Setups for alignment and on-ground calibration and characterization of the EnMAP Hyperspectral Imager

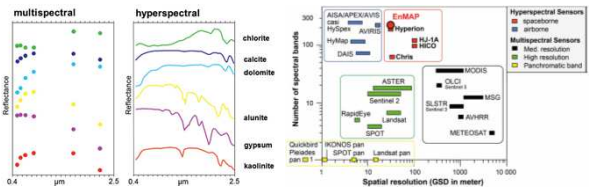
Anna Serdyuchenko[a], Leonhard Polz[a], Matthias Lettner[a], Sebastian Fischer[b]

[a]OHB System AG, Manfred-Fuchs-Str. 1, D-82234 Weßling;

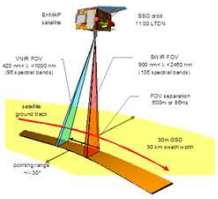
[b] DLR Space Administration, Königswinter Str. 522-524, 53227 Bonn, Germany

The ***Environmental Mapping and Analysis Program Hyperspectral Imager*** (EnMAP HSI) will allow to acquire images of the Earth surface in a push-broom configuration. Spectral coverage includes 230 wavelength bands between 420 nm and 2450 nm which are simultaneously recorded with a ground resolution of 30 m x 30 m. This contribution presents the setups and strategy of the on-ground alignment and characterization measurements. Instrument requirements on calibration accuracy will be reported and The traceability to national standards will be described.

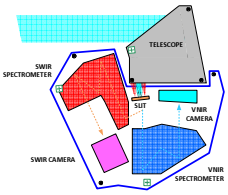
EnMAP Mission Benefits



EnMAP Instrument



Mean spectral sampling distance	VNIR: 6.5 nm SWIR: 10 nm
Radiometric calibration accuracy	< 5 %
Radiometric stability	< 2.5 %
Sensitivity to polarization	< 5 %
Spectral smile/keystone effect	< 20 % of a pixel
Co-registration VNIR-SWIR	< 20 % of a pixel



Alignment and Calibration Key Requirements

Telescope focusing
- Defocus <~10 µm
- For all field points
- For VNIR and SWIR channel

Spectral Calibration
- Pixel center wavelength
- Bandwidth
- Smile
- Spectral response function

Spectral calibration acc. < 0.1SSD

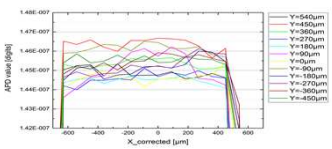
Geometrical and Image quality calibration
- Line of sight (LoS) of individual pixels
- Spectral channel co-registration
- Instrument/star sensors alignment
- Line spread function across /along track
- Field-of-view (FOV)
- MTF
- Keystone

LoS measurement acc. < 1 arcsec

Test Setup Development Approach

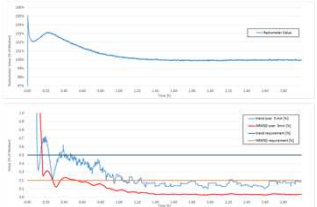
Modular, multi-purpose Architecture
- High degree of automatization
- Maximize re-use and synergies of recurring tasks
- Separate light source and instrument illumination optic allows high flexibility
- fiber Interfaces allow to connect various light sources

FAI: Full Aperture Illuminator *design and manufacturing by Bertin technologies upon OHB Specification*
- 200mm unobscured 2-mirror collimator, field: 1.5x4arcmin
- Positioning hexapod to cover the full instrument FOV
- Source assembly including defocus sensor
- Angular stability monitoring system
- Scene simulator (ALIO 2D stage and Optimask pattern plate)
- Multiple configuratons for mesurements: defocus, LoS, MTF and spectral



Illumination homogeneity in FAI focal plane, scanned with Avalanche Photo Diode (APD)

WiRAL: Wide Range Adjustable Light Source
- Monochromator based light source
- BroadBand mode and Scanning Mode: 382 - 2481 nm gapless
- Bandwidth 0.5 - 2 nm ±3% (entire range)
- Abs calibration and repeatability <50 pm (entire wavelength range)
- Smooth change of flux over Wavelength
- Radiometric fluctuations < ± 0.5%
- Light power > 0.3 µW and 0.05 µW for used bandwidth, coupled into multimode fiber.



WiRAL output power stability at 970nm: top - measured relative optical power, bottom - trend and NRMSD evolution over time.

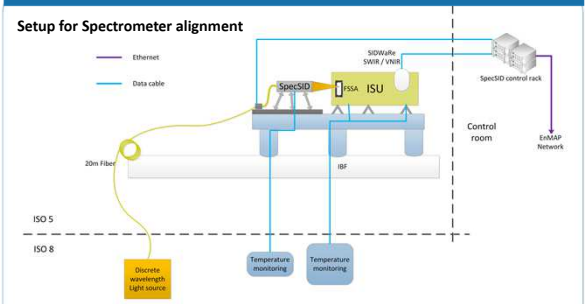
HDAC: High Dynamic Range Autocollimator
- Electronic autocollimation telescope (Möller Wedel Optical)
- +/- 23 mrad (1.32°) x +/- 0.5 mrad (0.03°)
- Accuracy 1.2 µrad (calibrated, to national standards)

FAM: Full Aperture Mirror
- 330 mm flat reference Mirror; SFE: < 6nm (rms)
- Tip tilt gimbal mount

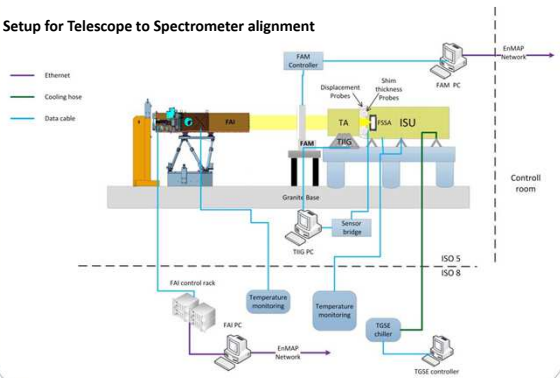
FIS: Fully Integrating Sphere (Property of DLR-IMF)
- Homogeneous broadband illumination at 14 different power levels, traceable calibrated to national standards

Alignment Setups

Setup for Spectrometer alignment



Setup for Telescope to Spectrometer alignment

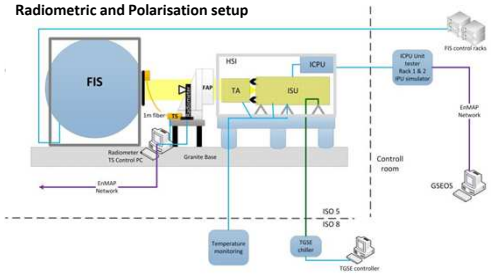


FMS: Fiber Mixing System
- Fiber based homogenizer, produces homogeneous spatial and angular intensity distribution

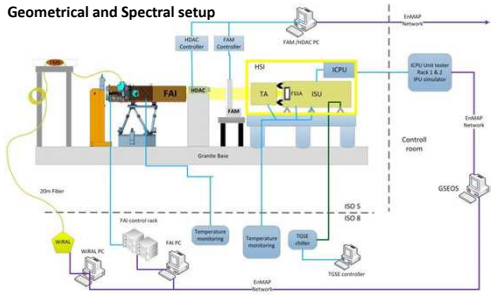
Abbreviations
- FAI: Full aperture Illuminator
- FAM: Full aperture Mirror
- FAP: Full Aperture Polarizer
- FIS: Fully Integrating Sphere
- FSSA: Field Splitter Slit Assembly
- GSEOS: Ground Support Equipment Operation System
- HDAC: High Dynamic Range Autocollimator
- ICPU: Instrument Control Power Unit
- ISU: Instrument Spectral Unit
- SLTS: Stray Light Test Source
- SIDWaRe: Spectrometer Illumination and Detection Wavefront Reference
- SpecSID: Spectrometer Illumination and Detection
- SWIR: Short Wave Infrared
- TA: Telescope Assembly

Calibration and Characterization Setups

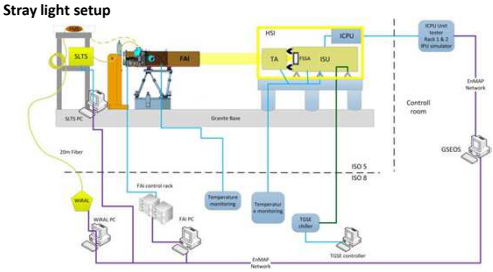
Radiometric and Polarisation setup



Geometrical and Spectral setup



Stray light setup



- TGSE: Thermal Ground Support Equipment
- TIIG: TA to ISU Integration GSE
- VNIR: Visible and Near Infrared
- WiRAL: Wide Range Adjustable Light Source

ICSO 2021, March 30th – April 2nd

Acknowledgement
The work presented on this poster was performed on behalf of the DLR Space Administration with funds of the German Federal Ministry of Economic Affairs and Energy under the grant No. 50 EP 0801.

Image credits:
GFZ Potsdam, OHB System AG, DLR, Trier University

Contact:
leonhard.polz@ohb.de
anna.serdyuchenko@ohb.de

We. Create. Space.