

MEMOS - Mars Environment Monitoring Satellite

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The Swedish Institute of Space Physics (IRF) in cooperation with the Swedish Space Corporation (SSC) has conducted first studies on a Mars Environment Monitoring Satellite (MEMOS). The MEMOS microsatellite (mass < 20 kg) will accommodate four scientific instruments: solar EUV/UV monitor (SEM), solar wind monitor (SWIM), magnetometer (MAG) and radiation environment monitor (REM). The payload monitors the solar conditions at Mars and characterizes the Mars environment to support other missions and science investigations. Monitoring of the solar wind parameters (velocity, density, and field) is the key for any aeronomy and solar wind interaction mission at Mars. The solar EUV / UV (HeII 30.4 nm and HII 121.6 nm) flux monitoring is required for upper atmosphere / ionosphere studies. The radiation environment monitoring is needed to study space weather effects on the near-Mars environment as well as for the preparations for man-flights.

MEMOS follows the design philosophy of a detached and autonomously flying instrument for achieving the mentioned objectives. It is intended to be carried “piggy-back” to Mars on a suitable mission. Potential missions are: ESA Mars orbiters within the NEXT or Cosmic Vision programs, NASA Mars orbiters, national / bilateral Mars missions. At Mars MEMOS is separated from its carrier (parent satellite) via the release mechanism implemented in the dual formation flight mission PRISMA. The separation will take place during the orbit insertion scenario of the parent satellite at Mars thus placing MEMOS in a highly elliptical orbit guarantying sufficient observation time in the solar wind.

In orbit MEMOS will autonomously detumble and spin-up to ~ 1 rpm for reasons of stabilization and to fulfill instrument requirements. Such a low spin-rate is suffi-

cient for a required inertial pointing accuracy of 2.5° because of the small external disturbance torques ($< 10^{-7}$ Nm) predominant at Mars responsible for nutation and precession of the spin-axis. The advances in micropropulsion systems providing μN -mN adjustable thrust levels and reducing the dry mass to ~ 2 kg respectively are key factors in keeping the microsatellite stabilized and sun-pointed without stressing the mass budget. The low thrust level enables precise and active nutation damping. Moreover the system offers the possibility of implementing active orbit control or formation flight demonstrations at Mars. Attitude will be determined on-board with an accuracy $< 1.0^\circ$ using miniaturized Horizon Crossing Indicators, a two-axis sun sensor and in support accelerometers and gyroscopes based on MEMS-technology.

TM/TC will be relayed via the parent satellite in the UHF frequency range. Therefore the Electra Lite (ELT) Proximity-1 transceiver will autonomously communicate with the parent satellite at inter-satellite ranges $< 10\,000$ km featuring adaptive bit rates > 2 kbit/s. The transceiver also implements a coherent transponding mode for orbit determination through two-way Doppler ranging between the parent satellite and MEMOS. In addition ELT is compatible with a future Martian communication and navigation network pursued by NASA, which could be taken advantage of in the future for relaying data or performing ranging via other satellites part of the network.

A system design driver for inter-satellite communication at Mars is the high demand of power. This leads to a disk-shape and thus easy to accommodate spacecraft configuration of MEMOS comprising a single sun-pointing solar array favourable in terms of power and spin stability. Multi-junction solar cells, which currently have an efficiency of $\sim 29\%$ under laboratory conditions are a key factor to keep MEMOS solar array area of ~ 1.15 m² small compared to the worst case system power requirements of ~ 105 W. During eclipse periods high-efficient Li-ion batteries (6 x 20 Wh) will ensure power supply.

The spacecraft and payload design will incorporate new technology developments such as autonomous navigation, MicroElectroMechanical Systems MEMS, Micro-Opto-ElectroMechanical Systems MOEMS and new materials to achieve low mass at high performance. Thereby it will profit from Swedish developments and heritage in small- / microsatellites like Astrid-2, SMART-1 or the upcoming rendezvous and formation flying demonstration mission PRISMA.