MERIS Validation Team Meeting, JRC Ispra, 9.3.2011

New calibration facility at DLR Oberpfaffenhofen

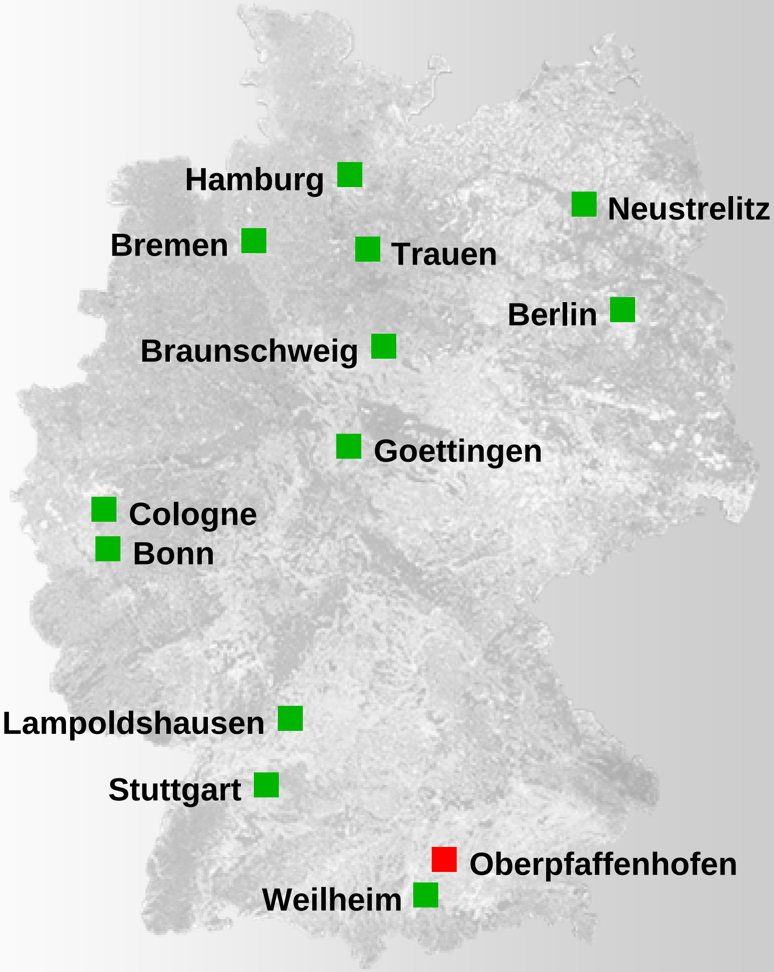
P. Gege, DLR, Remote Sensing Technology Institute

DLR – German Aerospace Center

6700 employees across
33 institutes and facilities at

- 13 sites.

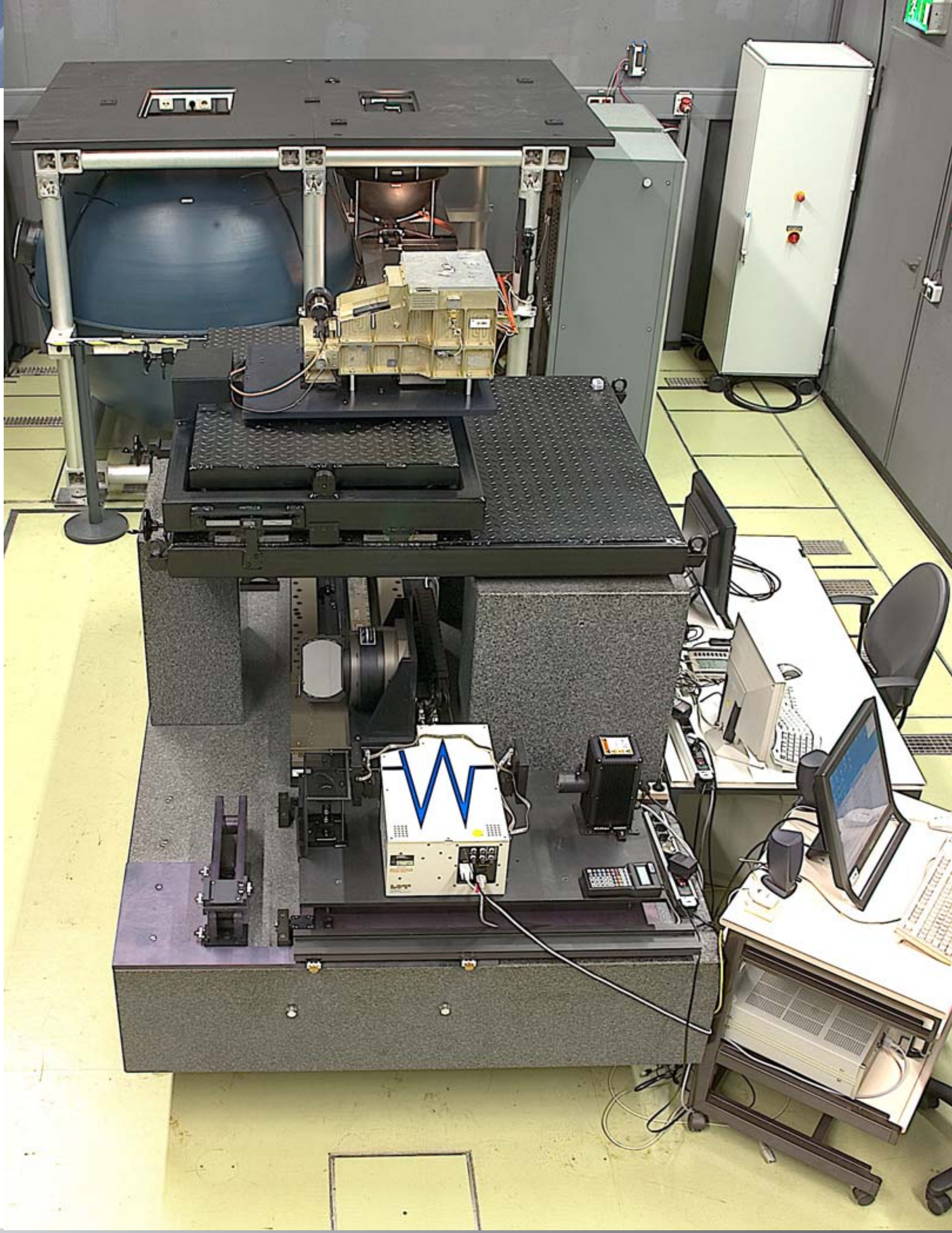
Offices in Brussels,
Paris and Washington.



Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

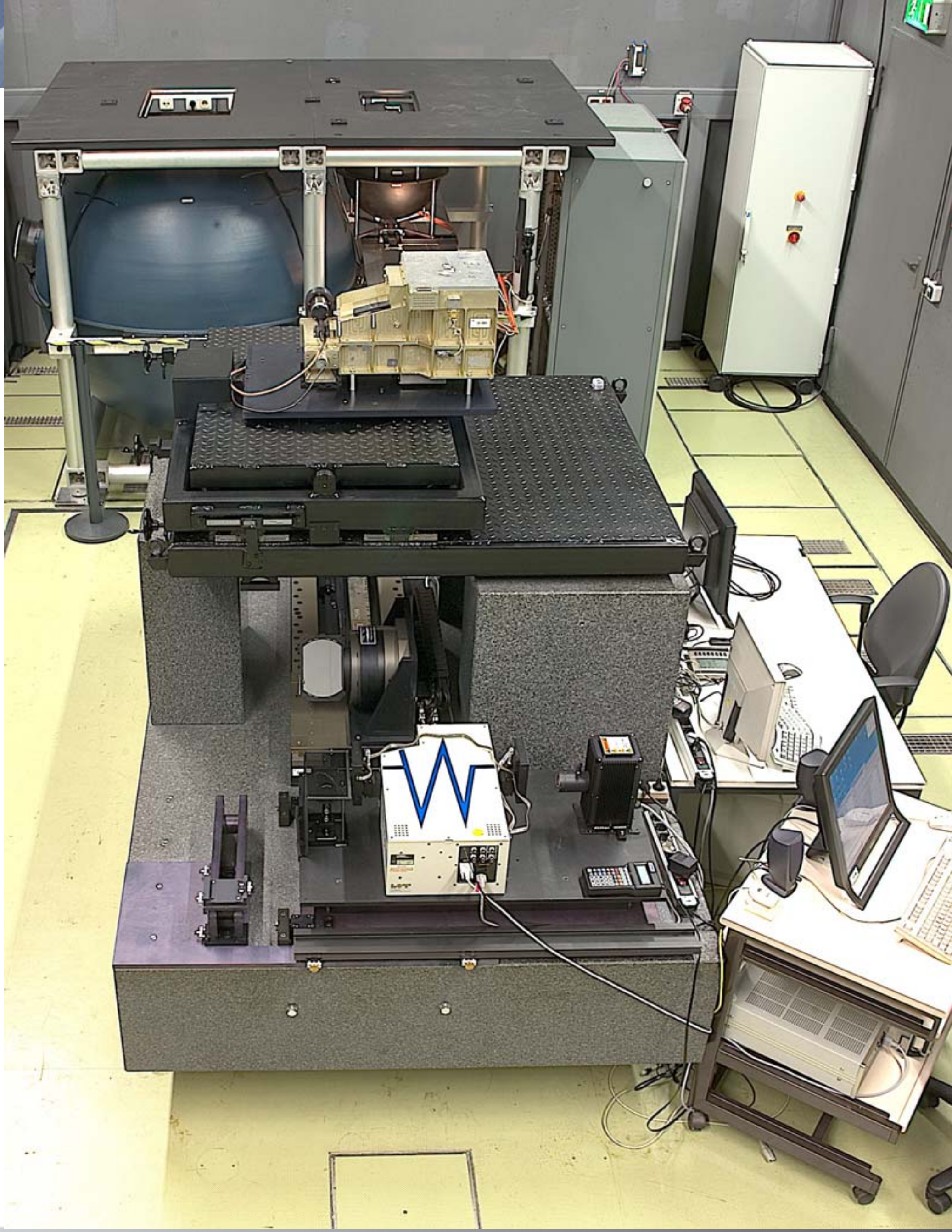
Introduction

- Funded partly by ESA to establish **Calibration Home Base (CHB)** for APEX
- Designed for hyperspectral sensors similar to APEX
  - Mass: 170 kg (excl. adapter)
  - λ-range: 380–2500 nm
  - Bandwidth: 5–10 nm
  - IFOV: 0.48 mrad
  - FOV: ±14°
- Operational since 2007.



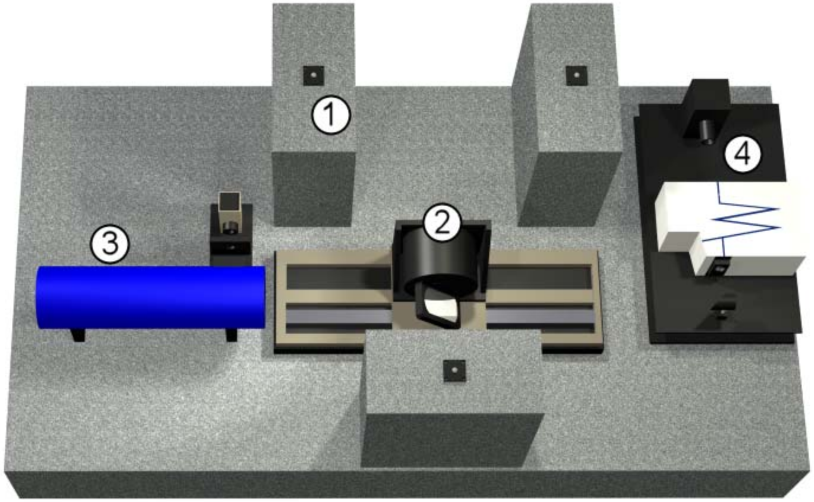
Premises

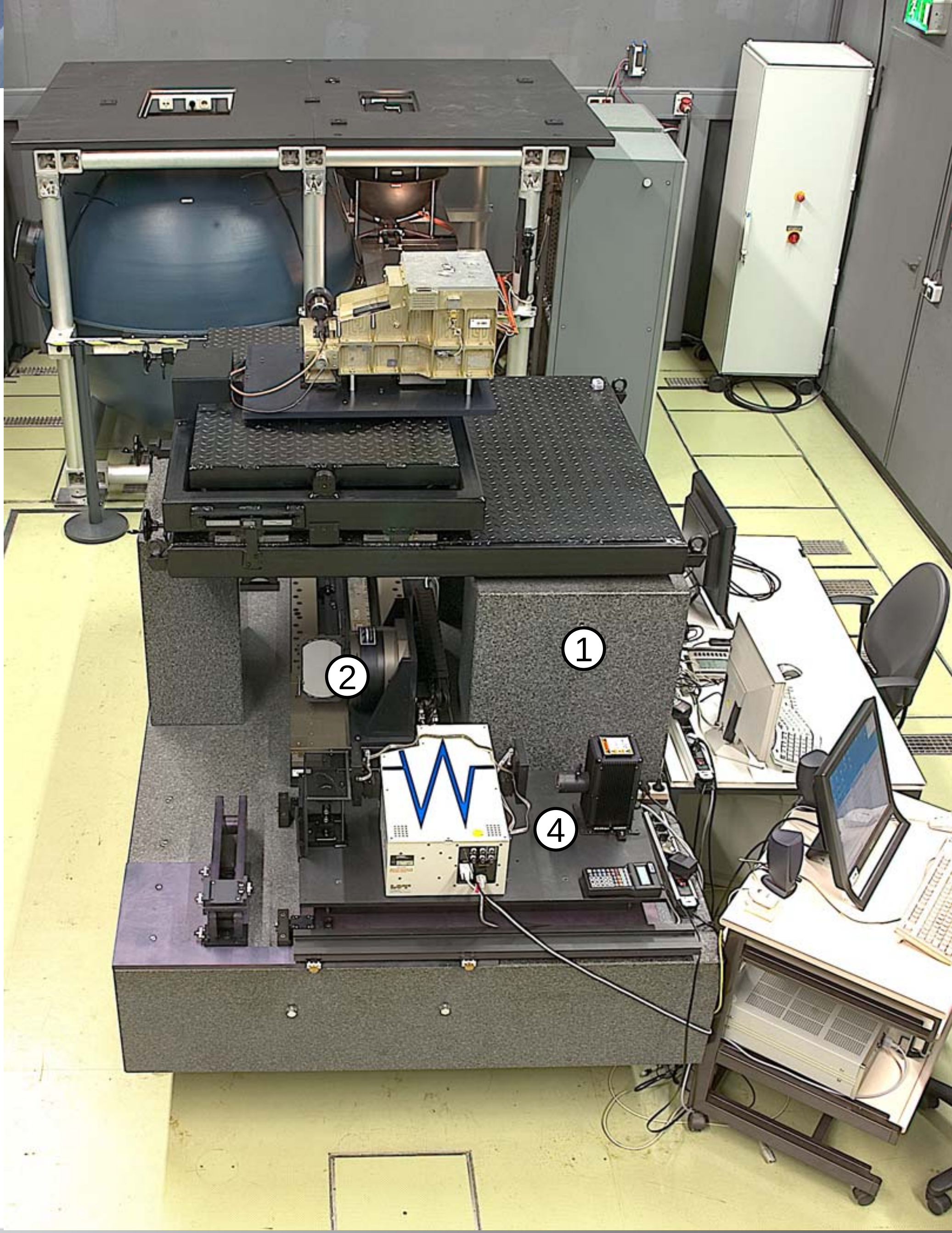
- Close to airfield of DLR Oberpfaffenhofen
- Suited for bulky and heavy instruments up to 500 kg (incl. adapter)
- Sensor in same position as in aircraft
- Sensor stable on vibrationally isolated calibration bench
  - Spectral calibration
  - Geometric calibration



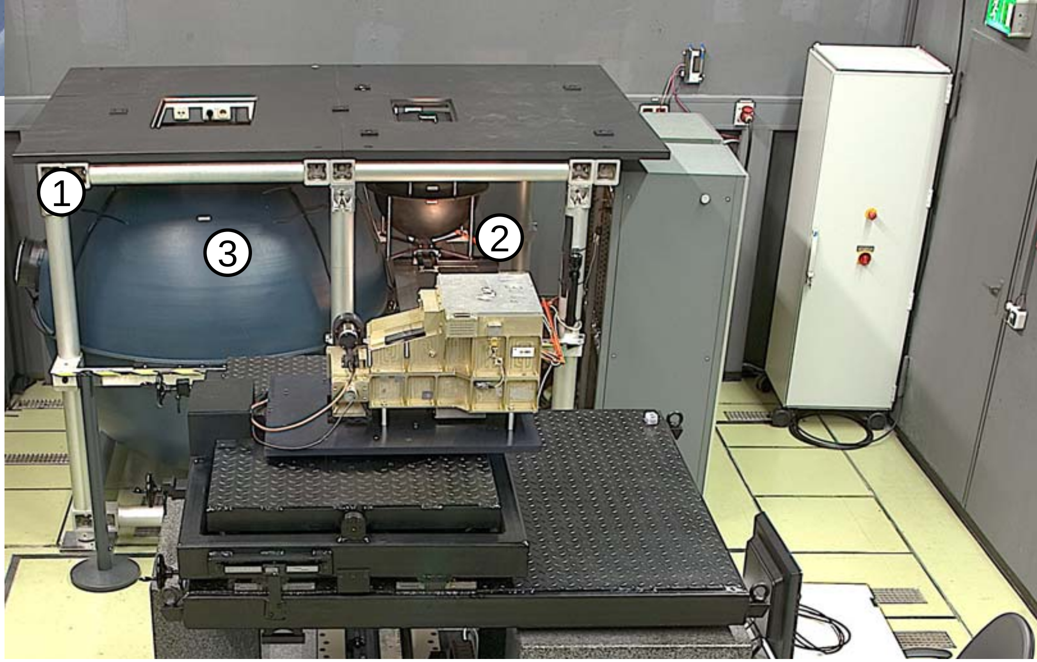
Folding mirror concept

1. Pillar bearing instrument + adapter
2. Folding mirror
3. Assembly for geometric measurem.
4. Assembly for spectral measurem.



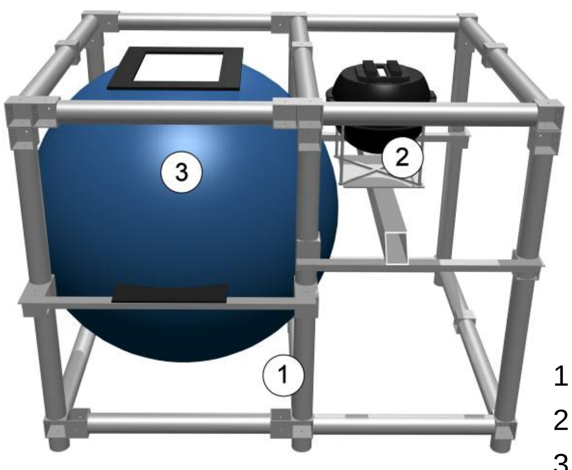


Flat-field measurements



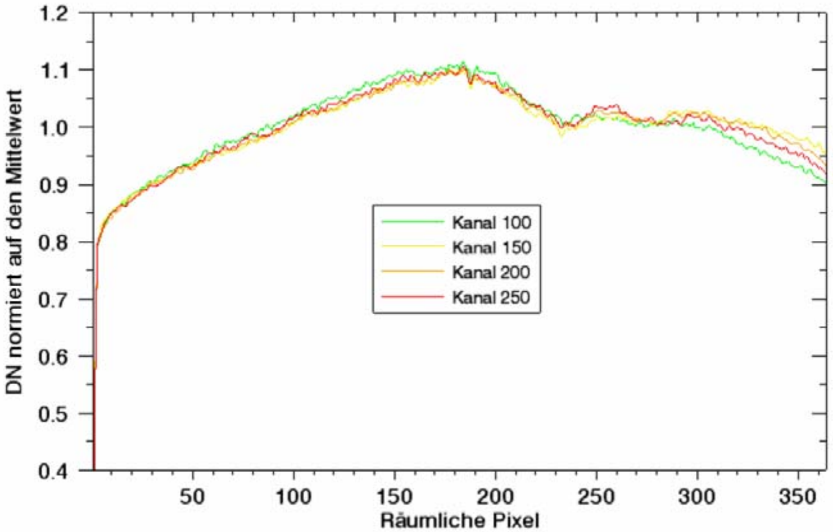
Large integrating sphere ③

- ∅ 1.65 m
- Aperture 55 x 40 cm²
- Inhomogeneity < 0.5 % rms
- 18 lamps
- Various radiance levels (57 – 1524 W m^{-2})



1. Frame
2. Small integrating sphere
3. Large integrating sphere

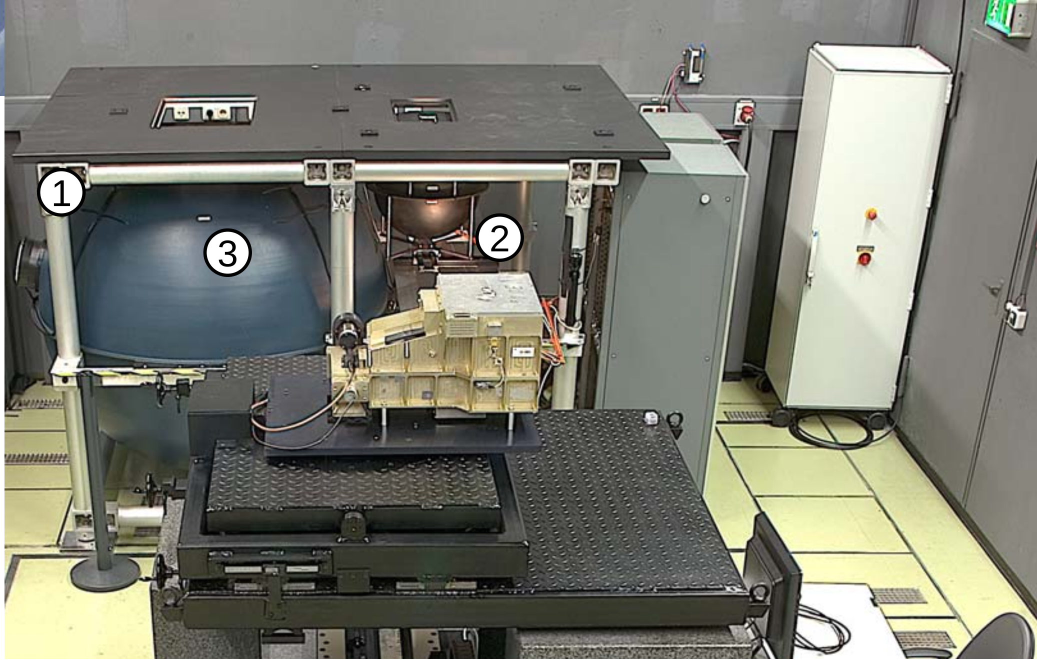
AISA (Kuhlbach 2008)

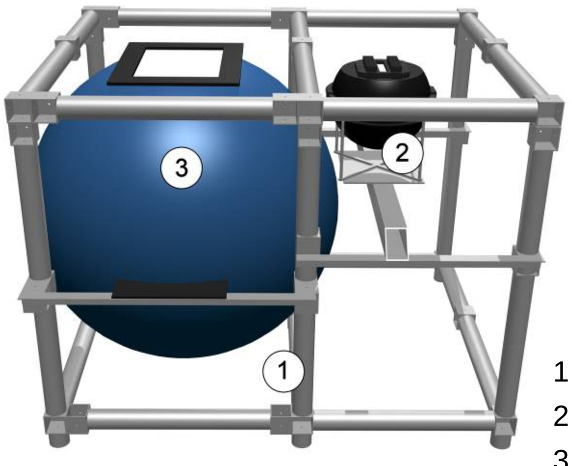


Radiometric calibration

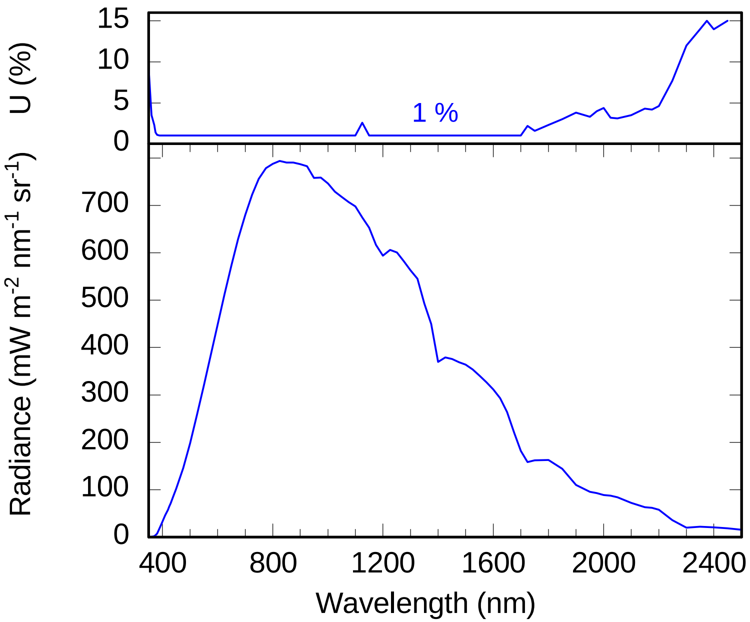
Small integrating sphere ②

- ∅ 0.50 m
- Aperture 4 x 20 cm²
- Traceable to PTB
- Uncertainty (k=2) 1 % in VIS





1. Frame
2. Small integrating sphere
3. Large integrating sphere



Absolute radiometric calibration of radiance sources

New

Relative radiance

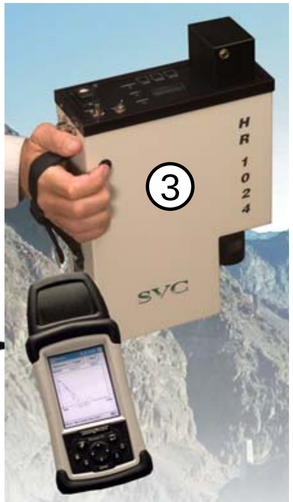
1. Calibrated halogen lamp
2. Calibrated diffuser
3. Spectrometer

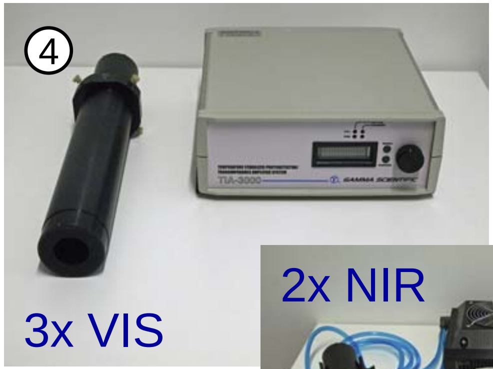
Absolute radiance

4. 5 Filter radiometers

Uncertainty goal

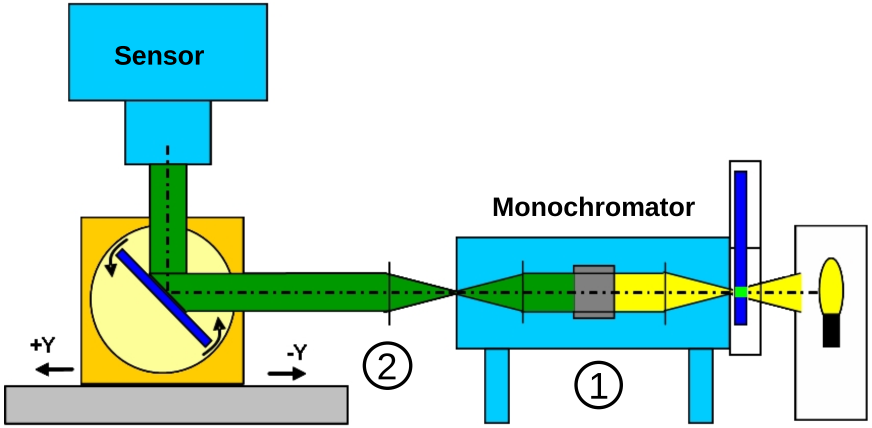
- 1σ = 1.5 % at 0.35-1.7 µm (2011)
- 1σ = 2.5 % at 1.7-2.5 µm (2012)

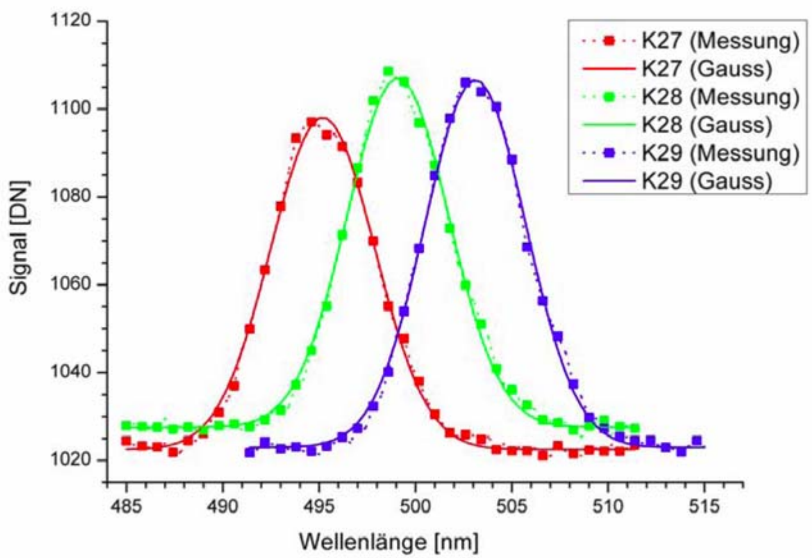




Spectral measurements

1. Monochromator Oriel MS257
   - Range: 0.38–14 µm using 7 gratings
   - Uncertainty: ± 0.1 nm
   - Spectral bandwidth: > 0.1 nm (depending on grating and slit width)
2. Parabolic mirror
   - f = 119 mm
   - Beam divergence ~ 0.8 x 8 mrad²
   - Beam cross section ~ 3 x 4 cm²

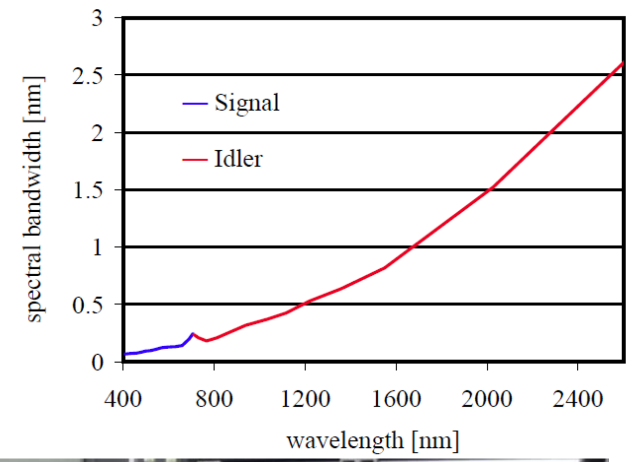




Spectral response function of 3 ROSIS channels (Harder 2008)

Spectral measurements: Tunable laser

New



Specifications

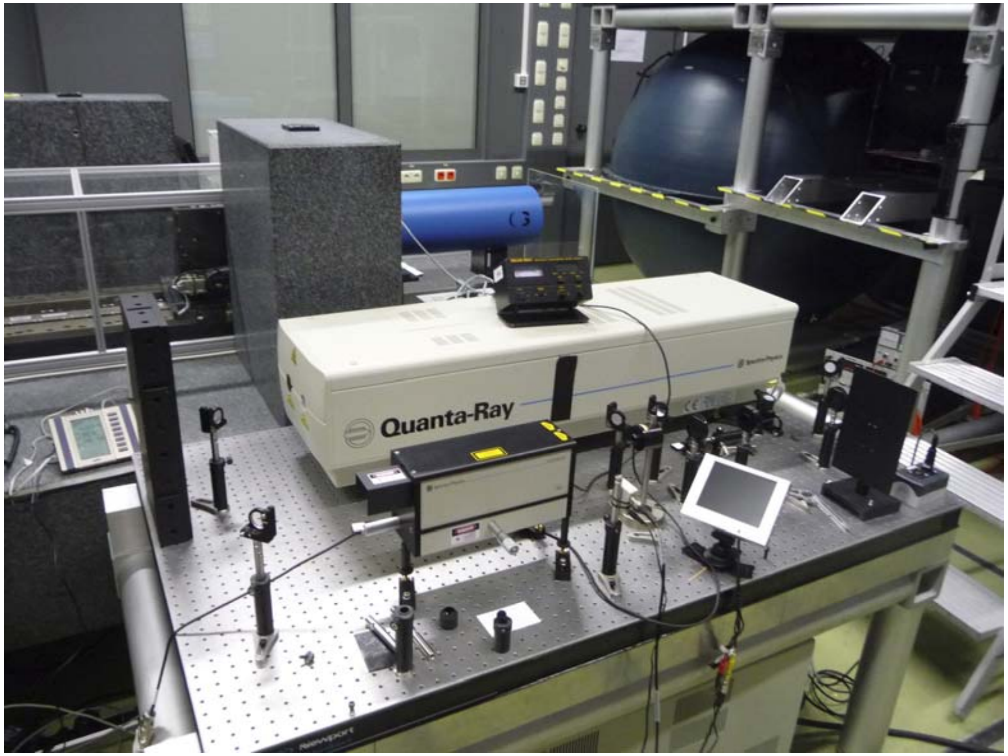
- Range: 0.4 – 2.5 µm
- Resolution: 3 – 7 cm^{-1}
- Repetition rate: 10 Hz

Advantages

- High energy
- No sensor alignment
- All pixels simultaneous

Disadvantages

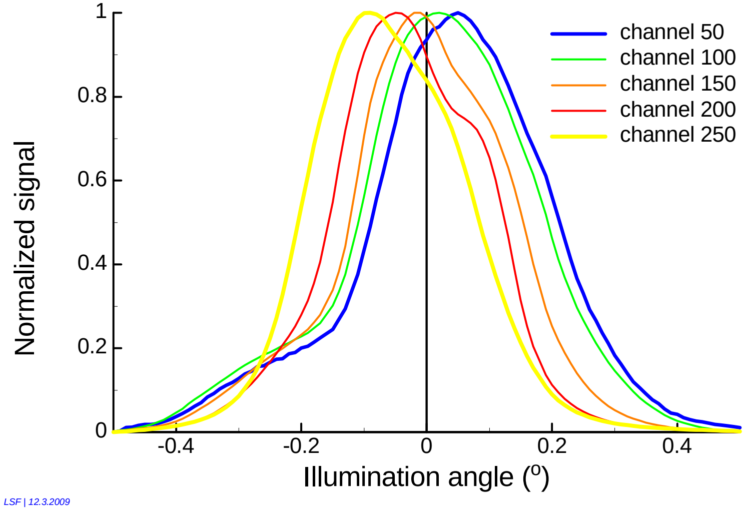
- High safety requirements
- Fix bandwidth
- Pulsed (not suited for scanners)

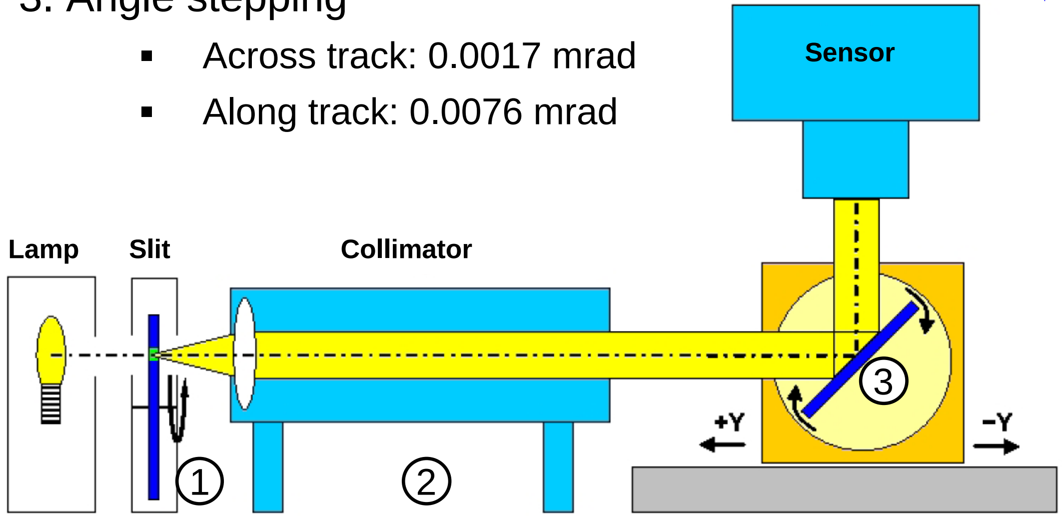


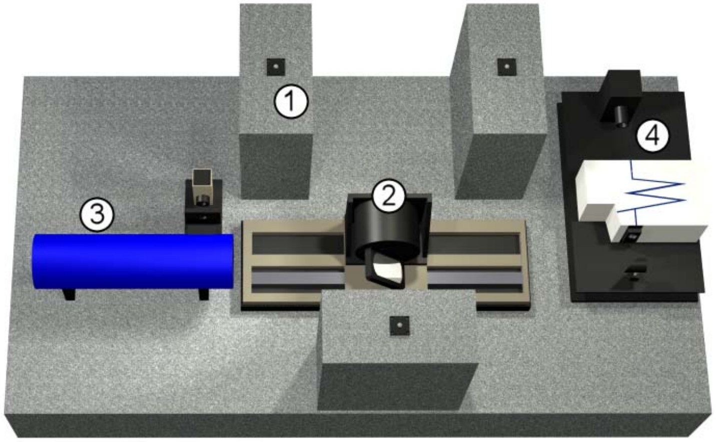
Geometric measurements

1. Slit wheel
   - 3 horizontal + 3 vertical slits
   - Widths: 50, 100, 1000 µm
2. Collimator
   - f = 750 mm
   - Divergences: 0.067, 0.13, 1.3 mrad
   - Beam cross section: ∅ 12 cm
3. Angle stepping
   - Across track: 0.0017 mrad
   - Along track: 0.0076 mrad

LSFs of AISA pixel no. 192
(adapted from Suhr 2008)





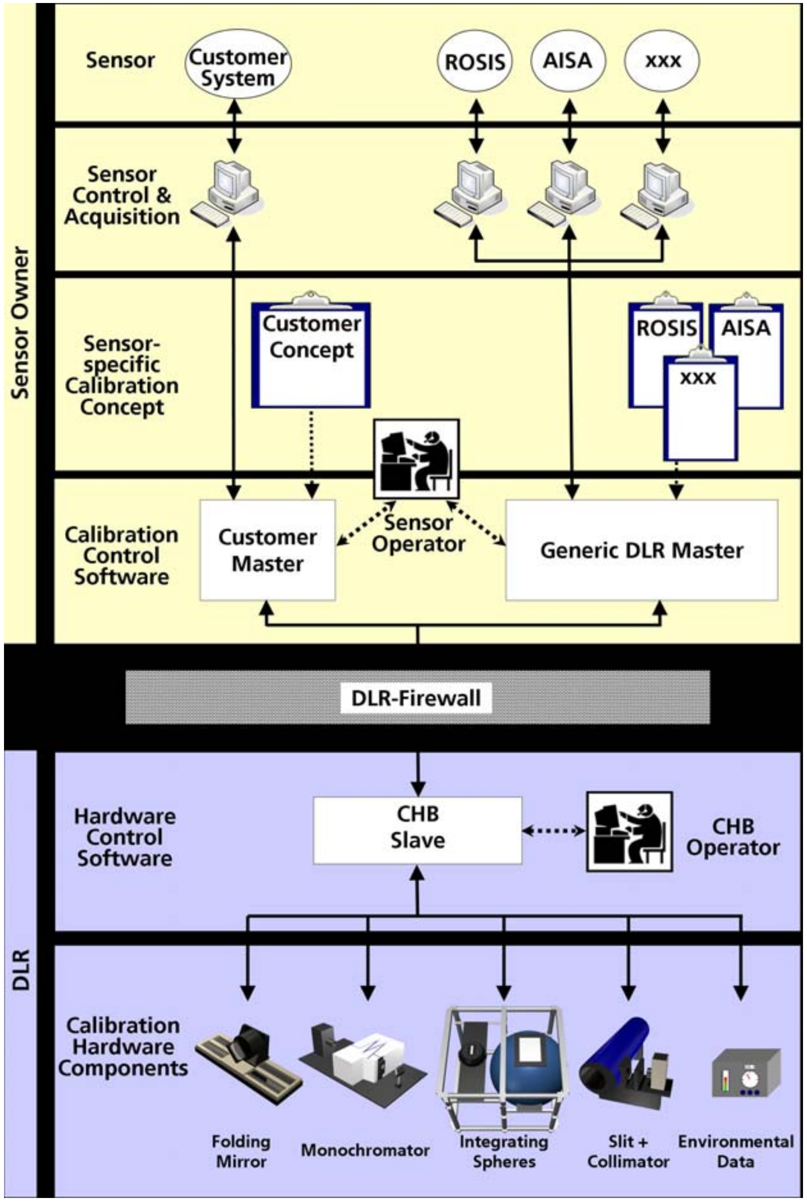


Auxiliary measurements

- Detector linearity
  - Small sphere and neutral density filters
- Spectral stray light
  - Monochromator
  - Small sphere and bandpass filters
  - New: Tunable laser
- Spatial stray light
  - From inside FOV: set-up for geometric measurements (LSF)
  - From outside FOV: large sphere and reflectance targets
- Polarisation
  - 3 linear polarisers 0.47 – 2.5 µm

Computer control

- CHB Slave
  - Controls CHB hardware components
- CHB Master
  - Measurement concept
  - Commands sensor
  - Commands CHB slave



Service

- CHB infrastructure accessible to customers on request

- DLR contributions:
  - Consultancy (calibration concept, campaign planing)
  - Support for system adaptation (mechanics, software control)
  - CHB mobilisation, wrap-up
  - Operation of CHB subsystems during campaign
  - Tbd: scientific support (data evaluation, interpretation)

- Timeline:
  - Preparation phase (standard): 2-3 months
  - Campaign duration (standard): 1 week +

- Cost: 10 k€+

Summary

- Facility for characterisation of airborne imaging spectrometers and field spectrometers
  - Bulky and heavy instruments up to 500 kg
  - Spectral range: 380 – 2500 nm
  - Radiometry
  - Spectroscopy
  - Geometry
- Continuously upgraded
  - Tunable laser
  - Transfer radiometer

CHB online: http://www.opairs.aero/chb_en.html

P. Gege et al. (2009): Calibration facility for airborne imaging spectrometers. *ISPRS Journal of Photogrammetry & Remote Sensing 64, 387-397.* doi:10.1016/j.isprsjprs.2009.01.006