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

Abstract

Very Low Earth Orbits enable high-performance space applications through lesser latency, better resolution and lower launch costs. However, since the atmospheric drag shortens satellite lifetimes, they are barely used. Thanks to state-of-the-art miniaturized electrical propulsion, VLEO nanosatellites is no longer a pipe dream. We introduce the detailed design of IonSat, a 6U Cubesat that will achieve innovative station-keeping at 300km and below, using a ThrustMe-provided iodine thruster. Since 2017, this project has gathered 65 undergraduates from l'Ecole Polytechnique. It enjoys sustained technical and financial support from the French space agency CNES, Thales Alenia Space and ThrustMe.

This year, the 11-student team is involved in advanced mission analysis and detailed platform design. The primary objective of IonSat is to demonstrate VLEO mission accessibility to Cubesats. Such capability will be displayed through a step-down descent featuring semi-major axis and eccentricity control. In addition, the satellite will also conduct two scientific experiments using secondary payloads. First, IonSat will help better understand the VLEO environment through atomic oxygen density measurements carried out by the 'Resistack' instrument, provided by ONERA. Second, it will also collect valuable data

on iodine plume contamination of the platform for the VKI.

This presentation focuses on the specificities of this VLEO mission and the design choice that have been made. After introducing the mission requirements, we will describe both the mission and platform design, focusing on the most critical points for each. When it comes to the flight scenario, the most significant challenge has been to find a compromise between multiple constraints. The orbital path starts at a 600km SSO with a 10-month long descent phase until suitable conditions for the demonstration phase. Because of this mission's operational complexity, the CONOPS has been carefully formulated with 4 modes. Next, the platform had to overcome serious design difficulties alike. So predominant are aerodynamic forces in VLEO that the EPS becomes ever more critical to ensure the platform survival. And so does the ADCS. As a result, IonSat requires the centre of mass and inertia matrix to be remarkably accurate to specifications. Finally, we will show how we overcame thermal dissipation's major struggle, dispersing heat from the electrical propulsion unit.

For better efficiency, the team is divided into technical subteams, organized by two project managers and a systems engineer who ensures team coherence. We fervently wish that IonSat will pave the way for broader use of VLEO, which on top of its technical convenience also promotes the sustainable use of space.