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DEVELOPING AND TESTING CUBESAT SUBSYSTEMS TOWARDS CREATION OF A UNIVERSITY CUBESAT BUS

Abstract

TUPEX-7 (TU Berlin Picosatellite EXperiment 7) is an experiment scheduled to fly on the 28 REXUS sounding rocket in March 2020 as part of the German-Swedish Rocket/Balloon Experiments for University Students (REXUS/BEXUS) program. The aim of TUPEX-7 is to develop miniaturized space technologies for a 1U CubeSat bus and demonstrate them in a milligravity environment.

Research at TU Berlin has yielded design guidelines for so-called Highly-Integrated CubeSat Side Panels (HISPs). HISPs contain elements from the electrical power system, communications system, and attitude determination and control system. A novel type of attitude control actuator known as picosatellite fluid-dynamic actuators (pFDAs) is embedded on the HISP as an alternative to reaction wheels. Combining these elements, research shows an achievable payload-to-volume ratio of up to 60% in comparison to a 25% ratio currently typical of CubeSats.

The primary objective of TUPEX-7 is to develop a low-cost HISP and test it in a near-space environment. In milligravity, the efficacy of the attitude determination and control techniques of the researched technology can be verified. The increase in payload volume can be employed by future experiments.

There are two secondary payloads in TUPEX-7: a software defined radio-based communications system, and a miniaturised Earth observation camera. The communications system is itself a technology demonstration goal to prove a flexible radio transceiver suitable for use at a high altitude can be built at low-cost using commercial-off-the-shelf parts. The camera will be used to independently assess the attitude determination and control performance of the HISPs.

Behind TUPEX-7 is a team of over twenty engineering students, many of whom are participating in the Master of Space Engineering program at TU Berlin. The project is primarily developed within a series of courses over consecutive semesters. Guided by advisors, the students organize themselves to design and build the hardware and software, manage the project schedule and costs, and promote the project to the public. To maintain the project between semesters, a subset of team members lead basic engineering disciplines and regularly discuss the project to further its progress.

This paper, submitted on behalf of the entire TUPEX-7 team, presents the design of the bespoke elements of the TUPEX-7 system, namely the low-cost HISPs, the self-developed communications system and miniaturised imager. The expected scientific results from the mission are introduced. Finally, future

work for the TUPEX-7 mission is outlined by describing the hardware and functional tests, as well as the data analysis plan.