

Smart sensor and system development for environmental monitoring



IFU GMBH

Privates Institut für Umweltanalysen

About IfU

OPTICAL MEASUREMENTS

- acousto-optical monochromation
- optical spectrometry
- meteorological temperature profiling
- specific camera systems

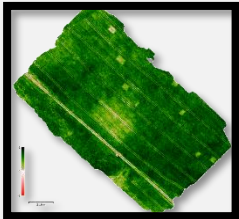
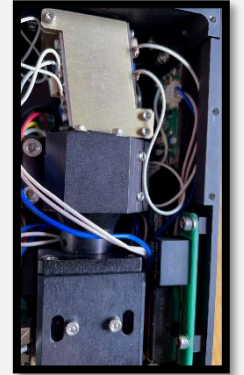


- exploring and monitoring the earth's (sub-)surface
- electrics, magnetic field, gravity field, radioactivity, ...
- instruments and services
- ground and drone-borne surveys

GEOPHYSICS & UAV

RESEARCH & DEVELOPMENT

- custom sensors
- electronics (real-time, low-power, ...)
- data interfaces & communication
- software

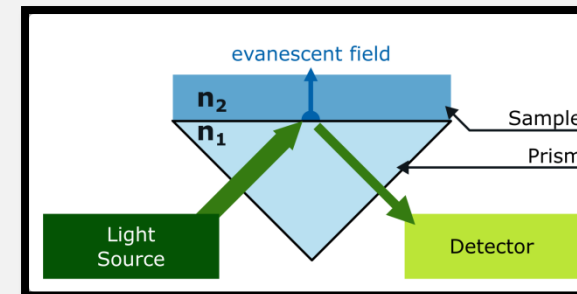
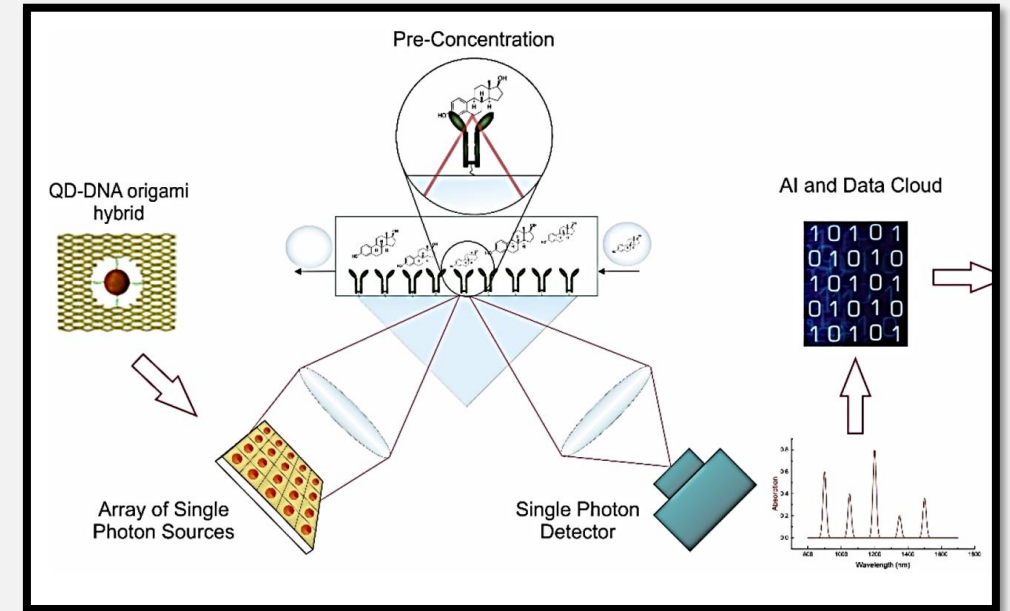


- monitoring & surveying
- vegetation and soil properties
- objects, utilities and subsurface structures
- agricultural + surveillance topics

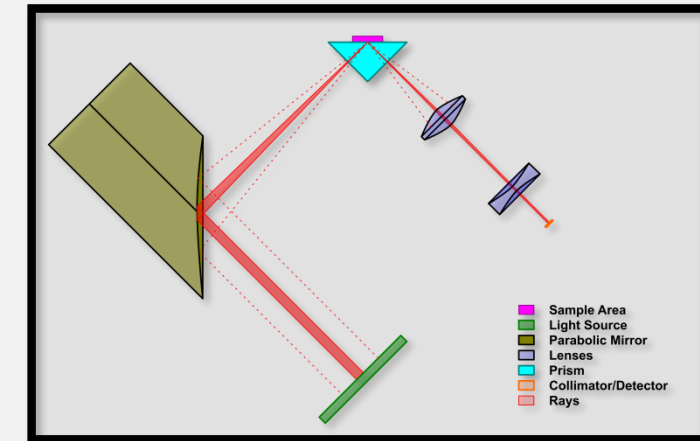
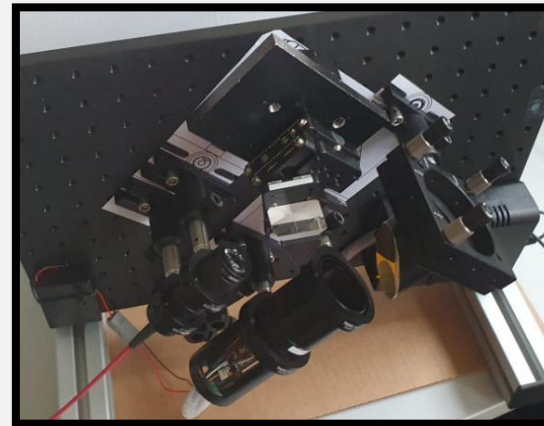
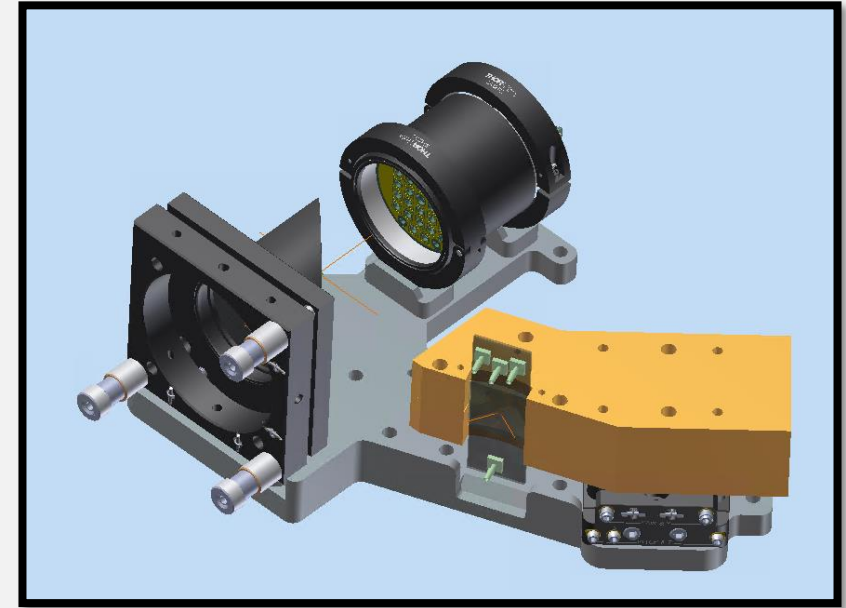


ENVIRONMENT

- project basics
 - array of Single Photon Sources distributed next to each other
 - specialized focusing optics
 - high-sensitive single photon detector
 - adapted processing algorithms



- IfU's tasks within the GREENER project:
 - joining partners components to assemble a fully functioning instrument
 - simulation and development of optical instruments
 - construction and manufacturing of instrument case
 - case electronics and user interface



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Smart system development for environmental monitoring

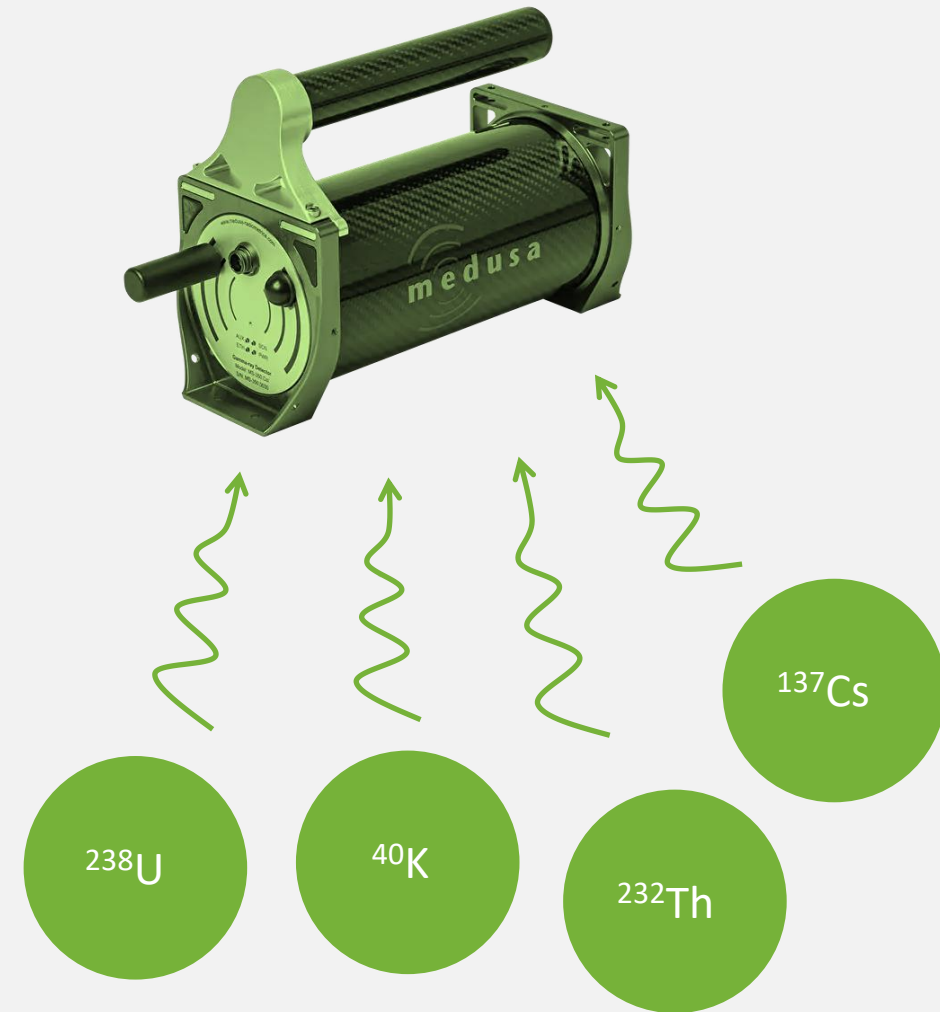


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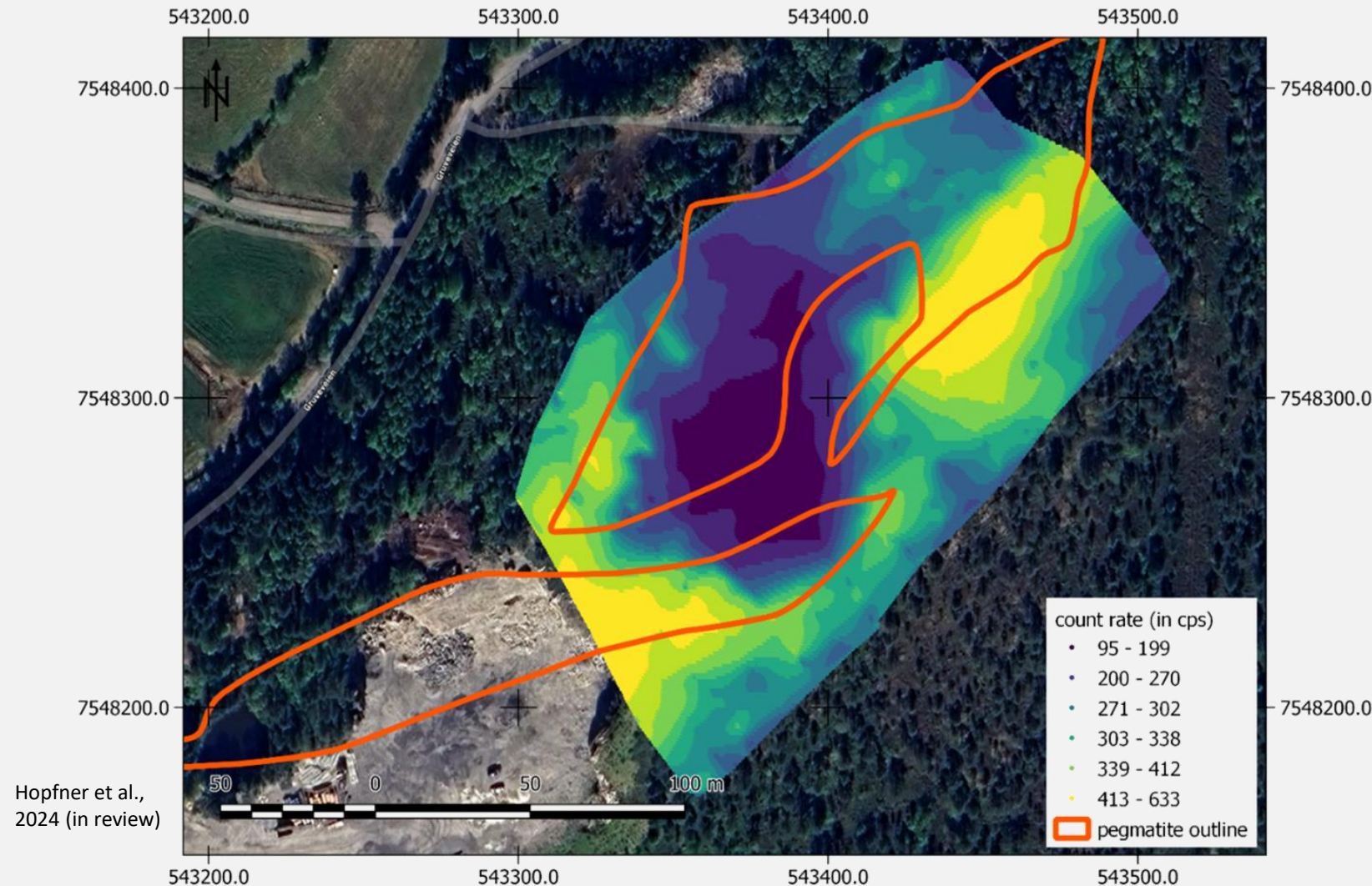
Radiometric mapping

- energy spectra, count rate, activity for ^{40}K , ^{238}U , ^{232}Th and ^{137}Cs isotopes
- ground-based and drone-borne applications
- ground: usual walking speed
- UAV: ~ 4 ha/h for full resolution



Radiometric mapping

- mineral exploration example
- altitude: 15 m
- area: 2 ha



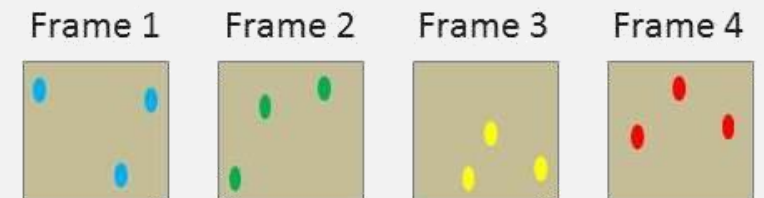
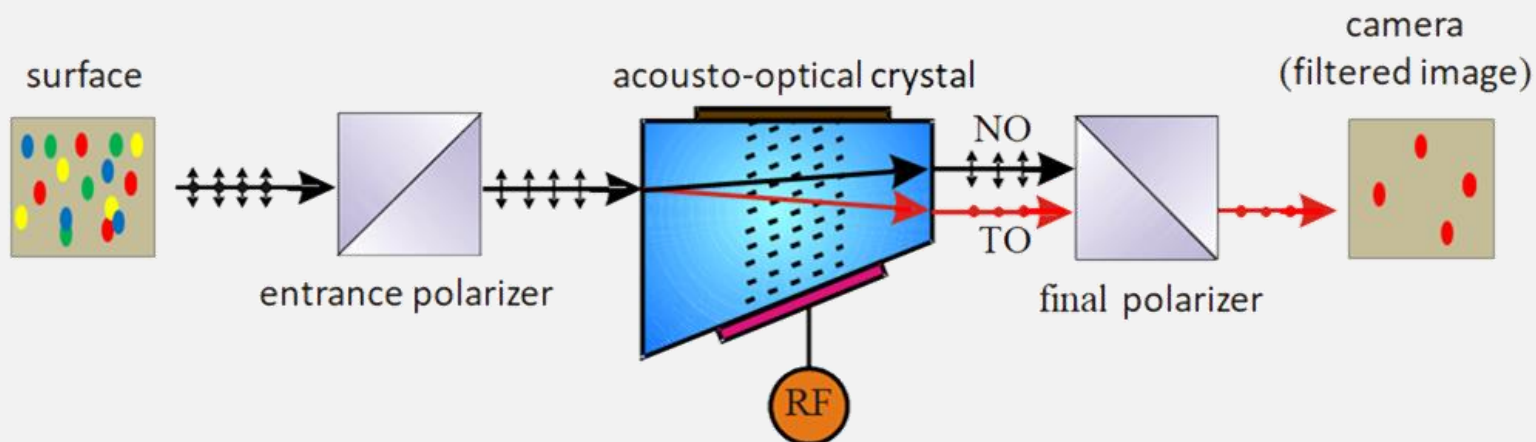
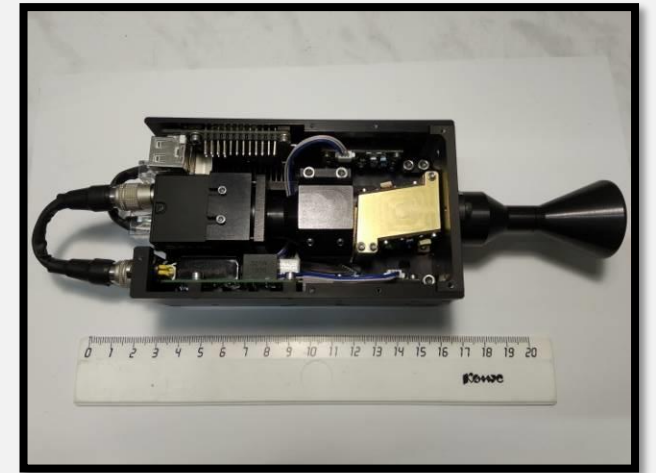
Radiometric mapping - applications

- (mineral exploration)
- agricultural soil properties
 - clay and sand contents
 - pH
 - available water
- swamp properties
 - water saturation
 - extents
- ...



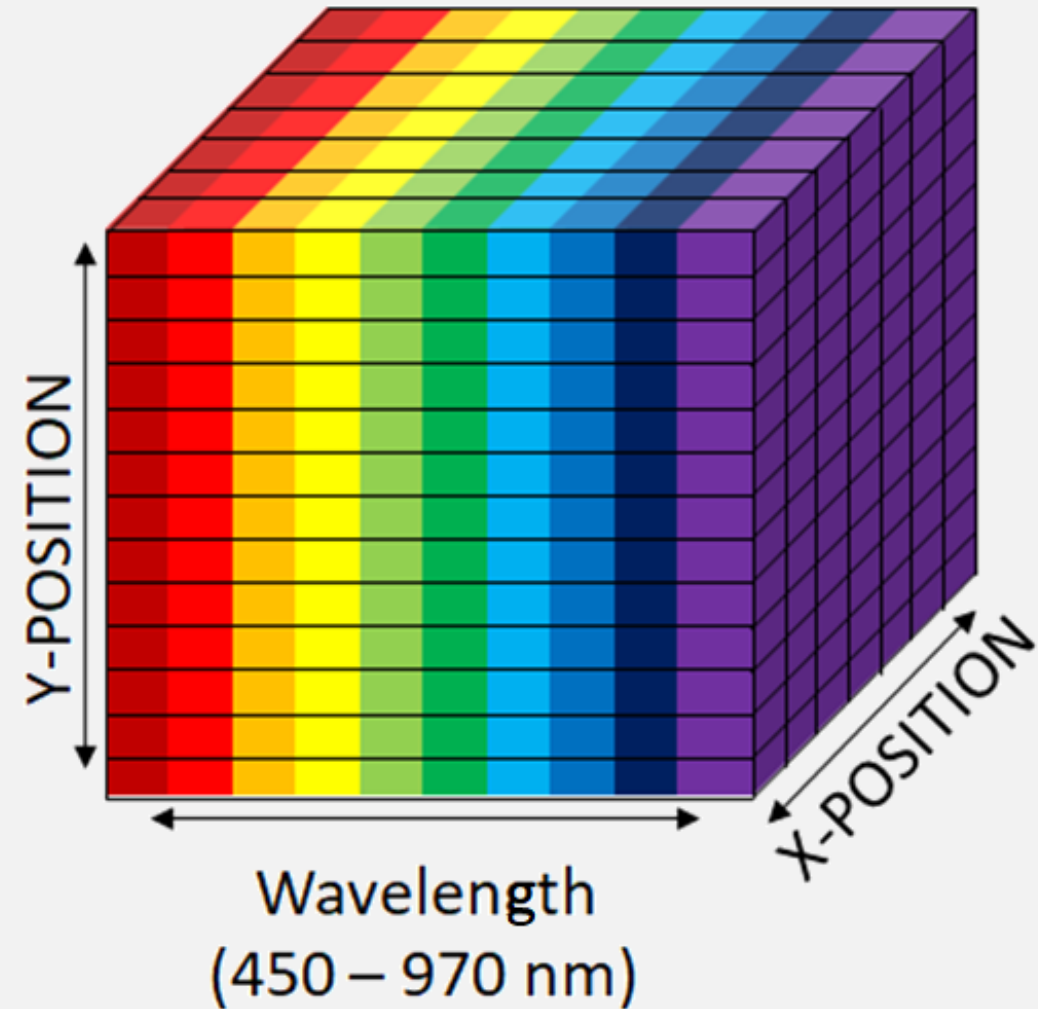
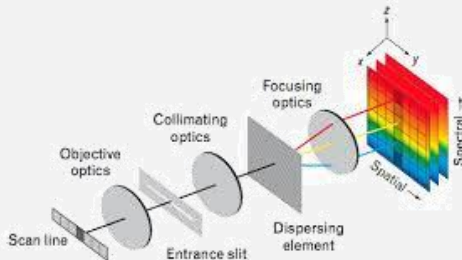
Hyperspectral imaging system – working principle

- principle: acousto-optical monochromator
- piezoelectric and birefringent crystal, e.g. TeO_2 , LiNbO_3
- excitation by high AC voltage, formation of an optical grid
- tunable wavelength: 450 – 970 nm @ 720x540 px



Hyperspectral cube

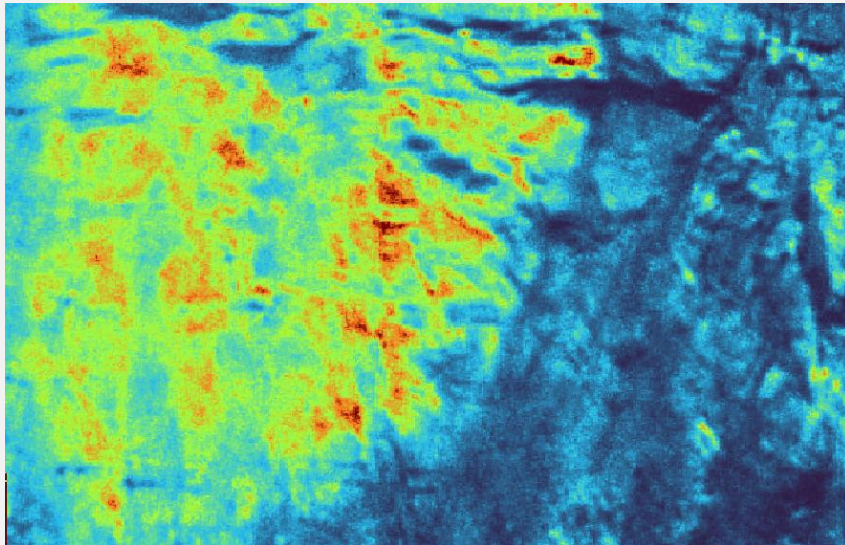
- our system:
Image scanning
- other systems:
Push-Broom scanning



Data interpretation

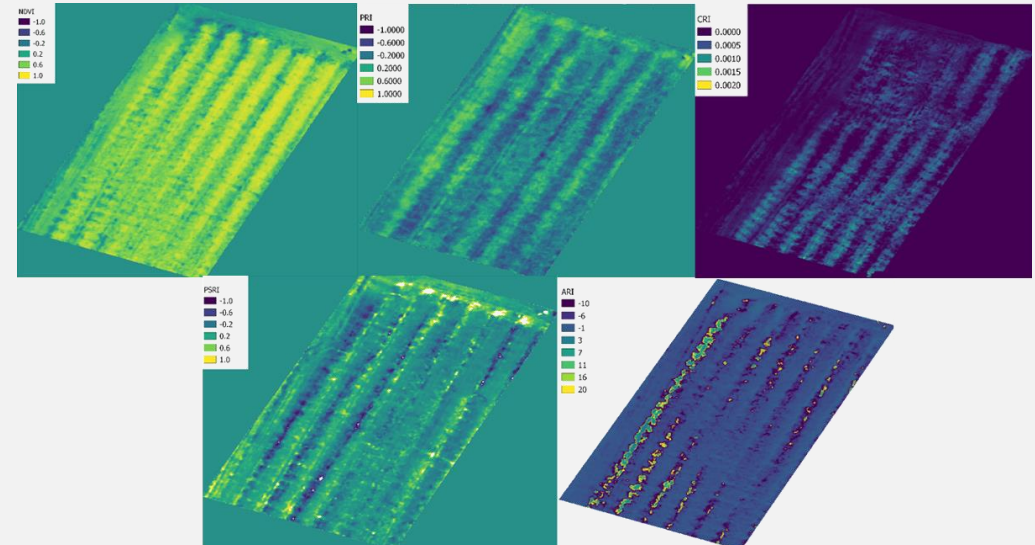
by structure

- find structures
(e.g. ore body outlines, changes in lithology, ...)
- mainly applicable in geology, but also forestry



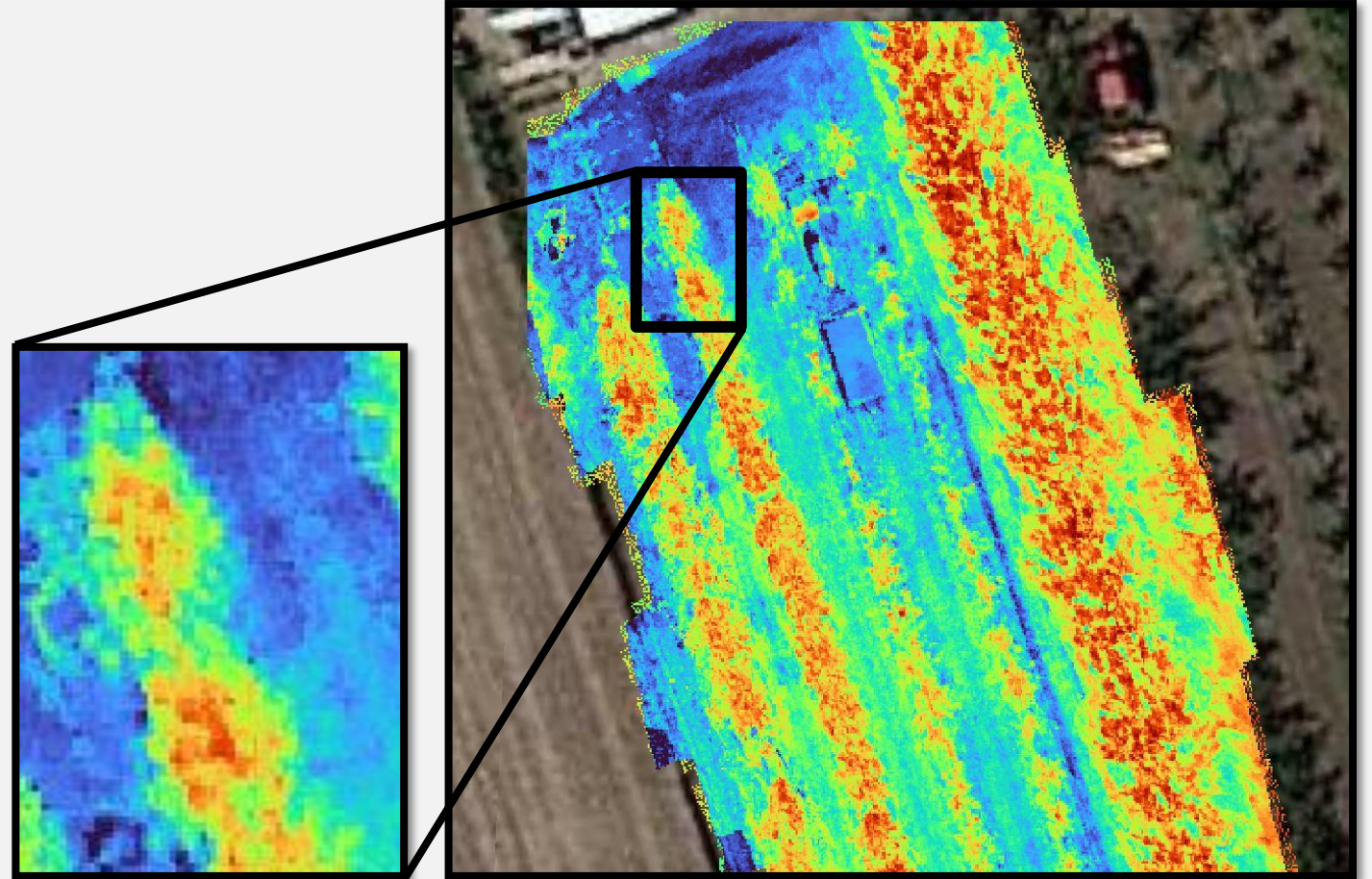
by value

- get actual property values
(e.g. element or nutrient contents, plant health, ...)
- mainly applicable in agriculture, but also geology



Hyperspectral imaging – N content

- cherry trees
- nitrogen concentration index
- $N = 1.61$
 $-2.2 * I(460 \text{ nm})$
 $+0.55 * I(550 \text{ nm})$
 $-2.47 * I(650 \text{ nm})$
 $+2.79 * I(780 \text{ nm})$



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Thank you for your attention!
Any questions? Let us know!