Paper ID: 70978
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29th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Space Science Missions (2)

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INTRA-ORBIT IN-SITU PLASMA MEASUREMENT USING COST-EFFECTIVE RESEARCH AND OBSERVATION IN MEDIUM EARTH ORBIT (ROMEO) MICROSATELLITE PLATFORM

Abstract

The plasma measurement instrument for characterizing the intra-orbital plasma environment with improved resolution is featured in this paper. This experiment is part of a novel small satellite "Research and Observation in Medium Earth Orbit" (ROMEO) that is being developed at the University of Stuttgart's Institute of Space Systems for implementing NewSpace philosophy to MEO. The Instrument is designed and developed in collaboration with International Space University. From an initial operational sun-synchronous orbit of 600 km altitude, the satellite will progress to achieve an elliptical orbit with an apogee above 2500 km, targeting the Van Allen radiation belt. Plasma Diagnostics is crucial in a plasma dominant MEO region where the spacecraft is more susceptible to surface charging effects leading to deterioration of surface, thermal, and optical properties. Due to the presence of high-energy particles and uncertain anomalies in the MEO region, the sensitive electronics present in the satellites are at a high risk of failure. Earlier research has found out that a system could be implemented with the mass and power constraints of a 60 kg satellite platform to be adopted for an intra-orbital observation. Different invasive plasma probe methods for plasma diagnostics were studied based on Plasma Sheath theory. A Double Langmuir probe was opted based on the adaptability in a small satellite platform because of its simplicity in development and operation. It operates by immersing the conductive surface of an electrode into plasma and measuring the current collected when a variable potential is applied across the electrode.

This paper present the systems development and space environment validation strategy for a spherical double Langmuir probe mission on-board the ROMEO satellite. The investigation of near-space environment viz. Ionosphere, Plasmasphere, lower Magnetosphere infers that the ROMEO is expected to encounter the plasma with an electron density of $1 \cdot 10^8 m^{-3} - 1 \cdot 10^{12} m^{-3}$ and electron temperature between 0.06 eV − 2 eV. The plasma interaction throughout the LEO-MEO orbital transition is analyzed using Particle-in-Cell (PIC) method in SPIS software with expected stringent plasma parameters.

Keywords: Plasma Diagnostics, Small Satellite, Langmuir Probe, MEO, SPIS