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BEOCUBE: A CUBESAT FOR A LASER RANGING EXPERIMENT

Abstract

Recent development of optical communication technology for small spacecraft has seen the integration of Laser Retro-Reflectors (LRR) into Cubesat standards as external calibration to the on-board satellite-based positioning system. Managed by the Institute of Space Systems (IRAS) at TU-Braunschweig, the BEOCUBE is a 1U-Cubesat proposed to flight in 2019 with a passive LRR based on the successful design of CHAMP and GRACE satellites. As the mission is expected to provide a technological demonstration of a highly integrated architecture for precise orbit determination (POD), a payload inclusion of a GNSS (Global Navigation Satellite System) software is considered, including a front-end module and hardware architecture. This paper introduces the current status of the BEOCUBE after the first test campaign of the retroreflector, and includes the system details along the technical aspects of the mission design. In particular, the concept of operations is presented with focus on the space-ground communication problem. The mission requires a sun-synchronous orbit with perigee below 600 km, to fulfill with both space debris mitigation guidelines and laser tracking campaigns at constant daytime. At such orbits, typical Cubesat velocity aberration angles are in the range of 25 to 50 μrad, and the far field diffraction (FFD) signals of the LRR array will be captured by the optical ground stations during operation. Therefore, FFD patterns were reproduced in laboratory at different array orientations for better estimation of the reflected signal energy. The data shows the possibility to scale the LRR model to deliver a return signal strength that can allow the optical ranging from stations of the ILRS (International Laser Ranging Services). With limited visibility time of a polar spacecraft, the radio-communication with ground segment at a single station in Braunschweig would not be sufficient for efficient operations. The support of HETE-2 primary network is examined. In order to meet the geo-pointing and stabilization requirements, we introduce the high-fidelity attitude control subsystem, which together with the power strategy and communication subsystem will form the core of the mission.