Paper ID: 53669
student

17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Space Debris Detection, Tracking and Characterization (1)

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SUB-MILLIMETER SPACE DEBRIS MEASUREMENT IN LOW EARTH ORBIT: THE DEBRIS DENSITY RETRIEVAL AND ANALYSIS (DEDRA) MISSION

Abstract

Space debris is one of the many threats that must be considered when designing a satellite mission. In recent years it has been gaining importance as the space industry develops and the number of satellites increases, causing the risk for severe debris-generating collisions to rise. The orbiting debris population comprises potentially lethal cm-sized objects, but is foremost formed by smaller particles that are responsible for long-term damage to exposed structures, such as solar panels. A better knowledge of the debris population and its dynamics is therefore of stringent need, especially for objects that are too small to be detected with ground-based systems. The Debris Density Retrieval and Analysis (DEDRA) mission is designed to acquire in-situ measurements of the sub-millimeter debris environment in Low Earth Orbit, delivering valuable data to validate and improve existing space debris and dust models.

The mission comprises a 6U Cubesat bus containing three debris sensing units. The instruments are a development of the Munich Dust Counter (MDC), a sensor architecture designed for the outer space environment that has been successfully flown on three different space probes. It consists of an aluminum and Nomex lightweight honeycomb, which in DEDRA's case is miniaturized to fit into a 10x10x10 cm frame of a 1U. The measurement principle relies on a plasma charge separation following a particle impact on the target surfaces. For each impact, the mass, velocity and flight direction of the incident particle can be determined. Extensive space debris environment simulations using ESA's model MASTER have been performed to determine an optimal sensor configuration in terms of particle velocity and mass measurement range. ESA's model DRAMA has been utilized to assess larger particle impact probabilities and verify the mission's compliance with the current mitigation guidelines.

The project was founded by a student's initiative in the frame of the international Master's program Earth-oriented Space Science and Technology (ESPACE) at the Technical University of Munich. This work reports the detailed sensor design and the results from the orbit and space debris environment simulations. The satellite bus configuration with three sensors as payload is also presented.