Ready for Orbit

Microgravity Facilities for Columbus (MFC)

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Introduction

The Microgravity Facilities for Columbus (MFC) Programme was approved in 1995 at the Ministerial Council in Toulouse, together with other elements of ESA's participation in the International Space Station (ISS). MFC includes the development of several complex multi-user facilities: Biolab; the Fluid Science Laboratory (FSL) and the European Physiology Modules (EPM) for Columbus, and the Materials Science Laboratory (MSL) and the Pulmonary Function System (PFS) for the US Destiny module. Developing the experiment hardware and preparing to improve the facilities' subsystems are also part of MFC.

The most productive research facilities yet built for the ISS are almost ready to fly ...

Status

The Phase-C/Ds of the facilities began in 1997-1999 in a staggered way, depending on the level of maturity reached during the definition phases. The industrial contracts were awarded to all the major European prime contractors, such as EADS-ST (D) for MSL, EADS-Astrium (F) for Biolab, Alenia (I) for FSL, OHB (D) for EPM and Damec (formerly Innovison; DK) for PFS.

PFS (circled) integrated in HRF-2 inside MPLM.

EPM (left) and Biolab installed in Columbus ready for IST.

Biolab, FSL and EPM
The Flight Models (FMs) completed verification of their Columbus interfaces using the Rack Level Test Facility (RLTF) at EADS-ST in Bremen (D) in 2003. They ended their qualification in April with their delivery for the Integrated System Test (IST) and the end-to-end System Verification Test (SVT) inside the Columbus FM module at Bremen.

The Training Models have been delivered to the European Astronaut Centre in Cologne (D), while the Engineering Models (EMs) will not be delivered until early 2005, in order to retrofit the late changes introduced in the FM models as a result of the scientifically required upgrades.

Materials Science Laboratory (MSL)
MSL, a cooperation with NASA, will be integrated in the US Materials Science Research Rack (MSRR-1) for launch in mid-2006. The EM has been delivered to NASA Marshall Space Flight Center, while the FM and Training Model will be delivered in the second half of 2004.

Pulmonary Function System (PFS)
PFS is a cooperative project with NASA that

allows ESA to have a flight opportunity before the Columbus launch. All models have been delivered to NASA and the FM is integrated in the US Human Research Facility-2 (HRF-2) for launch aboard the next Shuttle mission, LF-1, in 2005.

User support activities

The hardware for the first year of experiments in orbit is being built: Experiment Containers for FSL and Biolab, and cartridges for MSL. No new major development is required yet for EPM and PFS.

Challenges

Developing these facilities met several major challenges. They had to comply with very challenging scientific requirements established by the science teams. Each facility has about 1000 requirements – similar in quantity for the whole of Columbus. They include the highest degree of automation possible (Biolab's 7-degree-of-freedom robotic arm) in order to minimise crew involvement. Telescience operation from the ground allows scientists to interact with their experiments in space. The high level of modularity means that the facilities can be refurbished in orbit.

The facilities exploit developments funded by the Agency's technology programmes, and close cooperation with the Technical Directorate has been set up to define the required upgrades and the potential for evolution.

Satisfying the scientific requirements was constrained by the mass limit for each facility launched in Columbus: 500 kg. Similar and less complex NASA facilities are allowed up to 800 kg when carried by the Multi-Purpose Logistics Module (MPLM).

The MSL Engineering Model. MSL will be installed in NASA's Destiny module.

The overall engineering approach to the facilities' development was centralised within the HME-GF Division, allowing technical standards to be created that ensured a continuous learning process with limited staff. This approach was extended to the external payloads, with similar successful results.

Cooperative agreements have added to the programme the Microgravity Vibration Isolation System (MVIS), developed by the Canadian Space Agency for FSL, and Cardiolab, developed by CNES and DLR, for EPM. MVIS will greatly enhance FSL, providing good isolation for experiments from the Station's microgravity disturbances. Cardiolab offers a wide set of physiology instruments for cardiovascular studies in space.

The MFC facilities were developed within very tight financial budgets set by ESA. This forced a rigid financial discipline upon the prime contractors, which has allowed MFC to continue within those fixed resources longer than planned and with greater scope. The programme has awarded contracts totalling more than 50% of its budget to several small- & medium-sized enterprises (SMEs), developing skills in these companies that will be exploited in future programmes.

MFC is also working on behalf of ESA's ISS Exploitation Programme to procure spares and prepare procedures for a smooth transition to the operational phase in orbit.

The FSL FM ready for IST.

Outlook

At the end of the Columbus IST and SVT in August 2004, the EPM, Biolab and FSL FMs will be returned to their prime contractors for upgrading and robustness testing aimed at improving their performance and reducing the risk of on-orbit failures. This work will be completed 13 months before the launch date of Columbus, now planned for late 2006.

Conclusion

The MFC Programme is nearing conclusion; it has delivered the planned facilities, meeting or exceeding challenging technical requirements and the very tight financial constraints. These ESA facilities incorporate state-of-the-art technology with an optimum blend of automation and human intervention. They are the most complex and productive facilities yet built for the ISS, giving Europe the lead in exploiting the Station. This was achieved through the expertise and close cooperation of the ESA and Industry teams. ■