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Author: Mr. Aurélien Sicsik
Ecole Polytechnique, France, aurelien.sicsik@polytechnique.edu

Mr. Léopold Maurice
Ecole Polytechnique, France, leopold.maurice@polytechnique.edu
Mr. Adrien Pinard
Ecole Polytechnique, France, adrien.pinard@polytechnique.edu
Mr. Grégoire de Séréville
Ecole Polytechnique, France, gregoire.ligneau-chapelain-de-sereville@polytechnique.edu
Mr. Pedro Dumas
Ecole Polytechnique, Chile, pedropablodumasziehlmann@gmail.com

DETAILED DESIGN OF IONSAT: A STATION-KEEPING MISSION AT ALTITUDES BELOW 300KM

Abstract

Very Low Earth Orbits (VLEO, at 250-400km alt.) enable high-performance space applications through lesser latency, better resolution and lower launch costs. These orbits are seldom exploited as the atmospheric drag shortens the lifetime of the satellites. Thanks to state-of-the-art miniaturized electrical propulsion, nanosatellites are able to maintain their altitude in VLEO.

We introduce the detailed design of IonSat, a 6U Cubesat equipped with an ion thruster that will achieve station-keeping at 300km and below. Started in 2017, this student project has already gathered 54 undergraduates in École Polytechnique (Palaiseau, France) and is supported by the French space agency CNES, Thalès Alenia Space and the start-up ThrustMe. This year, our 16-student team is involved in the design of the mission and the platform. The primary objective of IonSat is to demonstrate the accessibility of VLEO missions. The operations concept is based on a step-down descent from 300 to 250km, with 2-month station-keeping stages in 10km decrements. In addition, IonSat will better determine the atmospheric drag and other characteristics, such as the atomic oxygen density with the instrument 'Resistack' (ONERA).

This presentation focuses on the specificities of an electrical propelled mission for VLEO station-keeping. After presenting the mission requirements, we will present the design of the platform focusing on the most critical aspects. In particular, we will present the power system designed to deliver 50W for the electrical propulsion, and the thermal design that withstands the internal power dissipation. In addition, an accurate attitude control is needed to reduce the drag and increase the power generation. Thus, four reaction wheels are coupled to magnetorquers, and the disturbing torque caused by atmospheric forces is taken into account in the control law. The station-keeping strategy is to propel IonSat on half an orbit, from periapsis to apoapsis, every several orbits to compensate drag on average and keep the orbit circular between the given margin. This strategy requires a robust flight software to automate the thrust process as much as possible.

To maintain an agile allocation of the skills, our team is organized in cells linked to each subsystem with a concurrent engineering methodology, while our team manager and our system engineer ensure the global coherence.

We expect that the success of IonSat will encourage new developments of propelled nanosatellites and entail new momentum in the exploitation of VLEO.