Aalto-1 Spectral Imager: Design and Mission

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The Aalto-1 Spectral Imager (AaSI) is a miniaturized spectral imager capable of recording images at 20+ selectable wavelength bands between 500 and 900 nanometers.

VTT has developed tunable Fabry-Pérot interferometer (FPI) modules based on piezo or electrostatic actuation. A spectral imager can be built by combining this kind of a tunable FPI and an RGB CMOS or CCD sensor. AaSI will have an RGB CMOS sensor consisting of 1024x1024 pixels, which allows the minimum ground pixel size of ca. 100 meters. These technologies enable extremely lightweight spectrometers and spectral imagers (< 500 g) which are suitable for small unmanned aerial vehicles and different space applications.

AaSI will be developed as a part of the ESA activity "MEMS Fabry-Perot interferometer technology for miniaturized hyperspectral imagers and microspectrometers", which has started in autumn 2012. This project will perform space qualification testing (vibration, thermal and thermal vacuum) for piezo-actuated and MEMS FPI's. The spectral, radiometric and spatial performance of the instrument will be tested on the Aalto-1 nanosatellite mission. As Aalto-1 will have limited downlink capacity, the amount of measured spectral bands has been reduced. However, the instrument itself can measure 60+ spectral bands, and this feature may still be tested during the mission. In-orbit spectral calibration is planned to be done by using known bright spectral features (e.g. Sahara) and measuring the spectrum around strong absorption peaks (e.g. O_2 absorption at 750-760 nm). AaSI will also include a normal RGB camera (ca. 1000 x 1000 pixels) with wider field of view. The images taken by this camera will be used as a georeference for the spectral images.

The main advantages of the AaSI concept are the small size and the spectral programmability, which provides flexibility and reduced data rate when the application is well defined. A successful space qualification and orbit demonstration will enable more advanced instruments based on piezo and MEMS Fabry-Pérot interferometer technologies.

Main specifications for AaSI:

- Across the flight FOV: 10° (105 km swath width at 600 km altitude)
- Along the flight FOV: 10°
- Spectral image size: 512 x 512 pixels (2x2 binning)
- Wavelength range: 500 – 900 nm
- Spectral resolution: 10 – 30 nm (FWHM)
- SNR (20 ms & 20 nm FWHM): > 50 (0.3 albedo near Finland in June)
- Amount of spectral bands: > 20
- Volume: 90 x 96 x 48mm^3
- Mass: 500 g