ESTCube Mission — Testing the Electric Sail with the First Estonian Satellite

Jouni Envall

Tartu Observatory
61602 Tõravere, Estonia
jouni.envall@estcube.eu

The ESTCube project [1] is a joint effort of the University of Tartu, the Tallinn University of Technology, and the Estonian Flight Academy. The project was initiated in Tartu. The goal of the project is to launch Estonia's first satellite, ESTCube-1, into orbit by the year 2012. The project team consists mainly of students of the aforementioned institutes, but students from the University of Surrey (UK), the International Space University (FR), and the Aachen University of Applied Sciences (DE) are taking or have taken part in the project.

ESTCube-1 will be based on the Cubesat standard [2]. The standard was primarily designed to serve the needs of the student satellite teams. The basic Cubesat, or the single Cubesat, is a cube with the dimensions $10\times10\times10$ cm^3. Its mass must not exceed 1 kg.

Unlike most student satellite projects, the ESTCube mission has quite ambitious scientific goals. ESTCube-1 will perform the first in-orbit test for the Electric Sail concept. The electric sail is a novel spacecraft propulsion method, which was invented and is currently being developed at the Finnish Meteorological Institute (FMI) [3, 4]. The electric sail consists of thin, conductive tethers, which are held at a high positive potential. The sail gets its thrust from the charged plasma flow of the solar wind. ESTCube-1 will contain one such tether, the length of which in this test mission will be approximately 10 meters. The primary objective of the mission is to test the deployment of the tether. The principle of the deployment is similar to that of the actual spacecraft; the satellite will spin around its axis and the tether is deployed with the help of the centrifugal force. The secondary objective is to measure the electric sail force as the satellite and the deployed tether move through the ionosphere plasma. The satellite also has an on-board camera. The main task of the camera is to photograph the deployment. Once this has been successfully done, the satellite will be oriented to enable the camera to take pictures of the Earth.

The subsystems of the satellite include the structure, attitude control, power system, thermal control, communications (including space and ground segments), command and data handling, and the payload. The design of each subsystem is handled by a dedicated team of students. The design and manufacture of the tether payload is handled by an international team, coordinated by FMI. The team includes members from FMI, the University of Helsinki, the University of Jyväskylä, and the German Aerospace Center (DLR). In addition, the project includes working groups for the issues of space environment and project management.

Currently the project has gone through phases 0 (mission analysis) and A (feasibility study). Phase B (preliminary definition) started in October 2009. The first hardware tests of the space segment have been scheduled to commence during 2009. The ground segment (the ground station used for communications) is nearly completed. The launch has been scheduled to 2011 and the mission is expected to reach its end by the end of 2012.

References

[1] http://www.estcube.eu/

[2] http://www.cubesat.org/

[3] http://www.electric-sailing.com/

[4] P. Janhunen and A. Sandroos, "Simulation study of solar wind push on a charged wire: basis of solar wind electric sail propulsion," *Ann. Geophys.*, vol. 25, pp. 755–767, March 2007.