Operations and Utilisation

Accommodation & Transport:

The European Physiology Modules facility will be launched inside the European Columbus laboratory.
New Science Modules and other necessary items, will be transported within the Multi-Purpose Logistics Module (MPLM). This is a pressurised cargo carrier that is carried inside the Space Shuttle cargo bay. EPM equipments can also be brought up by other available transport means such as the European Automated Transfer Vehicle (ATV), the Russian Progress and Soyuz vehicles or the Space Shuttle.
Samples are returned using the MPLM, the Shuttle's middeck lockers and the Soyuz spacecraft.

Operational Concept:

To correctly evaluate the on-board data, it is essential that reference (or base-line) data are collected prior to flight and following the return of the crew (the experiment subjects) to Earth. For this reason, the EPM facility will provide Baseline Data Collection Models that are functional copies of the on-board instruments. The Baseline Data Collection Models will be readily transportable to ensure availability of the equipment for the crew pre-launch and post-flight activities.

Utilisation Scenario:

The Facility Responsible Centre for the EPM facility will have the overall responsibility to operate it according to the needs of individual Science Modules.
The Principal Investigators can monitor the execution of their experiments from local User Home Bases.

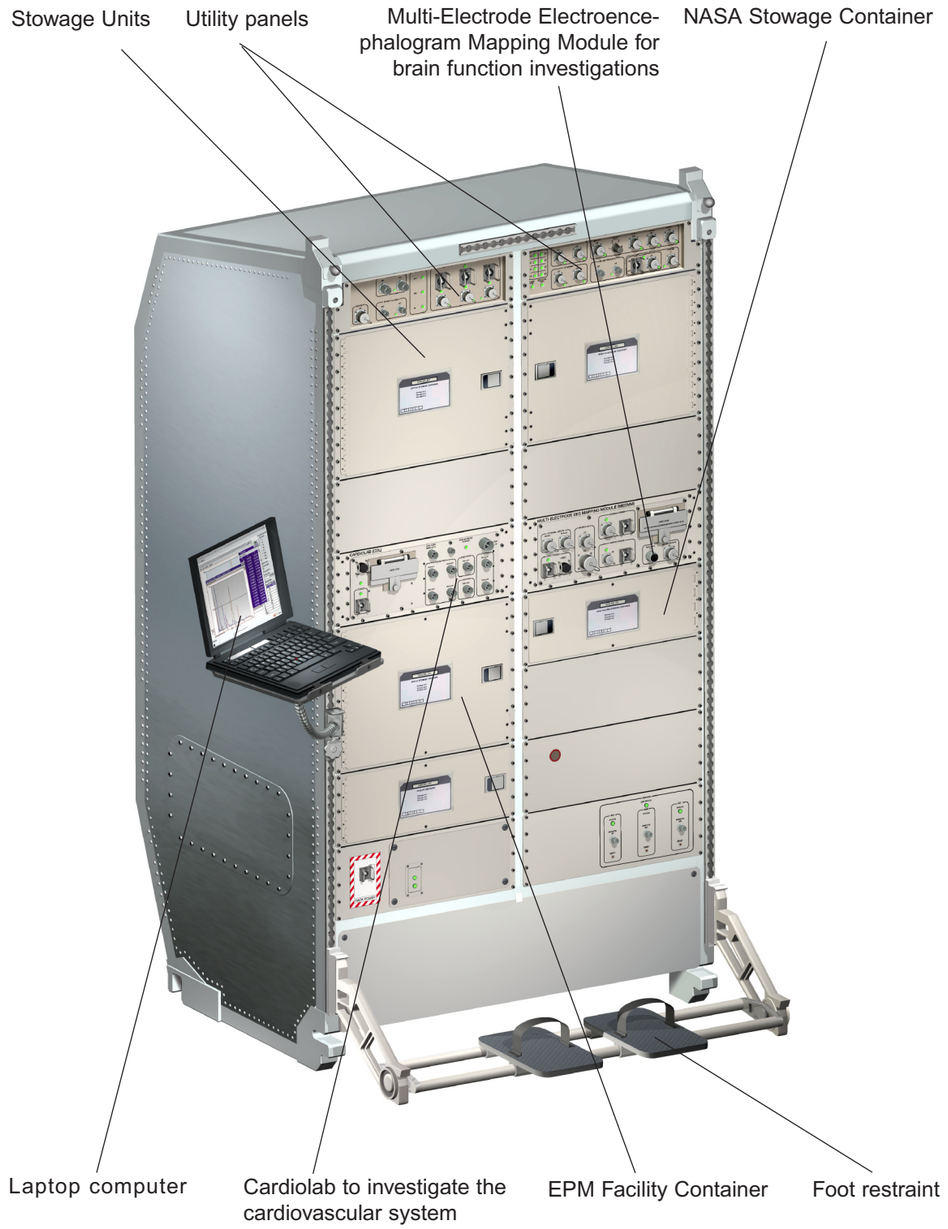
Schedule:

According to the current schedule, EPM will be launched aboard the Space Shuttle accommodated within the Columbus laboratory.
From then on, the facility will be accessible for the astronauts to perform human physiology experiments.

European Physiology Modules (EPM)

Research facility for human physiology experiments in Columbus

An International Standard Payload Rack, equipped with Science Modules to investigate the effects of long-duration spaceflight on the human body. The experiment results will also contribute to an increased understanding of terrestrial problems such as the ageing process, osteoporosis, balance disorders, and muscle wastage.



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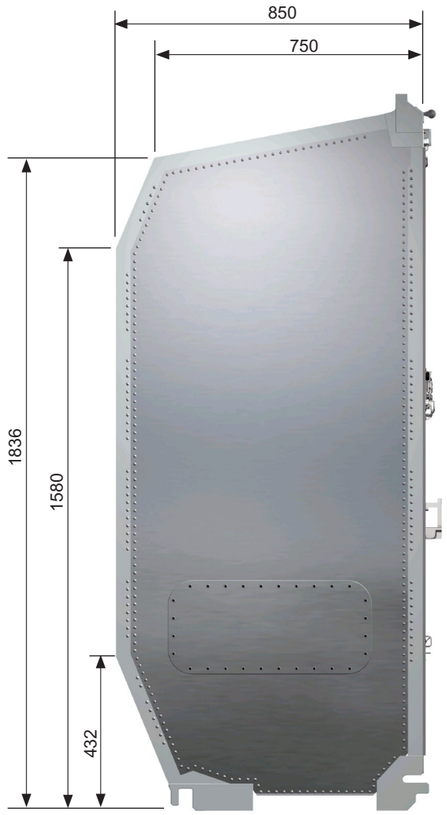

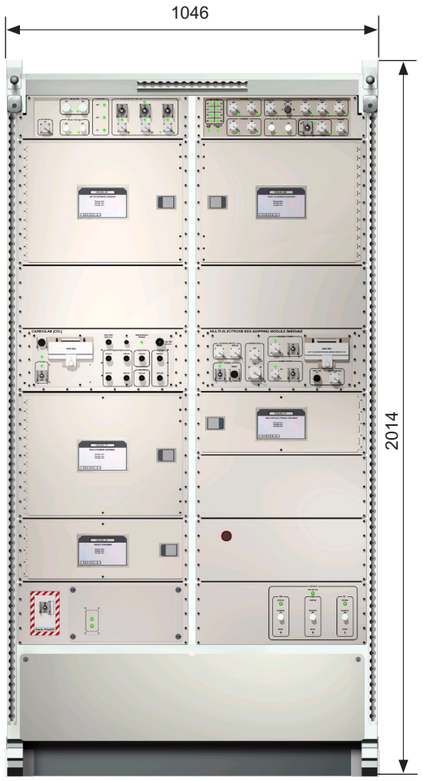

Facility Description

The facility will be accommodated in one International Standard Payload Rack, and consists of a complement of Science Modules together with the Carrier infrastructure to support their coordinated operation. The Carrier provides data handling, thermal control and mechanical accommodation for up to eight Science Modules.
These modules are accommodated in standard containers that interface with the rack via a standard guide system, thereby facilitating on-orbit installation and exchange. All rack-mounted modules are cooled via a ducted air system within the Carrier.
In addition to Science Modules mounted in the carrier, it is possible for instruments to be deployed in the Columbus centre aisle, to interface to the carrier via a Utility Distribution Panel, which provides the same interfaces as for the Science Modules.
Science Modules mounted in the EPM carrier are using the ESA-provided Standard Active Container, which provides all the mechanical, thermal and electrical interfaces to the carrier. This approach strongly reduces the effort of development for a Science Module developer. The containers are available in 2 sizes, the 4 Panel Unit and the 8 Panel Unit. The modular nature of the design provides for a high level of flexibility in the Science Module complement configuration.

NASA has developed a complementary facility to the EPM facility, known as the Human Research Facility (HRF). It is planned to collocate the Human Research Facility within the Columbus laboratory with the EPM facility in order to allow combined experiments using instruments from both facilities.
The European Physiology Modules facility builds upon the previous European experience gained through experiments on such facilities as Sled, Anthrorack, and Physiolab flown on Spacelab missions.

For the EPM launch configuration (termed EPM-1), a number of Science Modules are being developed by ESA and National Agencies. The EPM-1 configuration will have a few empty positions to be used by new science modules, to be developed in the future.

The EPM facility design philosophy is based on high modularity, both for the facility infrastructure and the science modules it accommodates. It allows multiple repeats of experiment runs under inclusion of on-orbit reconfigured science protocols as well as future on-orbit upgrades/refurbishment on Science Modules so as to provide the possibility to adapt the EPM Facility to the growing science needs throughout its utilisation phase.

The EPM-1 configuration consists of:

Multi-Electrode Electroencephalogram Measurement Module (MEEMM)

This Science Module will be used for different types of non-invasive brain function investigations.
The test subject wears a cap with up to 128 electrodes that measure low-level signals at very high sampling rates. Items to generate appropriate stimuli are available on-board, e.g. Virtual Environment Generator and muscle stimulators - both of which are part of the NASA Human Research Facility.
The MEEMM science module can easily be reconfigued with electromyogram electrodes to support research in the field of muscle physiology.

PORTEEM (Portable Electroencephalogram Module)

This instrument is a flexible, modular and portable digital recorder for ambulatory and sleep studies. The instrument is outfitted with a 16 channel EEG/polysomnography module for EEG sleep studies, but can be easily reconfigured for a wide variety of other applications according to the research needs.

Sample Collection Kit

Besides a collection of clinical and medical equipment necessary to collect in-flight samples of blood, saliva and urine, special containers for used medical/biohazard objects and for metallic and sharp objects are also included. Limited analyses can be performed on-board, but most samples are stowed in a controlled environment for later download to the ground for analysis.

Cardiolab

This Science Module, jointly developed by the Deutsches Zentrum für Luft- und Raumfahrt e.v. (DLR) and the Centre National d'Etudes Spatiales (CNES), supports cardiovascular research with a particular focus on the central and peripheral regulation and its short-term and long term adaptation to altered gravity levels. Cardiolab is comprised of stressors and sensors such as a blood pressure device, electrocardiogram measurement device or portable doppler instrument.

NASA Stowage Container

In order to enhance the co-operation between the European Space Agency and NASA an exchange of hardware has been initiated. ESA has provided the PFM/PAM Science Module to NASA. For the initial launch configuration (EPM-1), the allocated space in EPM for NASA will be used to stow some NASA Human Research Facility (HRF) instruments. Among the instruments selected to be launched in the NASA stowage container is the ESA developed Handgrip Dynamometer and Pinch Force Dynamometer (HGD/PDF, Kayser Italia) and the HRF Urine Collection Kit (UCK).

Ongoing developments for further improvement of EPM

The following two facilities are not part of EPM-1 but considered as enhanced capabilites for a EPM-2 rack.

Bone Analysis Module (BAM)

Originally foreseen to be developed for the EPM-1 configuration, the BAM development has recently introduced a new technology and the phase B has been resumed. This new technology has been subject of clinical performance tests, e.g. during the bed rest studies in Berlin and Toulouse.

Bone loss is a severe problem in long duration space flights. Understanding the related dynamics and developing effective countermeasures are important requirements for flying long-term missions. The BAM module will study the efficacy of various countermeasures by evaluating changes in the ultrasound transmission properties of the heel bone. The Bone Analysis Module is based on a commercial system, where the foot normally is placed in an open water tank. In the space version, the foot is placed between two water-filled latex bags. Ultrasound transducers assess changes is the bone structure via related changes in the propagation properties of ultrasound through the bone.

Portable Pulmonary Function System (PPFS)

As a contribution to the HRF-2 rack Pulmonary Function System, ESA has developed the Pulmonary Function Module/Photo Acoustic Analyser (PFM/PAM). In addition, to overcome the logistic problems of having various excercise equipment located in the different parts of the ISS, ESA also develops a portable, miniature device for pulmonary function measurements (PPFS).

The PPFS is outfitted with on oxigraph sensor, a photo-acoustic gas analyser, a flowmeter system and a mixing bag system. The instrument allows for the measurement of a wide range of pulmonary function parameters, including cardiac output, oxygen uptake, lung capacity, functional residual capacity, breath by breath measurements, tidal volume, fractional inspiratory and expiratory volumes, etc.