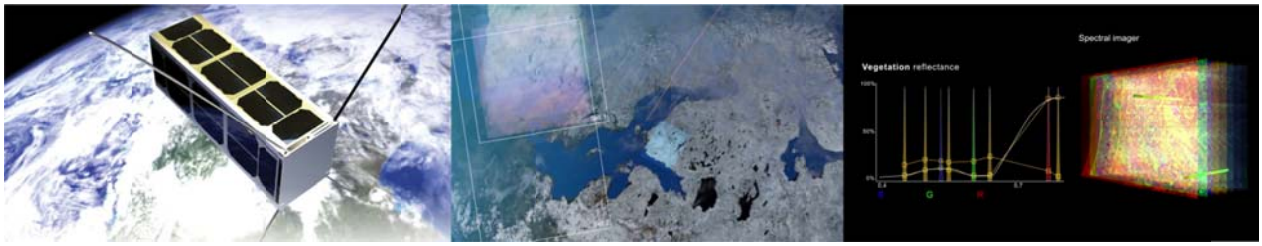
MEMS Fabry-Perot Interferometer Technology for Miniaturized hyperspectral Imagers and Microspectrometers

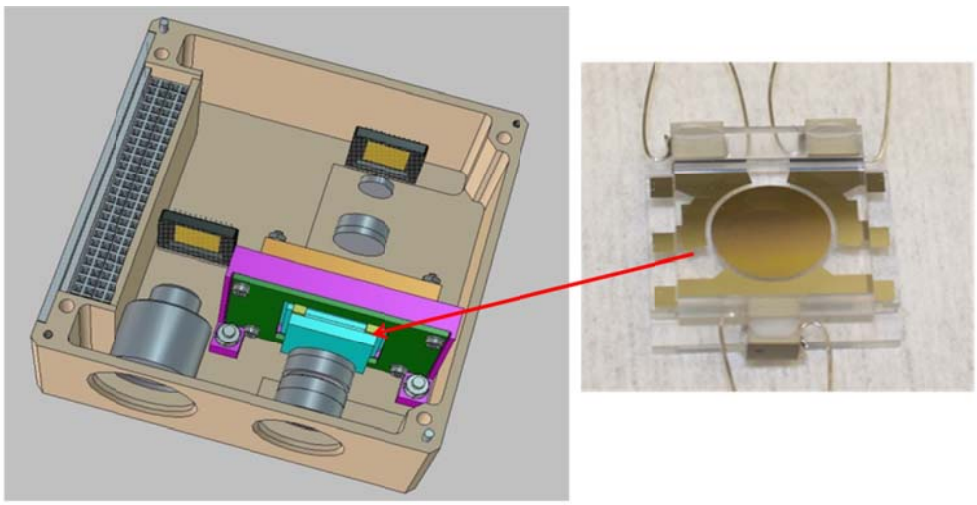
VTT has developed tuneable Fabry-Perot interferometer (FPI) modules based on piezo or electrostatic actuation fabricated with MEMS processes. These technologies enable lightweight spectrometers and spectral imagers. When an rgb-image sensor and data inversion is used, the spectral range is increased and three spectral bands are acquired simultaneously in one exposure. Satisfactory data inversion requires a meticulous spectral and radiometric calibration of the imager.

The project will perform space qualification testing of piezo FPI and MEMS electrostatic FPI modules including vibration, thermal and thermal vacuum tests.



The Finnish Aalto-1 student CubeSat mission provides a unique flight opportunity for small technology demonstration experiments. The satellite volume is 34x10x10 cm^3 and mass 4 kg and it is equipped with a high bandwidth S-Band downlink, which is more suitable for transferring spectral images than traditional vhf/uhf solutions. The Aalto-1 spectral imager (AaSI) instrument will be developed and flown on the Aalto-1 satellite. AaSI will be the primary payload for the Aalto-1 satellite and secondary payloads include a miniaturized radiation detector and a plasma brake for a de-orbiting experiment. The plasma brake will also be used to demonstrate the e-sail concept.

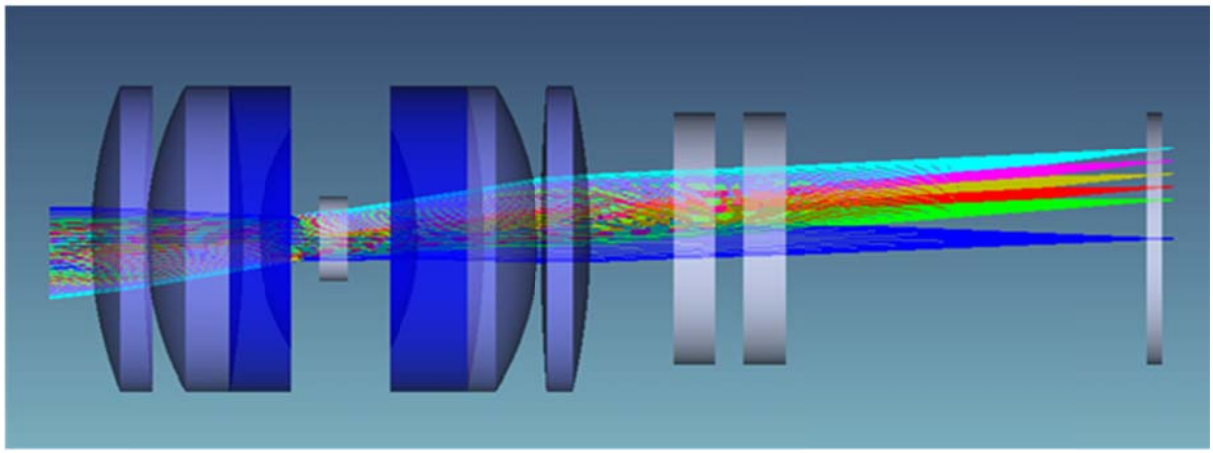
The spectral, radiometric and spatial performance of the AaSI will be tested in the mission for technology demonstration purposes. Also scientific, operational and educational goals are included for the AaSI hyperspectral data. Georeferencing of the individual frames is performed to acquire a hyperspectral data cube of the target.



The main specifications for AaSI are

Across the flight FOV	10° (0.174 rad)	120 km swath width @ 700 km altitude.
Along the flight FOV	10°	
Instantaneous FOV	0.02° (0.34 mrad)	ground pixel 240 m at nadir @ 700 km
Wavelength range	500 – 900 nm	
Spectral resolution	10..30 nm @ FWHM	
SNR @ 20 ms&20 nm FWHM	> 50	SNR requirement is defined for June and latitude of Helsinki (60) and for albedo 30%.
Spectral image size	512 x 512 pixels	
Number of spectral bands	>20	number of bands and centre wave length is programmable
Volume	50x100x100 mm^3	
Mass	500 g	

The activity will also develop a demonstrator for a MEMS FPI based spectral imager. This technology is especially suited for mass production.



The main advantages of the FPI based spectral imager concepts 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-Perot interferometer technologies.