Control Centres

Columbus Control Centre, Oberpfaffenhofen, Germany

Room K4 of the Columbus Control Centre in Oberpfaffenhofen, near Munich, Germany. 9 August 2004. (Image: DLR)

ESA's Columbus Control Centre (Col-CC) will be supporting the European Columbus Laboratory on orbit during the Alissé mission and the ongoing OasISS mission. It is situated at the German Aerospace Center (DLR) facility in Oberpfaffenhofen, near Munich, Germany.

The Control Centre is the direct link to the Columbus Laboratory in orbit. Its main functions are to command and control the Columbus laboratory systems, to coordinate operations of the European payloads on board the ISS and to operate the European ground communications network.

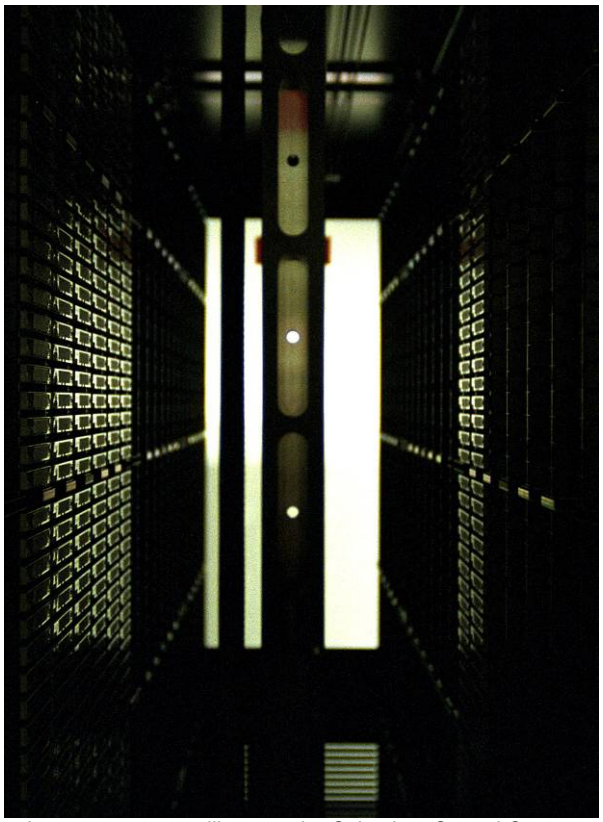
In its main function of commanding and controlling the systems of the Columbus Laboratory, the Columbus Control Centre will be making sure that astronauts working within Columbus have a safe and comfortable environment in which to work and that the payload facilities have the necessary system support in order to function properly. This will include monitoring and configuring, by remote command, the life support systems to maintain air quality, the power supply to experiment facilities, and systems for removal of heat from experiment facilities.

European and non-European astronaut activities inside Columbus will be monitored and coordinated from the Columbus Control Centre. The Control Centre also holds overall responsibility for such issues as safety in the Columbus Laboratory under the overall authority of the ISS Mission Control Center in Houston, Texas. The Columbus Control Centre will react to any changes during the mission, coordinating decisions and establishing priorities should any change interfere with the European experiments inside Columbus.

The Columbus Laboratory has experimental facilities both internally and externally covering a multitude of experiments over the course of its lifetime. The involvement of the astronauts with

these experiments could range from a high degree of interaction to only some activity limited to the integration and removal of the experiment from its processing location.

Any autonomous activities of the Columbus Laboratory systems and experiment facilities are monitored and coordinated through the Columbus Control Centre. The Columbus systems are configured as and when necessary to account for alterations in procedures or a change within the payload facilities. All data coming from the Columbus Laboratory is routed by the Columbus Control Centre, exercising its role as network operations centre. The engineering data is archived at Col-CC whereas the scientific and relevant experiment and facility data is distributed to de-centralised User Support and Operations Centres or USOCs, where these are processed and archived.



Long-term storage library at the Columbus Control Centre. (Image: ESA)

The USOCs are based in national centres distributed throughout Europe and are responsible for the specific operations of the ESA payload and experiment facilities within the Columbus Laboratory. At these centres scientific investigators can monitor, or be linked to, their experiments.

The Columbus Control Centre is responsible for distributing data to the USOCs and receiving information from them such as requests for resources and reconfiguration of Columbus systems in support of experiments and payload facility operations. Such information, is fed into the mission planning process that generates timelines for flight controllers and astronauts.

The European Astronaut Centre in Cologne, Germany. (Image: ESA)

The Columbus Control Centre is also linked to the European Astronaut Centre in Cologne, which is responsible for medical support, monitoring, and safety of ESA astronauts during missions.

Since the Columbus laboratory itself hosts non-European experiments such as US payload facilities, decisions taken such as changes in scheduling are coordinated with the ISS international partners. For this reason the Columbus Control Centre is connected to the ISS

The ISS Flight Control Room at the Mission Control Centre in Houston. (Image: NASA)

Control Centres

Mission Control Center at the Johnson Space Center in Houston, the Huntsville Operations Support Center in Huntsville, Alabama, and to the ISS Mission Control Centre in Moscow.

Further to its functions of command and control of Columbus Laboratory systems as well as the coordination of the Columbus payload operations, the Columbus Control Centre is responsible for operating the ground communications network that provides communication services (voice, video and data) to a large number of sites: ESA Operations Management at ESA/ESTEC; the USOCs; the European Astronaut Centre; industrial engineering support sites; and to the Automated Transfer Vehicle (ATV) Control Centre in Toulouse, France. The ATV is the European-built ISS re-supply ship, the first of which (Jules Verne) was launched on 9 March 2008 by an Ariane 5 rocket from Kourou, French Guiana. The ATV Control Centre coordinates and supports all ATV operations for ESA.

The ATV Control Centre in Toulouse, France receives communications services from the Columbus Control Centre. The ATV Control Centre shown here just after ATV undocking from the ISS (Image: ESA)

The Columbus Control Centre has two control rooms: one for real-time operation control and one for preparation activities, such as the training of controllers, simulations, etc. The second control room also acts as a backup for the first control room. A back-up control centre, which can take over operations in case of a major disaster such as fire in the control facility, is provided on site of DLR but not located in the same building.

Network Equipment Room at the Columbus Control Centre. (Image: ESA)

The Integrated Columbus Control Centre Flight Control Team is a joint DLR and EADS Astrium team. This mission control service is provided as part of the overall end-to-end operations service delivered by EADS Astrium as the ISS Industrial Operator. The Flight Control Team is led by DLR flight directors and is under the overall supervision of an ESA Mission Director based at DLR Oberpfaffenhofen.

User Support and Operations Centres (USOCs)

A decentralised scheme for the utilisation of European payloads on board the ISS was envisaged from the outset of the ISS Programme. USOCs located in various participating countries act as the link between the user community and ESA's Columbus Control Centre in Oberpfaffenhofen in Germany, NASA's Payload Operations Integration Center in Huntsville, Alabama, and the Mission Control Centre in Moscow.

Prior to the launch of Columbus, the USOCs were concerned with activities such as ground model operations, experiment-procedure development, payload and experiment optimisation and calibration, and support to crew training activities. With Columbus now on orbit the USOCs receive Columbus facility and experiment data and perform, in coordination with the Columbus Control Centre, the operations of the payloads for which they are responsible.

In addition, the USOCs are responsible for the interaction with the scientists in the User Home Bases in disseminating experiment data to them, and receiving and processing requests for experiment scheduling and direct commanding.

Depending on the scope of the task assigned to a USOC, it can assume three basic levels of responsibility. The first level is to operate as an Experiment Support Centre, supporting users from the country in which the USOC is situated, in preparing and conducting an experiment.

The second level is to operate as a Facility Support Centre supporting particular functions of an Agency-provided multi-user facility. The third level is to operate as a Facility Responsible Centre with full responsibility for the operation of a complete payload facility.

For the Columbus facilities the relevant USOCs are as follows:

Biolab: The Facility Responsible Centre for Biolab is at the Microgravity User Support Centre in Cologne, Germany. BIOTESC in Zurich, Switzerland acts as the Facility Support Centre.

European Drawer Rack: The Erasmus USOC at ESA's ESTEC facility in Noordwijk, the Netherlands is the Facility Responsible Centre for the European Drawer rack with the Belgian USOC in Brussels and the Dutch Utilisation centre in Emmeloord acting as Facility Support Centres.

European Physiology Modules: The Facility Responsible Centre for the European Physiology Modules is at CADMOS (Centre d'Aide au Développement des activités en Micro-pesanteur et des Opérations Spatiales) in Toulouse, France with DAMEC in Odense, Denmark acting as the Facility Support Centre.

Control Room at CADMOS, the Facility Responsible Centre for the European Physiology Modules facility. (Image: ESA)

Fluid Science Laboratory: The Facility Responsible Centre for the Fluid Science Laboratory is at the Microgravity Advanced Research and Support (MARS) Centre in Naples, Italy. MARS will be supported by the E-USOC in Madrid, which is the Facility Support Centre for Fluid Science Laboratory Operations.

Materials Science Laboratory:
The Facility Responsible and Support Centre tasks for the Materials Science Laboratory, which will be launched on the STS-128 flight are split between the Microgravity User Support Centre in Cologne, Germany and CADMOS in Toulouse, France.

External Payloads:
For the unpressurised external payloads, the Facility Responsible Centres are based at ESA's Erasmus USOC for EuTEF, which is returning as part of the STS-128 flight during the Alissé mission, and at the Belgian USOC for SOLAR.

Control Centres

European Astronaut Centre, Cologne, Germany

(Crew Medical Support Office)

EAC - home base of the European Astronaut Corps. (Image: ESA)

The European Astronaut Centre (EAC) of the European Space Agency is situated in Cologne, Germany. It was established in 1990 as a result of Europe's commitment to human space programmes and is the home base of the astronauts who are members of the European Astronaut Corps.

During the Alissé mission the Crew Medical Support Office, part of EAC, will be responsible for medical support and monitoring of ESA astronaut Christer Fuglesang following his arrival at the ISS. They will also be responsible for medical support and monitoring of ESA astronaut Frank De Winne who will still be serving as an Expedition crew member on the ISS and carrying out the long-duration European OasISS mission. The medical support team is composed of flight surgeons, biomedical engineers and specialists in the field of psychology, exercise and rehabilitation.

For launch, landing, and specific events such as American or Russian EVAs, medical support is provided by the relevant teams either from the Mission Control Center at the Johnson Space Center in Houston or from the Mission Control Centre (TsUP) in Moscow.

During all mission phases medical support comes from the Medical Console Room at EAC. This is staffed with a biomedical engineer and a flight surgeon working on consoles within shift schedules.

The main tasks of the team are to monitor the biomedical and environmental conditions for the crewmembers; to interact with all Medical Operations Groups from the international partners; and to provide guidance and advice for all medical procedures, in-flight fitness and countermeasures. Among their tasks is the execution of a daily or weekly medical conference with the ESA astronauts, depending on the phase of flight. The medical support team also provides medical support to the astronauts' families.

Control Centres

Kennedy Space Center

(Space Shuttle launch and post-flight operations)

Firing room during the launch of the Hubble Space Telescope on Space Shuttle STS-31 mission on 24 April 1990. (Image: NASA)

Control and monitoring of the Shuttle during the countdown and first seven seconds after launch takes place in one of the four firing rooms of the Launch Control Center at the Kennedy Space Center in Florida.

The Firing Room contains consoles associated with many different functions. The Launch Director heads the Firing Room having overall responsibility for management of launch activities and making the final determination to launch or stop.

The consoles are used to monitor the Shuttle systems during countdown and the first few seconds of launch including: navigation, guidance and flight control systems; main engine parameters to verify acceptance for main engine start; control system thrusters; Environmental Control and Life Support Systems; and electrical power systems.

Launch pad systems are also controlled from the Firing Room consoles. This includes functions such as loading the external tank with propellant around eight hours before liftoff and retraction of the Orbital Access Arm through which the crew enter the Shuttle prior to launch.

During the last nine minutes, most of the final configurations and systems checks are carried out by the computers, but the firing room engineers are still carefully checking everything to make sure that the Shuttle is still ready for launch.

At T-31 seconds, an automatic command is sent to the Shuttle on-board launch sequencer that allows the Shuttle to start its engines and launch. Once the Shuttle boosters are ignited the Shuttle is launched. After seven seconds when the Shuttle has cleared the service tower on the launch pad, the control is handed over to the Mission Control Center in Houston.

In addition to space shuttle processing and launching, Kennedy is also the preferred end-of-mission landing. On landing day a team of engineers monitor the orbiter in the firing room. Once the orbiter lands and rolls to a stop, Kennedy Space Center once again take over responsibility from the Mission Control Center in Houston.

Mission Control Center – Houston, Texas

(Overall Control of ISS activities and Space Shuttle Flight Control)

ISS Flight Control room at the Mission Control Center in Houston, Texas. (Image: NASA)

The NASA Mission Control Center, located at the Lyndon B. Johnson Space Center in Houston, Texas has been operational in the control of NASA Human Spaceflight launches since 1965. There are different Flight Control Rooms at the control centre covering ISS Operations and Shuttle flights.

The ISS Flight Control Room began operations on 20 November 1998. It acts as the command and coordination centre for all ISS activities, including ISS flight control. The Shuttle Flight Control Room takes control of Shuttle flight operations from the Kennedy Space Center seven seconds after a Shuttle launch, when the Shuttle has cleared the service tower until the shuttle rolls to a stop following landing.

The equipment and supporting structures in each control room are basically identical, though the ISS Flight Control Room is smaller with fewer consoles and requires fewer flight controllers. The ISS Flight Control Room normally operates with 12 or less flight controllers compared to about 20 in the Shuttle Flight Control Room. The consoles in each control room are associated with specific functions. A flight controller occupies each console with secondary support supplied by other engineers and flight controllers in different locations.

Work is undertaken in shift teams, monitoring systems and activities 24 hours a day with the use of sophisticated communications, computers, and data handling equipment. Each control room has large display screens at the front, two in the ISS Flight Control Room and three in the Shuttle Flight Control Room, and cameras for provision of live broadcasts.

The individual functions in the Flight Control Room start with the Flight Director. The Flight Director is the primary decision maker and responsible for the overall ISS or Shuttle mission operations. Next to him sits the capsule communicator or CAPCOM who is the primary communicator between the control room and the crew.

Other functions relate to guidance, navigation and control, and flight dynamics; monitoring ISS or Shuttle thermal control, power availability and life support systems; mission control and ISS or Shuttle infrastructure and communications systems; robotic arm operations; EVA and robotics operations; crew operations planning; crew health and Public Affairs. The Shuttle Control Room has additional functions such as for monitoring the performance of the main engine, solid rocket boosters, external tank and propulsion systems.

Control Centres

Payload Operations Center, Huntsville, Alabama

(Overall Control of ISS Research activities)

Payload Operations Center in Huntsville, Alabama. (Image: NASA)

The ISS Payload Operations Center (POC) is located at the Huntsville Operations Support Center, which is on NASA's Marshall Space Flight Center in Alabama. It is responsible for the overall control of scientific research activities on the ISS.

The Payload Operations Director at the POC is in charge of coordinating all payload activity, together with the Flight Director at Mission Control in Houston, international partners, crew and research facilities. From this interaction, timelines of scientific activity are drawn up.

The Payload Communications Manager at the POC coordinates voice communications between the International Space Station crew and the POC on payload matters, enabling researchers around the world to talk directly with the crew about their experiments.

There are further functions at the Payload Operations Center associated with separate elements of payload procedure. These functions cover the safety of experiments (and changes to them); coordinating experiment resources such as power; scheduling; prioritisation; and controlling and processing of voice, video and data channels. The authority for the control of payloads and hence experiments is distributed around the world. Each International Partner is responsible for the operation of its payloads in its on-orbit laboratory, as it falls within the given payload timelines, under the guidance of the POC.

Mission Control Centre – Moscow

(Responsibility for Soyuz/Progress spacecraft launch, ascent and descent phases and Russian ISS modules)

ISS Control Room at the Mission Control Centre in Korolev near Moscow. (Image: NASA)

The Russian Mission Control Centre, also known as TsUP in Russian, is situated in Korolev (formerly Kaliningrad) near Moscow. TsNIIMash, the Russian acronym for the Central Research Institute for Machine Building, operates the centre on behalf of the Russian Federal Space Agency, Roscosmos.

It was built in 1973 and is the same location for the Mission Control Centre of the Mir and Salyut space stations and further contains the flight control rooms for the Progress and Soyuz launches.

Flight control personnel are organized into teams, and each function has a NASA counterpart at Mission Control Center, Houston. These functions include the Flight Director, who provides policy guidance and communicates with the mission management team. This consists of the Flight Shift Director, who is responsible for real-time decisions, within a set of flight rules; the Mission Deputy Shift Manager for the Mission Control Centre, who is responsible for the control room's consoles, computers and peripherals; the Mission Deputy Shift Manager for ground control, who is responsible for communications, and the Mission Deputy Shift Manager for crew training.

The spaceflights are actually managed by numerous experts in control, space technology, ballistics, telemetry, communications, automated control, tracking systems, and by experts of scientific institutions.

A huge visual display in the centre of the Main Control Room is used to show information such as the current position of orbiting spacecraft. There are several digital and character displays for actual mission elapsed time, counters, telemetry data, orbital characteristics, etc. Specific information comes directly to each individual controller's computer display unit.

Control Centres

Kibo Control Room, Tsukuba, Japan

(Command and control of Japanese Kibo Laboratory systems and research facilities)

The Kibo Mission Control Room at the Tsukuba Space Centre in Tsukuba, Japan. (Image: NASA)

The Japanese Aerospace Exploration Agency (JAXA) operates and controls the Kibo Laboratory's systems and experiment payloads and facilities from the Space Station Operation Facility at the Tsukuba Space Centre in Tsukuba, Japan, with the main focus being the Kibo Mission Control Room.

In the Kibo Control Room, the JAXA Flight Control Team monitors the equipment and experiment devices on Kibo and copes with any problems that may occur aboard the Kibo during flight operations. The team is responsible for the preparation and evaluation of all plans and procedures performed by the crew aboard Kibo, and by controllers on the ground. They have the capability of making real-time operations planning changes, and can communicate directly with the crew aboard Kibo and the various international partner mission control centres located around the world.

The Flight Control Team consists of flight directors and over 50 flight controllers who support Kibo flight operations. The flight director oversees and directs the team, and the flight controllers possess specialized expertise on all Kibo systems such as environmental control and life support, thermal control, network systems and electrical power, experiment facilities, and robotics.

The Japanese flight control team monitors and controls Kibo around the clock in a three-shift per day schedule. Operations are jointly monitored and controlled with the Mission Control Center in Houston. As well as the Mission Control Room, the Japanese Space Station Operation Facility consists of a User Operations Area for distributing Japanese experiment data to the respective users, operations planning and rehearsal rooms, and an Engineering Support Room.