



MAG – IRS Straylight

12/11/2020 – Pierre Dussarrat



Introduction – IRS straylight

PSF first delivery

Residual computation

Spectral calibration





Conclusion



OHB PSFs – delivery 07/2020

- 6 wavelengths, 4.598, 5.347, 6.250 μ m (LWIR) and 8.264, 11.11, 14.29 μ m (MWIR)
- 9 FOV positions, centre, edges and corners
- Ray tracing simulation from a detector pixel through the instrument and projected on earth at NADIR



Example at 4.6 μm [log10 scale], each plot is re-centered:

 <u>Caution</u>: OHB simulation only ran on a +/-300km FOV around the pixel of interest, FOV is not complete, update expected for PFM (date ?)

OHB PSFs – delivery 07/2020

• Diffraction added to our simulation by convolution with the expected super-pixel PSF without straylight (see presentation last MAG)



- Scattering was expected, but not included in EUM simulations,
- The dichroic bouncing is a surprising effect that breaks the PSF symmetry,
- The two effects are visible in LWIR and MWIR

Residual computation

 Relative residual computation on the dark side of perfectly contrasted scene using the centre FOV PSF at all wavelengths, PSF with straylight convolution with a semi-illuminated scene:



 <u>Requirements</u>: below 1% at 50km and less than 0.5% at 100km Close to requirements in both bands (but x2 at 14.29μm)

Spectral calibration

- Spectral calibration impact !?
 Straylight mixes light that propagated trough the interferometer with different angles !
- Measured spectrum taking into account all parasites, their rescaling and the metrology onboard correction:



• Spectral calibration on the composite spectrum to extract its scaling factor.

Spectral calibration

• Recovered spectral shifts :



Spectral shift recovered at 4.598µm (before 07/2020 hypothesis)

 Spectral shifts dependent on <u>the scene non uniformity = Jitters</u>, <u>the FOV positions and the wavelengths = Biaises</u>!



Spectral calibration

• 07/2020 last update, worst cases (field centres and extremal wavelengths):



LWIR field centre (14.29 μ m)





Worst cases:

Biases of -8.5ppm (LWIR) and -1.4ppm (MWIR), and **Jitters**: $\sigma = 0.25ppm$ (LWIR) and $\sigma = 0.08ppm$ (MWIR) (3 and 1ppm requirements)

EUMETSAT

OHB analysis (CDR 10/2020)

• OHB have ran experiments using the same methodology (LWIR/MWIR):

	Assessment #2 (POI - Center Field)	Assessment #2 (POI - Middle Field)	Assessment #2 (POI - Corner Field)		Assessment #2 (POI - Center Field)	Assessment #2 (POI - Middle Field)	Assessment #2 (POI - Corner Field)
Worst Case	6.86 ppm	2.01 ppm	4.80 ppm		3.04 ppm	0.87 ppm	0.77 ppm
Mean Value for 19 Spectra from Spectral Calibration Zone	6.72 ppm Jitter	1.98 ppm	4.41 ppm	-	2.92 ppm	0.83 ppm	0.60 ppm
Standard Deviation for 19 Spectra from Spectral Calibration Zone	0.08 ppm	0.02 ppm	0.22 ppm		0.08 ppm	0.03 ppm	0.07 ppm

- Same order of magnitude for the biases, 6-3ppm (worst cases): good news!
- <u>But different experiment</u>: They use different input spectra but only uniform scenes! Therefore, OHB and EUM experiments are complementary, both jitter should be added to the budget!

Spectral accuracy budget (11/2020)

- OHB consider only scene diversity effect in the overall budget: (see MTG-KT-IR-RFD-0219)
- Adding scene non-uniformity effect from EUM does not degrade much the budget: MWIR would stay partial compliant (1.14ppm) and LWIR compliant (2.09ppm)
- NB: The budget assumes a perfect accountability of the chromatic biases in the processing (in L1 spectral calibration?) !

		MWIR [dv/v ppm]	LWIR [dv/v ppm]	
Requirement		< 1.00	< 3.00	
	E2E Worst Case Performance (from SCALG E2E Analysis Tool)	< 0.82	< 1.47	
	(+) TED Prediction Accuracy Margin (10% of E2E Worst Case Performance)	0.08	0.15	
Performance Report	(+) Etalon Stability Residual Effect (10% of E2E Worst Case Performance)	0.08	0.15	
	(+) In-Field Straylight Residual Effect (20% of E2E Worst Case Performance)	0.16	0.30	
	Commitment @ MTG-S CDR (Linear sum of E2E Worst Case Performance, TED Prediction Margin , Etalon Stability Residual, and In-Field Straylight Residual Effect)	< 1.14	< 2.07	
Compliance Status @ MTG-S CDR		Partial- Compliant	Compliant	

Conclusions - Discussion

Performances (Last PSF update 07/2020):

- IRS PSFs have bouncing and scattering highly dependent of the wavenumber (= chromatism)
- Up to 0.5% (MWIR) and 1% (LWIR) residuals (worst case): at 100km (x2 requirement)
- 11/2020: Following OHB budget (worst case) + EUM: $\sigma = 1.14$ ppm (MWIR) and 2.09ppm (LWIR) spectral accuracy

• Discussion:

- PSF last update has brought "good" news overall !
- We expect spectral calibration jitters due to the scene variability, but reasonable.
- We expect chromatic spectral biases, up to ~3-6ppm NOK But, they can be automatically corrected at the spectral calibration level in the L1 processing, but right chromatism inputs have to be derived for all pixels and wavenumbers to be well accounted !

Conclusions

- Limitations:
 - Impact on SRF shape not assessed but expected negligible, only shift.
- <u>Way-forward:</u>
 - Wait for OHB PSFs updates with all FOV included
 - Verify that OHB will provide the chromatism inputs of all pixels including straylight effects.
 - Development of an anticipation tool that could produce flags for spectra expected to be strongly impacted by straylight ?

