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Experience of an External Payload on the ISS : the SOLAR Payload, Implication for Earth Observations from the ISS.

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Introduction Since 2008, the SOLAR package on the ISS has been active in collecting the solar output in earth orbit combining three instruments ranging from the far UV to the infrared. The solar output is an essential parameter for earth atmospheric photochemistry and earth climate. The scientific objectives and results are described by the Principal Investigators in various publications (for example: G. Schmidtke, C. Froehlich and G. Thuillier , Advances in Space Research, 37, 2006, Pages 255-264). While a short summary of the already achieved science in 2008, 2009 and the first part of 2010 will be given, this presentation will insist on the possibilities given by the ISS and especially COLUMBUS to exterior payloads devoted to the observation of the earth.
Real operations will help understand the actual advantages and disadvantages of the ISS in terms of target pointing, telescience operations and possible use of crew resources.

SOLAR description.

The SOLAR payload consists of 3 instruments complementing each other to allow measure the solar flux throughout virtually the whole electromagnetic spectrum - from 17 nm to 3000 nm - in which 99% of the solar energy is emitted. The instruments are mounted on a Coarse Pointing Device for accurate Sun pointing and are controlled by a Control Unit. The scientific instruments are:

SOVIM (SOlar Variable & Irradiance Monitor) covers near UV, visible and thermal regimes (200 nm - 100 µm)
SOLSPEC (SOLar SPECctral Irradiance measurements) covers the 180 nm - 3000 nm range with high spectral resolution
SOL-ACES (SOLar Auto-Calibrating EUV/UV Spectrophotometers) measures the EUV/UV spectral regime (17 nm -220 nm) with moderate spectral resolution.

The Coarse Pointing Device is developed in two versions, one for the SOLAR payload and one for the EXPORT payload. Each version has different instruments accommodation and mess carrying capabilities. For SOLAR the maximum mass carrying capability is 75 kg.

The second version was also designed for the astronomical payload SPOrt (Sky Polarisation Observatory) which was abandoned in 2005 in favour of studies of the cosmic background using free-flyers, this CPD could be used for earth observations.

The performed operations satisfied the requirement as the sun source was observed at each observation opportunity, the source non-availabilities were more important than was expected before launch. These resulted from the sun astronomical ephemeris but also from non nominal attitudes before the solar panels became fully optional. They resulted also from the securing of external payloads during dockings, EVA's and manoeuvres. After commissioning, the operations of the CPD and payload were mainly nominal for two of the instruments: SOLSPEC and SOLACES, unfortunately, the SOVIM instrument lhad to be switched off after about one year of operation due to a power conditioning problem internal to the instrument. Crew intervention was limited to SOLAR installation and a very few troubleshooting actions in the commissioning phase.

Conclusions.

A balance of operations will be given until mid-2010 and compared to what a fully nominal mission would have given. However, the mission performed an important scientific objective in characterizing the sun during the anomalous minimum between cycles 23 and 24. Orbital parameters and station constraints did not affect the scientific objectives of SOLAR in a catastrophic way. This would not have been the case if a continuous operation had been requested as for space weather studies or if precise targets in time and geolocation had been requested. In particular, the orbit inclined at 51.6419° excludes the study of the polar regions. However, its extensive coverage of the equatorial and tropical zones makes it a quite interesting platform for earth observations as long as a specific time or sun angle is not required. Crew intervention for target selection for surface images was already tested with success. Atmospheric observations are also possible as long as both nadir and limb are accessible from the station. This possibility will be even possible from the inside when the final addition to the station, the cupola will extend the ISS optical capabilities, it should be reminded that a Russian methane monitoring instrument operating in the 1666 nm methane feature is now operated experimentally by the crew in the Russian module. The analysis of these activities will lead to a better use of the ISS in terms of earth observations.