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ESTCUBE-2 MISSION ANALYSIS: PLASMA BRAKE EXPERIMENT FOR DEORBITING

Abstract

Here we present the preliminary mission analysis for the ESTCube-2 three-unit CubeSat, which is designed to test Coulomb drag propulsion. One of the applications of Coulomb drag is the electric solar wind sail (E-sail), that could be used to travel within the Solar System with record speeds of up to 30 km/s, using solar wind as propellent. A second application includes the charging of a tether in low Earth orbit to decrease the orbital velocity of the satellite. The negatively charged plasma brake tether interacts with the ambient ionospheric plasma ram flow to slow down the satellite. To test this concept, ESTCube-2 will deploy a 300 m tether and subsequently charge it to 1 kV. The charged tether will be used to reduce the orbital altitude of the satellite. Such a tether could deorbit ESTCube-2 from an altitude of 700 km to 500 km in half a year. The previous ESTCube-1 and the upcoming Aalto-1 missions have shown that it is feasible to host a similar payload in 1/3 to 1/2 of a CubeSat unit. The mass of a 300 m long tether is nominally 30 grams according to conservative estimates. Hence the plasma brake is a lightweight, efficient, cost-effective, and scalable deorbiting system with a potential to address the space debris issue at critical altitudes of 900 km and less. The ESTCube-2 in-orbit demonstration platform will be designed and developed for future employment for other Coulomb drag propulsion experiments. One example is the demonstration the electric solar wind sail (E-sail) outside the Earth's magnetosphere, which would allow for the confirmation of analytical, numerical and laboratory estimations of the E-sail force. The main requirements for the satellite bus occupying 1/2 of a CubeSat unit are to provide the total angular momentum of 23 Nms for centrifugal tether deployment, to provide means of deployment verification, and to provide up to 3 W of power for charging the tether. This paper will present an overview of the requirements and performance dynamics of each subsystem housed in the miniaturized integrated bus and

its payloads. In addition, consideration of systems for high spin rate will be presented.