PA; Dr. Stefano Buzzaccaro, ESA	
ALTEA-Dosi	Anomalous Long Term Effects in Astronauts' - Dosimetry	NASA	Human Research	ALTEA-Dosi will operate in DOSI mode (unmanned) to provide an assessment of the radiation environment inside the space station, U.S. Laboratory, Destiny	Livio Narici, Ph.D., University of Roma Tor Vergata, Rome, Italy	
ALTEA-GAP	Anomalous Long Term Effects in Astronauts' Central Nervous System-GAP	NASA	Technology Development and Demonstration	ALTEA-GAP operates in DOSI mode (unmanned) to provide an assessment of the radiation environment inside the space station, U.S. Laboratory, Destiny	Livio Narici, Ph.D., University of Roma Tor Vergata, Rome, Italy	
AMS-02	Alpha Magnetic Spectrometer - 02	NASA	Earth and Space Science	A state-of-the-art particle physics detector constructed, tested and operated by an international team, the AMS-02 uses the unique environment of space to advance knowledge of the universe and lead to the understanding of the universe's origin by searching for antimatter, dark matter and measuring cosmic rays	Samuel Ting, Ph.D., Massachusetts Institute of Technology, Cambridge, MA	
Amine Swingbed	Amine Swingbed	NASA	Technology Development and Demonstration	The Amine Swingbed will determine if a vacuum-regenerated amine system can effectively remove carbon dioxide (CO_2) from the station atmosphere using a smaller more efficient vacuum regeneration system	John Graf, Ph.D., Johnson Space Center, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
BASS	Burning and Suppression of Solids	NASA	Physical Science	BASS examines the burning and extinction characteristics of a wide variety of fuel samples in microgravity, guiding strategies for extinguishing accidental fires in microgravity. BASS results contribute to the combustion computational models used in the design of fire detection and suppression systems in microgravity and on Earth	Paul Ferkul, Ph.D., National Center for Space Exploration Research, Cleveland, OH	
BCAT-3-4-CP	Binary Colloidal Alloy Test 3 and 4: Critical Point	NASA	Physical Science	Depending on their relative distances and energies, with respect to one another, atoms and molecules organize themselves to form gases, liquids, and solids. BCAT-3-4-CP studies the critical point of these systems, which is defined where gases and liquids no longer exist as separate entities and a new state of matter forms which is known as the critical point. The application of this experiment in the near term is to enhance the shelf life of everyday products and in the longer term, the development of revolutionary materials for electronics and medicine	David A. Weitz, Ph.D., Harvard University, Cambridge, MA	
BCAT-4-Poly	Binodal Colloidal Aggregation Test - 4: Polydispersion	NASA	Physical Science	BCAT-4-Poly involves two samples containing microscopic spheres suspended in a liquid, which are designed to determine how crystals can form from the samples after they have been well mixed. The two samples have the same average sphere size but one of them has a wider range (more polydisperse) of sizes in order to demonstrate the dependence of crystallization on particle size range. Results from these experiments help scientists develop fundamental physics concepts which will enable the development of a wide range of next generation technologies, such as in high speed computers and advanced optical devices	Paul Chaikin, Ph.D., New York University, New York, NY	
BCAT-5-3D-Melt	Binary Colloidal Alloy Test - 5: Three-Dimensional Melt	NASA	Physical Science	BCAT-5-3D-Melt involves crew members photographing specially designed microscopic particles (colloids) suspended in a liquid over a period of time. The particles are designed to melt when temperatures warm above a specific temperature (when the station is warmed by sun) and crystallize when the temperatures drop below a specific temperature (when the Earth blocks the sun). The results help scientists develop fundamental physics concepts which are important in developing next generation technologies in computers and advanced optics	Arjun Yodh, Ph.D., University of Pennsylvania, University Park, PA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
BCAT-5-PhaseSep	Binary Colloidal Alloy Test - 5: Phase Separation	NASA	Physical Science	BCAT-5-PhaseSep involves a crew member photographing mixed samples of microscopic particles (or colloids) suspended in a liquid, studying how the microscopic liquid suspended particles separate from each other (like oil and water) over time. The application of this experiment in the near term is in extending product shelf-life on Earth and space, and in the longer term, the development of next generation materials such as in computer technologies and advanced optics	David A. Weitz, Ph.D., Harvard University, Cambridge, MA	
BCAT-5-Seeded Growth	Binary Colloidal Alloy Test - 5: Seeded Growth	NASA	Physical Science	The systematic control of crystal growth in microgravity gives insight into the physical laws by which matter organizes itself. BCAT-5- Seeded Growth studies how the rules for the crystallization of microscopic particles (known as colloids) suspended in liquid change when seed particles are present. These experiments are anticipated to have application to the development of new smart materials	Paul Chaikin, Ph.D., New York University, New York, NY	
BCAT-6-Colloidal Disks	Binary Colloidal Alloy Test - 6: Colloidal Disks	NASA	Physical Science	BCAT-6-Colloidal Disks use microscopic particles (known as colloids) as models for studying the fundamental physics of a theoretically predicted, but until now unseen, liquid crystal phase. Liquid crystals have many useful physical properties, such as being useful for switching colors (light) on and off in the thin-screen monitors used for many computers, tablets, and cell phones. The use of anisotropic (asymmetric) particles, like the colloidal disks used in this experiment, should produce a new material (cubatic) phase that is predicted to have orientational (directional) order, but no translational (position dependent) order	Arjun Yodh, Ph.D., University of Pennsylvania, University Park, PA	
BCAT-6-PS-DNA	Binary Colloidal Alloy Test - 6: Polystyrene - Deoxyribonucleic Acid	NASA	Physical Science	BCAT-6-PS-DNA attempts to produce crystals in microgravity where the components of the crystals are held together by deoxyribonucleic acid (DNA). The crystals in this experiment are created from DNA coated spherical polymer particles. The experiment has applications in the design of new revolutionary nanomaterials	Paul Chaikin, Ph.D., New York University, New York, NY	
BCAT-6-Phase Separation	Binary Colloidal Alloy Test - 6: Phase Separation	NASA	Physical Science	BCAT-6-Phase Separation will provide unique insights into how gas and liquid phases separate and come together in microgravity. These fundamental studies on the underlying physics of fluids could provide the understanding needed to enable the development of less expensive, longer shelf-life household products, foods and medicines	Matthew Lynch, Ph.D., Procter and Gamble, Cincinnati, OH	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
BCAT-6-Seeded Growth	Binary Colloidal Alloy Test - 6: Seeded Growth	NASA	Physical Science	The systematic control of crystal growth from seeds in microgravity gives insight into the physical laws by which matter organizes itself. BCAT-6 Seeded Growth allows scientists to observe crystal growth mechanisms and crystal structures. The results from this experiment have application to a wide variety of products based on nanoscale materials	Paul Chaikin, Ph.D., New York University, New York, NY	
Bisphosphonates	Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss	NASA	Human Research	Bisphosphonates will determine whether an antiresorptive agent, in conjunction with the routine in-flight exercise program, protects space station crew members from the regional decreases in bone mineral density documented on previous station missions	Adrian Leblanc, Ph.D., Baylor College of Medicine, Houston, TX	
CCF	Capillary Channel Flow	NASA	Physical Science	CCF data will assist in identifying innovative solutions to transporting liquids (such as fuels, low temperature liquids like liquid nitrogen and water) in microgravity. By understanding capillary fluid flow rates in microgravity, hardware can be developed for pumping liquids from one reservoir to another without the need for a pump with moving parts. The reduced cost, weight and improved reliability of such equipment make this a particularly attractive technology for NASA	Michael Dreyer, Ph.D., University of Bremen, Bremen, Germany	
CEO	Crew Earth Observations	NASA	Earth and Space Science	CEO involves the station crew to photograph natural and human-made events 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 understand the planet from the perspective of the space station	Susan Runco, Johnson Space Center, Houston, TX	
CFE-2	Capillary Flow Experiment - 2	NASA	Physical Science	CFE-2 is a suite of fluid physics experiments that investigates how fluids move up surfaces in microgravity. The results could improve current computer models used by designers of low gravity fluid systems, and may improve fluid transfer systems for water on future spacecraft	Mark M. Weislogel, Ph.D., Portland State University, Portland, OR	
CSI-05	Commercial Generic Bioprocessing Apparatus Science Insert - 05: Spiders, Fruit Flies and Directional Plant Growth	NASA	Educational Activity and Outreach	CSI-05 examines the long duration orb weaving characteristics of a *Nephila clavipes* (golden orb-web spiders), the movement behavior of fruit flies, and the thigmotropic (directional plant growth in response to a stimulus of direct contact) and phototropic (directional plant growth in response to a light source) responses that occur during seed germination in microgravity. CSI-05 utilizes the unique microgravity environment of the space station as part of the K-12 classroom to encourage learning and interest in science, technology, engineering and math	Louis Stodieck, Ph.D., University of Colorado, BioServe Space Technologies	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
CSI-06	Commercial Generic Bioprocessing Apparatus Science Insert - 06	NASA	Educational Activity and Outreach	CSI-06 is one investigation in the CSI program series. The CSI program provides the K-12 community opportunities to utilize 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	Louis Stodieck, Ph.D., University of Colorado, BioServe Space Technologies, Boulder, CO	
CUSat	Cornell University Satellite	NASA	Technology Development and Demonstration	CUSat will perform autonomous metrology between the two-satellite CUSat formation using GPS technology that is cheaper, smaller size, and less mass with high precision comparable to larger, more expensive systems by using Commercial Off-the-Shelf (COTS) components in a modular design. The secondary mission objective is to collect visual imagery of both CUSat satellites and transmit the imagery to the ground segment where 3D models will verify GPS data and provide inspection information. Adoption of cost/size efficiency will enable potential formations or clusters of multiple cooperative spacecraft. Space flight demonstration of micro pulsed plasma thrusters for 6-axis control is also an objective of the CUSat mission	Abbie Stewart, Ph.D., Air Force Research Laboratory, Albuquerque, NM	
CVB	Constrained Vapor Bubble	NASA	Physical Science	CVB aims to achieve a better understanding of the physics of evaporation and condensation and how they affect cooling processes in microgravity using a remotely controlled microscope and a small cooling device	Peter C. Wayner, Jr., Ph.D., Rensselaer Polytechnic Institute, Troy, New York	
DECLIC-ALI	Device for the Study of Critical Liquids and Crystallization - Alice Like Insert	NASA	Physical Science	DECLIC-ALI studies liquids at the verge of boiling. The flow of heat during boiling events is different in microgravity than it is on Earth. Understanding how heat flows in fluids at the verge of boiling will help scientists develop cooling systems for use in microgravity	Yves Garrabos, Ph.D., Institut de Chimie de la Matire Condense de Bordeaux, Bordeaux, France	
DECLIC-DSI	Device for the Study of Critical Liquids and Crystallization - Directional Solidification Insert	NASA	Physical Science	DECLIC-DSI provides a better understanding of the relationship between micro- and macro-structure formation during solidification processes	Nathalie Bergeon, Ph.D., Universit Paul Czanne (Aix-Marseille III), Marseille, France	
DECLIC-HTI	Device for the Study of Critical Liquids and Crystallization - High Temperature Insert	NASA	Physical Science	DECLIC-HTI studies liquids just beyond the verge of boiling. The flow of heat during boiling events is different in microgravity than it is on Earth. Understanding how heat flows in fluids at the verge of boiling will help scientists develop cooling systems for use in microgravity	Yves Garrabos, Ph.D., Institut de Chimie de la Matire Condense de Bordeaux, Bordeaux, France	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
DOD SPHERES-CSAC	Department of Defense Synchronized Position, Hold, Engage, Reorient, Experimental Satellites-Chip Scale Atomic Clock	NASA	Technology Development and Demonstration	Atomic clocks are the most accurate time keepers in the world. An atomic clock is a precision clock that depends for its operation on an electrical oscillation regulated by the natural vibration frequencies of an atomic system. The CSAC program will demonstrate the performance of an atomic clock in the sustained microgravity environment of ISS	Andrei Shkel, Defense Advanced Research Projects Agency, Washington, D.C	
DTN	Disruption Tolerant Networking for Space Operations	NASA	Technology Development and Demonstration	DTN establishes a long-term, readily accessible communications test-bed onboard the space station. Two Commercial Generic Bioprocessing Apparatus (CGBA), CGBA-5 and CGBA-4, will serve as communications test computers that transmit messages between station and ground Mission Control Centers. All data will be monitored and controlled at the BioServe remote Payload Operations Control Center (POCC) located on the Engineering Center premises at the University of Colorado - Boulder	Kevin Gifford, Ph.D., University of Colorado, Boulder, CO	
EarthKAM	Earth Knowledge Acquired by Middle School Students	NASA	Educational Activity and Outreach	EarthKAM is a NASA education program that enables thousands of students to photograph and examine Earth from a space crew's perspective. Using the Internet, the students control a special digital camera mounted onboard the International Space Station. This enables them to photograph the Earth's coastlines, mountain ranges and other geographic items of interest from the unique vantage point of space. The team at EarthKAM then posts these photographs on the Internet for the public and participating classrooms around the world to view	Sally Ride, Ph.D., University of California - San Diego, San Diego, CA	
ELITE-S2	Elaboratore Immagini Televisive - Space 2	NASA	Human Research	ELITE-S2 investigates the connection between brain, visualization and motion in the absence of gravity. By recording and analyzing the three-dimensional motion of crew members, this study helps engineers apply ergonomics into future spacecraft designs and determines the effects of weightlessness on breathing mechanisms for long-duration missions. This experiment is a cooperative effort with the Italian Space Agency, ASI	Francesco Lacquaniti, M.D., University of Rome Tor Vergata, Rome, Italy	
EPO-Demos	Education Payload Operation - Demonstrations	NASA	Educational Activity and Outreach	EPO-Demos records video education demonstrations performed on the space station by crew members using hardware already onboard. EPO-Demos enhance existing NASA education resources and programs for educators and students in grades K-12, in support of the NASA mission to inspire the next generation of explorers	Trinesha Dixon, Johnson Space Center, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
ERTD Demo	Exploration Research and Technology Division Demonstration	NASA	Biology and Biotechnology			
FLEX	Multi-User Droplet Combustion Apparatus FLame Extinguishment EXperiment	NASA	Physical Science	FLEX will assess the effectiveness of fire suppressants in microgravity and quantify the effect of different possible crew exploration atmospheres on fire suppression. This research is expected to provide definition and direction for large scale fire suppression tests and selection of the fire suppressant for next generation crew exploration vehicles	Forman A. Williams, University of California, San Diego, San Diego, CA	
FLEX-2	Flame Extinguishment Experiment - 2	NASA	Physical Science	FLEX-2 is the second of two investigations on the station which uses small droplets of fuel to study the special burning characteristics of fire in space. FLEX-2 will study the rate and manner in which fuel is burned, the conditions that are necessary for soot to form, and the way in which a mixture of fuels evaporate before burning. The results from the FLEX experiments will give scientists a better understanding of how fires behave in space, providing important information that will be useful in increasing the fuel efficiency of engines using liquid fuels	Forman A. Williams, University of California, San Diego, San Diego, CA	
Functional Task Test	Physiological Factors Contributing to Changes in Postflight Functional Performance	NASA	Human Research	Functional Task Test will test crew members on an integrated suite of functional and physiological tests before and after short- and long-duration space flight. The study identifies critical mission tasks that may be impacted, maps physiological changes to alterations in physical performance, and aids in the design of countermeasures that specifically target the physiological systems responsible for impaired functional performance	Jacob Bloomberg, Ph.D., Johnson Space Center, Houston, TX	
HDEV	HIGH Definition Earth Viewing	NASA	Technology Development and Demonstration	HDEV payload incorporates four commercially available high definition cameras to provide high definition views of the earth. The HDEV selected four different camera types, which have shown potential in early ground-based testing and studies to best survive the radiation and space environment. While providing these earth viewing images, the payload is also demonstrating the longevity of these cameras in the space environment, to provide data and reduce risk in the selection of cameras that will be considered for future use on NASA spacecraft	Carlos Fontanot, Johnson Space Center, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
HET-Smartphone	Human Exploration Telerobotics Smartphone	NASA	Technology Development and Demonstration	HET-Smartphone demonstrates and assesses Intravehicular Activity (IVA) free-flyer telerobotic operations using SPHERES and remote operation of SPHERES by ground control and crew. HET-Smartphone assesses telerobotic operations to increase crew efficiency and productivity for future human exploration missions	Terry Fong, NASA Ames Research Center, Moffett Field, CA	
HiMassSEE	Spacecraft Single Event Environments at High Shielding Mass	NASA	Technology Development and Demonstration	HiMassSEE measures space radiation interactions with spacecraft structure and shielding using several passive track detector technologies to provide a more accurate definition of space station payload accommodation	Steven Koontz, Ph.D.	
HREP-HICO	HICO and RAIDS Experiment Payload - Hyperspectral Imager for the Coastal Ocean	NASA	Earth and Space Science	HREP-HICO operates a specialized visible and near-infrared camera to detect, identify and quantify coastal features from the space station. The experiment demonstrates the retrieval of coastal products including the water depth, the water clarity, chlorophyll content, and sea floor composition for civilian and naval purposes	Mike Corson, Naval Research Laboratory, Washington, D.C.	
HREP-RAIDS	HICO and RAIDS Experiment Payload - Remote Atmospheric and Ionospheric Detection System (RAIDS)	NASA	Technology Development and Demonstration	HREP-RAIDS provides atmospheric scientists with a complete description of the major constituents of the thermosphere and ionosphere. The thermosphere is the layer of the Earth's atmosphere where the space station orbits the Earth, and the ionosphere is the portion of the upper atmosphere that affects radio waves. RAIDS provides density, composition, temperature and electron density profiles at altitudes between 59 miles (95 kilometers) – 186 miles (300 kilometers)	Scott Budzien, Naval Research Laboratory, Washington, D.C.	
ISS Ham Radio	International Space Station Ham Radio	NASA	Educational Activity and Outreach	Ham (amateur) radios are used to increase student interest in space exploration by allowing them to talk directly with crew members living and working aboard the space station	Kenneth Ransom, Johnson Space Center, Houston, TX	
InSPACE-3	Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions - 3	NASA	Physical Science	InSPACE-3 obtains data on fluids containing ellipsoid-shaped particles that change the physical properties of the fluids in response to magnetic fields	Eric M. Furst, Ph.D., University of Delaware, Newark, DE	
InSPIRE-EMFF-SPHERES		NASA				
InSPIRE-VBN-SPHERES	International Space Station hosted SPHERES Integrated Research Experimentation - Vision Based Navigation - Synchronized Position, Hold, Engage, Reorient, Experimental Satellites	NASA	Technology Development and Demonstration	InSPIRE Vision Based Navigation will demonstrate, in a realistic test environment, critical technologies in the area of visual inspection/navigation. This effort will develop hardware and software to enable one or two SPHERES to construct a 3D model of another object (likely a third SPHERE, but applicable to any object) and perform relative navigation solely by reference to this 3D model	Roger Hall, Defense Advanced Research Projects Agency, Washington, D.C.	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Integrated Cardiovascular	Cardiac Atrophy and Diastolic Dysfunction During and After Long Duration Spaceflight: Functional Consequences for Orthostatic Intolerance, Exercise Capability and Risk for Cardiac Arrhythmias	NASA	Human Research	Integrated Cardiovascular aims to quantify the extent, time course and clinical significance of cardiac atrophy (decrease in the size of the heart muscle) associated with long-duration space flight and identify the mechanisms of this atrophy and the functional consequences for crew members who spend extended periods of time in space	Benjamin D. Levine, M.D., Institute for Exercise and Environmental Medicine, Presbyterian Hospital and University of Texas Southwestern Medical Center at Dallas, Dallas, TX	
Integrated Immune	Validation of Procedures for Monitoring Crew Member Immune Function	NASA	Human Research	Integrated Immune will assess the clinical risks resulting from the adverse effects of space flight on the human immune system and will validate a flight-compatible immune monitoring strategy. To monitor changes in the immune system, researchers collect and analyze blood, urine and saliva samples from crew members before, during and after space flight	Clarence F. Sams, Ph.D., Johnson Space Center, Houston, TX	
ISERV	ISS SERVIR Environmental Research and Visualization System	NASA	Earth and Space Science	ISERV is an automated system designed to acquire images of the Earth's surface from the space station. It is primarily a means to gain experience and expertise in automated data acquisition from station, although it is expected to provide useful images for use in disaster monitoring and assessment, and environmental decisionmaking	Burgess Howell, National Space Science and Technology Center, Huntsville, AL	
ISSAC	International Space Station Agricultural Camera	NASA	Earth and Space Science	ISSAC will take frequent images, in visible and infrared light, principally of vegetated areas (growing crops, grasslands, forests) in the northern Great Plains region of the United States. The sensor is also being used to study dynamic Earth processes around the world, such as melting glaciers, ecosystem responses to seasonal changes, and human impacts, and including rapid-response monitoring of natural disasters. ISSAC was built and is being operated by students and faculty at the University of North Dakota, in Grand Forks, ND	Dr. Bruce Smith, University of North Dakota, Grand Folks, ND	
Journals	Behavioral Issues Associated With Isolation and Confinement: Review and Analysis of Astronaut Journals	NASA	Human Research	Journals obtains information on behavioral and human issues that are relevant to the design of equipment and procedures and sustained human performance during extended-duration missions. Study results will provide information to help prepare for future missions to low-Earth orbit and beyond	Jack W. Stuster, Ph.D., CPE, Anacapa Sciences, Inc., Santa Barbara, CA	
LEGO Bricks	LEGO Bricks, formerly known as NLO-Education-2	NASA	Educational Activity and Outreach	LEGO Bricks is a series of toy LEGO kits that are assembled on orbit and used to demonstrate scientific concepts. Some of these models include satellites, a space shuttle orbiter, and a scale model of the space station	The Lego Group, Billund, Denmark	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
MFMG	Miscible Fluids in Microgravity	NASA	Physical Science	Honey and water are miscible fluids, that is, fluids that dissolve completely in each other. Water will be injected into honey to test if it will act like an immiscible fluid, such as water being injected into oil, and spontaneously form a spherical drop. The experiment needs to be performed in weightlessness	John Pojman, Ph.D., Louisiana State University, Baton Rouge, LA	
Micro-5	Investigation of Host-Pathogen Interactions, Conserved Cellular Responses, and Countermeasure Efficacy During Spaceflight Using the Human Surrogate Model Caenorhabditis Elegans	NASA	Biology and Biotechnology	Micro-5 aims to better understand the risks of in-flight infections in space explorers during long-term space flight using the model organism *Caenorhabditis elegans* (roundworm) with the microbe *Salmonella typhimurium* (causes food poisoning in humans)	Cheryl A. Nickerson, Ph.D., Arizona State University, Tempe, AZ	
Micro-6	Microbiology - 6	NASA	Biology and Biotechnology	Micro-6 will study basic questions of how life responds to gravity and space environments		
MISSE-8	Materials International Space Station Experiment - 8	NASA	Technology Development and Demonstration	MISSE-8 is a test bed for materials and computing elements attached to the outside of the space station. These materials and computing elements are being evaluated for the effects of atomic oxygen, ultraviolet, direct sunlight, radiation, and extremes of heat and cold. This experiment allows the development and testing of new materials and computing elements that can better withstand the rigors of space environments. Results will provide a better understanding of the durability of various materials and computing elements when they are exposed to the space environment, with applications in the design of future spacecraft	Robert Walters, Ph.D., Naval Research Laboratory, Washington, DC	
MSL-CETSOL and MICAST	Materials Science Laboratory - Columnar-to-Equiaxed Transition in Solidification Processing and Microstructure Formation in Casting of Technical Alloys Under Diffusive and Magnetically Controlled Convective Conditions	NASA	Physical Science	MSL-CETSOL and MICAST support research into metallurgical solidification, semiconductor crystal growth (Bridgman and zone melting), and measurement of thermo-physical properties of materials. This is a cooperative investigation with the European Space Agency and NASA for accommodation and operation aboard the International Space Station	Charles-Andre Gandin, Ph.D., Ecole de Mines de Paris, ARMINES-CEMEF, Sophia Antipolis, France (CETSOL)	
NanoRacks-CubeLabs Module-9	NanoRacks-CubeLabs Module-9	NASA	Physical Science	The NanoRacks-CubeLabs Module-9 processes materials science samples in microgravity. The science goals for NanoRacks-CubeLabs Module-9 are proprietary	Jeffrey Manber, NanoRacks, LLC, Laguna Woods, CA	
NanoRacks-E-Book	NanoRacks-Electronic-Book	NASA	Technology Development and Demonstration	NanoRacks-E-Book places a commercial off-the-shelf e-book on the space station to study how the commercial product behaves in microgravity. NanoRacks-E-Book is part of a long-term study by NanoRacks to explore the use of readily available products and technologies for use by crew members in the years to come		

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
NanoRacks: NanoRacks-FCHS-Robot	NanoRacks-Fremont Christian High School-Mini-Robot	NASA	Educational Activity and Outreach	NanoRacks-FCHS-Robot, a NanoLab project, will study the effects of microgravity on remotely controlled robot control mechanisms and mechanical devices		
NanoRacks-Fischer-18S-rRNA	NanoRacks-Fischer Institute of Air and Space - Footsteps of Creation and Origin of Life	NASA	Biology and Biotechnology	NanoRacks-Fischer-18S-rRNA investigates the behavior of 18S Ribosomal Ribonucleic Acid (RNA) in microgravity, which is of strong interest to a number of leading biomedical research institutes	Jeffrey Manber, NanoRacks, LLC, Laguna Woods, CA	
NanoRacks-Fischer-Bone	NanoRacks-Fischer Institute of Air and Space-Bone Study	NASA	Biology and Biotechnology	NanoRacks-Fischer-Bone investigates the MC3T3 mouse bone cell line in microgravity, which has strong commercial applications within biopharmaceutical markets		
NanoRacks-NanoKit-1	NanoRacks-DreamUP!-Crystal Microplates-NanoKit-1	NASA	Educational Activity and Outreach	NanoRacks-NanoKit-1 is an educational project targeting mainly home-schoolers to allow them and their parents the opportunity to take part in understanding the value of undertaking space-based research projects		
NanoRacks-Smartphone-2	NanoRacks-Smartphone-2	NASA	Technology Development and Demonstration	NanoRacks-Smartphone-2 is a commercial smartphone, with a commercially available open operating system, to study the use of readily available products and technologies as a new pathway for crew member operations		
NanoRacks-Terpene	NanoRacks-Terpene Extraction in Microgravity	NASA	Biology and Biotechnology	NanoRacks-Terpene, sponsored by a commercial organization, hopes to find new chemical building blocks for their products through microgravity extraction of the terpenes from wood samples		
NanoRacks-VCHS-Electromagnetic Ferrofluid	NanoRacks-Valley Christian High School-Electromagnetic Effects on Ferrofluid	NASA	Educational Activity and Outreach	NanoRacks-VCHS-Electromagnetic Ferrofluid is a Valley Christian High School student developed experiment		
NanoRacks-VCHS-Electroplating	NanoRacks-Valley Christian High School-Electroplating	NASA	Educational Activity and Outreach	NanoRacks-VCHS-Electroplating, a NanoLab project, will study the effects of microgravity on electroplating		
NanoRacks-VCHS-Plant Growth	NanoRacks-Valley Christian High School-Plant Growth	NASA	Educational Activity and Outreach	NanoRacks-VCHS-Plant Growth, a NanoLab project, will study the growth and growth rate of Marigold and Thyme seeds in microgravity		
NanoRacks-WCHS-E. Coli and Kanamycin	NanoRacks-Whittier Christian High School-E.Coli Bacteria and Kanamycin Antibiotic	NASA	Educational Activity and Outreach	NanoRacks-WCHS –E. Coli and Kanamycin, a NanoLab project, will study the growth of Escherichia coli (E. coli) bacteria in microgravity and the E. coli bacteria's resistance to the antibiotic Kanamycin by varying the antibiotic dosage		
NLP-Cells	National Laboratory Pathfinder – Cells	NASA	Biology and Biotechnology	NLP-Cells-8-10 are commercial payloads serving as pathfinders for the use of the space station as a National Laboratory after station assembly is complete. Several different experiments are involved that examine cellular replication and differentiation of cells. This research is investigating the use of space flight to enhance or improve cellular growth processes used in ground based research	Louis Stodieck, Ph.D., University of Colorado, BioServe Space Technologies, Boulder, CO	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
Nutrition	Nutritional Status Assessment	NASA	Human Research	Nutrition is a comprehensive in-flight study designed to understand changes in human physiology during long-duration space flight. This study includes measures of bone metabolism, oxidative damage, and chemistry and hormonal changes; as well as assessments of the nutritional status of the crew members participating in the study. The results have an impact on the definition of nutritional requirements and development of food systems for future exploration missions to the Moon and Mars. This experiment also helps researchers understand the effectiveness of measures taken to counteract the effects of space flight, as well as the impact of exercise and pharmaceutical countermeasures on nutritional status and nutrient requirements for crew members	Scott M. Smith, Ph.D., Johnson Space Center, Houston, TX	
PACE-2	Preliminary Advanced Colloids Experiment - 2: 3D Particle Test	NASA	Technology Development and Demonstration	PACE-2 characterizes the resolution of the high magnification colloid experiments with the Light Microscopy Module (LMM) to determine the minimum size of the particles that can be resolved by the Advanced Colloids Experiment (ACE). There is a direct relationship between magnification, particle size, test duration and onorbit vibration that is quantified	Jacob N. Cohen, Ph.D., Ames Research Center, Moffett Field, CA	
Particle Flux	Particle Flux Demonstrator	NASA	Technology Development and Demonstration	The Particle Flux Demonstrator (Particle Flux) is a handheld, battery-operated cosmic ray (charged particle) detector	Mark Pearce, Royal Institute of Technology, Stockholm, Sweden	
Photosynth	PhotosynthTM Three-Dimensional Modeling of ISS Interior and Exterior	NASA	Educational Activity and Outreach	Photosynth synthesizes three-dimensional models of the International Space Station from a series of overlapping still photographs, mainly as a tool for education and public outreach. Photosynth is a collaboration between NASA and Microsoft Live Labs	Dylan Mathis, Johnson Space Center, Houston, TX	
Pro K	Dietary Intake Can Predict and Protect Against Changes in Bone Metabolism During Spaceflight and Recovery	NASA	Human Research	Pro K is NASA's first evaluation of a dietary countermeasure to lessen bone loss of astronauts. Pro K proposes that a flight diet with a decreased ratio of animal protein to potassium will lead to decreased loss of bone mineral. Pro K has impacts on the definition of nutritional requirements and development of food systems for future exploration missions, and could yield a method of counteracting bone loss that would have virtually no risk of side effects	Scott M. Smith, Ph.D., Johnson Space Center, Houston, TX	
Reaction Self Test	Psychomotor Vigilance Self Test on the International Space Station	NASA	Human Research	Reaction Self Test is a portable five-minute reaction time task that will allow the crew members to monitor the daily effects of fatigue on performance while on board the space station	David F. Dinges, Ph.D., University of Pennsylvania School of Medicine, Philadelphia, PA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
REBR	ReEntry Breakup Recorder	NASA	Technology Development and Demonstration	REBR tests a cost-effective system that rides a reentering space vehicle, records data during the reentry and breakup of the vehicle, and returns the data for analysis	William Ailor, Ph.D., The Aerospace Corporation, El Segundo, CA	
Repository	National Aeronautics and Space Administration Biilogicla Specimen Repository	NASA	Human Research	The National Aeronautics and Space Administration Biological Specimen Repository (Repository) is a storage bank that is used to maintain biological specimens over extended periods of time and under well-controlled conditions. This repository supports scientific discovery that contributes to our fundamental knowledge in the area of human physiological changes and adaptation to a microgravity environment and provides unique opportunities to study longitudinal changes in human physiology spanning many missions. Samples from the International Space Station (ISS), including blood and urine, are collected, processed and archived during the preflight, in-flight and postflight phases of ISS missions. This investigation archives biosamples for use as a resource for future space-flight-related research	Kathleen A. McMonigal, M.D., Johnson Space Center, Houston, TX	
Robonaut	Robonaut	NASA	Technology Development and Demonstration	Robonaut serves as a spring board to help evolve new robotic capabilities in space. Robonaut demonstrates that a dexterous robot can launch and operate in a space vehicle, manipulate mechanisms in a microgravity environment, operate for an extended duration within the space environment, assist with tasks, and eventually interact with the crew members		
RRM	Robotic Refueling Mission	NASA	Technology Development and Demonstration	RRM demonstrates and tests the tools, technologies and techniques needed to robotically refuel satellites in space, even satellites not designed to be serviced. RRM is expected to reduce risks and lay the foundation for future robotic servicing missions in microgravity	Frank Cepollina, Goddard Space Flight Center, Greenbelt, MD	
SATS-Interact	Supervision of Autonomous and Teleoperated Satellites - Interact	NASA	Technology Development and Demonstration	SATS is a research effort aimed at drastically improving remote operation of space assets by enabling one user to control multiple maneuvering satellites. SATS effort is developing Interact, a command and control user interface, which enables one user to supervise the tasking and monitor the activity of a team of remote nanosatellites working on a common mission	Vadim Slavin, and Randy Stiles, Lockheed Martin Space Systems Company, Sunnyvale, CA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SCAN Testbed	Space Communications and Navigation Testbed	NASA	Technology Development and Demonstration	SCAN Testbed will be a station-based experimental facility investigating reprogrammable, Software Defined Radio (SDR) technology during space missions. The experiments will advance a common SDR architecture standard, and demonstrate advanced communications, navigation, and networking applications. The Testbed includes three software defined radios communicating with Tracking and Data Relay Satellite System (TDRSS) constellation at S-band and Ka-band, direct to ground at S-band, and receive L-band (GPS) signals. The SCAN Testbed will advance many technologies to enhance future human and robotic missions including high data rate transmission and reception, new data coding and modulation, adaptive cognitive applications, real-time networking including disruptive tolerant networking, and precise navigation at current and emerging GPS frequencies. The testbed will also host SDR investigations by other government agencies, commercial and academic users	Richard C. Reinhart, Glenn Research Center, Cleveland, OH	
Seedling Growth	Seedling Growth, formerly Seed Growth-2	NASA	Biology and Biotechnology	Seedling Growth studies the effects of microgravity on the growth of plants. The Seedling Growth experiment will be performed onboard the space station in collaboration with the European Space Agency. Images of the plants will be captured and down-linked to Earth. Samples of the plants will be harvested and returned to Earth for scientific analysis. The results of this experiment can lead to information that will aid researchers in food production studies concerning future long-duration space missions, as well as data that will enhance crop production on Earth	John Z. Kiss, Ph.D., Miami University, Oxford, OH; Francisco Javier Medina, Centro de Investiga-ciones Biologicas, Madrid, Spain	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SHERE-II	Shear History Extensional Rheology Experiment - II	NASA	Physical Science	SHERE-II involves a non-Newtonian fluid that will undergo preshearing (rotation) for a specified period of time, followed by stretching. This combination of shearing and extensional deformations is common in many earth-based polymer processing and manufacturing operations such as extrusion, blow-molding and fiber spinning. However, to accurately predict the flow behavior of polymeric fluids under such deformation histories, an accurate knowledge of the extensional viscosity of a polymer system and its variation with strain rate is critical and will be measured during this experiment. The fundamental understanding and measurement of these complex fluids is important for containerless processing, a key operation for fabrication of parts, such as adhesives or fillers, using elastomeric materials on future exploration missions	Gareth H. McKinley, Ph.D., Massachusetts Institute of Technology, Cambridge, MA	
SLICE	Structure and Liftoff In Combustion Experiment	NASA	Physical Science	SLICE investigates the nature of flames in microgravity. The results from these experiments could lead to improvements in technologies which aim to reduce pollution emissions and improve burning efficiency for a wide variety of industries	Marshall B. Long, Ph.D., Yale University, New Haven, Connecticut	
SNFM	Serial Network Flow Monitor	NASA	Technology Development and Demonstration	SNFM, using a commercial software CD, will monitor the payload local area network (LAN) to analyze and troubleshoot LAN data traffic. Validating LAN traffic models may allow for faster and more reliable computer networks to sustain systems and science on future space missions	Carl Konkel, Boeing, Houston, TX	
SpaceDRUMS	Space Dynamically Responding Ultrasonic Matrix System	NASA	Physical Science	SpaceDRUMS will provide a suite of hardware capable of facilitating containerless advanced materials science, including combustion synthesis and fluid physics. That is, inside SpaceDRUMS samples of experimental materials can be processed without ever touching a container wall	Jacques Guigne, Ph.D.,Guigne Space Systems, Incorporated, Paradise, Newfoundland, Canada	
SPHERES	Synchronized Position Hold, Engage, Reorient, Experimental Satellites	NASA	Technology Development and Demonstration	SPHERES are bowling-ball sized spherical satellites 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 fly within the cabin of the Space 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	David W. Miller, Ph.D., Massachusetts Institute of Technology, Cambridge, MA	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
SPHERES-Zero-Robotics	Synchronized Position Hold, Engage, Reorient, Experimental Satellites-Zero-Robotics	NASA	Educational Activity and Outreach	SPHERES-Zero-Robotics establishes an opportunity for high school students to design research for the space station. As part of a competition, students write algorithms for the SPHERES satellites to accomplish tasks relevant to future space missions. The algorithms are tested by the SPHERES team and the best designs are selected for the competition to operate the SPHERES satellites onboard the station	David W. Miller, Ph.D., Massachusetts Institute of Technology, Cambridge, MA	
Sprint	Integrated Resistance and Aerobic Training Study	NASA	Human Research	Sprint evaluates the use of high intensity, low volume exercise training to minimize loss of muscle, bone, and cardiovascular function in station crew members during long-duration missions	Lori Ploutz-Snyder, Ph.D. Universities Space Research Association, Houston, TX	
STP-H3-Canary	Space Test Program - Houston 3 - Canary	NASA	Technology Development and Demonstration	STP-H3-Canary investigates the interaction of ions with the background plasma environment around the station	Geoff Mcharg, Ph.D., US Air Force Academy, CO	
STP-H3-DISC	Space Test Program - Houston 3 - Digital Imaging Star Camera	NASA	Technology Development and Demonstration	STP-H3-DISC captures images of star fields for analysis by ground algorithms to determine the attitude of the station. The results will lead to the creation of more robust and capable satellites to be used by ground systems for Earth-bound communications	Andrew Nicholas, Naval Research Laboratory, Washington, DC	
STP-H3-MHTEX	Space Test Program - Houston 3 - Massive Heat Transfer Experiment	NASA	Technology Development and Demonstration	STP-H3-MHTEX, capillary pumped loop heat transfer equipment, which operates by continuous fluid flow to transfer heat from multiple spacecraft sources to an external vehicle surface to improve the understanding of two-phase flow microgravity performance	Andrew Nicholas, Naval Research Laboratory, Washington, DC	
STP-H3-VADER	Space Test Program - Houston 3 - Variable Emissivity Radiator Aerogel Insulation Blanket Dual Zone Thermal Control Experiment Suite for Responsive Space	NASA	Technology Development and Demonstration	STP-H3-VADER tests a new form of multilayer insulation that uses Aerogel as the thermal isolator to protect spacecraft from the harsh extremes of the space environment	Andrew Nicholas, Naval Research Laboratory, Washington, DC	
Treadmill Kinematics	Biomechanical Analysis of Treadmill Exercise on the International Space Station	NASA	Human Research	Treadmill Kinematics is the first rigorous investigation to quantify the biomechanics of treadmill exercise conditions during long-duration space flight on the station. Exercise prescriptions are developed under the assumption that walking and running in microgravity have the same training effects as during normal gravity. However, if locomotion kinematics and kinetics differ between microgravity and normal gravity, understanding these mechanisms allows the development of appropriate exercise prescriptions to increase exercise benefits to crew health and well-being	John De Witt, Ph.D., Wyle, Houston, TX	

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
VIABLE ISS	Evaluation and Monitoring of Microbiofilms Inside International Space Station	NASA	Biology and Biotechnology	VIABLE ISS involves the evaluation of the microbial biofilm development on space materials. Both metallic and textile space materials, either conventional or innovative, are located inside and on the cover of Nomex pouches that are placed inside the space station	Francesco Canganella, Universita della Tuscia, Viterbo, Italy	
VO2max	Evaluation of Maximal Oxygen Uptake and Submaximal Estimates of VO2max Before, During, and After Long Duration International Space Station Missions	NASA	Human Research	VO2max documents changes in maximum oxygen uptake for crew members on board the space station during long-duration missions	Alan D. Moore, Jr., Ph.D., Johnson Space Center, Houston, TX	
YouTube Space Lab	YouTube Space Lab Competition	NASA	Educational Activity and Outreach	YouTube Space Lab is a world-wide contest for students 14-18 years old. Students submit entries via a two-minute YouTube video in the areas of physics or biology – deadline for submission is December 7, 2011. The top two experiments are flown to and conducted on the space station	Zahaan Bharmal, Google, London, UK	
ТХН-9	Kristallizator (Crystallizer)	RSA	Physico-chemical processes and material in condition of cosmos	Biological macromolecules crystallization and obtaining bio-crystal films under microgravity conditions		Kibo
КПТ-21(ТЕХ-20)	Plazmennyi Kristall (Plasma Crystal)	RSA	Physico-chemical processes and material in condition of cosmos	Study of the plasma-dust crystals and fluids under microgravity		MRM2
ГФИ-1	Relaksatsiya	RSA	Geophysics and located beside land outer space	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		
ГФИ-8	Uragan	RSA	Geophysics and located beside land outer space	Experimental verification of the ground and space-based system for predicting natural and man-made disasters, mitigating the damage caused, and facilitating recovery		
ГФИ-16	Vsplesk (Burst)	RSA	Geophysics and located beside land outer space	Seismic effects monitoring. Researching high-energy particles streams in near-Earth space environment		
ГФИ-17	Molnija- Gamma (Lightning-Gamma)	RSA	Geophysics and located beside land outer space	Study atmospheric hits gamma and optical radiation in condition of the storm activity		
ГФИ-28	Microsatellite	RSA	Geophysics and located beside land outer space	Testing of run in automatic mode microsatellite Chibis-M using the cargo ship “Progress”		Progress
МБИ-12	Sonokard	RSA	Biomedical studies	Integrated study of physiological functions during sleep period throughout a long space flight		
МБИ-16	Vzaimodeistvie (Interaction)	RSA	Biomedical studies	Monitoring of the group crew activities under space flight conditions		

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
МБИ-20	Tipologia	RSA	Biomedical studies	Researching for typological features of the activities of the station crews as operators activities in long-term space flight phases		
МБИ-21	Pneumocard	RSA	Biomedical studies	Study of space flight factors impacts on vegetative regulation of blood circulation, respiration and contractile heart function during long space flights		
МБИ-24	Sprut-2	RSA	Biomedical studies	Investigation of the dynamics of body composition and distribution of human body fluids during prolonged space flight		
БИО-1	Poligen	RSA	Biomedical studies	Detection of genotypic features (experimental object – Drozophila midge), determining individual characteristics of resistance to the long-duration flight factors		
БИО-2	Biorisk	RSA	Biomedical studies	Study of space flight impact on microorganisms-substrates systems state related to space technique ecological safety and planetary quarantine problem		EVA
БИО-5	Rasteniya	RSA	Biomedical studies	Study of the space flight effect on the growth and development of higher plants		
БИО-8	Plazmida	RSA	Biomedical studies	Investigation of microgravity effect on the rate of transfer and mobilization of bacteria plasmids		
ДЗЗ-12	Rusalka	RSA	Remote flexing the Land	Testing of the procedure to determine the carbon dioxide and methane content in the Earth atmosphere to understand a role of natural processes in human activity		
ДЗЗ-13	Seyener	RSA	Remote flexing the Land	Experimental methods of the interaction of the crews to cosmic station with court Fishing in process of searching for and mastering commercial-productive region of the World ocean		
ДЗЗ-14	СВЧ - radiometry Microwave radiometry	RSA	Remote flexing the Land	Investigation of the underlying surface, ocean and atmosphere		
КПТ-25	Econ-M	RSA	Remote flexing the Land	Experimental researching of space station Russian Segment (RS) resources estimating for ecological investigation of areas		
ИКЛ-2В	BTN-Neutron	RSA	Study of the Solar system	Study of fast and thermal neutrons fluxes		
БТХ-8	Biotrack	RSA	Cosmic biotechnology	Study of space radiation heavy charged particles fluxes influence on genetic properties of bioactive substances cells-producers		
БТХ-11	Biodegradatsiya	RSA	Cosmic biotechnology	Assessment of the initial stages of biodegradation and biodeterioration of the surfaces of structural materials		
БТХ-14	Bioemulsiya (Bioemulsion)	RSA	Cosmic biotechnology	Study and improvement of closed-type autonomous reactor for obtaining biomass of microorganisms and bioactive substance without additional ingredients input and metabolism products removal		

Research Experiments (continued)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
БТХ-29	Zhenshen'-2 (Ginseng-2)	RSA	Cosmic biotechnology	Study of the possibility to increase the ginseng biological activity		
БТХ-35	Membrane	RSA	Cosmic biotechnology	Study of the possibility of the reception in principal new пористых material with regular structure for use as filter and membrane		MRM2
БТХ-41	Bakteriofag	RSA	Cosmic biotechnology	Study of the influence factor space flight on bakteriofages		
БТХ-42	Structure	RSA	Cosmic biotechnology	Reception high-quality crystal рекомбинантных squirrel		
БТХ-43	Constant	RSA	Cosmic biotechnology	Study of the influence factor space flight on activity ferment		
БТХ-44	Calcium	RSA	Cosmic biotechnology	Studies on the effect of microgravity on the solubility of calcium phosphates in the water		
ТЕХ-14 (SDTO 12002-R)	Vektor-T	RSA	Technical studies and experiments	Study of a high-precision system for station motion prediction		
ТЕХ-15 (SDTO 13002-R)	Izgib	RSA	Technical studies and experiments	Study of the relationship between the onboard systems operating modes and station flight conditions		
ТЕХ-22	Identifikatsiya (SDTO 13001-R)	RSA	Technical studies and experiments	Identification of disturbance sources when the microgravity conditions on the station are disrupted		
ТЕХ-38	Veterok	RSA	Technical studies and experiments	Otrabotka new technology to optimization of the gas ambience in inhabited compartment station RS		
ТЕХ-39	SLS (System lazer relationship)	RSA	Technical studies and experiments	Otrabotka systems laser relationship for issue greater array to information from target equipment		EVA
ТЕХ-44	Sreda-ISS (Environment)	RSA	Technical studies and experiments	Studying space station characteristics as researching environment		
ТЕХ-58	Vinoslivost (Endurance)	RSA	Technical studies and experiments	Investigation of the influence of space factors on the mechanical properties of materials for space purposes		
КПТ-2	Bar	RSA	Technical studies and experiments	Testing of principles and methods for the space station leak area control, selection of the sensor design and configuration		
КПТ-24	Test	RSA	Technical studies and experiments	Experimental studies of the possibility of structural elements mikrodestruktsii space station modules, PC components under the influence of its own external atmosphere and the presence of conditions for life on the surface microflora germokorpusa under EVTI		
РБО-3	Matryeshka-R	RSA	Study of the physical conditions in outer spaces on station orbit	Study of radiation environment dynamics along the space station RS flight path and in station compartments, and dose accumulation in anthropomorphous phantom, located inside and outside the station		
ОБР-3	MAI-75	RSA	Formation and popularization cosmic studies	Spacecraft and up-to-date technologies for personal communications		

Research Experiments (concluded)

Acronym	Title	Agency	Category	Summary	Principal Investigator	Ops Location
КПТ-14	Ten' - Mayak (Shadow – Beacon)	RSA	Formation and popularization cosmic studies	Working out the method for radio probing of board-ground space for supporting preparation of "Ten" ("Shadow") plasma experiment on the station RS		
КПТ-10	Kulonovskiy crystal	RSA	Formation and popularization cosmic studies	System speaker study of the charged particles in magnetic field in the condition of microgravity		MRM2

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NASA's Commercial Orbital Transportation Services (COTS)

Through a revolutionary program begun in 2006, NASA's Commercial Crew and Cargo Program is investing financial and technical resources to stimulate efforts within the private sector to develop and demonstrate safe, reliable, and cost-effective space transportation capabilities. In a multiphase strategy, the program is helping spur the innovation and development of new spacecraft and launch vehicles from the commercial industry, creating a new way of delivering cargo – and possibly crew – to low Earth orbit and the International Space Station.

As NASA sets its sights on exploring once again beyond low Earth orbit, the ability for private industry to take on the task of providing routine access to space and the International Space Station is of vital importance. NASA's Commercial Crew and Cargo Program is the catalyst for this expanding new industry.

The first phase of this strategy is known as Commercial Orbital Transportation Services (COTS). Under COTS, NASA is helping commercial industry develop and demonstrate its own cargo space transportation capabilities to serve the U.S. government and other potential customers. The companies lead and direct their own efforts, with NASA providing technical and financial assistance.

Two companies have funded COTS agreements with NASA: Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation (Orbital). Since their competitive selection, these two companies have been working vigorously to develop technologies and capabilities to complete orbital spaceflight demonstrations. The International Space Station Program has already purchased future cargo delivery services from both of these companies to resupply the station through 2015.

Orbital Sciences Corporation

Just 100 miles up the coast from where the Wright brothers first flew their airplane at Kitty Hawk, North Carolina, Orbital is planning to launch its new COTS system at the Mid-Atlantic Regional Spaceport (MARS), located at NASA's Wallops Flight Facility in Virginia. Founded in 1982 with the goal of making space technology more affordable, accessible, and useful, Orbital has grown to become a leading developer and manufacturer of space and rocket systems. Its COTS system design is based on the new Taurus II rocket with a Liquid Oxygen (LOX)/kerosene (RP-1) first stage powered by two Aerojet AJ-26 engines. The Taurus II second stage is ATK's Castor 30 solid propellant motor derived from their flight-proven Castor 120. The spacecraft, known as Cygnus, is derived from Orbital's heritage DAWN and STAR spacecraft projects and International Space Station pressurized cargo carriers.

Space Exploration Technologies (SpaceX)

At Florida's Cape Canaveral, within sight of where every NASA human spaceflight mission has launched, SpaceX is planning to launch its new COTS system. Established in 2002, SpaceX is well into the development of a new family of launch vehicles, and has already established an extensive launch manifest. SpaceX is based on the philosophy that simplicity, low cost and reliability go hand in hand. SpaceX personnel have a rich history of launch vehicle and engine experience, and are developing their Dragon cargo and crew capsule and the Falcon family of rockets from the ground up, including main- and upper-stage engines, cryogenic tank structure, avionics, guidance and control software and ground support equipment. In December 2010, SpaceX completed the first COTS demonstration mission and became the first commercial company in history to successfully launch and recover a spacecraft to and from low Earth orbit.

Media Assistance

NASA Television and Internet

The digital NASA Television 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 the following four digital channels:

1. NASA Public Channel ("Free to Air") featuring documentaries, archival programming, and coverage of NASA missions and events.

2. NASA Education Channel ("Free to Air/Addressable") dedicated to providing educational programming to schools, educational institutions and museums.

3. NASA Media Channel ("Addressable") for broadcast news organizations.

4. NASA Mission Channel (Internal Only) provides high-definition imagery from science and human spaceflight missions and special events.

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

NASA Television Now in High Definition

NASA TV now has a full-time High Definition (HD) Channel available at no cost to cable and satellite service providers. Live coverage of space shuttle missions; on-orbit video of Earth captured by astronauts aboard the International Space Station; and rocket launches of advanced scientific spacecraft are among the programming offered on NASA HD. Also available are imagery from NASA's vast array of space satellites, as well as media briefings, presentations by expert lecturers, astronaut interviews and other special events, all in the improved detail and clarity of HD.

Getting NASA TV via satellite (AMC3 Transponder 15C)

In continental North America, Alaska and Hawaii, NASA Television's Public, Education, Media and HD channels are MPEG-2 digital C-band signals carried by QPSK/DVB-S modulation on satellite AMC-3, transponder 15C, at 87 degrees west longitude. Downlink frequency is 4000 MHz, horizontal polarization, with a data rate of 38.86 Mhz, symbol rate of 28.1115 Ms/s, and 3/4 FEC. A Digital Video Broadcast (DVB) compliant Integrated Receiver Decoder (IRD) is needed for reception.

Effective Sept. 1, 2010, NASA TV changed the primary audio configuration for each of its four channels to AC-3, making each channel's secondary audio MPEG 1 Layer II.

For NASA TV downlink information, schedules and links to streaming video, visit **http://www.nasa.gov/ntv**

Television Schedule

A schedule of key mission events and media briefings during the mission will be detailed in a NASA TV schedule posted at the link above. The schedule will be updated as necessary and will also be available at

http://www.nasa.gov/multimedia/nasatv/mission_schedule.html

Status Reports

Status reports and timely updates on launch countdown, mission progress and landing operations will be posted at **http://www.nasa.gov/shuttle**

Internet Information

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

Information on the International Space Station is available at **http://www.nasa.gov/station**

The NASA Human Space Flight Web contains an up-to-date archive of mission imagery, video and audio at **http://spaceflight.nasa.gov**

Resources for educators can be found at **http://education.nasa.gov**

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