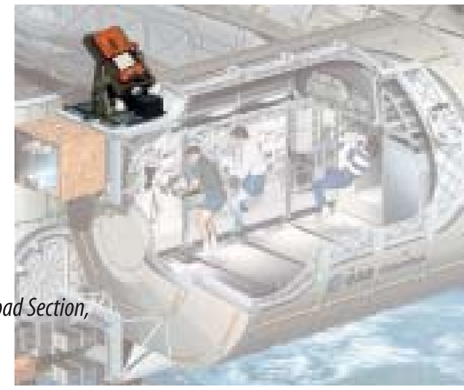
Watching the Sun



The SOLAR Payload for the ISS

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Columbus will host an important solar observatory ...

Introduction

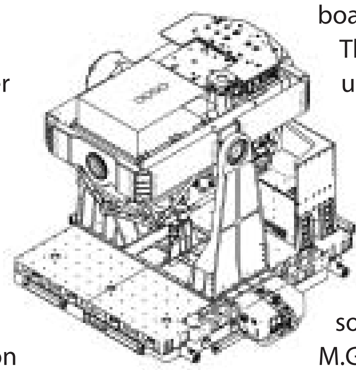
Europe's Columbus laboratory offers the opportunity to mount payloads outside the International Space Station on its External Payload Facility (EPF). One of these external payloads, SOLAR, will study the Sun across most of its spectral range for 18 months, extendible to 3 years, from the EPF zenith position. Its three complementary solar science instruments – SOVIM, SOLSPEC and SolACES – were selected in 1997 via an Announcement of Opportunity issued by the Directorate of Human Spaceflight (MSM), ESA's Directorate of Scientific Programmes (SCI) supported instrument selection.

The instruments are carried on a Coarse Pointing Device (CPD) that points at the Sun by compensating for the Station's orbital movement. The overall payload is integrated on a NASA-provided Columbus External Payload Adapter (CEPA), developed by Boeing (USA) in tight coordination with MSM's External Payloads Section. SOLAR development and integration with the science instruments and CEPA are the responsibility of Alenia Spazio (Turin, I). Carlo Gavazzi Space (Milan, I) and Oerlikon Contraves Italiana (Rome, I) are subcontractors respectively for the CPD control unit and the CPD pointing mechanism. SOLAR is planned to be launched on an Integrated Cargo Carrier-Lite in the Space Shuttle cargo bay in 2006 (see the other Columbus articles in this issue).

The SOLAR Science Instruments

SOVIM (Solar Variability and Irradiance Monitor) will measure the solar spectral irradiance via filter-radiometers in the near-UV (402 nm), visible (500 nm) and near-IR (862 nm) regions, together with the total solar irradiance using two types of radiometers covering the range from 200 nm to 100 µm. The Principal Investigator (PI) is C. Fröhlich at the Physikalisch-Meteorologisches Observatorium Davos / World Radiation Center (PMOD/WRC, Davos, CH), under Swiss national funding. Most of the industrial effort is subcontracted to Oerlikon Contraves (Zurich, CH). SOVIM relies on a contribution from the Institut Royal Météorologique de Belgique (IRMB, Bruxelles, B), responsible for the development of the DIARAD radiometer, and on support from ESA's SCI, via the PRODEX programme.

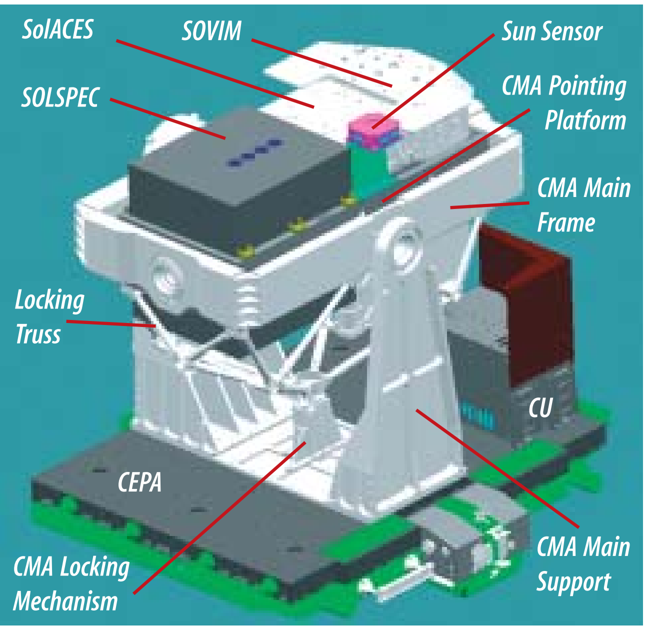
The instrument concept is based on upgrading the SOVA instrument that flew on Eureca; indeed, it is reusing electronics boards retrieved from that mission. The Flight Model is currently undergoing verification testing.



SOLSPEC (SOLar SPECtral irradiance measurements) will operate in the range 180-3000 nm, with an accuracy of 2% in UV and 1% in visible and IR, and will study solar variability. The PI is M.G. Thuillier at the Centre National de la Recherche Scientifique (CNRS), Service d'Aeronomie (Verrières le Buisson, F), with French national funding from CNES. SOLSPEC relies on partnership contributions from the Belgian Institute for Space Aeronomy (IASB/BIRA, B) and Landessternwarte (LSW, Heidelberg, D). Through the Belgian partnership, SOLSPEC can access expertise from ESA's SCI via PRODEX. The instrument concept upgrades the Eureca SOSP instrument.

The FM is completing integration and testing.

SolACES (Solar Auto-Calibrating EUV/UV Spectrophotometers) will measure the spectral irradiance in the UV and Extreme-UV regions (16-220 nm). The PI is G. Schmidtke at the Fraunhofer-Institut für Physikalische Messtechnik (IPM, Freiburg, D), with German national funding from DLR. MSM supports them with a contract to provide industrial human spaceflight expertise from EADS-ST (Friedrichshafen, D). In addition, they can also rely on support from SCI, for contamination expertise. The FM is planned to be ready by end-September 2004.



The Coarse Pointing Device (CPD)

CPD consists of a Control Unit (CU), CPD Mechanical Assembly (CMA) and Sun Sensor. It tracks the Sun in two axes with an accuracy of 1° and a stability of 0.3° (over 10 s). It provides pointing ranges of ±40° along the primary rotational axis, and ±25° along the secondary axis. The CU integrates the data handling, control and communication functions into a single box. It uses ESA's Standard Payload Computer board, and its design is partly based on the Remote Power Distribution Assembly.

The major constituents of the CMA are:

- two main lateral supports hosting the two bearings, brushless DC motor and optical encoder, to drive and control rotation around the main axis;
- the rectangular main frame, suspended between the main lateral supports along the main rotation axis; it hosts the two bearings, brushless DC motor and optical encoder, to drive and control rotation around the secondary axis at 90° to the main axis;
- the smaller rectangular frame (CMA pointing platform) hosting the science instruments and the Sun Sensor, and suspended from the main frame along the secondary axis;
- the locking mechanism, to hold the CMA pointing platform during launch, on-orbit installation and return to Earth;
- a bottom baseplate, hosting the whole CMA, and interfacing with the CEPA.

The CPD locking truss.

The digital Smart Sun Sensor from Galileo Avionica provides 2-axis fine detection of the Sun with an accuracy of 0.02°.

SOLAR Payload Challenges and Status

The development of SOLAR called for innovative design solutions for the CPD and the science instruments. CPD's structural design was particularly challenging because of the combination of mechanical and structural requirements (loads, mass, pointing requirements, return to Earth after a 3-year mission). The design involves use of composite materials, supported by campaigns to characterise the materials and processes (including the molybdenum-coating hardening process for the bearing bushes, used for the first time on a space mission). When recovered after its 18-36 month mission, SOLAR is expected to be Europe's record-holder for the longest exposure to space before return to Earth; Eureca was in orbit for about 9 months before recovery.

A campaign of integrated software tests using the software simulators of the three science instruments with the CPD CU Engineering Model was completed in February 2004. The SOLAR Engineering/Structural Thermal Model, used for CMA environmental qualification and CU functional verification, without instruments, will be completed in July. A fit-check of the CEPA FM with its Flight Releasable Attachment Mechanism counterpart on the Columbus EPF has been completed. Integration of the SOLAR Proto-Flight Model will be completed by the end of the year. Integration with the ICC-L launch carrier will begin at Cape Canaveral about 5-6 months before launch. ■