2nd URSI AT-RASC, Gran Canaria, 28 May – 1 June 2018

Nanosatellite based spectral imager Earth Observation mission results

Jaan Praks[(1)], Petri Niemelä[(1)], Antti Näsilä[(2)], Hannu Leppinen[(3)], Antti Kestilä[(1)], Tuomas Tikka[(4)], Bagus Riwanto[(1)], Nemanja Jovanovic[(1)], Rami Vainio[(5)], Pekka Janhunen [(6)]
(1) Aalto University,School of Electrical Engineering, Department of Electronics and Nanoengineering, P.O. Box 15500, 00076 Aalto, Finland, Email: jaan.praks@aalto.fi,
(2) VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland,
(3) SSF, Kappelitie 6 B, 02200, Espoo, Finland,
(4) Reaktor Space Lab, Mannerheimintie 2, 00100 Helsinki,
(5) University of Turku, FI-20014 TURUN YLIOPISTO, Finland,
(6) Finnish Meteorological Institute, P.O. BOX 503, FI-00101, Finland

In this paper we analyse mission results from Finnish Aalto-1 CubeSat, concentrating on in-orbit demonstration of miniature spectral imager for Earth Observation. The satellite was launched to space on June 23th 2017, by Indian PSLV rocket. The satellite was inserted successfully to a Sun-synchronous orbit at altitude of 505 km and it has been in operation since then.

The satellite is built by a consortium of universities and institutes in Finland, as a student lead project. The mission has its main goals in education [1], technology demonstration and science. The satellite platform was developed in most parts by students of Aalto University while the payloads were developed by various consortium partners.

The main payload of the mission is a miniature hyperspectral camera AaSI. The EO mission started with power-up of the AaSI payload a week after the launch. During the first in-orbit tests the power consumption and housekeeping data of the subsystem were checked. The first picture was taken using visible wavelength (VIS) secondary camera on 5th of July, shown also in Figure 1. The picture was compressed using gzip deflation algorithm to 3.7 Megabytes file before downlinking. The downlink process over UHF-link was completed in approximately in 2 weeks. The first picture with spectral camera was taken shortly after the VIS image was downloaded. In Figure 1 also some spectral channels, captured by the AaSI SPE camera are shown. It can be noted that near the edges the image overlap varies as sliding over several spectral channels takes time and the satellite rotation moves the camera. The spectral camera was also calibrated in orbit and the response indicates only slight deviation from ground calibration. The payload capability is technically demonstrated, but the EO mission is continued with more image acquisitions.

Figure 1. First VIS camera image taken on 5. July 2017 (left) band the first spectral image composite as a false color composite over wavelengths 509 nm, 536 nm, 565 nm, 671 nm, 711 nm and 752 nm (right).

Due to problems with attitude system of the satellite, the satellite has been tumbling during first six months of the mission. As this is not favorable for the EO payload, most of the mission has actually been concentrating on secondary payload operations. The secondary payload is a radiation monitor RADMON, made by University of Turku, and it detects particle energy loss (ΔE) and the residual energy (E′) for incident charged particles. The data product of the RADMON consists of (10 MeV) proton and (700 keV) electron flux measurements in 9 energy bands at 15-second time resolution. The miniature instrument weights only 400 grams and has demonstrated excellent performance over extended experiment. The instrument was operated also during the solar storms in September 2017 and it provided valuable scientific insight to radiation belt physics.,The satellite carries also a deorbiting experiment, developed by Finnish Meteorological Institute. The experiment will be carried out during the end of the mission in the future.