Paper ID: 77656
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IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IPB)

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IMPLEMENTATION OF A PSEUDO-DRAG FREE SYSTEM FOR THE BEPICOLOMBO ORBIT DETERMINATION AT MERCURY

Abstract

BepiColombo is a joint ESA-JAXA mission to Mercury with the aim to study the planet's internal structure, surface composition and magnetosphere formation. The Mercury Orbiter Radioscience Experiment (MORE) scientific objectives pertain to the determination of the static and dynamic Hermean gravity field, at least up to degree 35, and to infer on the rotational state of Mercury, measuring right ascension and declination of the pole and physical librations in longitude. This information will help modelist to constraint the internal structure of the innermost planet of the Solar System. MORE will provide such information by means of its extremely advanced on-board instrumentation suite. The Mercury Planetary Orbiter (MPO) is equipped with an on-board Transponder (KaT) that enables accurate Doppler and ranging measurements in Ka-band. A multi-frequency radio-link is enabled by the TTC Deep Space Transponder (DST) supporting X- and Ka-band. In cruise measurements show that MORE has been able to achieve range rate and range coherent two-way measurements accurate to 0.0042 mm/s (at 1000 s integration time) and 5 cm every 2 s, respectively. The vicinity of Mercury with respect to the Sun makes difficult to model non gravitational perturbation (NGP) acting on the spacecraft. The main disturbances are due to the direct solar radiation pressure, visible and infrared emission of Mercury, pointing out the necessity of hosting a high accuracy accelerometer on-board. The Italian Spring Accelerometer (ISA) measures the non-gravitational perturbation with an accuracy of $10^{-8} m/s^2$ in the frequency band of $[3 * 10^-5, 10^-1] Hz$, supporting the precise orbit determination (POD). This allows MORE to realize a pseudo-drag-free system in which MORE does not need to model non-gravitational perturbation in the accelerometer measurement bandwidth. On the other hand, in the POD we need to estimate ISA calibration parameters and provide a model for NGP outside the ISA measurement bandwidth. This work shows the results of a perturbative analysis for the full mission scenario. The aim is to assess the effect of a realistic ISA data processing on the expected results of the MORE experiment.