The BepiColombo Spacecraft, its Mission to Mercury and its Thermal Verification. Roger J. Wilson[1] and Markus Schelkle[1], [1] Airbus Defence and Space, Friedrichshafen, Germany (roger.wilson@astrium.eads.net)

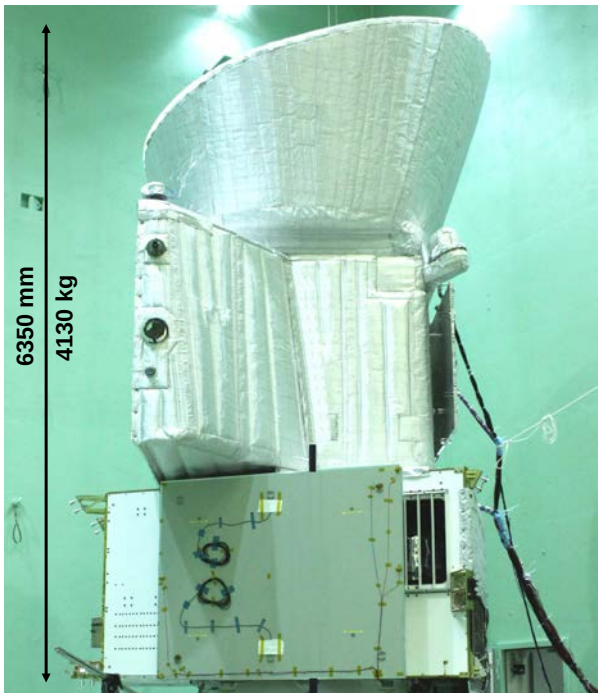
BepiColombo is an interdisciplinary mission performed in a partnership between ESA (European Space Agency) and JAXA (Japan Aerospace Exploration Agency). JAXA provides the MMO (Mercury Magnetospheric Orbiter), whilst Airbus Defence and Space is prime contractor for ESA, providing the MPO (Mercury Planetary Orbiter) and all other spacecraft hardware. The scientific payload is provided by national agencies.

This paper provides an overview of the mission (including its trajectory to Mercury) and spacecraft design (in particular its staging characteristics). It further addresses the thermal testing performed to demonstrate the ability of the spacecraft and its equipments to survive the harsh thermal environments experienced during cruise and in Mercury orbit.

The BepiColombo mission involves the delivery of the MPO and the MMO to different operational orbits around the planet Mercury. Two further modules MTM (Mercury Transfer Module) and MOSIF (MMO Sunshield and Interface Structure) complete the 4-module stack to be launched by an Ariane 5-ECA in July 2016. After a cruise phase of 7.4 years (including 17 orbits around the sun and 8 planetary swing-bys) the modules will be progressively separated. The MTM will be separated in November 2023. A free gravity capture will pull the composite of MPO/MOSIF/MMO into Mercury orbit in January 2024. Thereafter the MPO will perform descent manoeuvres until the MMO and MPO reach their respective low polar orbits. The MPO will nominally operate for 1 year, with a 1 year extension capability.

Since Mercury is the closest planet to the sun (0.31 AU to 0.47 AU distant) a peak solar intensity of 11 solar constants (14,500 W/m2) is experienced which imposes enormous thermal challenges on the spacecraft modules and their external equipment.

The European hardware and the stack configuration centre around the MPO. Once in polar orbit around Mercury (with periherm 480 km and apoherm 1500 km) the MPO is a free-flying spacecraft optimised for its operational mission. From launch until the separation of the MOSIF, the MPO performs command and control for the 4-module stack – using mainly capabilities anyway needed during its scientific mission. The (lower) MTM provides power and deceleration thrust by electric propulsion (using 2 x 145 mN ion engines) during the cruise whilst the (upper) MOSIF shades the normally spinning MMO.



The BepiColombo Spacecraft

Building and launching a stack to be separated after 7 years poses challenges, which are enhanced in BepiColombo by the severe thermal environments encountered both in-orbit (when the MPO is constantly nadir pointing) and during cruise. Combatting the thermal environment has necessitated the development and implementation of high-temperature solutions for all external items, the avoidance of unprotected separation interfaces on the MPO and the enhancement of the avionics not only to control the stack attitude but also to ensure safe pointing of the solar arrays (both of these capabilities also being necessary in failure situations) – thereby avoiding excessive temperatures.

The thermal verification programme contained classical, module-level tests with system operation in vacuum as well as with solar simulation phases. Specific tests for MLI performance and antenna verification were also performed. In total, 8 module sized tests will be performed (starting in autumn 2010 with the MMO under JAXA responsibility) at up to 8 solar constants in the LSS (Large Space Simulator) at ESTEC.