Paper ID: 60923
oral
student

48th STUDENT CONFERENCE (E2)
Student Team Competition (3-GTS.4)

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IONSAT : A STUDENT NANOSAT WITH AN IODINE THRUSTER IN VERY LOW EARTH ORBIT

Abstract

With better resolution, lesser latency and lower launch cost, Very Low Earth Orbits (VLEO, under 400km) reveal unexploited potentials. Nanosatellites and electrical propulsion (EP) provide the opportu-

nity to pave the wave of space applications at these altitudes.

The main challenge at VLEO is the strong atmospheric drag, and thus the very short life expectancy of a free falling satellite. We propose to use the new miniaturized EP devices that have recently become available, and the associated high total impulse to weight ratio, in a CubeSat. However, designing such a mission and the corresponding platform is not easily feasible for students, and no student projects with such an ambitious propulsion plan exist, at any orbit.

We present the preliminary design of IonSat, a 6U CubeSat capable of maintaining a fixed altitude under 300 km for several months. This student-driven project is supported by the French space agency CNES, École polytechnique (Paris), and ThrustMe, which provides a thruster working with iodine. The launch is scheduled in the early 2020s. The team of fifteen undergraduate students is involved in all part of the project (design, management, research of funding, etc.), and changes every year. The design conducted during the last three years led to a nanosatellite capable of withstanding the high demand for power, and achieving a successful station-keeping at the targeted altitude. The operations plan include a step-down descent from 350km to 250km, with 2-month intervals and a 10 km decrement. The goal is to achieve a lasting orbit control at the lowest possible altitude.

We emphasize our presentation on three challenges: orbit control, attitude control, and thermal design. It is possible to maintain the orbit at 300km within a 10km margin and a maximal eccentricity of 0.002 for more than 6 months using a discrete strategy consisting of precisely calculated thrusts around the apoapsis, while controlling eccentricity. A specific strategy privileging minimization of drag over maximization of input power is presented. More demanding strategies can bring more precision but increase the operation complexity. The minimal attitude control system for orbit keeping is achieved without star trackers, only with reaction wheels and magnetorquers. We also present the thermal design of the nanosatellite that have to withstand more than 50W in 6U.

We believe that IonSat will help inspire new trends of space development, regarding the use of electric propulsion for nanosatellites in the exploration and exploitation of VLEO.