

Payloads and Cargo

Principal Payload: Multi-Purpose Logistics Module (MPLM)



The Leonardo Multi-Purpose Logistics Module in the cargo bay of Space Shuttle Discovery on 10 March 2001 (Image: NASA)

The MPLMs are pressurised cargo containers that travel in the Space Shuttle's cargo bay. Three of these modules were built for the Italian Space Agency (ASI) by Thales Alenia Space in Turin. These modules, named Leonardo, Raffaello and Donatello, are key elements in International Space Station resupply. Leonardo first visited the station on the STS-102 mission in March 2001 and has been used on four missions since then (STS-105, STS-111, STS-121 and STS-126). Raffaello docked to the ISS first in April 2001 on the STS-100 mission, which brought ESA astronaut Umberto Guidoni as the first ESA astronaut to visit the ISS, and has been used twice since (STS-108 and STS-114).

Essentially, each module is a cylinder 6.5 m long and 4.5 m in diameter, with conical endcaps that house docking mechanisms and hatches. There is room for up to 16 payload racks. The MPLM has its own life-support system, as well as a 3 kw internal power supply. Payload racks, along with other equipment and supplies, travel to and from the station in a pressurised environment. Once an MPLM is docked with the station, it provides additional shirt-sleeve workspace for the station crew for up to two weeks at a time.

In some ways, the MPLM is a descendant of Spacelab, which flew aboard the Shuttle between 1983 and 1996. However, the MPLM took full advantage of the improved technology that had been developed, particularly in welding. As a result, the MPLM is much lighter than its predecessor, which means that more than 9 tonnes of its 14-tonne launch weight can be given over to useful cargo. At the same time, the MPLM is robust enough for a service life of 25 return trips to space.

The MPLM also shares some basic systems with Europe's Columbus laboratory, which has been permanently attached to the ISS since February 2008. Their structures are similar, although Columbus has a "skin" twice as thick as the MPLM, and both Columbus and the MPLM make use of ESA's Environmental Control and Life Support Sub-system.

In the case of the MPLM, ESA was able to 'trade' with the Italian Space Agency, exchanging the ECLSS for Italian-developed structural elements that were used in Columbus. Without such cash-free transactions, international space programmes would be much more expensive.

Secondary Payload: Ammonia Tank Assembly



Ammonia Tank Assembly attached to the support structure that will be transported in Discovery's cargo bay for the STS-128 flight. Photo taken at the Kennedy Space Center on 9 July 2009 (Image: NASA)

The Ammonia Tank Assembly is principally a tank containing the liquid ammonia used for thermal regulation on the ISS. It will be transported to the ISS on a support structure placed in the Shuttle's cargo bay along with the MPLM.

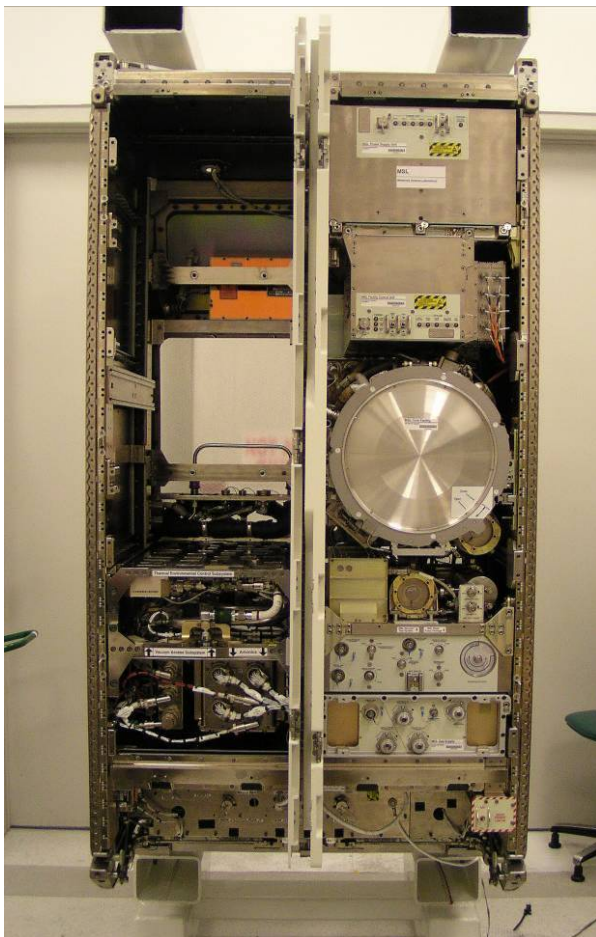
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MPLM Principal Cargo Items

The following is a list of the major facilities, equipment and cargo items being brought to the ISS in the MPLM by STS-128 Shuttle Discovery, and does not take account of any smaller items or supplies being transported.

Materials Science Laboratory (in the Materials Science Research Rack)

ESA's Materials Science Laboratory facility is the principal facility within NASA's first Materials Science Research Rack (MSRR-1) in which it will be transported to the ISS. This is the first materials research rack on the ISS and will be located in the US Laboratory. The Materials Science Laboratory will carry out a variety of materials research in weightlessness.



The Materials Science Research Rack (MSRR-1) Flight Unit in launch configuration. The right side of the rack contains the Materials Science Laboratory Flight Model. The left side contains the MSRR-1 Rack Support Subsystems (lower portion) and the stowage container (upper portion). The left side has the accommodations/interfaces to support an additional furnace module if required

The Materials Science Laboratory consists of a Core Facility, together with associated support sub-

systems. The Core Facility consists mainly of a vacuum-tight Processing Chamber capable of accommodating different individual Furnace Inserts, within which sample processing is carried out. The processing chamber provides a controlled environment and measurement of microgravity levels. Processing conditions are normally either a vacuum or an inert gas (e.g. Argon).

The Core Facility supports Furnace Inserts with up to eight heating elements, and provides the mechanical, thermal and electrical infrastructure necessary to handle the Furnace Inserts, the experiment cartridge, together with any associated experiment-dedicated electronics that may be required. Microgravity levels during an experimental run are measured by an integrated three-axis accelerometer package.

A Furnace Insert is an arrangement of heating elements contained in a thermal insulation assembly. On the outer envelope of this assembly is a water-cooled metal jacket.

The currently available Furnace Inserts are the Low Gradient Furnace designed mainly for Bridgman crystal growth of semiconductor materials and the Solidification and Quenching Furnace designed mainly for metallurgical research.

The samples to be processed are contained in experiment cartridges (Sample-Cartridge Assemblies) that consist of a leak-tight tube, crucible, sensors for process control, sample probe and cartridge head (i.e. the mechanical and electrical interface to the process chamber).

The Materials Science Laboratory safety concept requires that experiment samples containing toxic compounds are contained in Sample-Cartridge Assemblies that support the detection of potential leaks. The volume between the experiment sample and the cartridge tube is filled with an inert gas including a pre-defined quantity of krypton, allowing leak detection by mass spectrometry.

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MELFI (Minus Eighty - degrees - Laboratory Freezer for the ISS)

The second flight unit of the Minus Eighty (Degrees) Laboratory Freezer for the ISS (MELFI) will be flying to the ISS on the STS-128 flight. It is a rack-size facility which provides the Space Station with refrigerated volume for storage and fast freezing of life science and biological samples. It will fly in passive mode in the Multi-Purpose Logistic Module (MPLM) installed in the Shuttle's cargo bay. MELFI was designed for an operational lifetime of 10 years, but thanks to additional spares and sophisticated maintenance operations defined by European Industry will remain permanently on orbit during the life of the ISS.



ESA astronaut Frank De Winne preparing to put samples in MELFI in the Japanese Kibo Laboratory on the ISS on 6 June 2009. (Image: NASA)

MELFI samples can be stowed in four compartments (dewars), whose temperature can be independently controlled at different levels (-80, -26, +4 °C). Each dewar is a cylindrical

vacuum insulated container, having an internal volume of about 75 litres, divided internally in four sectors. Each sector hosts one tray, which can be extracted without disturbing the samples in the other three. MELFI provides standard accommodation hardware for the insertion of samples of different shapes and sizes.

MELFI has a sophisticated cooling machine, which is able to provide the required temperatures while using very limited power (less than 1 kW in the worst case). It is mounted within a complex enclosure, called the Cold Box, in order to minimize any thermal loss and contamination of the cooling fluid. The Cold box contains in addition two heat exchangers, consisting of a total of 10 km of piping.

The cooling machine is designed to be an Orbital Replacement Unit. It can be dismantled from the Cold Box with the help of dedicated tools, in less than eight hours, allowing the preservation of specimen even in case of machine failures. In order to improve the reliability and availability of the freezer also this second flight unit configuration includes a spare electronic unit and a spare cooling machine. The cooling fluid is high purity nitrogen. All the lines and components through which the nitrogen flows are double walled, with high vacuum and multi-layer insulation in between the two walls. This allows maintaining the selected temperature for up to eight hours even without power.

Upon arrival at the ISS, MELFI will be transferred to its location in the Japanese Kibo Laboratory and will be ready to start its service life.

MELFI was developed by the European Space Agency (ESA) in the frame of international barter agreements with NASA and the Japan Aerospace Exploration Agency (JAXA). In addition, ESA delivered ground units for training and experiments preparation and will provide the necessary spares and sustaining engineering to maintain MELFI for the ISS lifetime.

EADS- ASTRIUM (France) led the Industrial Team including L'Air Liquide (France), LINDE (Germany), Kayser-Threde (Germany) and ETEL (Switzerland).

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Additional Facilities/Equipment

Atmospheric Revitalization System



A crane lifts the European-built Node 3 from its shipping container on 26 May 2009 (Image NASA)

The Atmospheric Revitalization System is one of the Environmental control and Life Support Systems that will be located in the European-built Node 3 when it arrives at the ISS in February 2010. It provides carbon dioxide removal, trace contaminant control, and gas constituent analysis. Crew-generated carbon dioxide is removed from the cabin atmosphere by sorbent beds that are designed to absorb carbon dioxide. The beds are regenerated upon exposure to heat and space vacuum. A Trace Contaminant Control System ensures that over 200 various trace chemical contaminants generated from material off-gassing and crew metabolic functions in the habitable volume remain within allowable and safe concentration limits. Gas is analysed by a mass spectrometer, measuring oxygen, nitrogen, hydrogen, carbon dioxide, methane and water vapour present in the cabin.

Fluids Integrated Rack

This facility will carry out experiments with fluids, in the US Destiny laboratory. It makes up half of the Fluids and Combustion Facility, which deals with the challenges of working with fluids and combustion processes in weightlessness. The Fluids Integrated Rack provides data acquisition and control, sensor interfaces, laser and white light sources, advanced imaging capabilities, power, cooling, and other resources. It can accommodate a wide range of experiments. The focus of the fluid physics research is on complex fluids, interfacial phenomena, dynamics and instabilities, multiphase flows, and phase changes. Investigations range from fundamental research to technology development in support of the NASA Exploration missions. These include areas of life support, power, propulsion, and thermal control systems.



The Fluids Integrated Rack shown with the door open with the first experiment inside (Image: NASA)

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COLBERT Treadmill

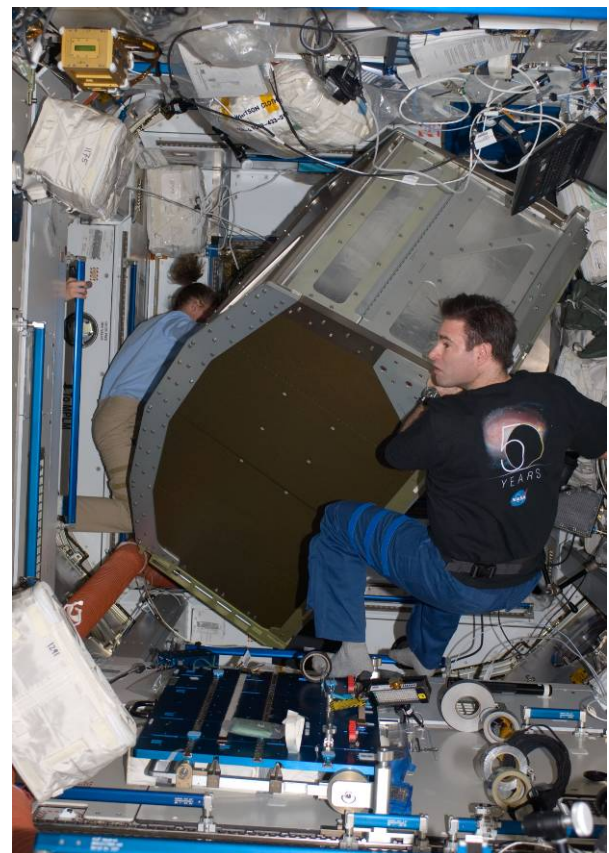
COLBERT is a new treadmill, which will go into the European-built Node 2 (and later Node 3) to act as an important exercise device for the ISS Crew. It is adapted from a regular treadmill but designed so as not to shake the rest of the Station. This vibration damping system does not use power and hence makes it more reliable. The astronauts use elastic straps over the shoulders and round the waist to keep them in contact with the running belt. The treadmill is also wider than the one currently on the Station. Although it is built to handle 240,000 km of running, it will likely see about 60,000 km during its time in orbit.



COLBERT treadmill being prepared prior to installation in a Multi-Purpose Logistics Module. (Image: NASA)

New Crew Quarters

The crew quarters provide each of the station's occupants with their own compartment where they can keep their personal belongings, sleep and spend their recreational time. Each unit provides the crew member with visual, light and acoustic isolation, as well as laptop connectivity. The new crew quarters will be installed in the Japanese Kibo laboratory. The delivery of new crew quarters was necessary in light of the increase to a permanent six-person ISS Expedition crew.



NASA astronauts Greg Chamitoff and Sandra Magnus move a crew quarters rack during the STS-126 mission on 19 November 2008. (Image: NASA)