Columbus Control Centre

(Monitoring and Coordination of European Mission Operations)

Columbus Control Centre in Oberpfaffenhofen, Germany. (Image: DLR)

The European Payload Operations Centre for the Astrolab Mission is based at the Columbus Control Centre, at the German Aerospace Center's (DLR's) facility in Oberpfaffenhofen, near Munich, Germany. During the mission the European Payload Operations Centre will be responsible for coordinating operations for the European experiments and experiment payloads on board the ISS and monitoring the activities of ESA astronaut Thomas Reiter under the supervision of an ESA Mission Manager and Operations Management Team.

The European Payload Operations Centre is responsible for coordinating the User Support and Operations Centres (USOCs), Facility Support Centres and Facility Responsible Centres. These centres, based in national centres distributed throughout Europe, will be responsible for specific ESA experiments and experiment facilities on the ISS and will be where scientific investigators can monitor, or be linked to, their experiments. Relevant data will be distributed to these centres and information received from them such as requests to reconfigure experiments and experiment facilities.

The European Payload Operations Centre will react to any changes during the mission, coordinating decisions and establishing priorities should any change interfere with the European experiment programme. Any issues arising will be coordinated in close cooperation with the Mission Control Centres in Houston, and Moscow and with the Operations Support Center in Huntsville, Alabama, which has overall responsibility for ISS experimental payload activities. The European Payload Operations Centre will also be linked to the European Astronaut Centre in Cologne, which is responsible for medical support and monitoring, and crew safety of ESA astronauts on missions.

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 12 European astronauts who are members of the European Astronaut Corps.

During the Astrolab mission the Crew Medical Support Office, part of EAC will be responsible for medical support and monitoring of the ESA astronaut(s). 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 EVAs medical support is provided by the team from the Mission Control at the Johnson Space Center in Houston. Russian EVAs would be supported from the Mission Control Centre 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 astronaut, depending on the phase of flight. The medical support team also provides medical support to the astronauts' families.

European User Support and Operations Centres

(Monitoring and supporting European experiments and experiment facilities)

During the Astrolab mission the European Payload Operations Centre will coordinate the activities of different User Support and Operations Centres. The prime responsibility of USOCs is as an Experiment Support Centre providing support to users for conducting experiments and being responsible for single experiments, whether stand alone or located in a multi user experiment facility. The USOCs provide a location where scientific investigators can monitor, or be linked to, their experiments. These centres are based in national centres distributed throughout Europe.

USOCs can also be allocated the additional responsibility as a Facility Support Centre or Facility Responsible Centre. A Facility Support Centre provides support for particular functions of an ESA experiment facility such as a facility sub rack or experiment container. A Facility Responsible Centre has the responsibility of a complete multi-user experiment facility. For the Astrolab mission the following centres will be utilised in connection with the European experiment programme:

CADMOS (France). CADMOS (Centre d'Aide au Développement des activités en Micro-pesanteur et des Opérations Spatiales) was created in 1993 at the French Space Agency, CNES, in Toulouse, in order to support all French human spaceflight missions performed on-board the Mir Space Station or Space Shuttle. For this mission it will support the Cardiocog, Cult, ETD, Card and Immuno experiments.

The CADMOS Control Room. (Image: CNES)

DAMEC, (Denmark). Located in Odense, Denmark, Damec developed the European elements of the Pulmonary Function system for ESA as well as the Science interfaces and utilisation hardware of the Minus 80 degrees laboratory freezer for the ISS (MELFI). During the mission Damec will support operations for the Pulmonary Function System, MELFI, and the Card and NOA experiments.

The location of Damec in Odense, Denmark. (Image: Innovision)

MARS (Italy). MARS (The Microgravity Advanced Research and Support Centre) is a Consortium between the University of Napoli "Federico II" and Alenia Spazio, established in Naples in 1988. It has taken part in more than 20 space missions. For the Astrolab mission the Mars Center will be responsible for the Altcriss experiment.

MUSC (Germany). MUSC (The Microgravity User Support Centre), located at the DLR German Aerospace Centre in Cologne will be the Facility Responsible Centre for the Matroshka facility and will support all the Kubik and biology experiments as well as the PK-3+ and GTS-2 experiments. It will further be supported by BIOTESC in Zurich, Switzerland during the 12S and 13S visiting time, i.e. Expedition Crew exchange period.

N-USOC (Norway). The Norwegian User Support and Operations Centre in Trondheim in Norway was established in 2002 and, as the relevant Facility Responsible Centre, will be supporting in-flight operations and commissioning of the European Modular Cultivation System and the NASA Tropi experiment that will take place in the EMCS. N-Usoc will be further provided with engineering support from ESC in Friedrichshafen, Germany based at EADS who led the industrial development of the EMCS.

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.

Mission Control Centre – Moscow

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

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.

Payload Operations Center, Huntsville, Alabama

(Overall Control of ISS Research activities)

Payload Operations Center in Huntsville, Alabama. (Source: 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 Payload Operations Center.

There are four additional centres in America, which are equivalent to the European User Support and Operations Centres that support the Payload Operations Center by managing certain scientific operations.

These are the Marshall Space Flight Center, where the POC is itself situated, for materials science, biotechnology and microgravity research, and space product development; the Ames Research Center in California, for gravitational biology and ecology; the John Glenn Research Center in Ohio for fluids and combustion research; and the Johnson Space Center in Houston, Texas, for human life sciences, including crew health and performance.