MSI – L1 products in orbit validation

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with contributions from Airbus and the CARDINAL team

1st ESA-JAXA EarthCARE In-Orbit Validation Workshop
14 – 17 January 2025 | VIRTUAL EVENT

The MSI IOV Plan was focusing on the following main topics:

- Radiometric Precision (signal-to-noise)
  - TIR NedT
  - VNS SNR
- Radiometric Accuracy (absolute radiometric calibration)
  - TIR
  - VNS
- Inter-channel Accuracy
  - TIR
  - VNS
- Radiometric Stability
  - TIR
  - VNS
- VNS Diffuser Aging

MSI – L1 In-Orbit performance

- TIR Radiometric Precision : **Compliant.**

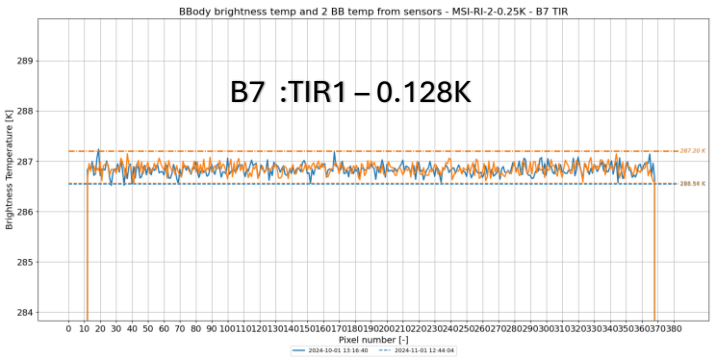
TIR NedT : Below criteria of 0.25 K in all 3 TIR bands when observing high signal (on board calibration black body).

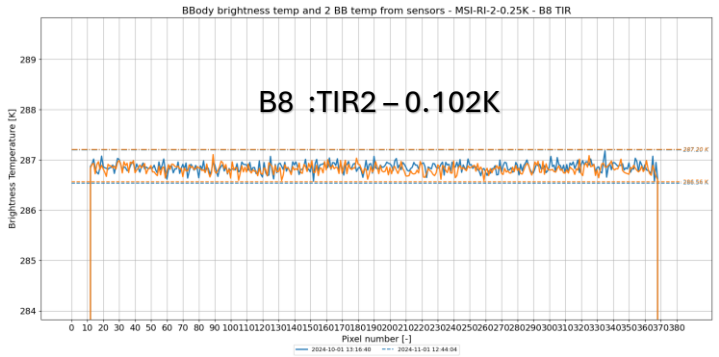
NedT are available per BBS products (Black Body Calibration products).

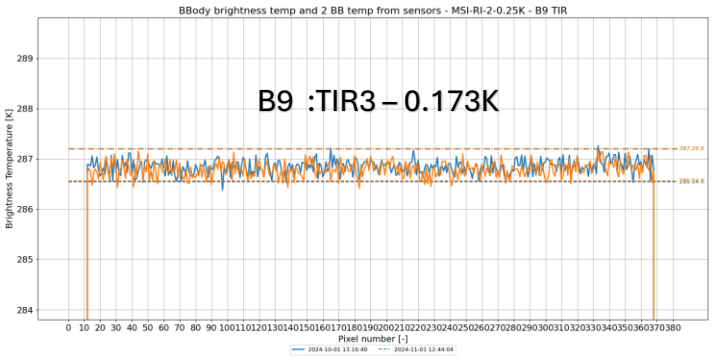
EG NedT from :

ECA_EXAC_MSI_BBS_1B_20241001T130816Z_20241001T133606Z_01954C.h5 and

ECA_EXAD_MSI_BBS_1B_20241101T123319Z_20241101T142757Z_02436C.h5







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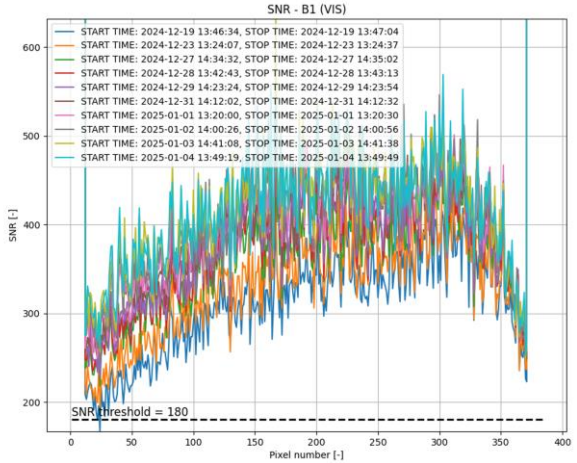
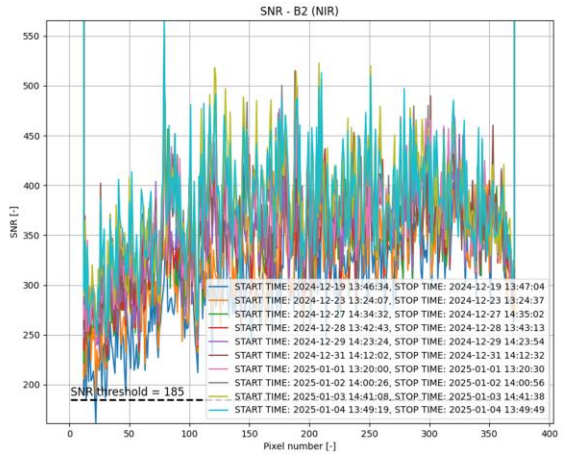
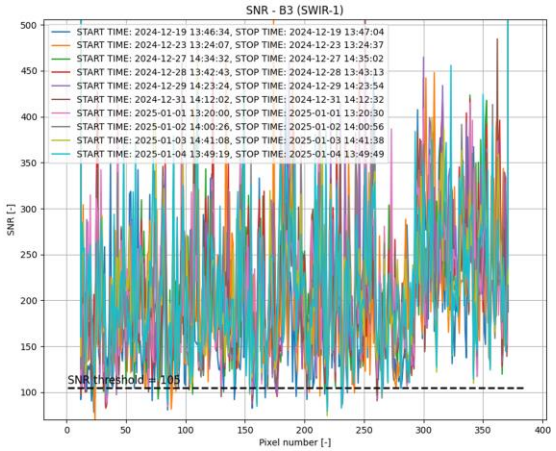
- VNS Radiometric Precision : **Compliant.**

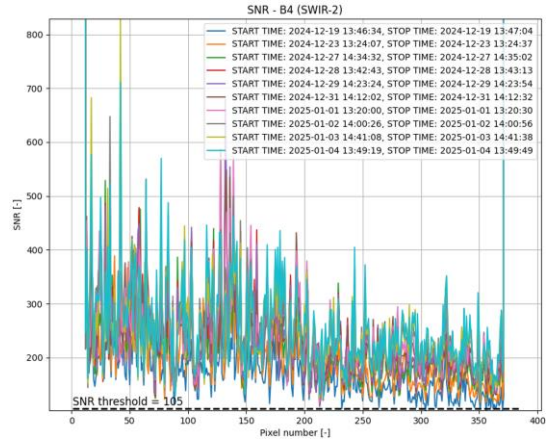
VNS SNR : Compliant to below defined criteria. SNR are available per sun diffuser calibration products.

Band			Min Signal(1)	Reference Signal(1)		Max Signal(1)	SNR @ Reference Signal	
				Low	High		Low	High
							Goal	Threshold
			$W.m^{-2}.sr^{-1}.\mu m^{-1}$					
B	1	VIS	3.85	30	444.6	489.1	75	500
B	2	NIR	0.95	17	282.7	311.0	65	500
B	3	SWIR 1	0.016	1.5	67.9	69.3	18	250
B	4	SWIR 2	0.0015	0.5	24.6	24.6	21	250
(1)	TOA spectral radiance							









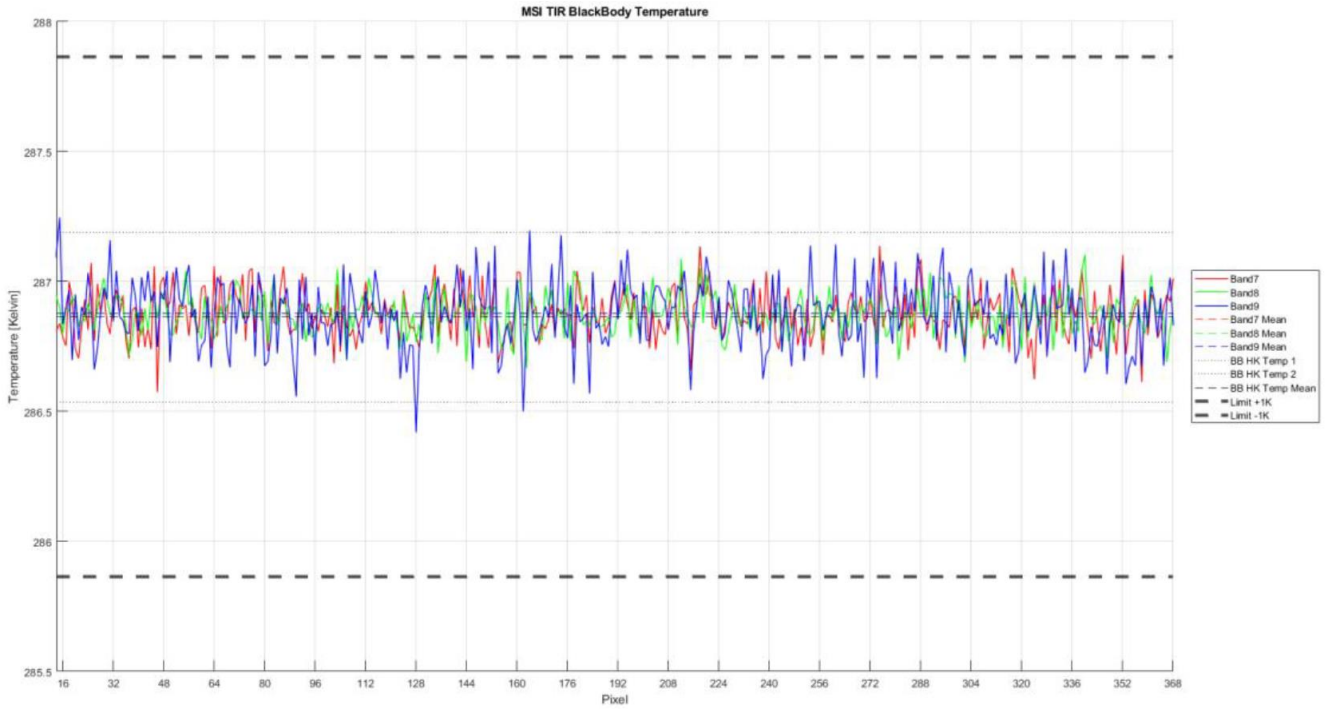
MSI – L1 In-Orbit performance

- TIR Absolute Radiometric Accuracy : **Compliant.**

  "The absolute radiometric accuracy of the data acquired in the TIR channels shall be smaller than 1 K over the reduced dynamic range, traceable to SI units".

  After application of provided TIR Calibration Maintenance Gains, the accuracy for blackbody measurements is excellent and fully within limits [+/- 1 K]:

Source : IOCR report.



There is preliminary evidence from comparison to SEVIRI (by CARDINAL team), that the accuracy of the earth measurements is also within specification.

MSI – L1 In-Orbit performance

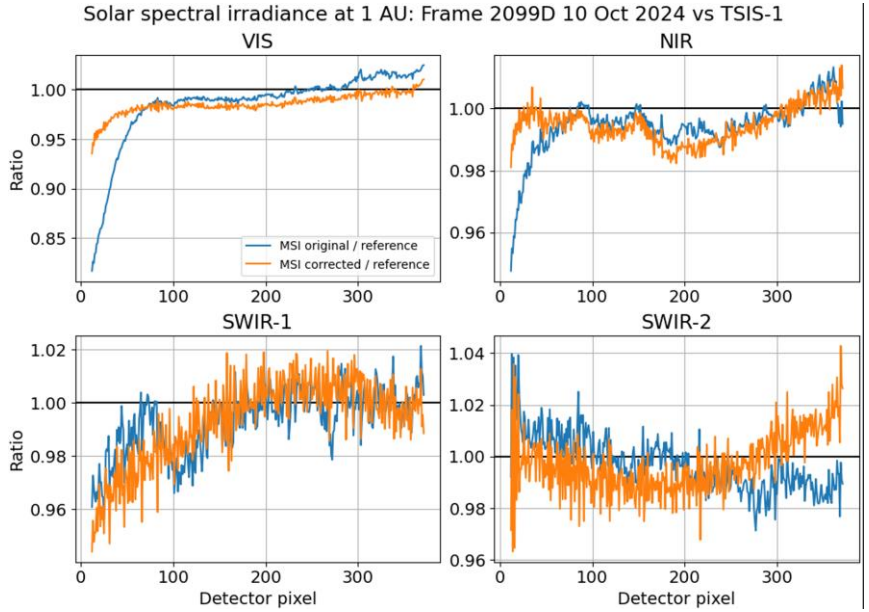
- VNS Absolute Radiometric Accuracy : **Compliant** **with the caveat on the start of the VIS band.**

  "The absolute radiometric accuracy of the data acquired in the solar channels shall be smaller than 10% over the reduced dynamic range, traceable to the SI units."

  After application of the ESA VNS Calibration Maintenance Gains, and the update of the diffuser BSDF using the (external) TSIS-2 solar irradiance spectrum and empirical correction factors as a reference, the accuracy is improved. The signals across track are within 10% to the theoretical value. However, at the first 100 pixels of the VIS band the solar irradiance varies more than expected between solar calibrations.

  Across-track variation corrected by a first update of diffuser BSDF. This is a preliminary correction.

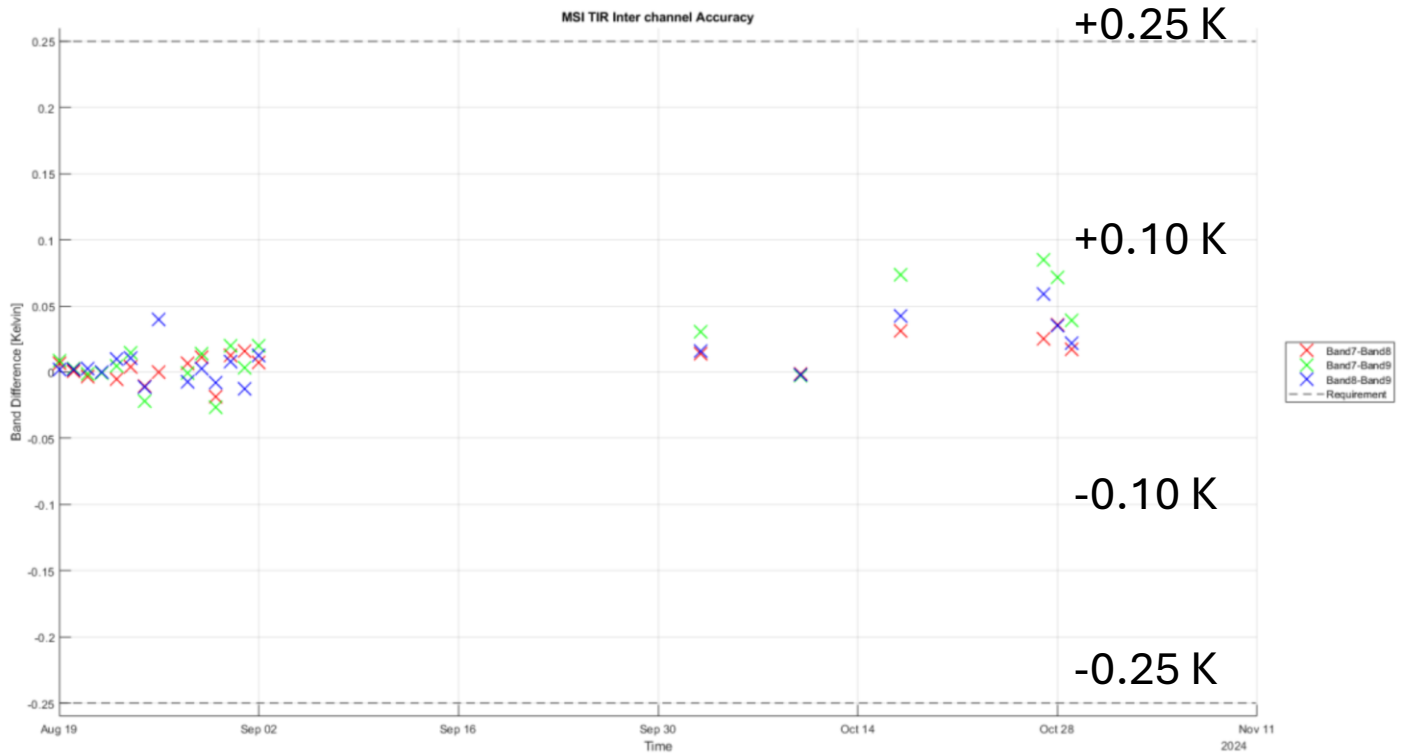
  ⇒ ***A full year in orbit characterization and further diffuser BSDF update will allow to restore full compliance.***



Source : IOCR report.

MSI – L1 In-Orbit performance

- TIR Inter-channel Radiometric Accuracy : **Compliant.**
  - "The inter-channel measured brightness temperature difference between all TIR channels looking at the same black body scene shall be less than 0.25K (goal: 0.1 K)."
  - *The accuracy is excellent and fully within goal requirements:*



MSI – L1 In-Orbit performance

- VNS Inter-channel Radiometric Accuracy: **Not Yet Compliant for the VIS band.**
  - "The inter-channel relative reflectance difference between all solar channels looking at a spectrally constant reflectance reference target shall be less than **2%** of the estimated reflectance value" [RFD-0024].

Not yet compliant as a consequence of the absolute radiometric accuracy non-compliance.

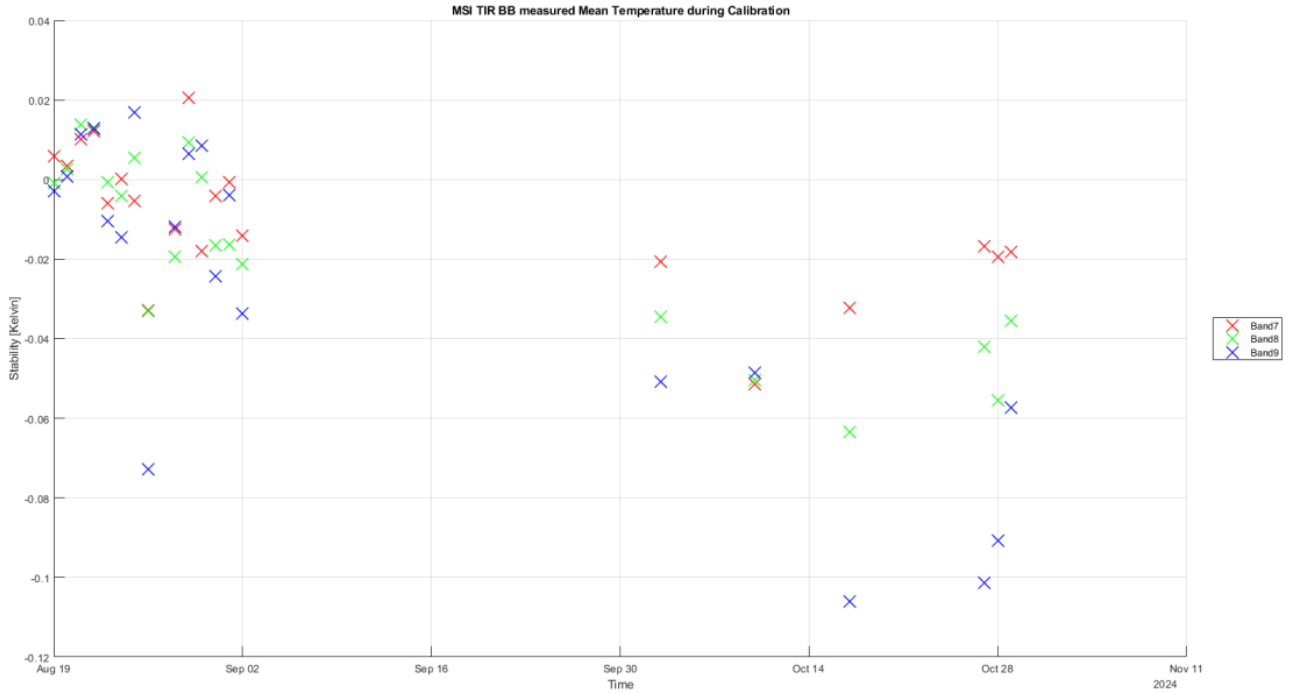
Expected to be compliant after further update of diffuser BSDF (once a year of data is available).

MSI – L1 In-Orbit performance

- TIR Long Term Radiometric Stability : **Compliant within the limited time period observed**
  - Long term stability is very difficult to assess as there is no stable scene which can be analysed. Best possibility is to evaluate the BlackBody measurements to the BlackBody Temperature. Maximum deviation is seen around 0.1K.

    Therefore within 0.3K requirement (note that requirement is for 1 year of measurements)

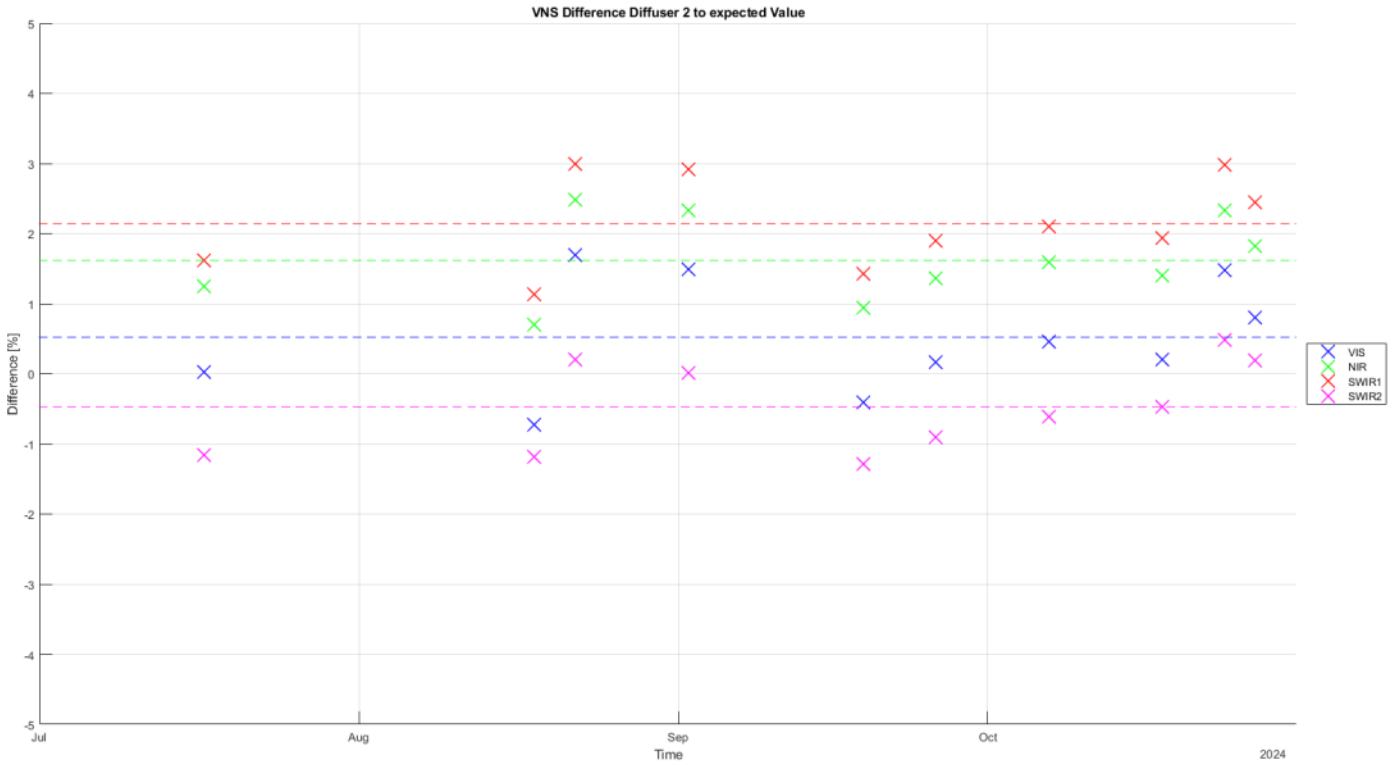
  - *Remark : Drift, when they occur would be corrected by ICMF, using data from blackbody calibrations*



MSI – L1 In-Orbit performance

- VNS Long Term Radiometric Stability : **Compliant within the limited time period observed**
  - Long term stability is very difficult to assess as there is no stable scene which can be analysed. Best possibility is to evaluate the Sun Calibration measurements. The variations towards the mean is roughly +-1% for all channels.

  - *Remark : Drift, when they occur would be corrected by ICMF, using data from solar calibrations.*



MSI – L1 In-Orbit performance

VNS Diffuser Ageing : **Compliant within the limited time period observed**

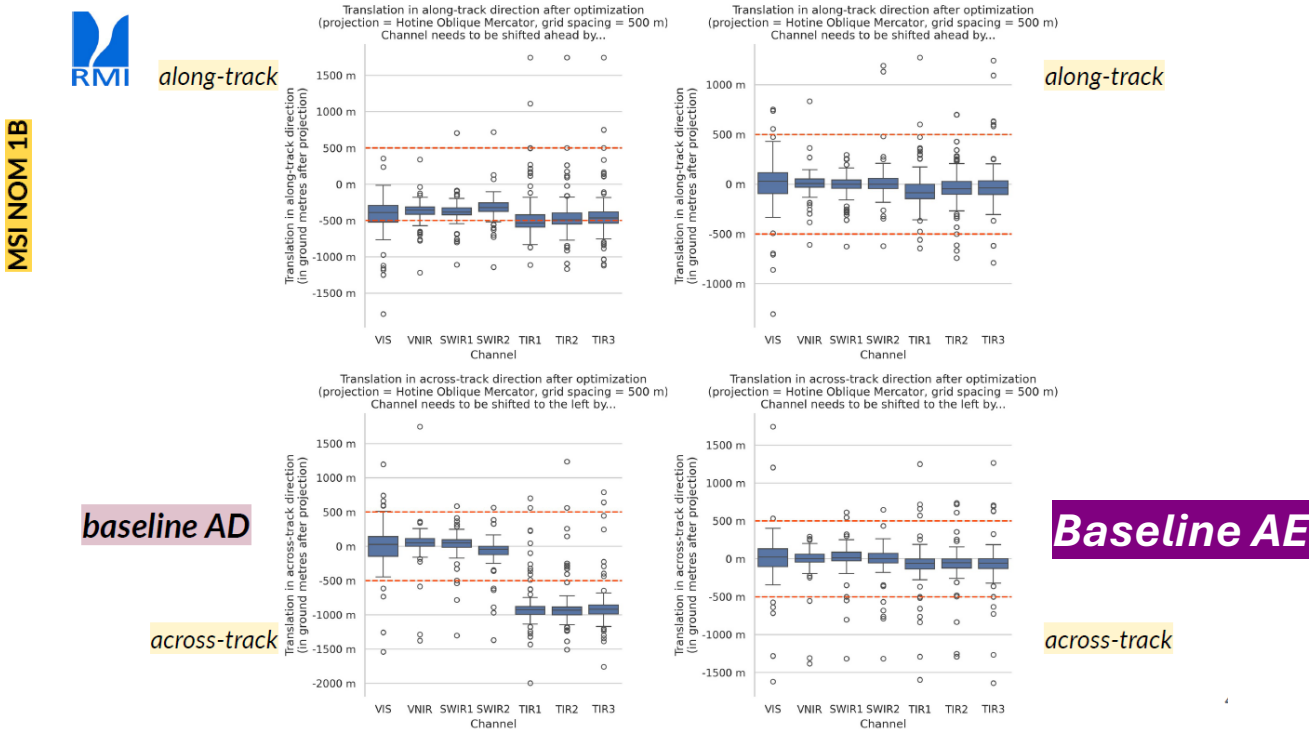
Within available time frame no trending is available. Ageing is deemed very small from manual verification on data though long term trending will be put in place according offline ATBD by ICMF.

MSI – L1 In-Orbit performance

MSI TIR-VNS co-registration: **Compliant.**

“The inter-channel spatial co-registration shall be smaller than 0.15 SSD for L1 products”.

Co registration parameters were updated during commissioning.



L1B Accuracy results showing compliance to requirements verified on “baseline AE” that is to say the last up to date release of image products set.

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Conclusion :

At L1 level data are compliant to requirements.

MSI data was released to validation teams on 20th September 2024 and the public data release is 14 January 2025, coincident with the first Post Launch Validation Workshop.

The data is freely accessible at in accordance with ESA's Earth observation data policy:

EarthCARE L1 products, Earth Online Dissemination Service, https://earth.esa.int/eogateway/catalog/earthcare-l1-products