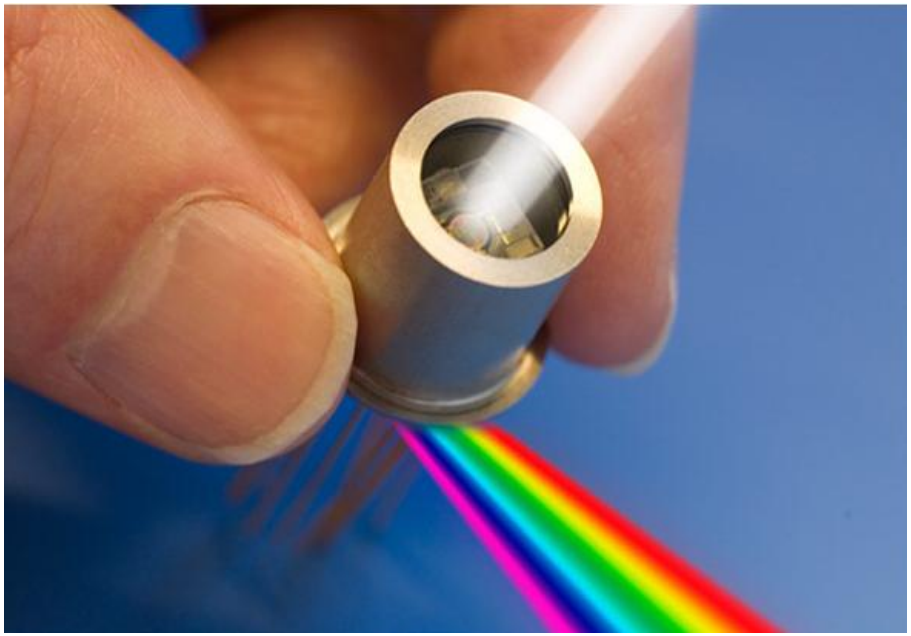
Rikola Ltd.



- Founded 1993
- Provides tools for spectral measurements:
  - hyperspectral cameras
  - miniature spectrometers
  - customized spectro LED modules
  - customized multichannel detector modules
- Development and OEM production of custom modules in small to medium quantities

OEM Production & Development

Rikola provides state-of-the-art packaging technology for opto- and microelectronic modules.

- Flexible and cost effective
- Proven high-end quality in long customer relationhips
- Good facilities:
  - Clean room ISO6-7
  - Semiautomatic die and wire bonders
  - Various testing equipments
- Wide and trusted partner network

Multichannel Detector Modules

Customized modules with hermetic packing for simultaneous measurements of multiple channels.

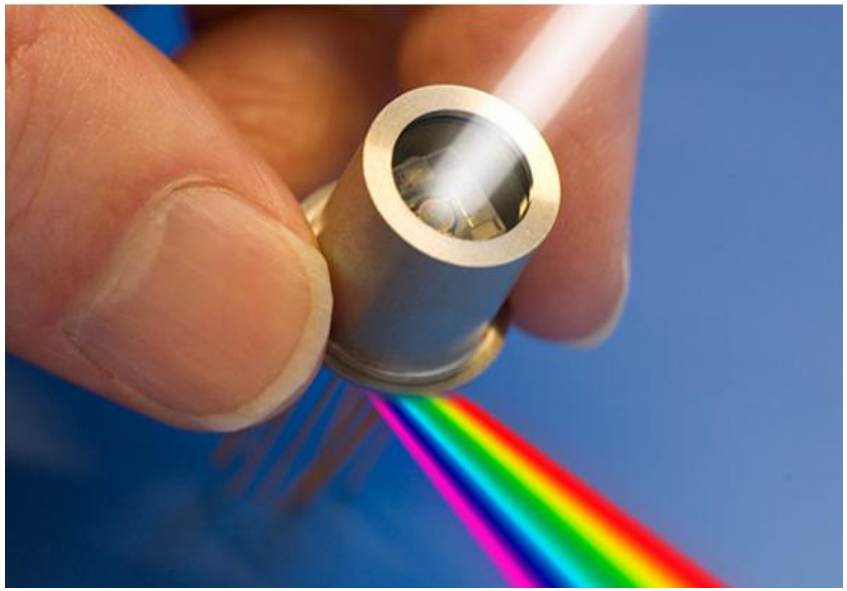
- Various detector chips: Si, lead salts, InGaAs, Extended InGaAs
- Designed for excellent performance:
  - Light leakage between channels <0,01%
  - Temperature tracking 0,01%/C
  - Uses micro-optics: S/N-ratio improved 4X
- Simultaneous measurement of all channels
- Up to 6 channels into single TO-8 (TO-66) housing

Spectro LEDs

Hermetically sealed LED modules with various wavelengths.

- **Central wavelength range: 280nm-2500nm,**
- **Bandwidth: 10 nm-150 nm**
- **CW accuracy: 5-20nm**
- **1-12 LEDs in one module**
- **Chip sizes: 0,2mm x0,2mm-1,5mm x 1,5mm**
- **Micro-optics available**

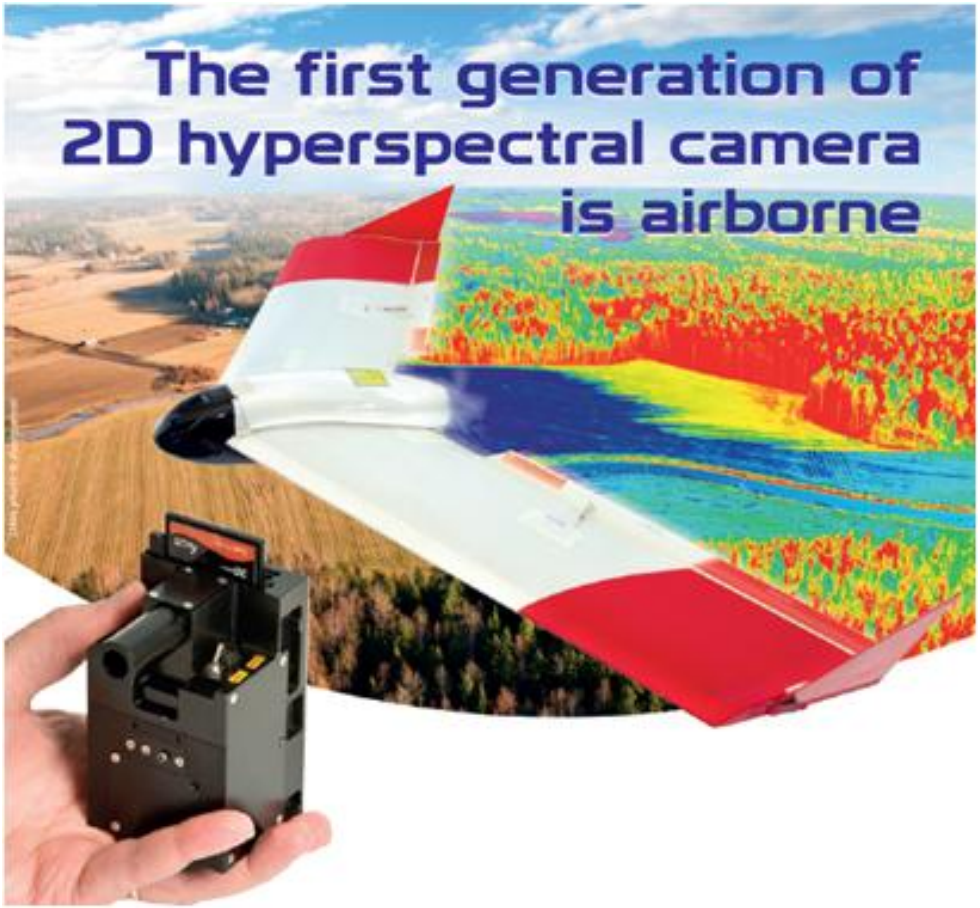
Miniature Spectrometer



Fabry-Perot technology based tunable filter enables extremely small spectrometer with following advantages:

- Small and lightweight: 10 g-100 g
- Robust: all solid sate
- High optical throughput (filter diameter 3-20 mm)
- Low cost and easy to integrate
- Tolerant against harsh environments

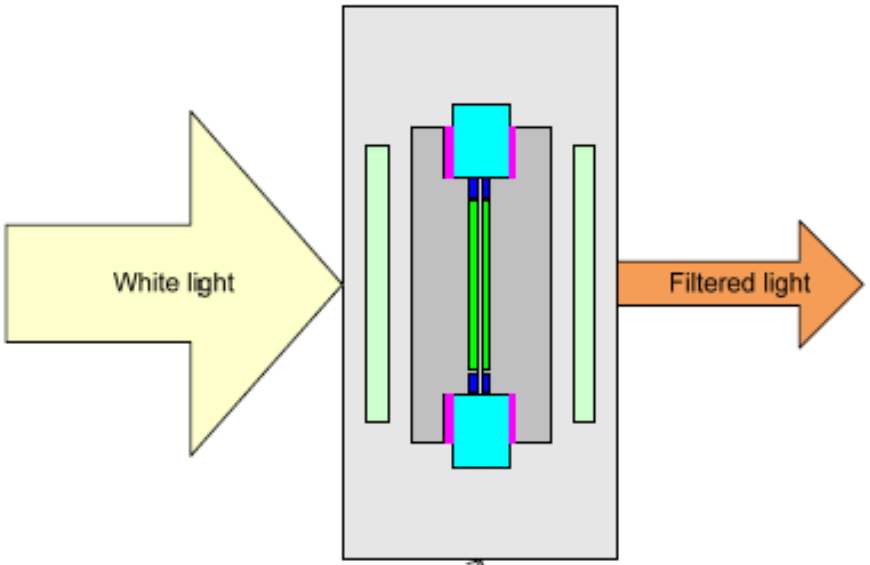
Hyperspectral Camera for UAVs

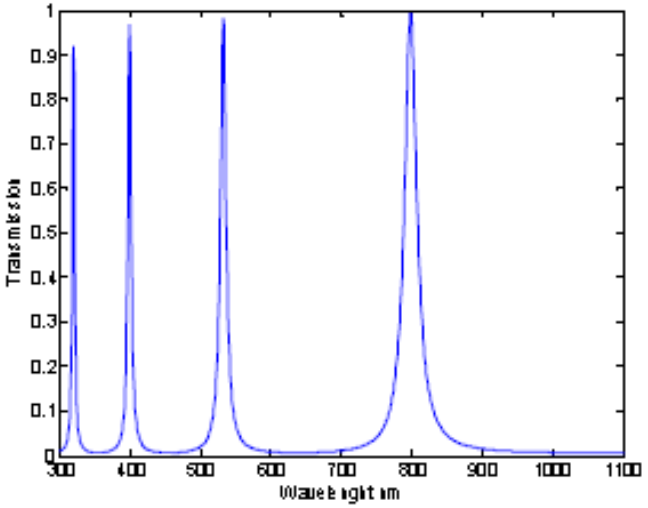


First in the world, Rikola's camera is frame based hyperspectral solution providing full 2D images at every exposure.

- **Lightweight < 600 g**
- **Small and robust: handheld size**
- **High accuracy image mosaics at low cost**
- **Approx. 30X faster than LCTF based devices**

Fabry-Perot Principle





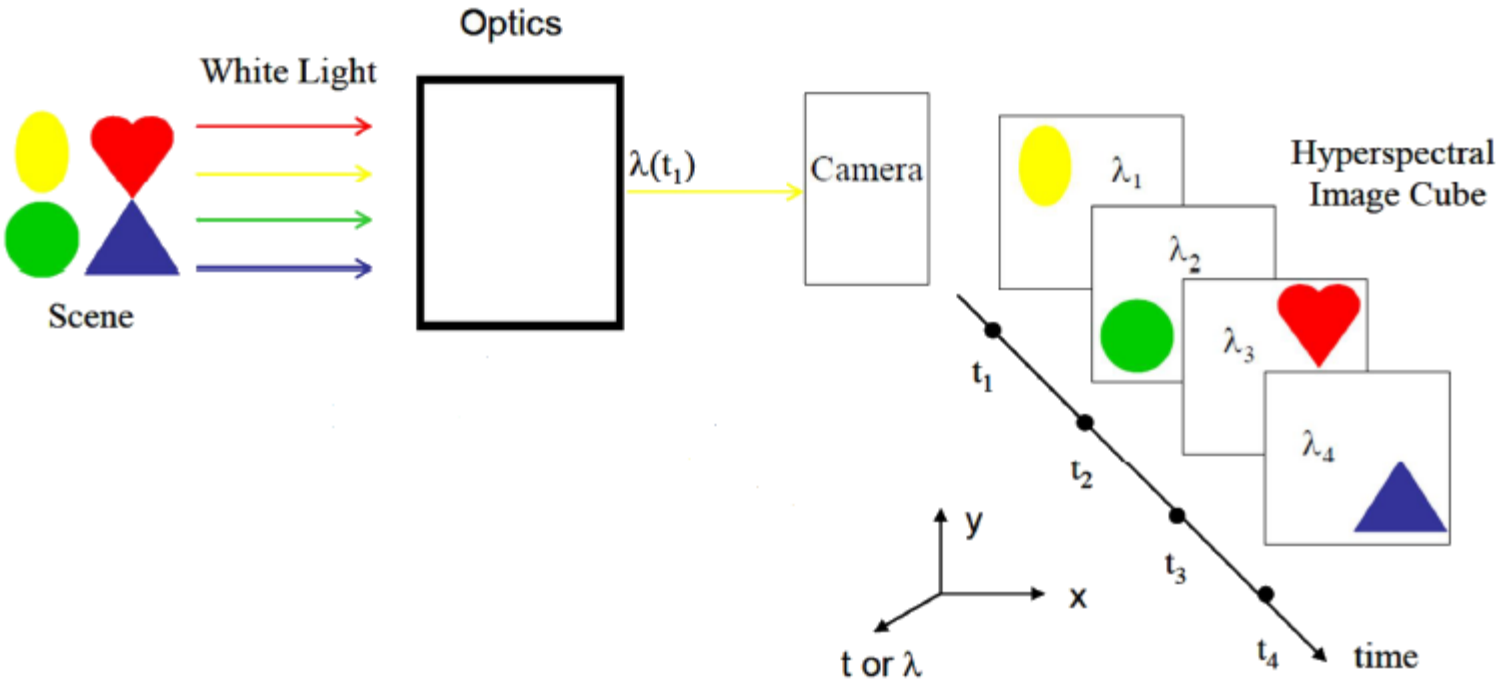
$$T_e = \frac{(1-R)^2}{1+R^2-2R\cos\delta} = \frac{1}{1+F\sin^2(\delta/2)},$$

$$\delta = \left(\frac{2\pi}{\lambda}\right) 2n\ell\cos\theta.$$

Fabry-Perot Interferometer Module

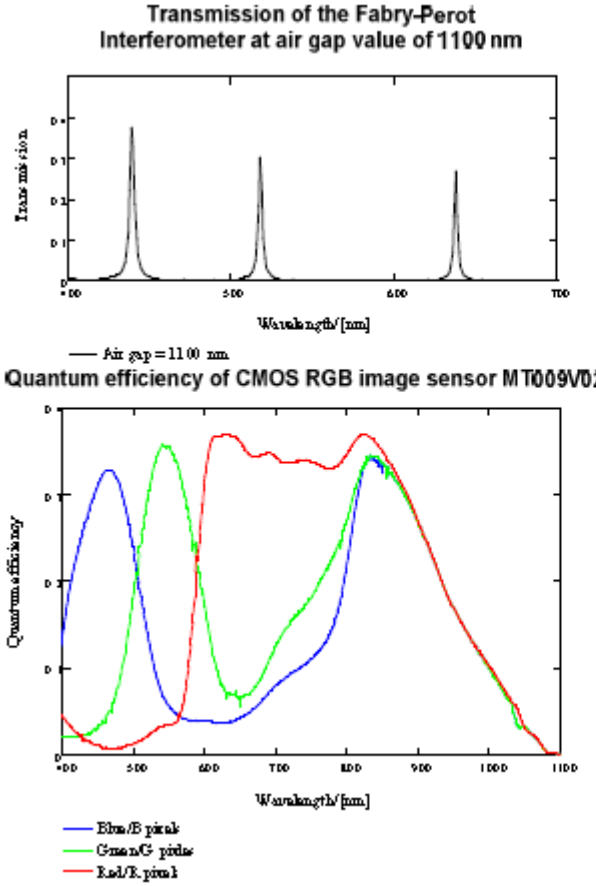
Courtesy of Heikki Saari/VTT, ”Fabry-Perot Interferometer Hyperspectral Imaging Technology Transfer to Space Applications”8th ESA Round Table on Micro and Nano Technologies for Space Applications

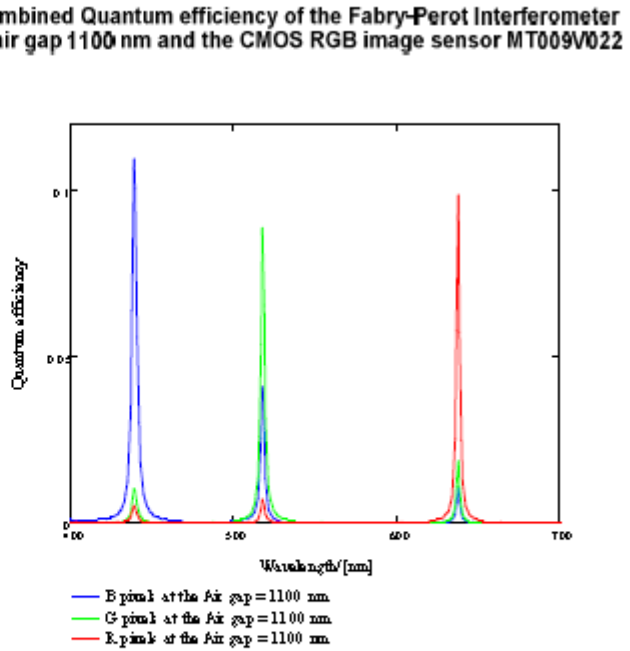
Fabry-Perot- Frame Based



Ref. Hyperspectral imager development at Army Research Laboratory, Gupta et. Al. Proc. Of SPIE Vol. 6940 69401P-3, 2008. http://lib.semi.ac.cn:8080/tsh/dzzy/wsqk/SPIE/vol6940/69401P.pdf

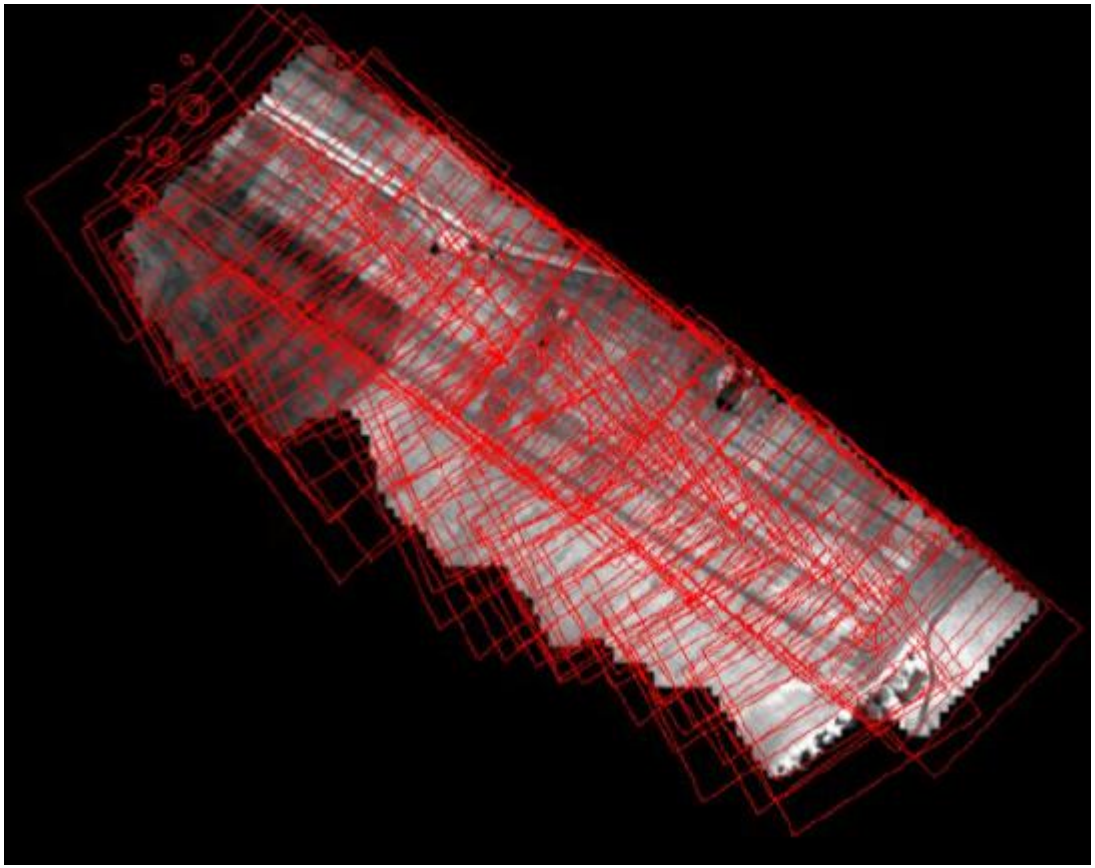
Calibration with Color Sensor





Courtesy of Heikki Saari/VTT, ”Novel MEMS and Piezoactuated Fabry-Perot spectral imagers for atmospherics studies”,38th Annual European Meeting on Atmospheric Studies by Optical Methods

Frame Overlapping



Courtesy of Lauri Markelin, Eija Honkavaara/FGI, ”Hyperspectral reflectance signatures and point clouds for precision agriculture by light weight UAV imaging system”, XXII ISPRS Congress Melbourne 2012

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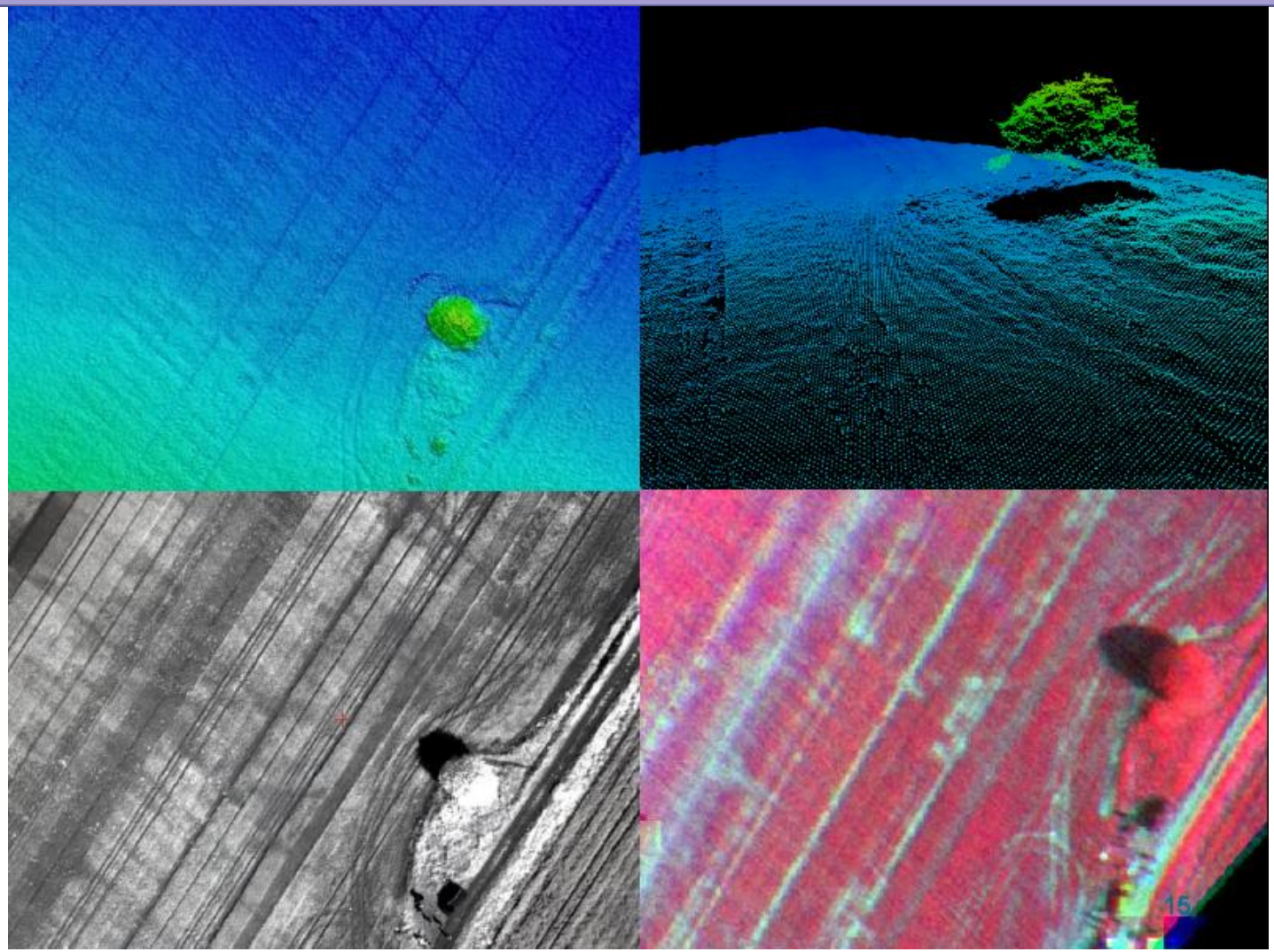
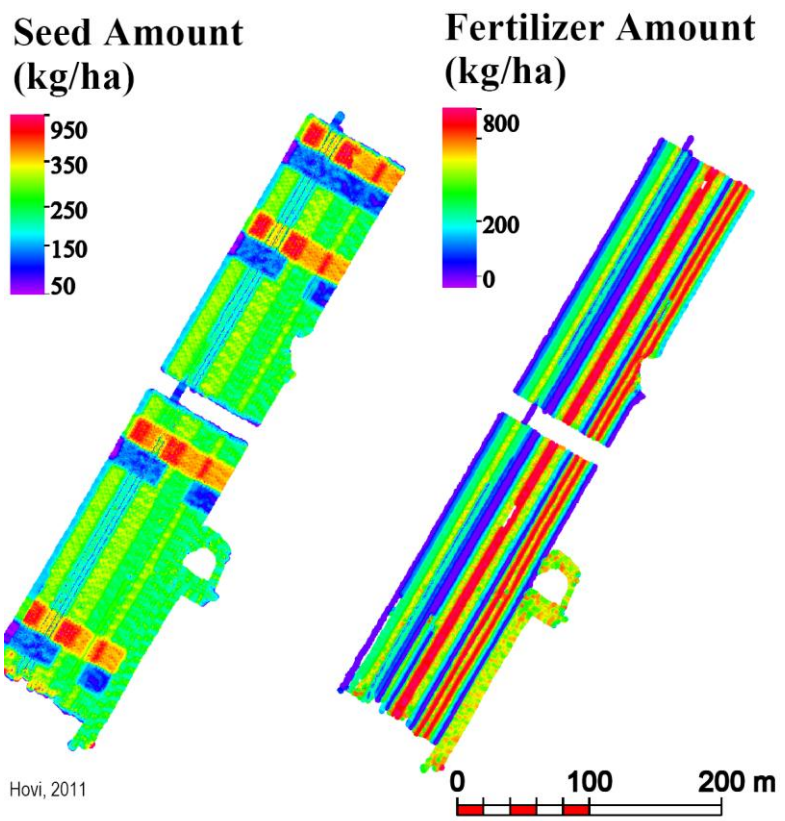
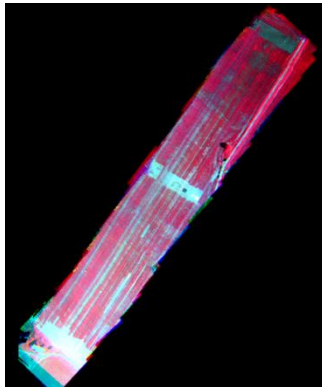


Courtesy of Lauri Markelin, Eija Honkavaara/FGI, ”Hyperspectral reflectance signatures and point clouds for precision agriculture by light weight UAV imaging system”, XXII ISPRS Congress Melbourne 2012

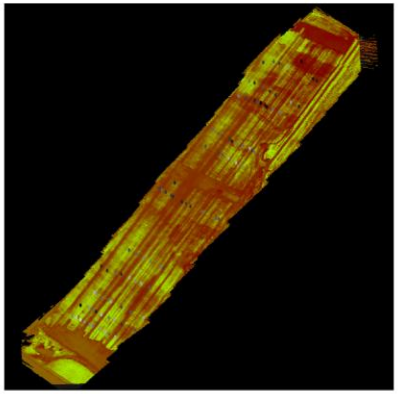
HyperSpectral Camera Measurement Campaigns



False-Color map



Biomass estimate map

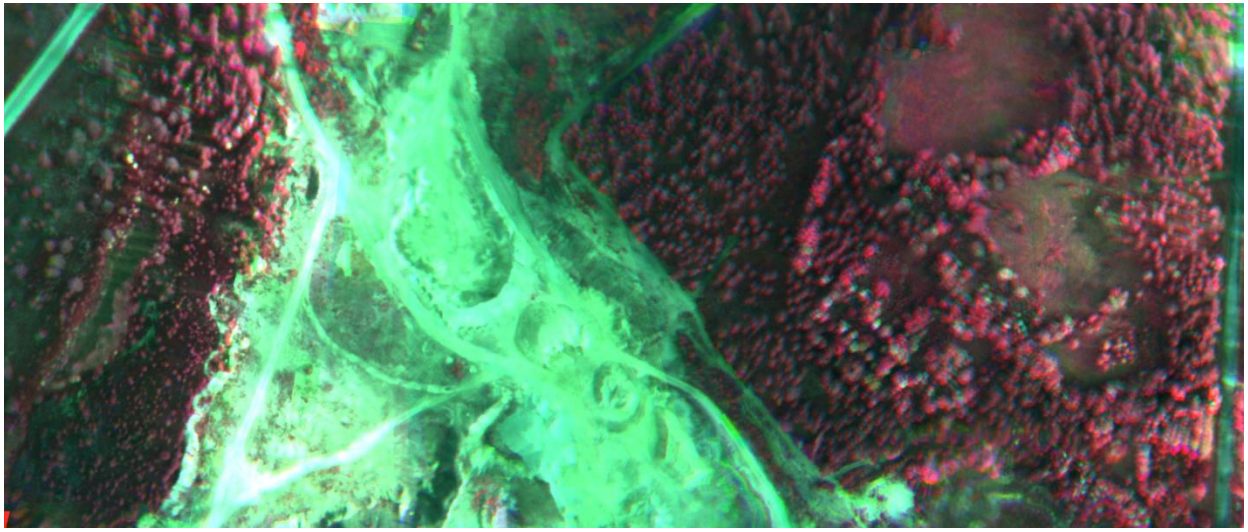


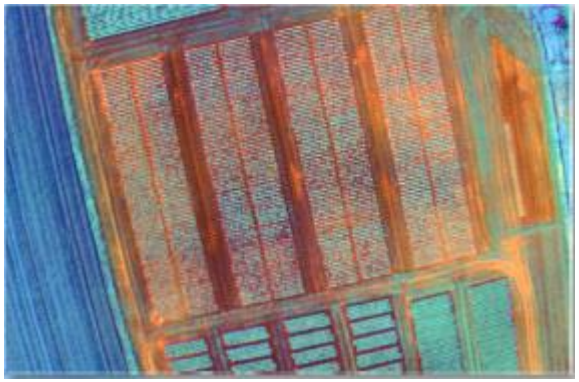
Rikola hyperspectral camera has been tested in several measurement campaigns in agricultural, forestry and water research.

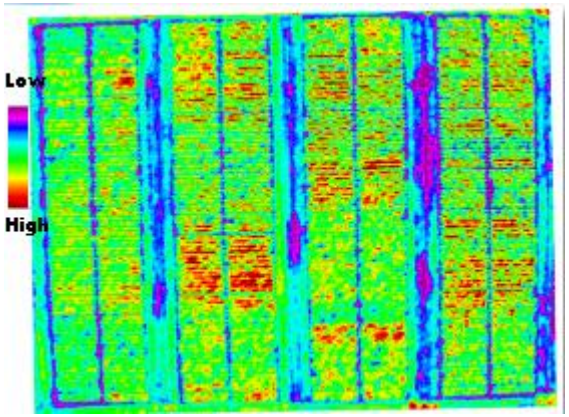
- **Platforms: Infotron, Microdrones, C-Astral Bramor, Mikrokopter**
- **Articles: Eija Honkavaara, Ilkka Pölönen, Jere Kaivosoja, Heikki Saari**

Courtesy of Lauri Markelin, Eija Honkavaara/FGI, ”Hyperspectral reflectance signatures and point clouds for precision agriculture by light weight UAV imaging system”, XXII ISPRS Congress Melbourne 2012

On-Going Projects- Highlights





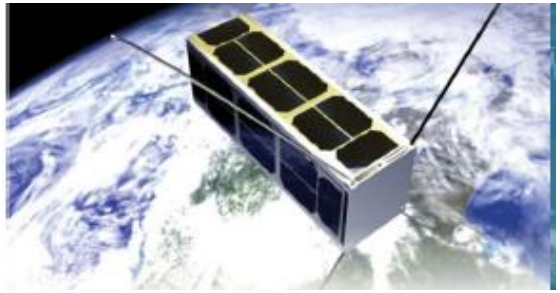


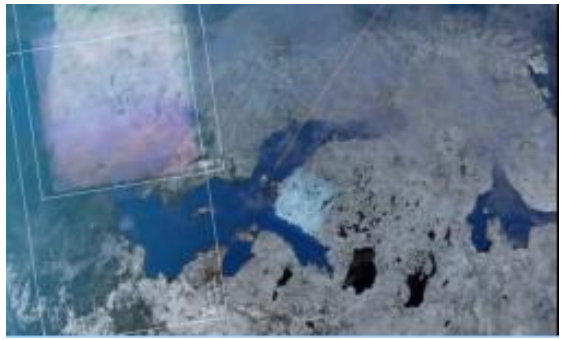
Courtesy of Jere Kaivosoja/MTT, ”UASI Potato Monitoring flight campaign preliminary results”,Finnish Remote Sensing Days 2012

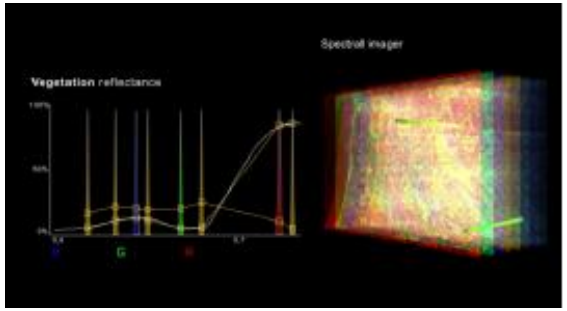
Platform Examples

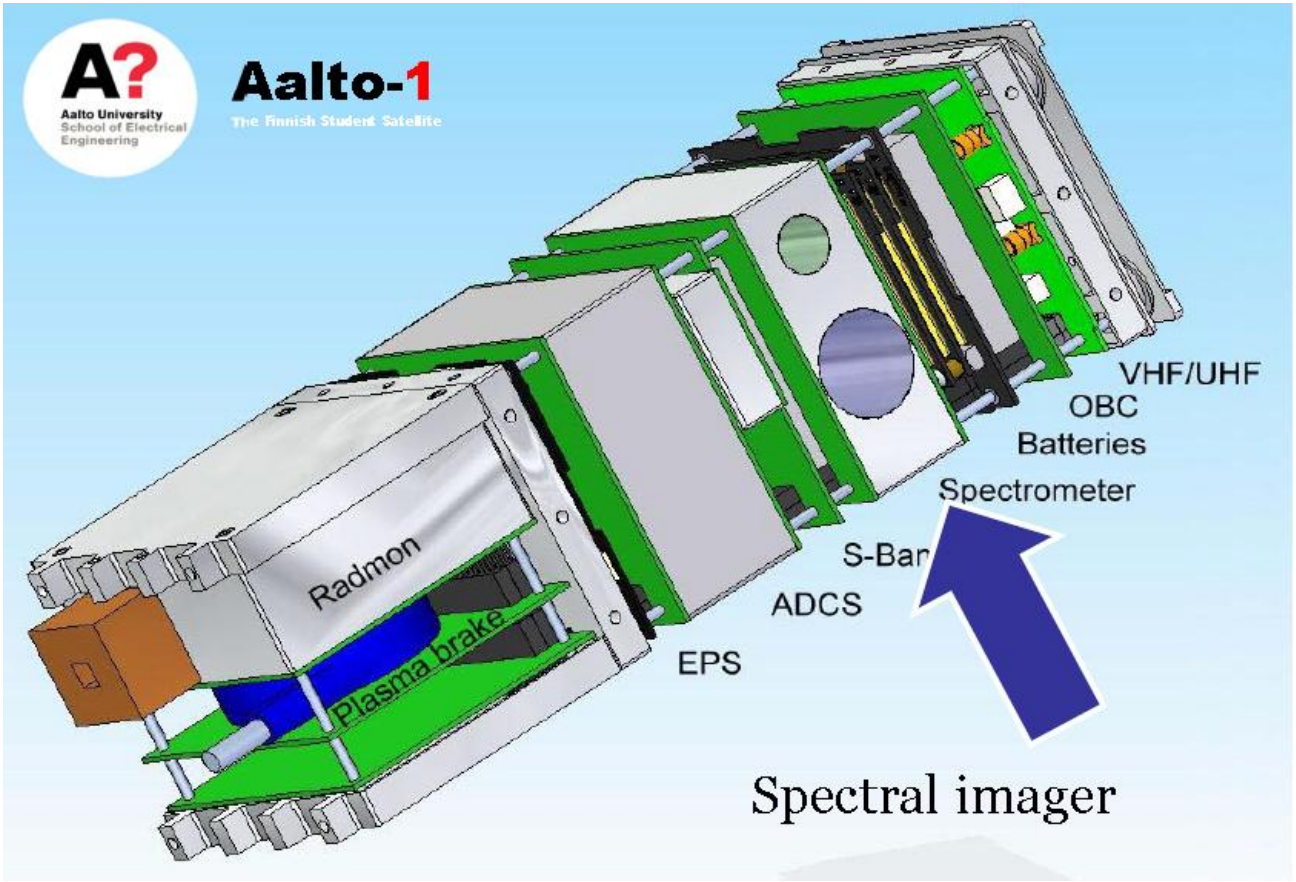
Courtesy of Heikki Saari/VTT, ”Novel MEMS and Piezoactuated Fabry-Perot spectral imagers for atmospherics studies”,38th Annual European Meeting on Atmospheric Studies by Optical Methods , , ”Fabry-Perot Interferometer Hyperspectral Imaging Technology Transfer to Space Applications”8th ESA Round Table on Micro and Nano Technologies for Space Applications, Jere Kaivosoja/MTT, ”UASI Potato Monitoring flight campaign preliminary results”,Finnish Remote Sensing Days 2012

Coming Platform









Courtesy of Heikki Saari/VTT, ”Fabry-Perot Interferometer Hyperspectral Imaging Technology Transfer to Space Applications”8th ESA Round Table on Micro and Nano Technologies for Space Applications