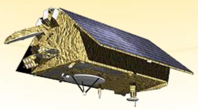
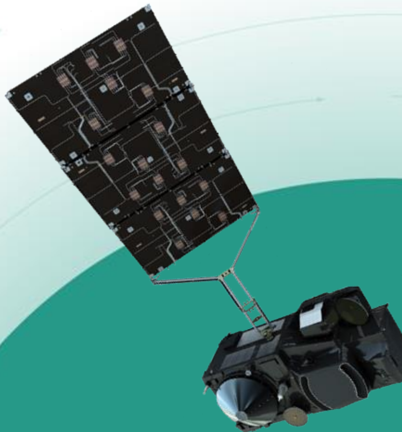
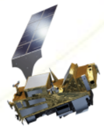


Sentinel-3 OLCI In-Flight Diffuser Characterisation

E. Kwiatkowska IOCS 2019



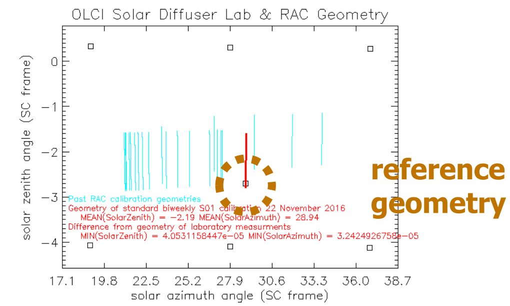


OLCI-A/B solar diffuser BRDF characterization

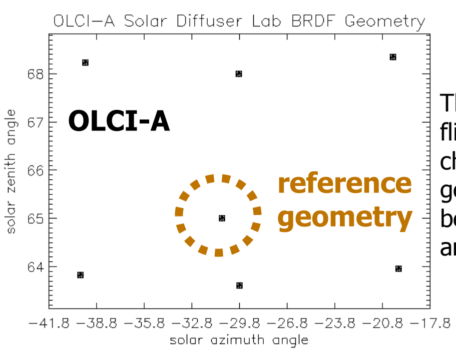
- **Solar diffusers are the radiometric standard of OLCI instrument**

- **Lab characterization of solar diffusers is complex, performed at selected geometries/wavelengths**
  - **S3A and S3B OLCI solar diffuser BRDF characterized in the lab at the same geometries and wavelengths**
    - **all 5 cameras**
    - **7 wavelengths**
    - **7 incidence angles (and 2 additional angles at 681nm)**
    - **9 observation angles**

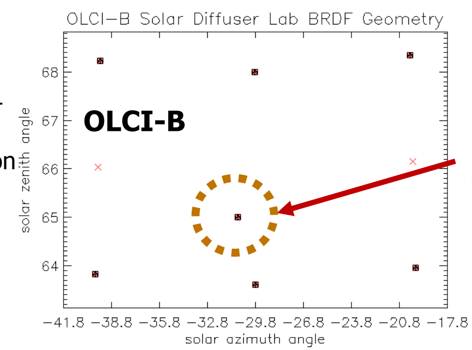
- **OLCI-A – only a single Lab BRDF solar incidence angle matches the geometry of in-flight nominal calibrations 'reference geometry'**



- **OLCI –A and –B diffuser BRDF comparisons of lab measurements**
  - **Differences in OLCI –A and –B Lab BRDF measurements**
    - **no spectral trend**
    - **differences +/- 1%**

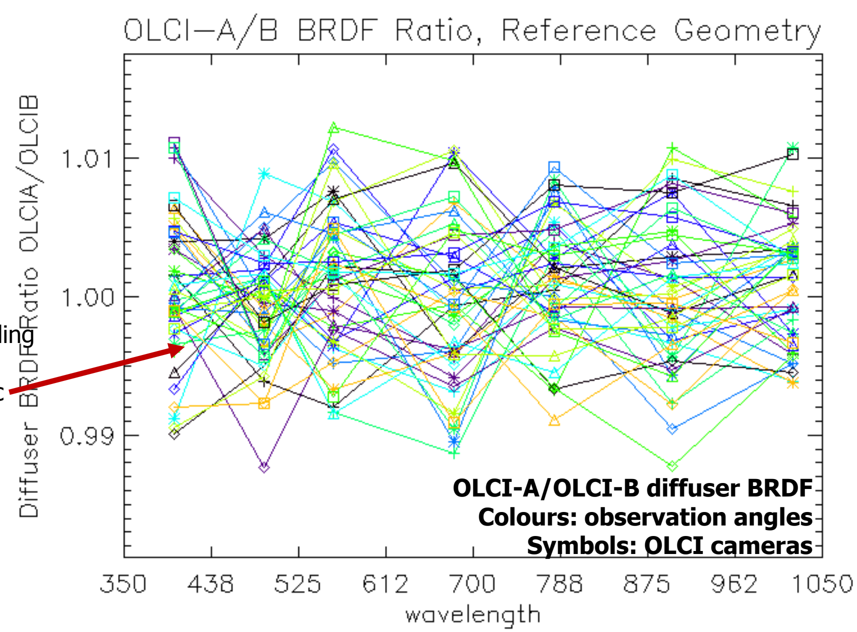


The same pre-flight characterization geometries between S3A and S3B OLCI



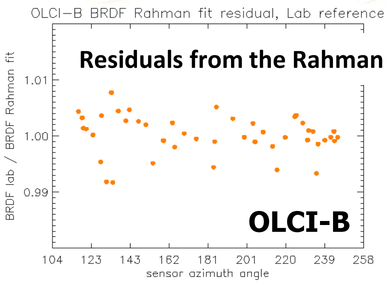
x Additional characterization data at 681nm

Single incidence angle corresponding to in-flight radiometric calibration geometry



S3 yaw manoeuvres for in-flight diffuser modelling

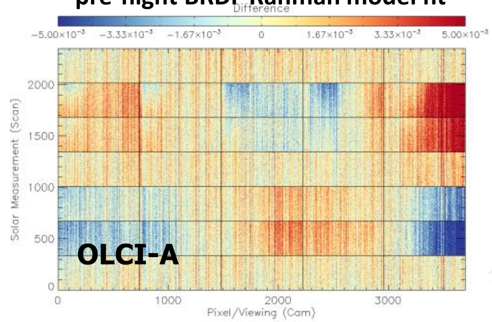
- **S3 OLCI pre-flight solar diffuser BRDF model**
  - Pre-flight diffuser BRDF model – Rahman
  - Pre-flight BRDF model reproduces the reference geometry within ± 1 %, the same in OLCI-A and -B
  - Experience with pre-flight model (Envisat MERIS, S3A and B OLCI): pre-flight BRDF model results in seasonal patterns in radiometric gains
- **Satellite yaw manoeuvres reproduce in a single day the annual range of variations in solar geometry on the solar diffuser**
- **Lessons learned from S3A yaw menoeuvres for an in-flight diffuser characterisation**
  - Yaw manoeuvers provide accurate relative BRDF model: RMS performance << 0.1%
  - For the SI-traceable lab absolute reflectance, need to tie to the pre-launch 'reference geometry'



Sentinel-3 yaw manoeuvres

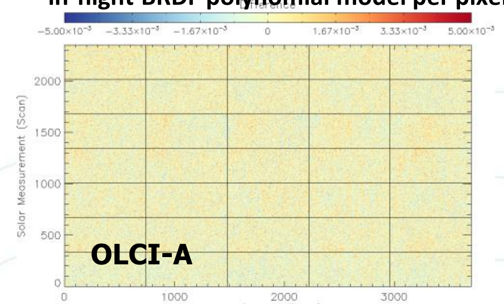
- S3 MAG recommendation to conduct satellite yaw manoeuvres during E2 PDGS Commissioning Ramp-up (S3MAG–M4–A10)
- OLCI Cal/Val task in ESA/EUM S3 Cal/Val Plan, 2014 (OLCI-L1B-CV-280)
- S3A IOCR technical meeting recommendation (S3-MN-ESA-OL-752)
- S3B IOCR technical meeting recommendation (S3-MN-ESA-SY-918)

Residuals
pre-flight BRDF Rahman model fit



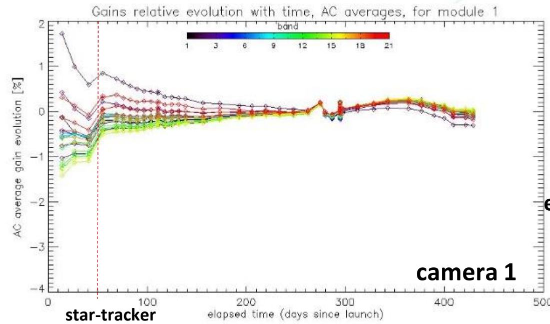
EARTH SPACE SOLUTIONS

Residuals
in-flight BRDF polynomial model per pixel



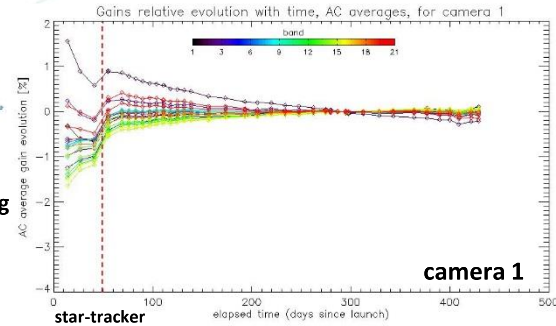
OLCI 5 cameras cross-track

7 yaw manouvres along-track



star-tracker anomaly

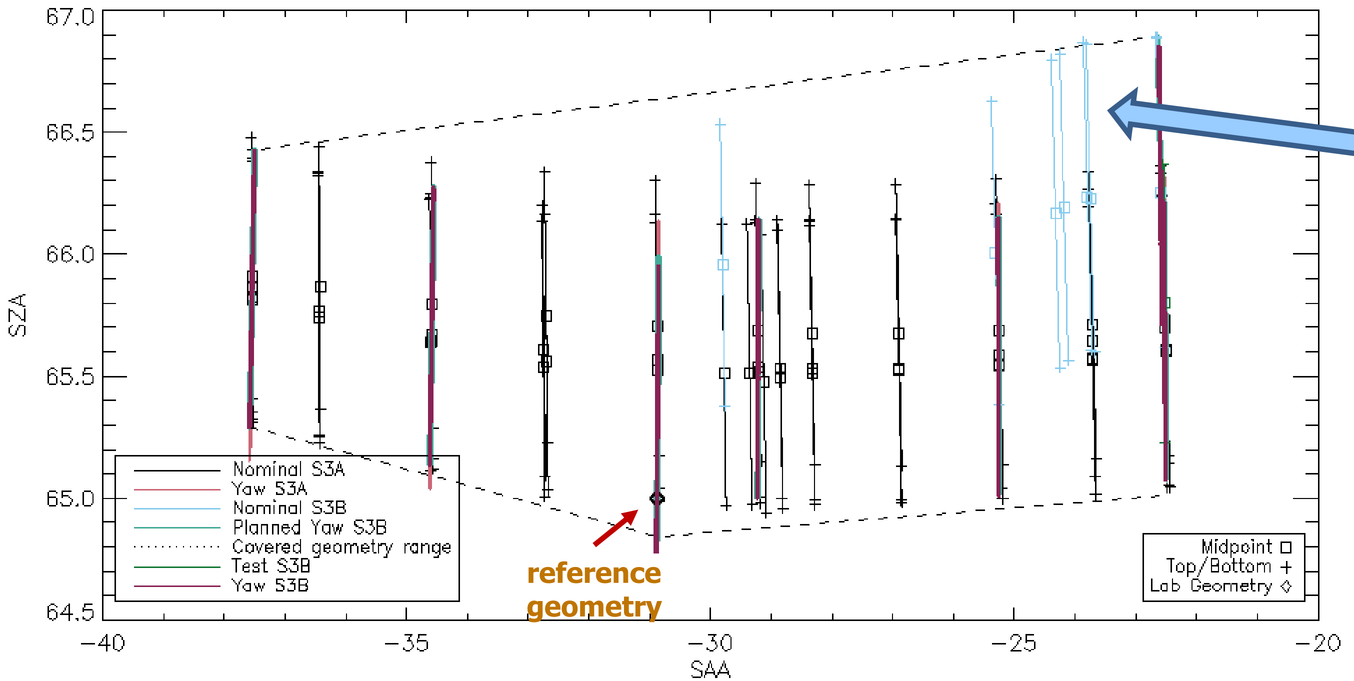
stability of OLCI-A evolution modelling



star-tracker anomaly

OLCI-A -B differences in the diffuser normal vectors

- **Normal vectors to the solar diffuser are different between OLCI-A and OLCI-B**
  - **Normal vector to the solar diffuser for S3A OLCI 0.33373345 0.18074450 -0.92517750**
  - **Normal vector to the solar diffuser for S3B OLCI 0.32712910 0.18138800 -0.92740760**
- **Difference in the diffuser normal causes differences in calibration geometries between OLCI-A/-B**
  - **OLCI-A and -B have 0.4^{0} difference in diffuser normal vector**
  - **OLCI-B solar diffuser does not acquire the lab 'reference geometry' during nominal calibrations**
  - **The difference produces a shift in solar zenith angle for OLCI-B of about 6.6 sec compared to OLCI-A**



OLCI-B – (0.4^{0} difference in normal)

Reference in SD coordinates (S3A & S3B)
-30.8730 65.0000 SAA SZA

Reference in S/C coordinates S3A
28.9192 -2.69597

Reference in S/C coordinates S3B
29.0062 -3.03425

Difference B-A
0.0869961 -0.338277

EUMETSAT

EARTH SPACE SOLUTIONS

Scheduling of the S3B yaw manoeuvres

- **Requirements for the planning of S3B yaw maneuvers for OLCI solar diffuser in-flight modelling**
  - **Need to cover the geometry range of operational nominal calibrations**
  - **Need to reproduce the pre-launch 'reference geometry' to tie to the SI-traceable lab absolute reflectance**
  - **Need to replicate the geometries of OLCI-A yaw manoeuvres**
  - **Need to select geometries for the maneouvres to provide a BRDF model within OLCI-A nominal calibration geometries and extendible to the past OLCI-B nominal geometries**
  - **Need to improve on the geometry prediction of the OLCI-A yaw manoeuvres**

- **Execution of S3B yaw maneuvers on 11 Dec 2018 (yaw test on 6 Dec 2018)**

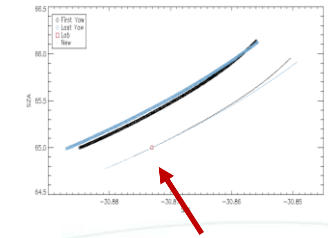
Executed S3A yaw manoeuvres

Cal#	Type	target SAA in SC frame [deg]	target SEA in SC frame [deg]	yaw bias [deg]
1	S01	28.919	-2.179	0.117
2	S01	35.0		-5.957
3	S01	32.3		-3.249
4	S01	27.41		1.648
5	S01	23.8		5.265
6	S01	21.3		7.771
7	S01	28.919		0.158
8	S05	28.919		0.166

Executed S3B yaw manoeuvres

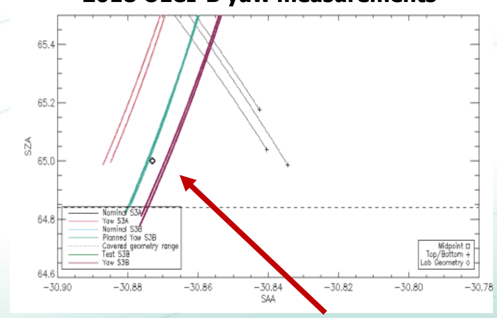
Cal#	Type	target SAA in SC frame [deg]	target SEA in SC frame [deg]
0	S01	21.3846	-2.55304
1	S01	28.9956	-2.60774
2	S01	21.4035	-2.05690
3	S01	21.3846	-2.55304
4	S01	35.0921	-2.26595
5	S01	23.8826	-2.50057
6	S01	32.3914	-2.32562
7	S01	27.4926	-2.42725
8	S01	28.9962	-2.64484
9	S05	28.9962	-2.64484

2016 OLCI-A yaw measurements



reference geometry slightly missed

2018 OLCI-B yaw measurements

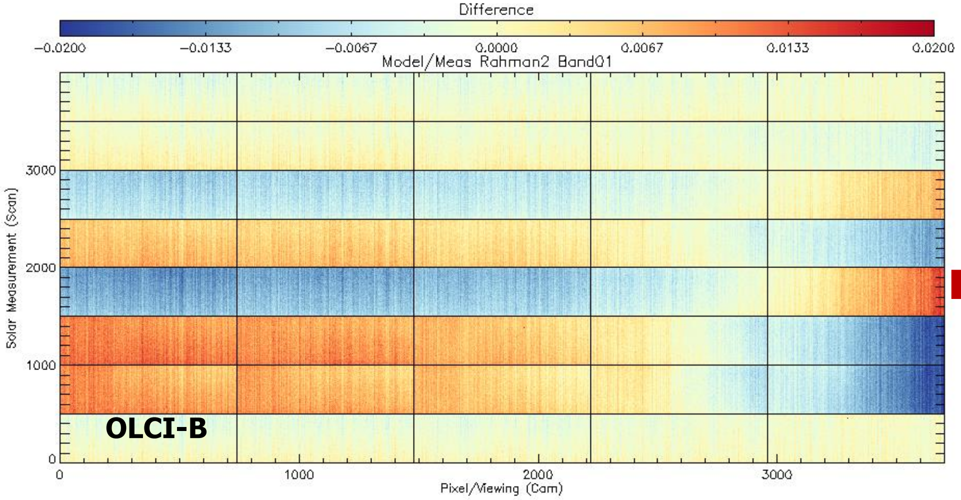


reference geometry well approximated

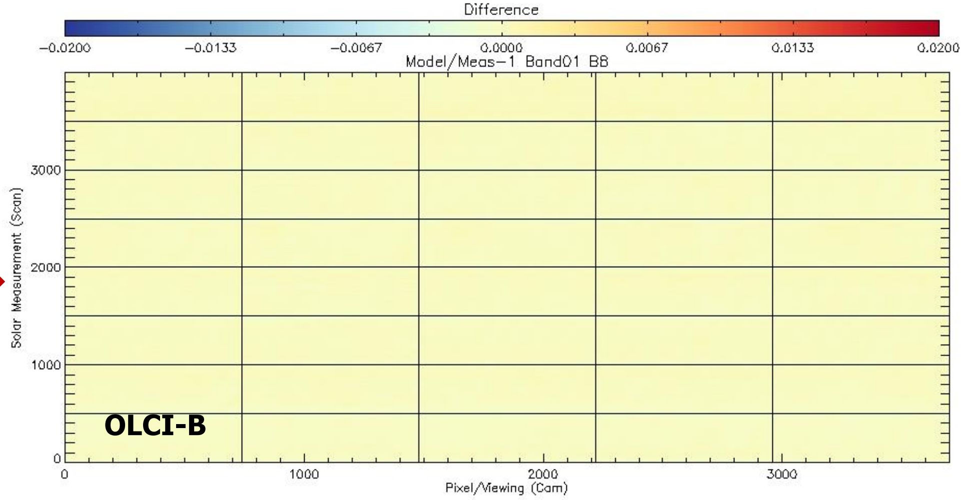
Results from S3B yaw manoeuvre diffuser BRDF model

- **New Model: Polynomial per pixel**
  - P0* [absolute calibration] *
  - (1+P1*SZA+P2*SAA [linear]
  - +P3*SAA*SZA [cross-term]
  - +P4*SZA^2+P5*SAA^2 [second order])

Residuals
pre-flight BRDF Rahman model fit



Residuals
in-flight BRDF polynomial model per pixel

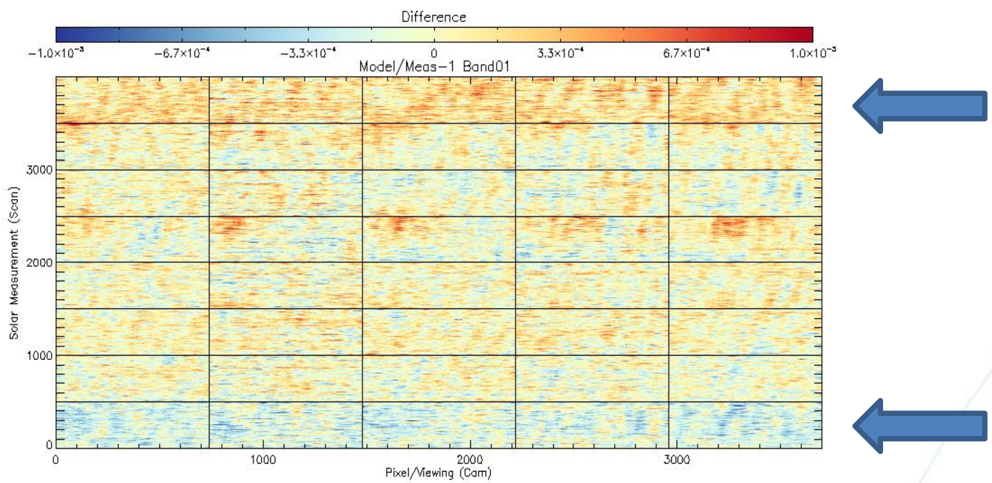


- **New OLCI Diffuser BRDF Model**
  - Relative accuracy to < 0.05% → derived from yaw maneuvers
  - Absolute model accuracy needs to tie to the pre-launch absolute reference reflectance which was characterized with 1% uncertainty; i.e. absolute accuracy < 1% → dependent on on-ground calibration

Conclusions and lessons learned

- **Yaw maneuvers provide accurate relative BRDF model**
  - **More Yaw angles allow a more accurate model and even characterization of diffuser speckles**
- **The on-ground lab reference measurement dominates the absolute calibration accuracy**
  - **Repeat several times to achieve the lowest possible uncertainties of the lab reference**
- **For OLCI-B, compensate diffuser normal offset by scheduling the nominal calibrations 6.6 sec earlier to match OLCI-A nominal calibration geometries**
  - **Recommendation implemented for OLCI-B: OLCI-B nominal calibrations now routinely acquire the lab reference geometry and match OLCI-A calibration geometries**
- **OLCI-A and -B radiometric temporal evolution is now modelled accurately!**

Verifying the degradation of the solar diffuser during the yaw manoeuvre calibrations



Verifying the degradation of the solar diffuser during the yaw manoeuvre calibrations