CALIBRATION ACTIVITIES

EUMETSAT

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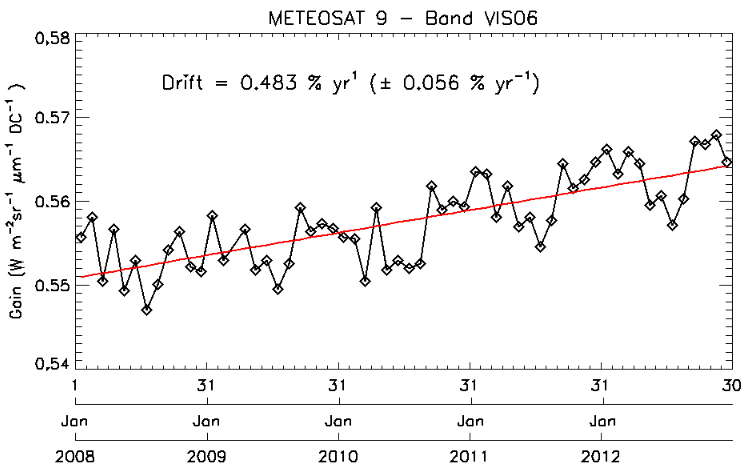
Examples of EUMETSAT calibration activities

EUMETSAT mission calibration activities

- Missions developed by ESA and industry based on EUMETSAT requirements
- EUMETSAT – calibration concepts, cal/val planning, operational calibration, Science Advisory and Quality Working Groups, in-house studies and inter-calibration activities

GEO-LEO VIS/NIR Calibration: DCC

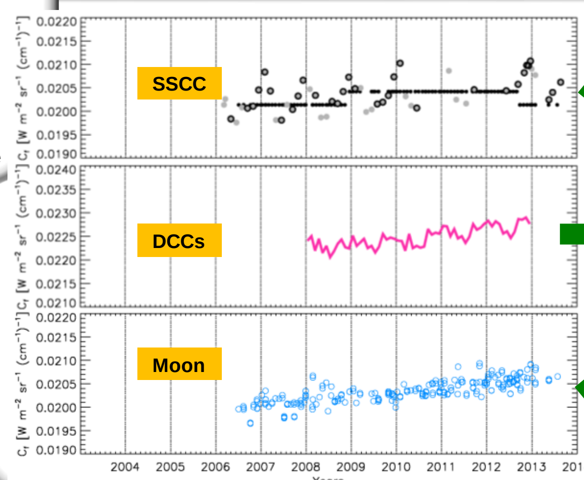


Gain time series derived for MET-09/VIS06 using MODIS Aqua as a reference

Chair GSICS Research Working Group

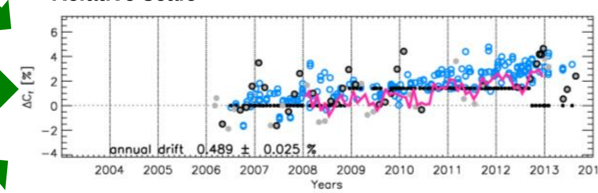
GSICS
Global Space-based Inter-Calibration System

GEO-LEO VIS/NIR Calibration with the Moon



Multi-Mission Calibration and Monitoring System

Relative scale



Example of the VIS06 band on MSG2/SEVIRI. Grey/black big dots: SSCC gains. Black small dots: gains as available in Level 1.5 image headers (derived from SSCC). Blue dots: lunar calibration. Magenta: DCC gains

EUMETSAT

gsics.wmo.int

- **What is GSICS?**
  - Initiative of Coordination Group for Meteorological Satellites (CGMS) and World Meteorological Organization (WMO)
  - Effort to produce consistent, well-calibrated data from the international constellation of operational Earth Observing satellites
- **GSICS basic strategies**
  - Improve on-orbit calibration by developing an integrated inter-comparison system
  - Best practices for calibration and characterisation
  - Provide on-orbit traceability of measurements
  - Retrospectively re-calibrate archive data
  - Better specify future instruments
- **Recent contribution: Moon calibration**
  - Lunar Calibration Workshop, 1-4 December 2014
  - Collaborative effort to define a common unique lunar calibration reference at international level in order to achieve instrument inter-calibration
  - Under agreed data policy
    - GSICS Implementation of the ROLO (GIRO) model, and
    - GSICS Lunar Observation Dataset (GLOD)
  - Ambition to reduce GIRO's absolute uncertainty to 1%

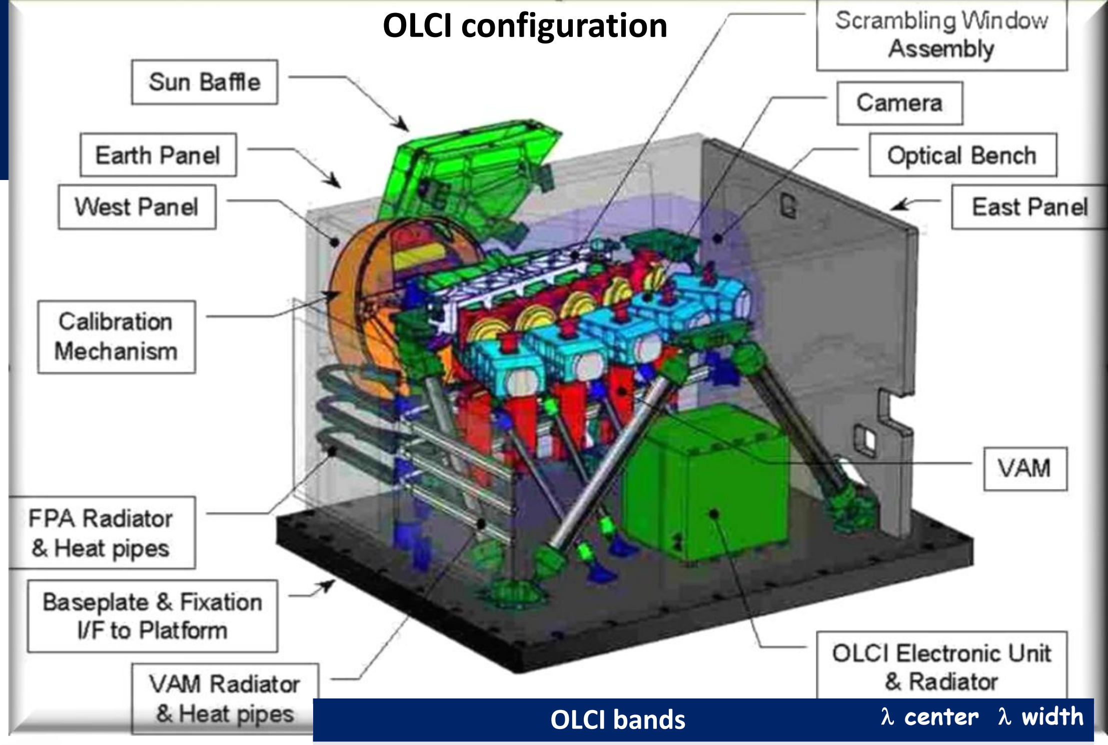
GSICS
Global Space-based Inter-Calibration System

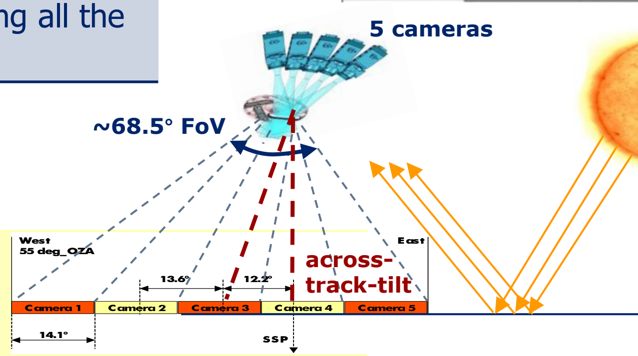
EUMETSAT CNES JMA
NOAA CMA KMA
ISRO NASA WMO
USGS NIST JAXA
ROSHYDROMET IMD ESA

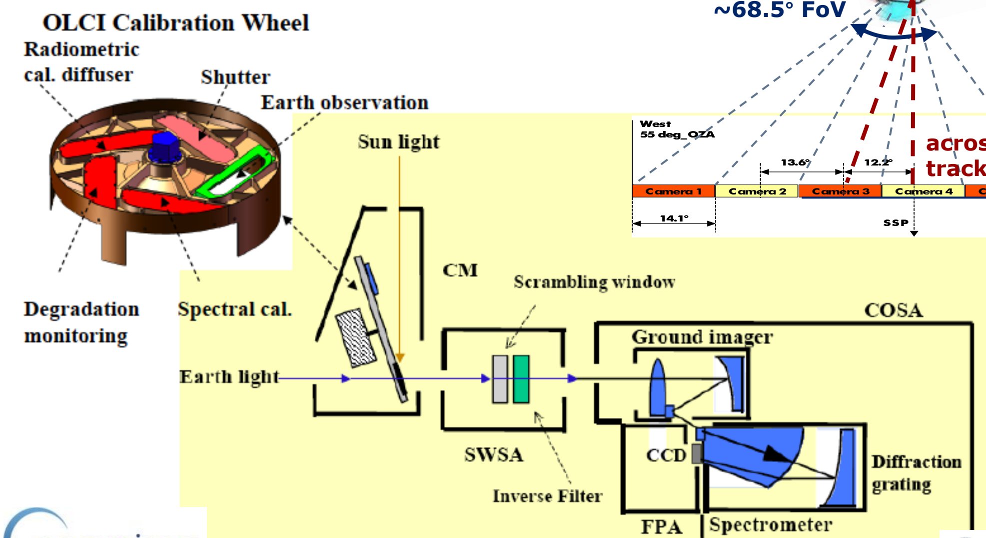
Sentinel-3 OLCI

OLCI – **Developed by ESA and industry**
– **Programmable imaging spectrometer**
– **ENVISAT-MERIS heritage**

5 Camera Optical Sub Assemblies (COSA)
5 Focal Plane Assemblies (FPA)
5 Video Acquisition Modules (VAM)
1 Scrambling Window Assembly
1 Calibration Assembly allowing radiometric and spectral calibrations
1 OLCI Electronic Unit (OEU) managing all the instrument functions







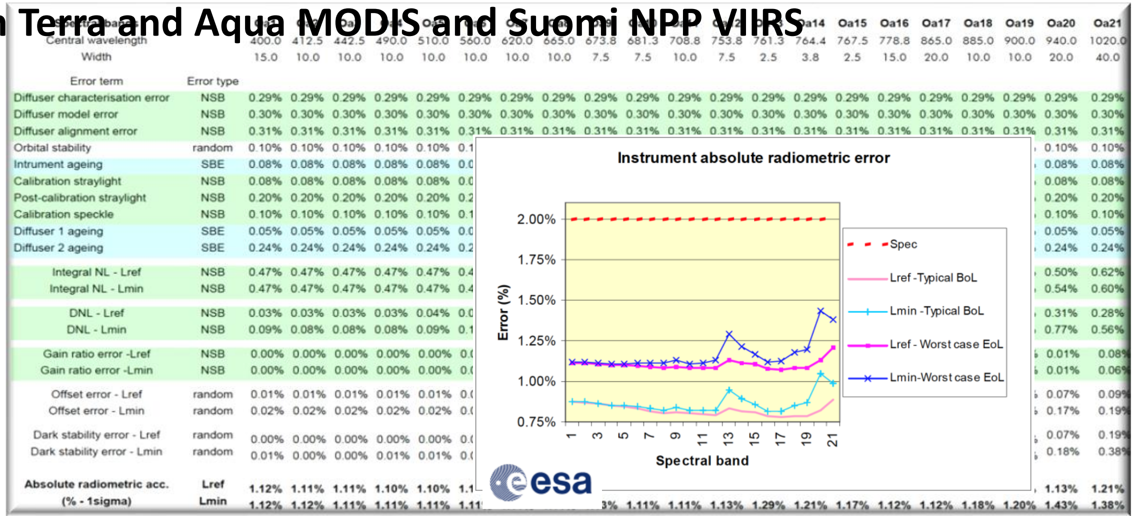
OLCI optical layout

	OLCI bands	λ center	λ width
1	aerosol, in-water properties	400	15
2	yellow substance, detritus	412.5	10
3	chlorophyll absorption max	442.5	10
4	chlorophyll and other pigments	490	10
5	suspended sediments, red tide	510	10
6	chlorophyll absorption min	560	10
7	suspended sediments	620	10
8	chlorophyll absorption and fluorescence	665	10
9	fluorescence	673.75	7.5
10	chlorophyll fluorescence peak	681.25	7.5
11	chlorophyll fluorescence ref, atmospheric correction	708.75	10
12	vegetation, clouds	753.75	7.5
13	O_2 R-branch absorption	761.25	2.5
14	atmospheric parameters, O_2A cloud top pressure	764.375	3.75
15	cloud top pressure	767.5	2.5
16	O_2 P-branch absorption	778.75	15
17	atmospheric correction	865	20
18	vegetation, water vapour reference	885	10
19	water vapour, land	900	10
20	atmospheric correction, H_2O absorption	940	20
21	atmospheric correction, aerosols	1020	40

Solar diffuser characterization

- **Solar diffusers as OLCI primary radiometric standard**
  - Solar diffusers on OLCI are the primary radiometric standard for the instrument
  - Knowledge of solar diffuser BRDF allows quantitative interpretation of OLCI radiometric response and temporal degradation, via regular on-orbit radiometric calibrations
- **Importance of solar diffuser characterization for the quality of ocean colour products**
  - Ocean colour products are particularly sensitive to instrument characterization (IOCCG Report 13)
  - Accuracy and stability of ocean colour products depend on solar diffuser BRDF uncertainties
- **Pre-launch characterization**
  - Pre-launch BRDF characterization is difficult and can only be made at a limited set of solar illumination and camera view angles, at a few selected bands, and at best absolute uncertainty of around 0.3% (with estimated total absolute uncertainty of around 0.5% + uncertainty of diffuser baffle straylight)
- **Potential of solar diffuser assessment on-orbit**
  - Assessment of solar diffuser characterization may be possible on orbit with yaw manoeuvres
  - Experience from Terra and Aqua MODIS and Suomi NPP VIIRS

OLCI absolute radiometric error (S3-TN-TAF-OL-00942v3 2011)



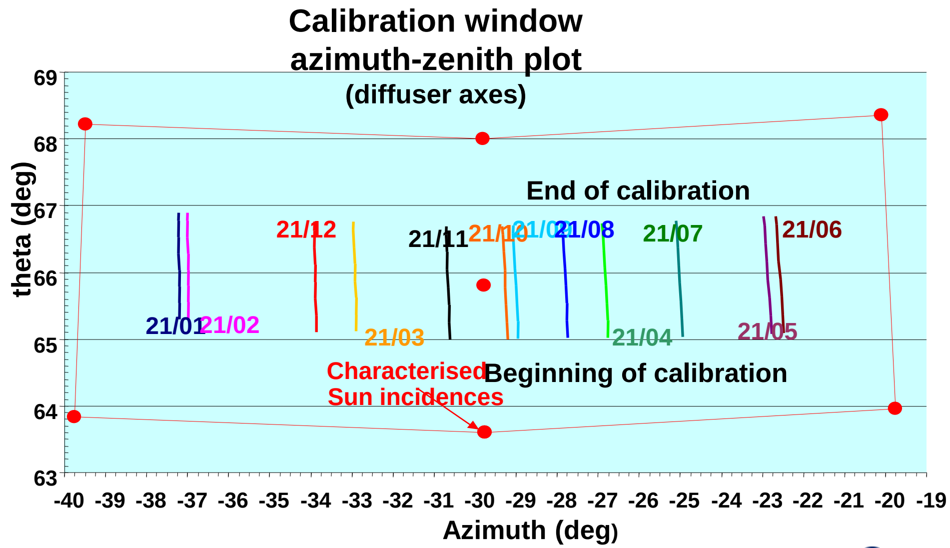
Overall budget contributors currently under reassessment

OLCI solar diffuser pre-launch characterization

- **OLCI solar diffuser pre-launch laboratory BRDF characterizations applied lessons learned from MERIS**
  - BRDF measurements (relative and absolute) for OLCI flight modules (FM) FMA and FMB were performed at Centre Spatial de Liège (CLS) for all five cameras, seven wavelengths, seven incidence angles covering the flight range, and nine observation angles
  - Traceability to the international standard was established by PTB, Germany
  - On-going activities
    - Comparisons at NASA GSFC
    - Comparisons with instrument-level tests

- **OLCI solar diffuser BRDF model**
  - BRDF model was developed and tested to fit the absolute measurements with about 0.3% uncertainty (Rahman model)

	Absolute		Relative spatial	
	Perf	Req	Perf	Req
400 nm	0.338%	0.50%	0.301%	0.30%
490 nm	0.206%	0.50%	0.063%	0.30%
560 nm	0.226%	0.50%	0.134%	0.30%
681 nm	0.214%	0.50%	0.097%	0.30%
780 nm	0.252%	0.50%	0.171%	0.30%
900 nm	0.225%	0.50%	0.078%	0.30%
1020 nm	0.242%	0.50%	0.080%	0.30%

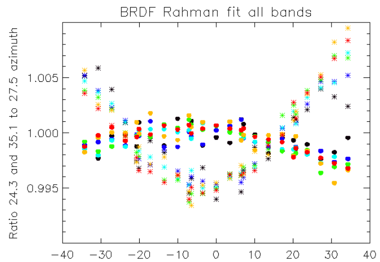


MERIS solar diffuser experience

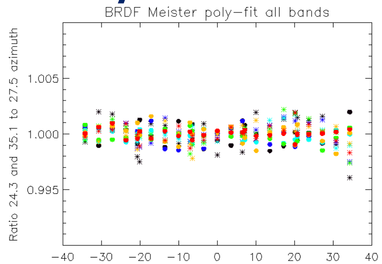
- **MERIS radiometric gains display a seasonal pattern**
  - Gain patterns were correlated with solar azimuth angles on the solar diffuser
  - Workarounds were implemented in operational processing
  - Studies to improve BRDF modelling have not been successful
  - For OLCI, quality data are needed early in the mission

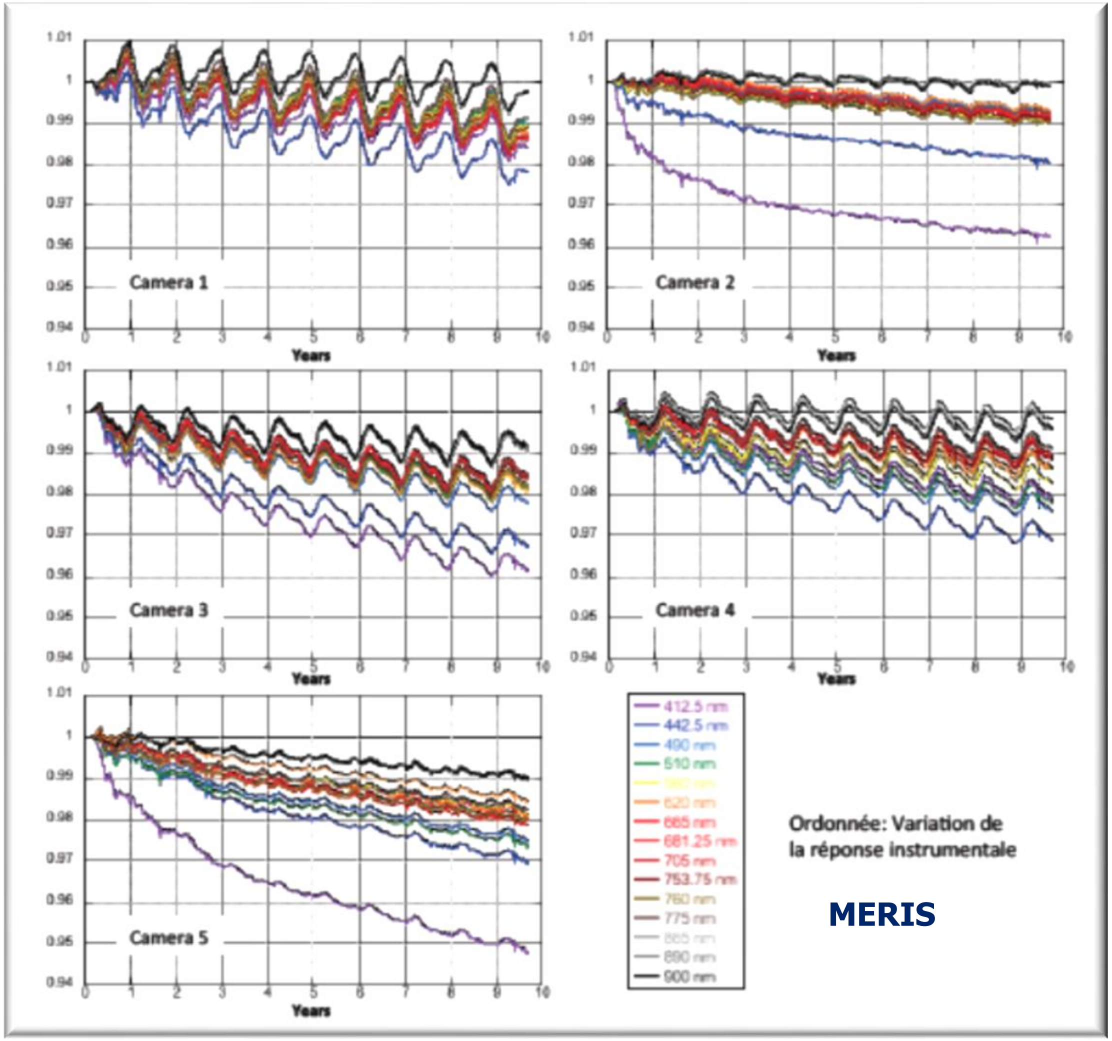
Solar diffuser BRDF model errors on the pre-launch measurements, for solar azimuths 24.3^0 and 35.1^0 versus 27.5^0

Rahman model



Polynomial model





Investigations into the feasibility of solar diffuser assessment on-orbit (Sentinel-3 MAG recommendation)

- **Proposal**
  - A single set of satellite yaw manoeuvres to reproduce annual variations in solar geometry on the diffuser in a one-day sequence over consecutive orbits (calibrations performed at orbital South Pole)
  - Yaw manoeuvres require no modification to operations, it is a low risk routine
- **Initial strategy**
  - Use of the same solar azimuth geometries as applied in pre-launch characterizations and, additionally, extension of the azimuth geometry beyond the pre-launch angles and addition of angles in between
  - Two options:
    1. nominal radiometric S01 calibrations,
    2. extended double-collection-time radiometric S01 calibrations (require a patch in OLCI flight software)
  - Two cases: (1) with or (2) without including SLSTR solar diffuser measurements in yaw coverage
  - Planning of radiometric calibrations at pre-defined and annually repeatable solar azimuth geometries
  - Parallel planning of diffuser ageing calibrations and their coordination with the yaw manoeuvre routine
- **Benefits**
  - Complete range of elevation angles, more azimuth angles, all observation geometries
  - Coverage of all spectral bands
  - Extraction of effective BRDF (straylight from the baffle, diffuser alignment error, etc.)
  - Coverage of both OLCI and SLSTR diffusers (support for SLSTR solar diffuser vignetting assessment)
- **Disadvantages**
  - Additional degradation of OLCI nominal diffuser, the need to incorporate the diffuser ageing calibration
  - Resource demanding task for preparations and follow-on data analyses
- **Investigations on-going, results will be presented to ESA and EUMETSAT teams and management**