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Magnetic field experiment at Jupiter icy moons (JUICE J-MAG) and in-flight sensor alignment calibration

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The magnetometer (J-MAG) is one of the core instruments on the JUICE spacecraft and is critical for examining prime scientific objectives of the mission. Firstly, we are expecting to gain an understanding of the interior structure of the icy moons of Jupiter, specifically those of Ganymede, Callisto and Europa. We will be able to obtain the knowledge of the depth at which the liquid oceans reside beneath their icy surfaces. We are also interested in the configuration of internal magnetic fields and the induced magnetic fields arising within these oceans. Secondary, the magnetic field drives the plasma processes within the Jupiter system. Magnetic field observations allow for a better interpretation of dynamical plasma processes, auroral phenomena and various current systems within the Jovian magnetosphere.

Defined J-MAG science targets result in a requirement to determine accurate knowledge of the sensing orientation by two fluxgate sensors, MAGIBS and MAGOB, on the spacecraft. Due to the long MAG boom it is not possible to meet J-MAG's alignment requirement by mechanical stability alone. To evaluate the alignment error of the sensing direction, the spacecraft includes two orthogonal coils mounted around its body. The coils can be driven with a current which produces a measurable magnetic field vector at the fluxgate sensors. This signal can then be used by the fluxgates to track the variation in the sensor alignment. In the presentation we show the results of an analysis using an alignment recovery technique that was developed for the Kaguya mission, applied to the specific case of JUICE, considering the relative positions of the fluxgate sensors with respect to JACS.

We derived equations to calculate the directions of the measurement axes in the frame fixed to the spacecraft, namely alignment angles, from the measurement results of reference magnetic fields generated by JACS. The errors of the alignment angle estimation and their dependence on measurement noise as well as inaccuracy of the coil current intensity are examined. Based on the quantitative results, the requirements to the JACS design and operation to satisfy the requests to the alignment accuracy are determined.