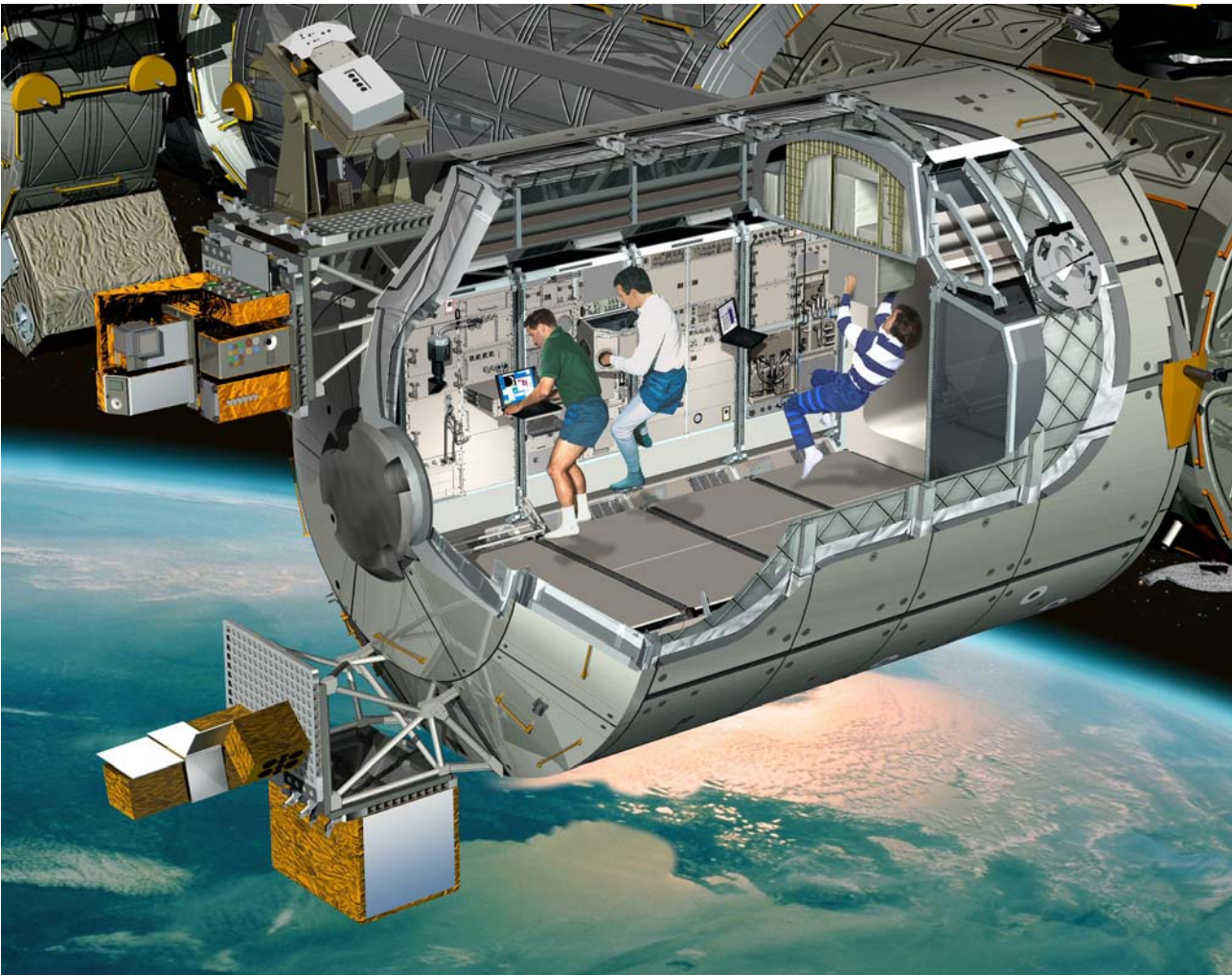


What is the Columbus Laboratory?

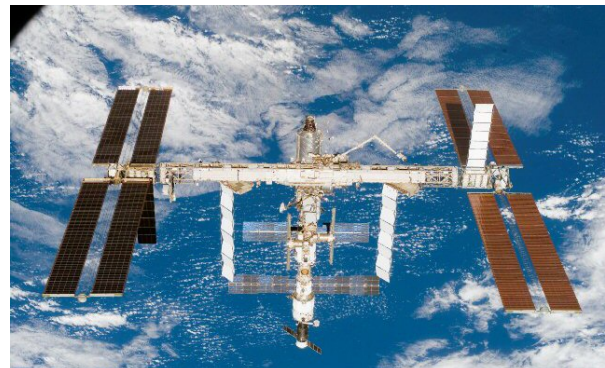


Artist's impression of the Columbus Laboratory, cutaway view. (Image: ESA/Ducros)

The Columbus laboratory is the cornerstone of ESA's contribution to the International Space Station (ISS) and is the first European laboratory dedicated to long-term research in space. Named after the famous explorer from Genoa, the Columbus laboratory will give an enormous boost to current European experiment facilities in weightlessness and to the research capabilities of the ISS once it becomes an integral part of the Space Station. This is currently scheduled in February 2008 following its launch on Space Shuttle Atlantis on ISS assembly flight 1E.

During its projected lifespan of 10 years, Columbus will support sophisticated research in weightlessness, having internal and external accommodation for numerous experiments in life sciences, fluid physics and a whole host of other disciplines. The laboratory marks a significant enhancement in European space experimentation and hardware development when compared to the

missions of the European-developed Spacelab in the 1980s and 1990s.



The International Space Station photographed from Space Shuttle Endeavour after undocking during the STS-118 mission on 19 August 2007. (Image: NASA)

The 7 m long Columbus laboratory consists of a pressurised cylindrical hull 4.5 m in diameter, closed with welded end cones. To reduce costs

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and maintain high reliability, the laboratory shares its basic structure and life-support systems with the European-built Multi-Purpose Logistics Modules (MPLMs): pressurised cargo containers, which travel in the Space Shuttle's cargo bay.



Multi-purpose Logistics Module 'Leonardo' in the Space Shuttle cargo bay on 10 March 2001 during STS-102 mission to the ISS. The Columbus Laboratory shares its basic structure with the Multi-Purpose Logistics Modules. (Image: NASA)

The primary and internal secondary structures of Columbus are constructed from aluminium alloys. These layers are covered with a multi-layer insulation blanket for thermal stability and a further two tonnes of panelling constructed of an aluminium alloy together with a layer of Kevlar and Nextel to act as protection against bombardment from space debris.

The Columbus laboratory has a mass of 10.3 tonnes and an internal volume of 75 m<sup>3</sup>, which can accommodate 16 racks arranged around the circumference of the cylindrical section in four sets of four racks. These racks have standard dimensions with standard interfaces, used in all non-Russian modules, and can hold for example experimental facilities or subsystems.



Columbus Laboratory at EADS Astrium in Bremen with debris protection panels. Insulation material exposed under one section of panelling. July 2004. (Image EADS Astrium)

Ten of the sixteen are International Standard Payload Racks fully outfitted with resources (such as power, cooling, video and data lines), to be able to accommodate an experiment facility with a mass of up to 700 kg. This extensive experiment capability of the Columbus laboratory has been achieved through a careful and strict optimisation



International Standard Payload Rack into which experiment facilities, subsystems or storage racks can be fitted. (Image: EADS Astrium)

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of the system configuration, making use of the end cones for housing subsystem equipment. The central area of the starboard cone carries system equipment such as video monitors and cameras, switching panels, audio terminals and fire extinguishers.



Columbus Laboratory in integration hall of EADS in Bremen. Primary structure exposed. June 2002. (Image: EADS Astrium)

Although it is the Station's smallest laboratory module, the Columbus Laboratory offers the same payload volume, power, and data retrieval, for example, as the Station's other laboratories, but on a smaller and cheaper scale. A significant benefit of this cost-saving design is that Columbus will be launched already outfitted with 2500 kg of experiment facilities and additional hardware. This includes the ESA-developed experiment facilities:



Biolab Experiment facility during payload integration. May 2004. (Image: ESA)

Biolab, which supports experiments on micro-organisms, cell and tissue culture, and even small plants and animals;

Fluid Science Laboratory, looking into the complex behaviour of fluids, which could lead to

improvements in energy production, propulsion efficiency and environmental issues;

European Physiology Modules facility, which supports human physiology experiments concerning body functions such as bone loss, circulation, respiration, organ and immune system behaviour in weightlessness;

and the European Drawer Rack, which provides a flexible experiment carrier for a large variety of scientific disciplines.

These multi-user facilities will have a high degree of autonomy in order to maximise the use of astronauts' time in orbit.



Columbus Laboratory with External Payload Facility attached. August 2004. (Image: EADS Astrium)

Outside its pressurised hull, Columbus has four mounting points for external payloads related to applications in the field of space science, Earth observation, technology and innovative sciences from space. Two external payloads will be installed after the Columbus Laboratory is attached to the ISS: the European Technology Exposure Facility (EuTEF) will carry a range of experiments, which need exposure to space, and the SOLAR observatory, which will carry out a spectral study of the Sun for at least 18 months.

These will be followed in the first instance by the Atomic Clock Ensemble in Space (ACES), which will test a new generation of microgravity cold-atom clock in space and the Atmosphere Space Interaction Monitor, which will study the coupling of thunderstorms processes to the upper atmosphere, ionosphere and radiation belts and energetic space particle precipitation effects in the mesosphere and thermosphere.

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In addition to the accommodation for experiment facilities, three rack positions contain Columbus laboratory subsystems such as water pumps, heat exchanger and avionics, and three racks are for general storage purposes. When fully outfitted the Columbus laboratory will provide a shirt sleeve environment of 25 m<sup>3</sup> in which up to three astronauts can work. The laboratory will receive a supply of up to 20 kW of electricity of which 13.5 kW can be used for experimental facilities.



Columbus subsystem racks during testing.

For the internal environment, Columbus is ventilated by a continuous airflow sucked in from Node 2, the European-built ISS module where the Columbus Laboratory will be permanently attached. The air returns to Node 2 for refreshing and carbon dioxide removal. This air content is monitored by Columbus subsystems for contamination.



The interior of the European-built Node 2, photographed on 27 October 2007 after it was attached to its temporary location on the International Space Station during STS-120 flight day five activities. (Image: NASA)

The crew can also control the temperature (16-27°C) and humidity in Columbus. A water loop system, connected to the ISS heat removal system, serves all experimental facility and

system locations for removal of heat and thus stopping equipment from overheating. In addition, there is an air/water heat exchanger to remove condensation from the cabin air. A system of electrical heaters also helps to combat the extreme cold possible at some Station attitudes.

Once it is attached to the ISS, ESA's Columbus Control Centre (Col-CC) in Oberpfaffenhofen in Germany on the premises of DLR's German Space Operations Centre will be responsible for the control and operation of the Columbus laboratory. All the European payloads on Columbus will transfer data, via the ISS data transfer system, directly to the Columbus Control Centre.



Control Room at the Columbus Control Centre in Oberpfaffenhofen in Germany. (Image: ESA)

Col-CC will coordinate European experiment (payload) operations. Relevant data will be distributed from Col-CC to the different User Support and Operations Centres across Europe, responsible for either complete facilities, subsystems of facilities or individual experiments.

Col-CC will also be in close contact with the Mission Control Centre in Houston, USA, which has overall responsibility for the ISS, together with the Mission Control Centre in Moscow. In addition, Col-CC coordinates operations with the ISS Payload Operations and Integration Center at the Marshall Space Flight Center in Huntsville, Alabama, USA, which has overall responsibility for ISS experiment payloads.