SENSOR DEVELOPMENT & CAL/VAL ACTIVITIES @ DLR-OS

DLR Institute of Optical Sensor Systems
on behalf of the Sensor Design and Development &
Data Processing teams

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CEOS WGCV IVOS 35

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Oberpfaffenhofen

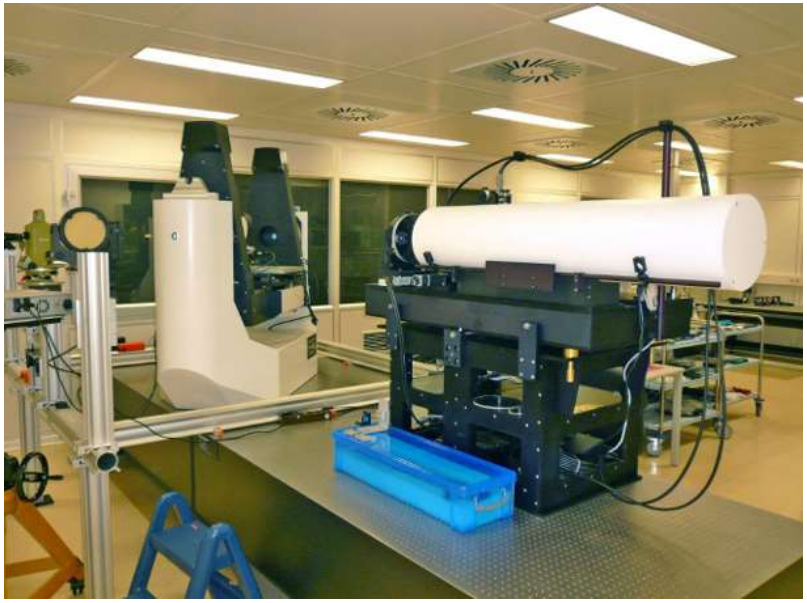
Geometric calibration and static / dynamic MTF (UV, VIS, NIR, SWIR)

Static MTF measurement and geometric calibration in UV / VIS / NIR / TIR

Dynamic MTF measurement for TDI sensors

Adjustment / Measurement of cameras, spectrometer, star cameras

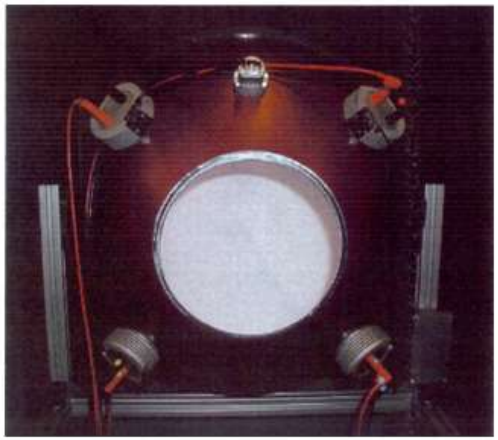
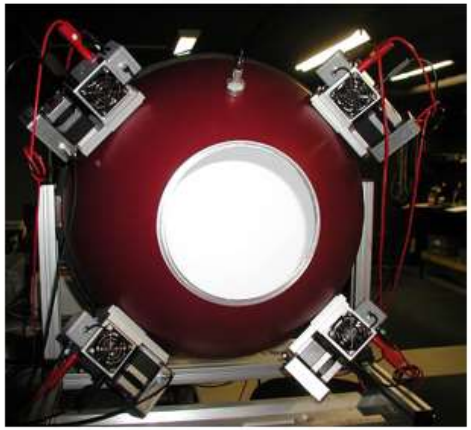
Spectrometer spectral and spatial resolution measurement



- Clean room class ISO8
- Temperature stabilised (±1.0 °C)
- Gimbal-Mount (2 rotations, 3 translations, 100 kg)
- Mirror and Lens collimator F/#8, 1200mm
- Combined with monochromator und halogen radiation source
- Monochromator UV / VIS / NIR
  - Spectral range: $\lambda \in 0.25 – 2.5$ µm, spectral resolution 0.1 – 2 nm
- Calibrated detectors
  - Si-Diode ($\lambda \in 0.4 – 1.05$ µm)
  - PbS-detector ($\lambda \in 0.75 – 3.0$ µm)
  - Spectral line lamps, LEDs, fiber coupled …

Radiometric calibration (UV, VIS, NIR, SWIR, TIR)

- Clean room class ISO8 (ISO5 tent for open detectors), ESD protection
- NIST and PTB- traceable integrating spheres
- Absolute calibration (radiance, irradiance), linearity, PRNU, SNR, PTC for cameras,
- focal planes, single detectors, spectrometer …
- LED combined sphere available
- Different calibrated black bodies für SWIR and TIR , Avantes spectrometer VIS and SWIR
- Microscopes for inspection, test benches, TV chamber
- LED measurement set-up

Successful projects and projects in preparation

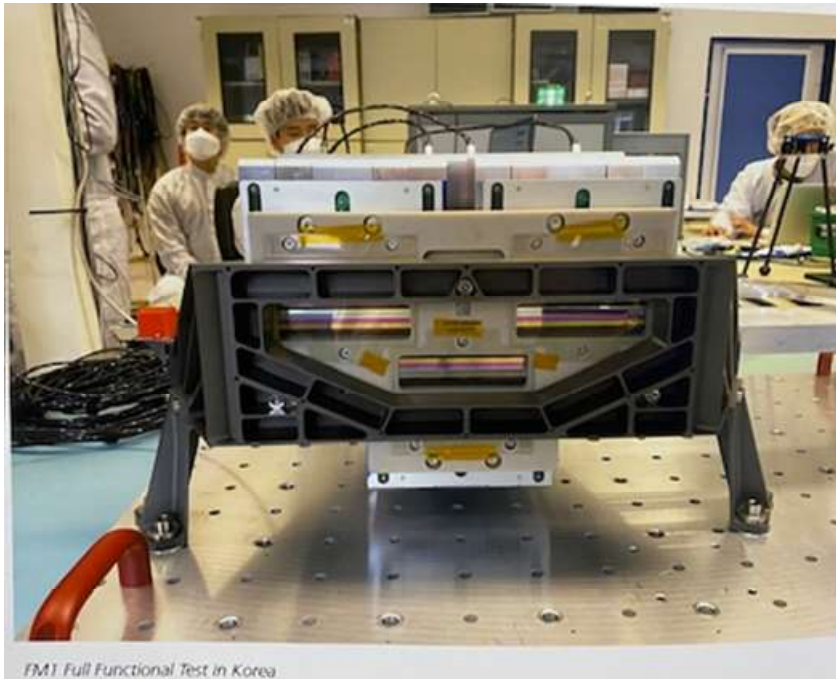
- BIRD, FireBIRD (TET, BIROS): LWIR, MWIR, VIS cameras
- MERTIS IR spectrometer for Bepi Colombo

- KOMPSAT 3 focal planes
- KOMPSAT 7 focal planes
- DESIS VIS spectrometer on ISS
- EnMAP VNIR focal plane

- MACS Aerial camera systems
- RAX Raman spectrometer for MMX-Mission

On-going activities:

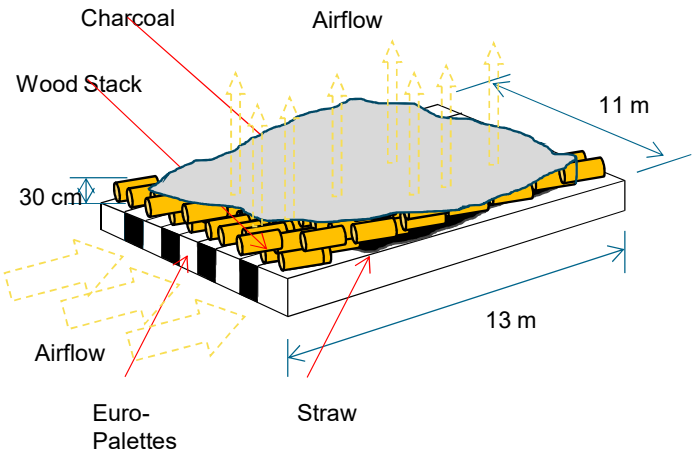
- PLATO Fine Guidance System
- VEM for VERITAS Mission
- COSIS for CO2Image



FM1 Full Functional Test in Korea

FireBIRD - Field Experiments

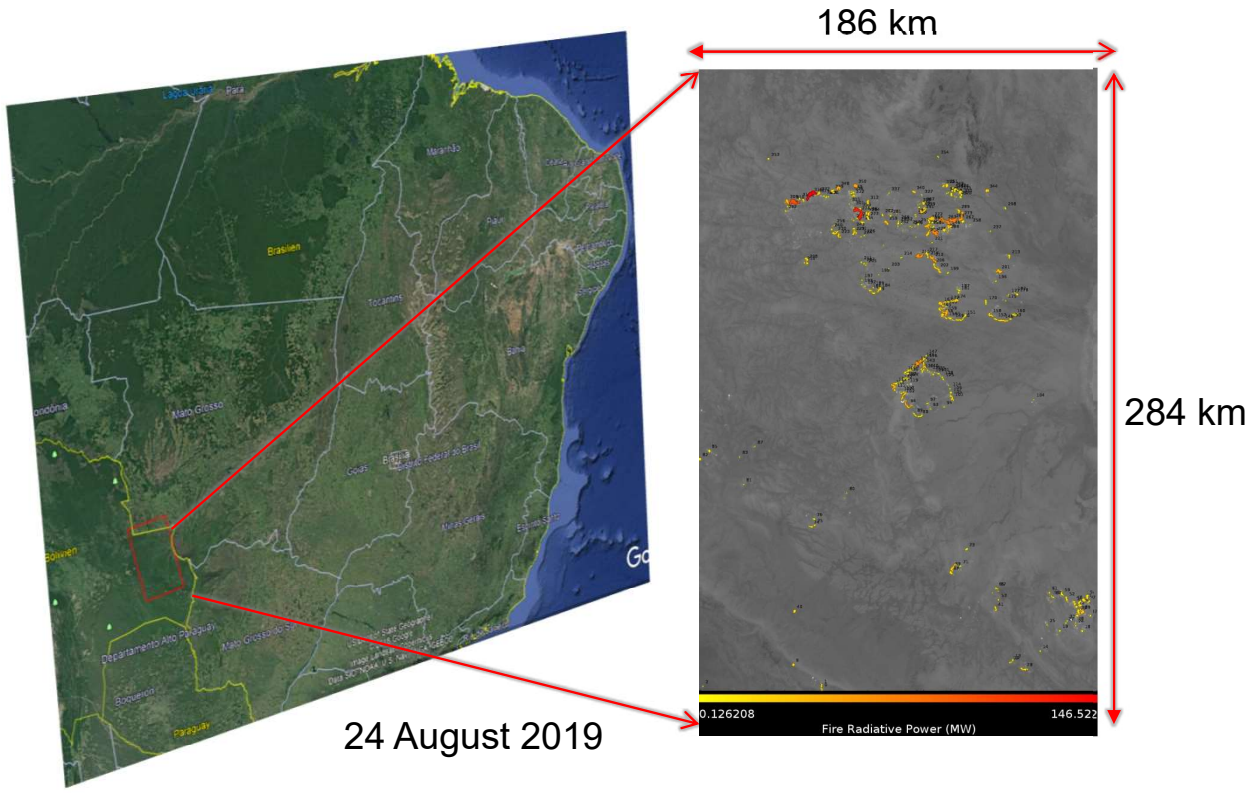
- On-ground measurements:
  - Fire temperature for calculating FRP

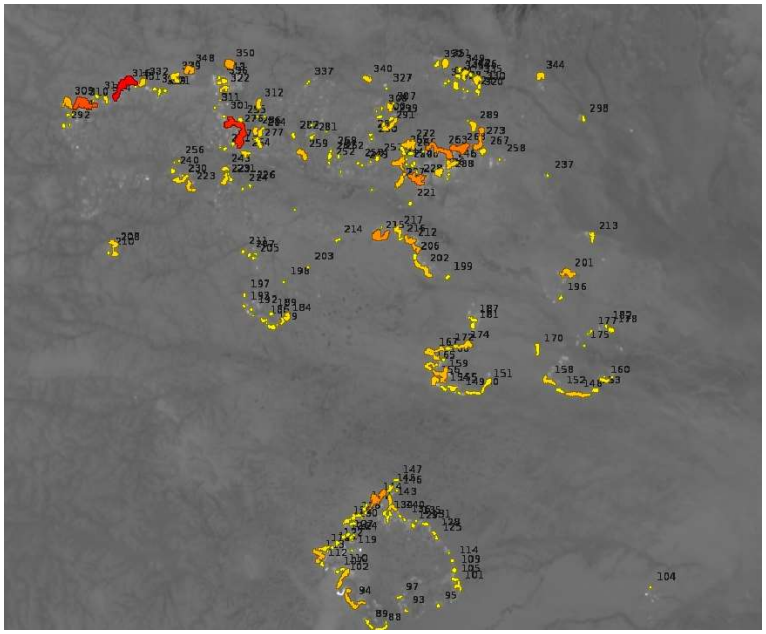


- On-ground measurements:
  (@BAM: Federal Inst. for Materials Research and Testing)
  - Analyse flame characteristics.
  - Compare IR images with measured potential influencing variables, such as gas flow.

- Aerial surveys:
  - Validate on-ground results with imagery from aerial surveys (closer to satellite's perspective).
  - Analyse the effects of the flight height (i.e. rough "atm. correction").

FireBIRD - Forest Fires in Bolivia 2019





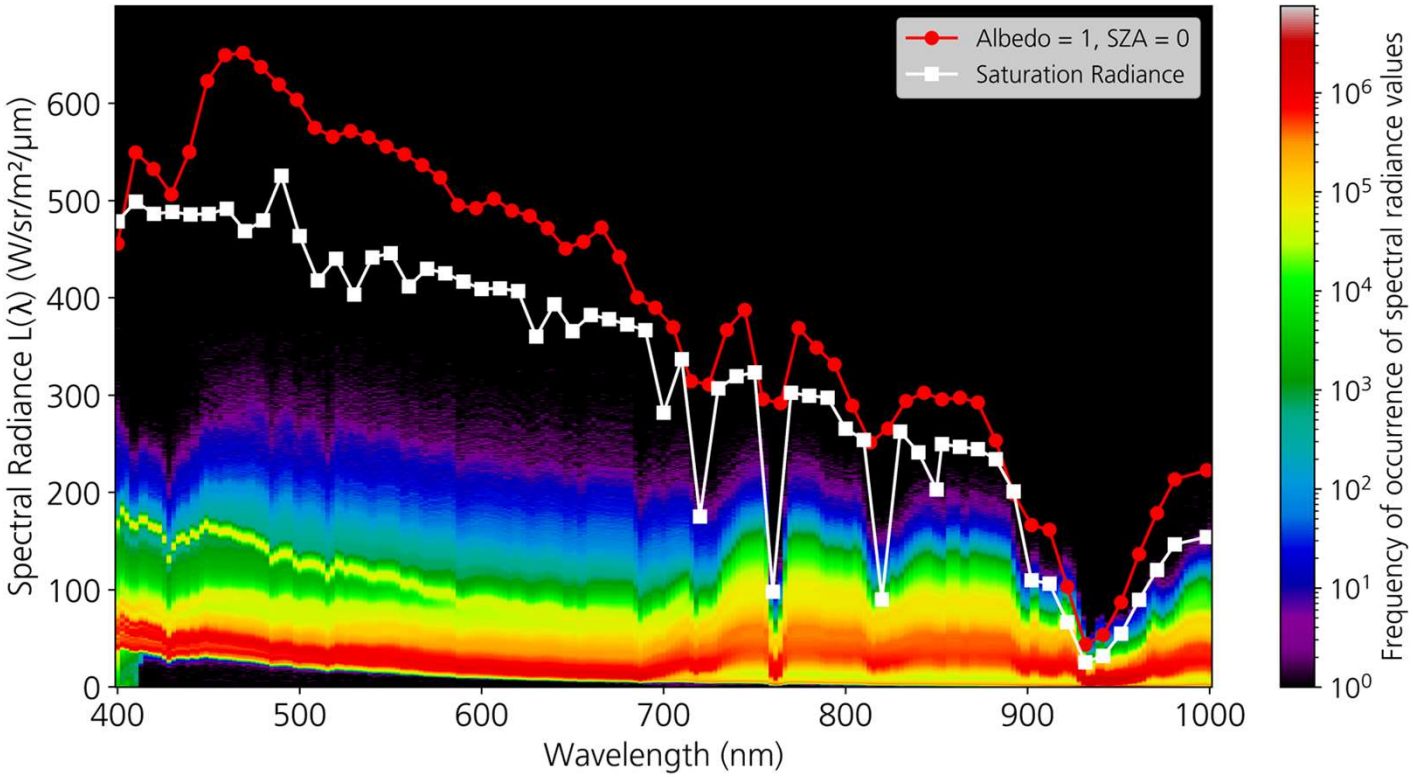
detected cluster: 357

size: ~ 223 km²

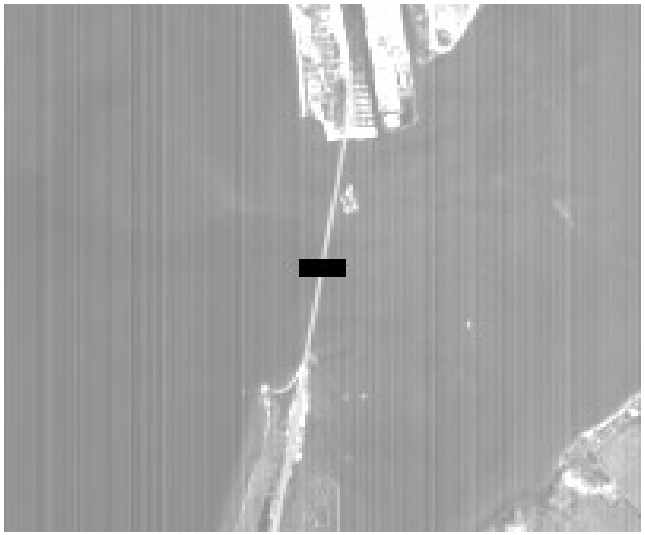
FRP: ~3 GW

DESIS- Radiance Data Analysis

- ~ 600 scenes from 2018 - 2023
- Analysis of land cover types
- Consideration of sun sensor geometry & characterization of image phenomena
- Statistical analysis of outliers



DESIS - Vicarious Assessment of Geometric Quality



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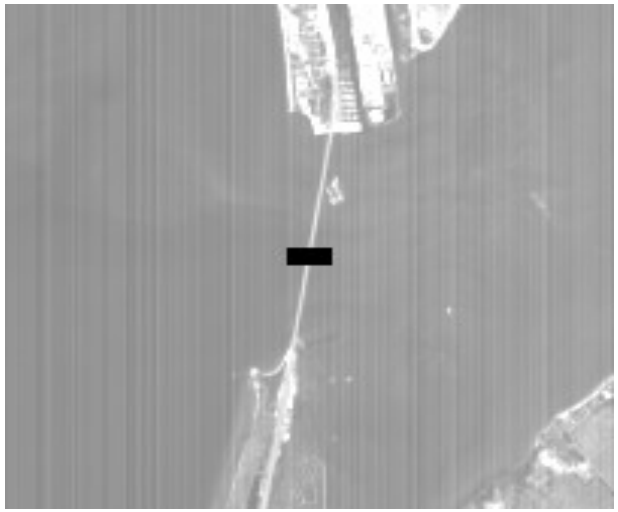
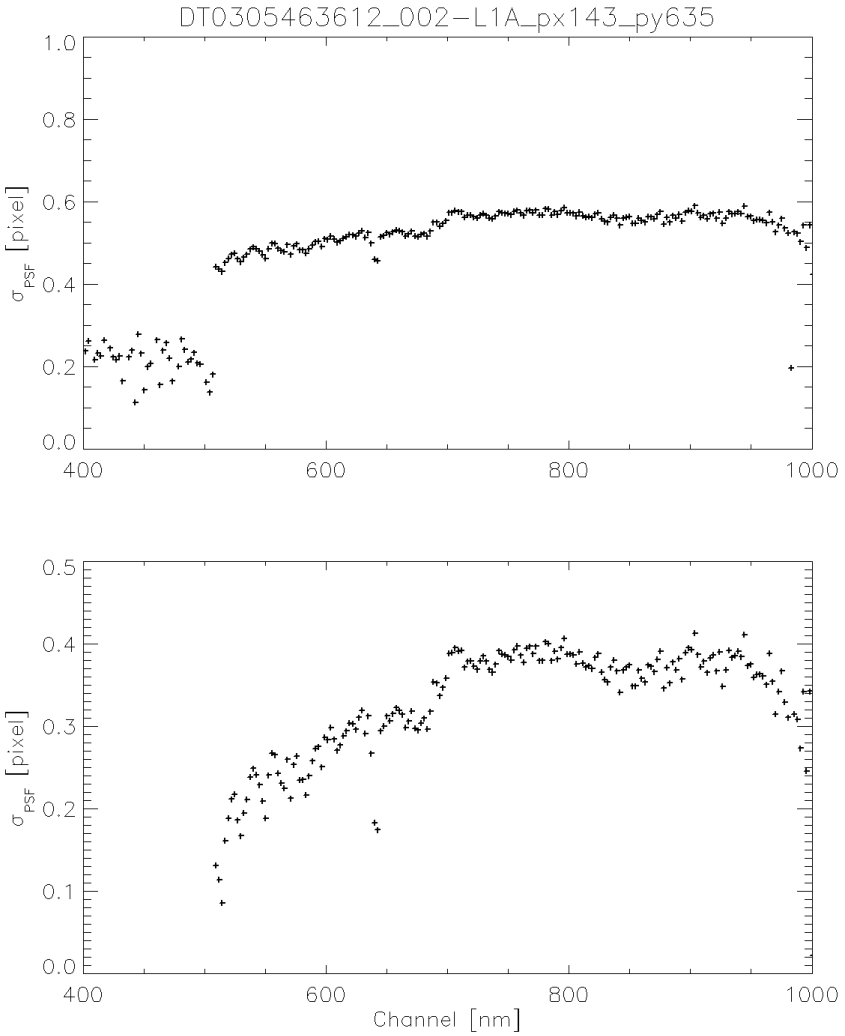
Corpus Christi
(Nueces Bay Causeway)

- The use of bridges or similar allows an estimation of the PSF from a gauss fit.
- To improve the accuracy one can use a similar method as slanted edge.
- This gives an improvement of the information on intermediate or sub-pixel positions.
- To determine the sensor PSF, one have to consider the width of the test structure used.
  In addition, smearing effects, caused by motion have be taken into account.
- This is taken into account here by the additive properties of sigma (PSF) of the individual components.

Vicarious Assessment – σ PSF



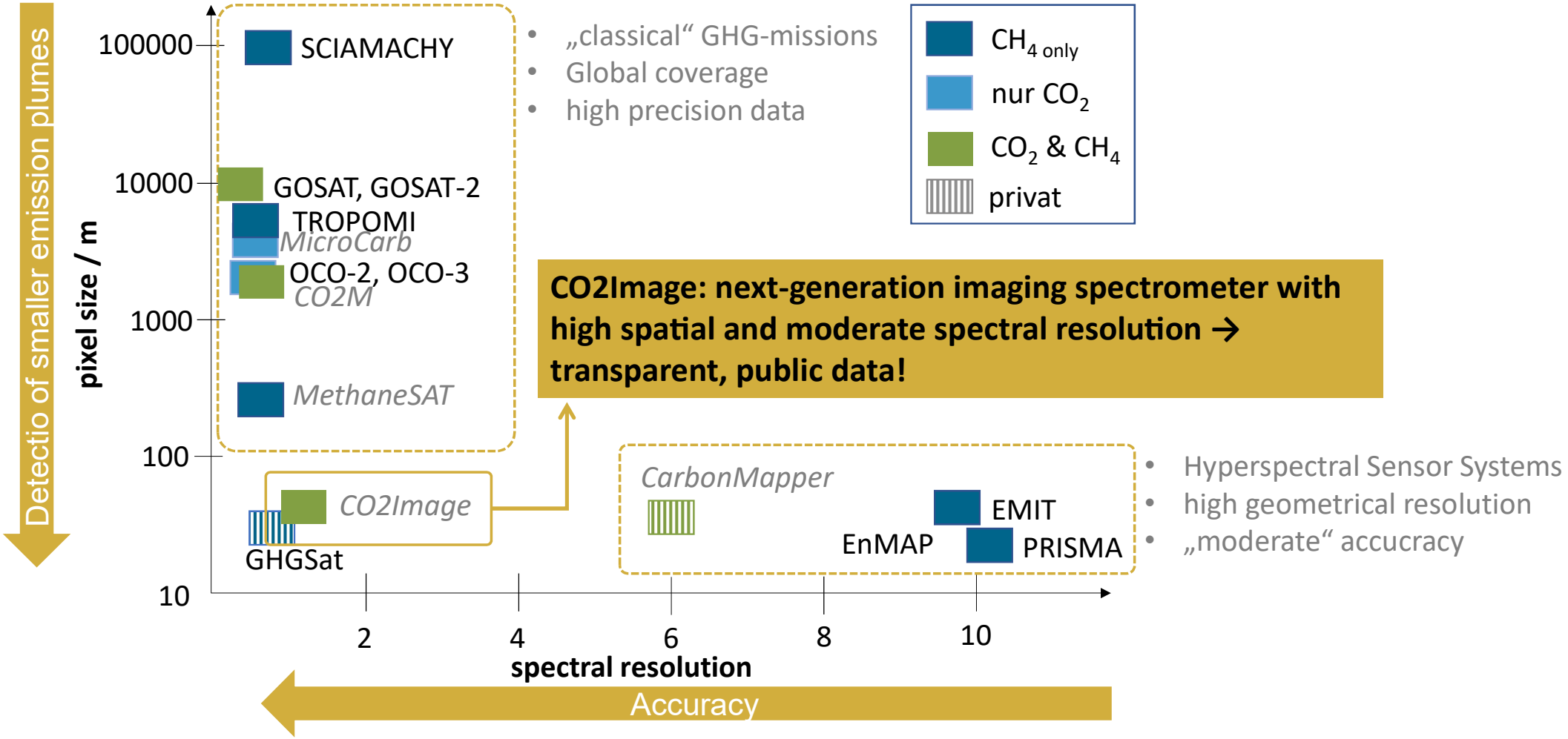


Sigma PSF L1A data: calculations for taking the edge of the bridge as a test object, in flight direction => grey stripes

upper right: calculation along-track: changes up to 60% (inverted modular transfer function MTF), due to smearing effects caused by motion.

lower right: cross-track: sigma is clearly smaller, but variability is clearly visible.

CO2Image: Innovation in comparison to other Missions

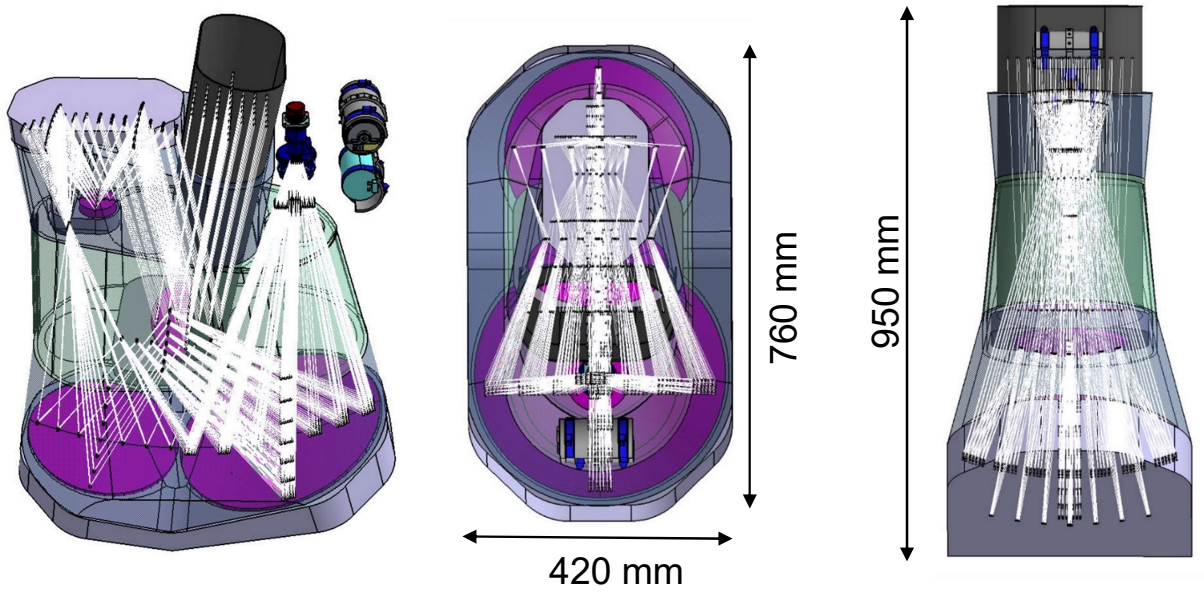


CO2Image: COSIS Instrument

Mass	110 kg
Swath	50 km
Spatial resolution	50 m x 50 m
Spectral range	1972-2400 nm
FWHM (2.5 pix)	1.3 nm
Resolving power	1600
Aperture diameter	15.0 cm
f number	2.0
Optical efficiency (η)	0.48
Integration time	70 ms
Detector pixel area	900 μm^2
Quantum efficiency (Qe)	0.8 e^- $photon^{-1}$
Dark current	1.6 fA pix^{-1} s^{-1}
Readout noise	100 e^-
Quantization noise	40 e^-

[Krutz et al., 2022]

- Single-Pass TMA Spectrometer
- Design by DLR-OS, optics manufactured by Fraunhofer Institute for Applied Optics and Precision Engineering, Jena
- Detector: AIM AGD, 1280 x 1024 pixel



PoC

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