IASI MetOp-B
Radiometric noise and interpixel radiometry

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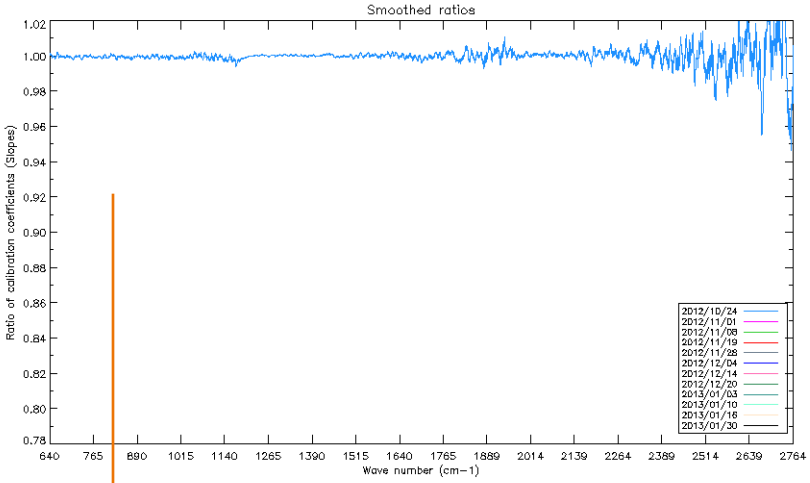
OUTLINE

- Sounder radiometric noise
  - Instrument transmission and decontamination
  - Interferometric contrast
  - Stability of the detector temperature
  - Band merging
  - L0 noise
  - L1B & L1C noise covariance matrix (NCM)
- Interpixel radiometry
- Conclusion

Sounder radiometric noise

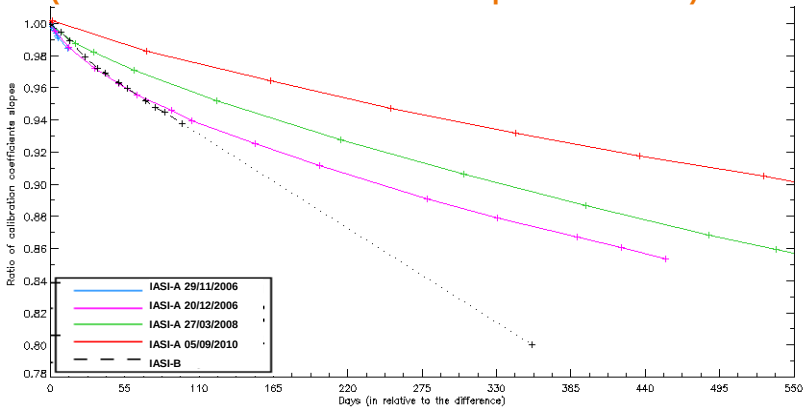
Instrument transmission and decontamination

Ratio of calibration coefficients slopes = f(wavenumber)



Evolution of the transmission

(ratio of calibration coefficients slopes at 850 cm-1)



- The evolution of the instrument transmission is monitored through the **ratio of calibration coefficient slopes**
- The decrease of the ratio of calibration coefficient slopes at **850 cm^{-1}** is proportional to the loss of instrument gain due to ice contamination (desorption).
- Desorption : water released by materials at 300 K (MLI, electronics)

  → condensation on field lens at 100 K (entrance of Cold Box Subsystem)

  → formation of ice

  → instrument transmission decreases

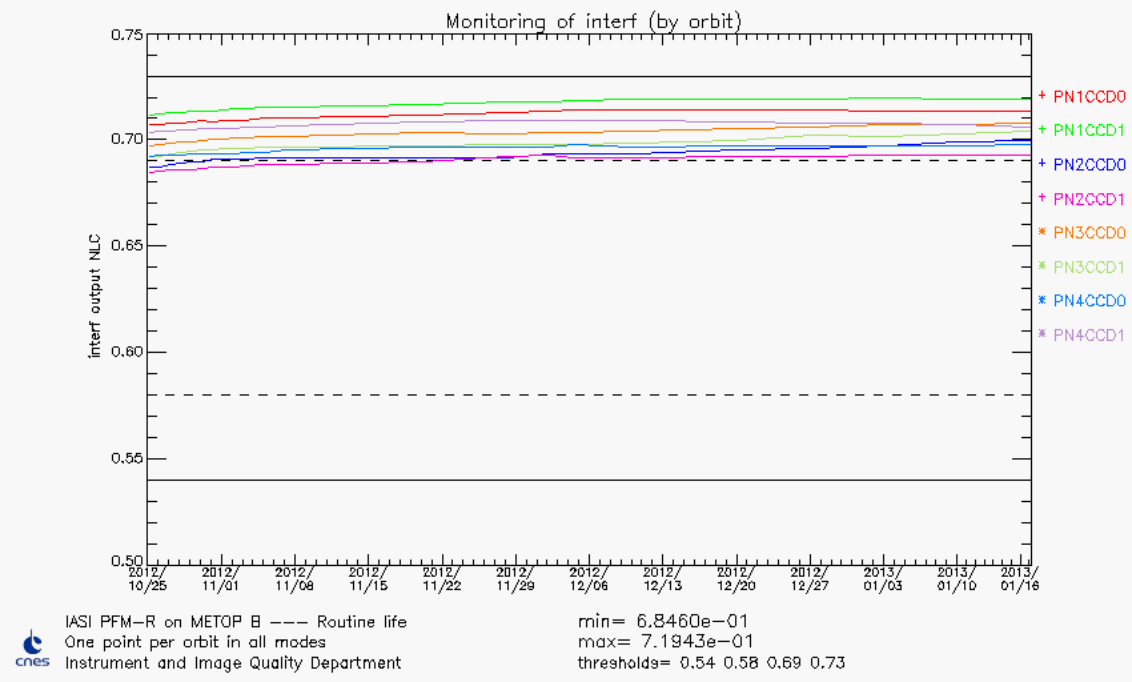
  → less signal → NeDT increases

  →decontamination needed to remove ice before the transmission loss reaches 20%

- First decontamination @300 K performed during SIOV (October 2012)
- According to the current trend, **no decontamination needed before the beginning of 2014**

Sounder radiometric noise

- Interferometric contrast



- Low drift of the contrast (in the way of improvement)
  Probably due to Wave Front Error evolution (in addition to Cube Corner alignment effect)
  - » Strain release in the beam splitter due to hygroscopic effect (optical coatings, gluing)
  - » Deformation of cube corners
  - » Drift should decrease with time (cf. IASI-A)

- The interferometric contrast is defined as the interferogram fringe discrimination power:
  - » Evaluated on mean BB and CS interferograms, for each SB, PN, CCD :

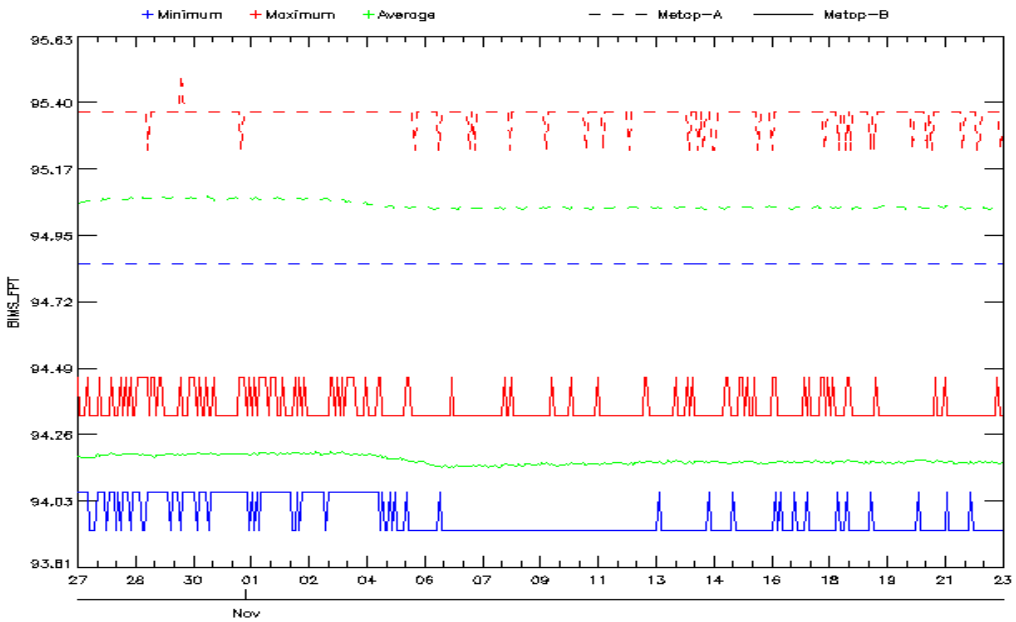
$$Contrast = \frac{\left(\max(|InterfBB|) - \min(|InterfBB|)\right) + \left(\max(|InterfCS|) - \min(|InterfCS|)\right)}{2\left(BaselineBB - BaselineCS\right)}$$

- The higher it is the better wrt NedT

Sounder radiometric noise

- Stability of the detector temperature

Focal plane temperature (K)

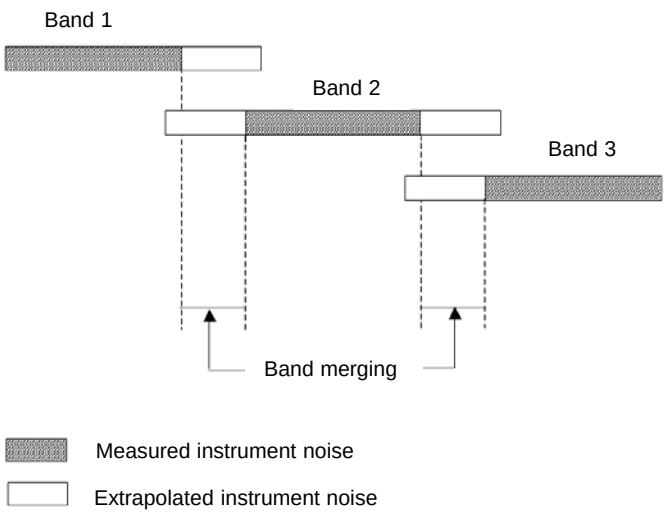


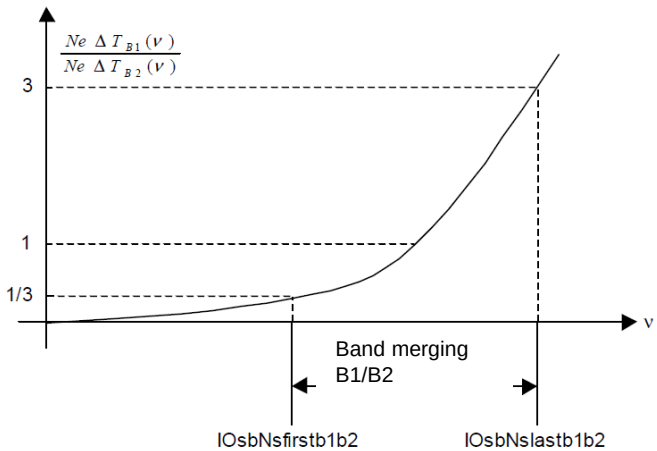
✦ Nominal behaviour

✦ Stability of FPT → stability of instrument noise

Sounder radiometric noise

- Band merging





✦ Linear combination of 2 bands (ex. : B1/B2) :

$$S_{merged\_B1B2}(\nu) = w(\nu) \times S_{B1}(\nu) + (1 - w(\nu)) \times S_{B2}(\nu)$$

✦ Determination of spectral band limits (SBL) and merging weights using 3 criteria:

» Maximum accepted noise level (0.5 K in B1, 1 K in B2, 3 K in B3)

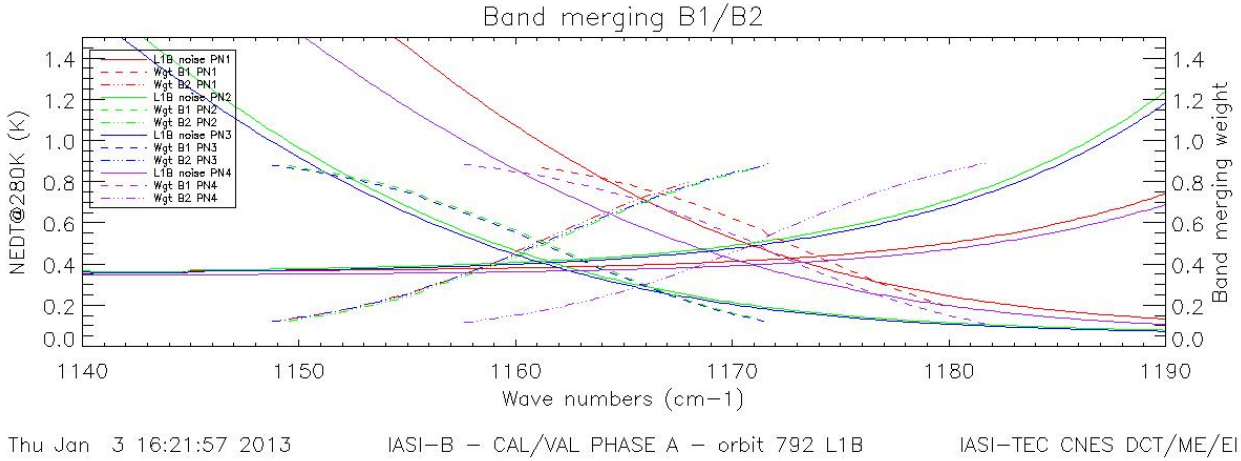
» In the band merging area : ratio of noise in the 2 bands between 1/3 and 3

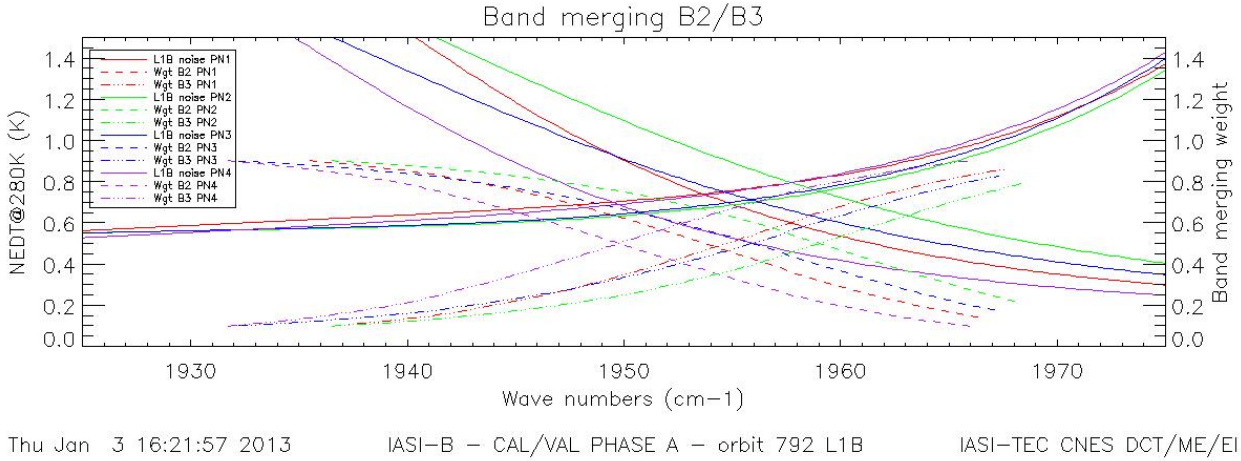
» Dimensioning constraints of the DPS

(maximum number of samples in the B1, B2, B3 bands and in the interbands B1/B2 & B2/B3)

Sounder radiometric noise

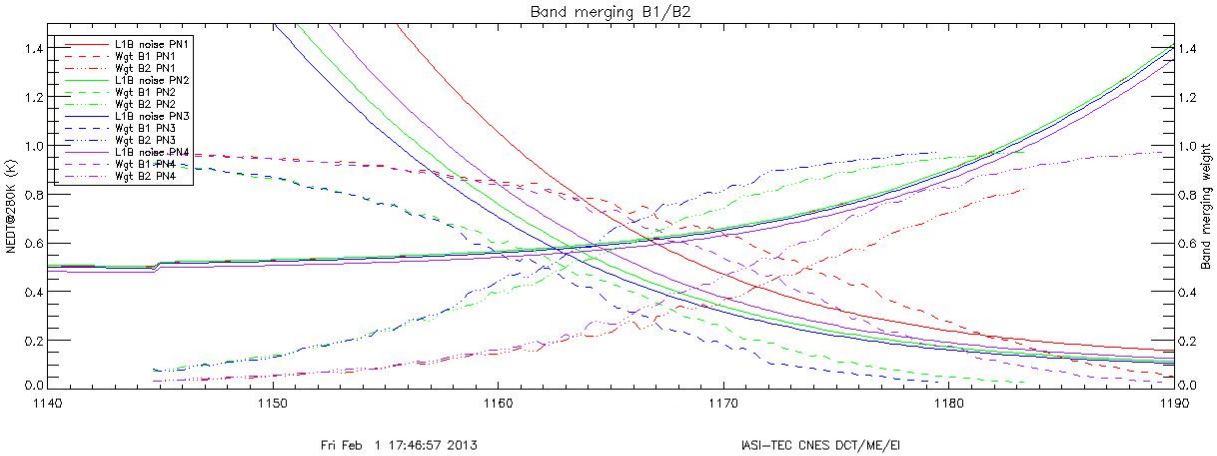
- Band merging
  - ✦Current SBL

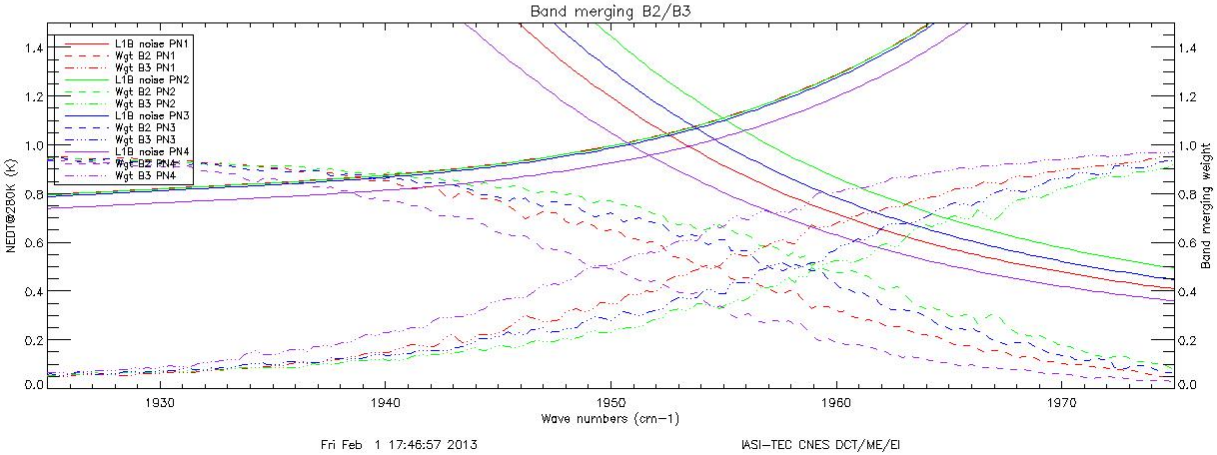




Sounder radiometric noise

- Band merging
  - ✦Optimized SBL

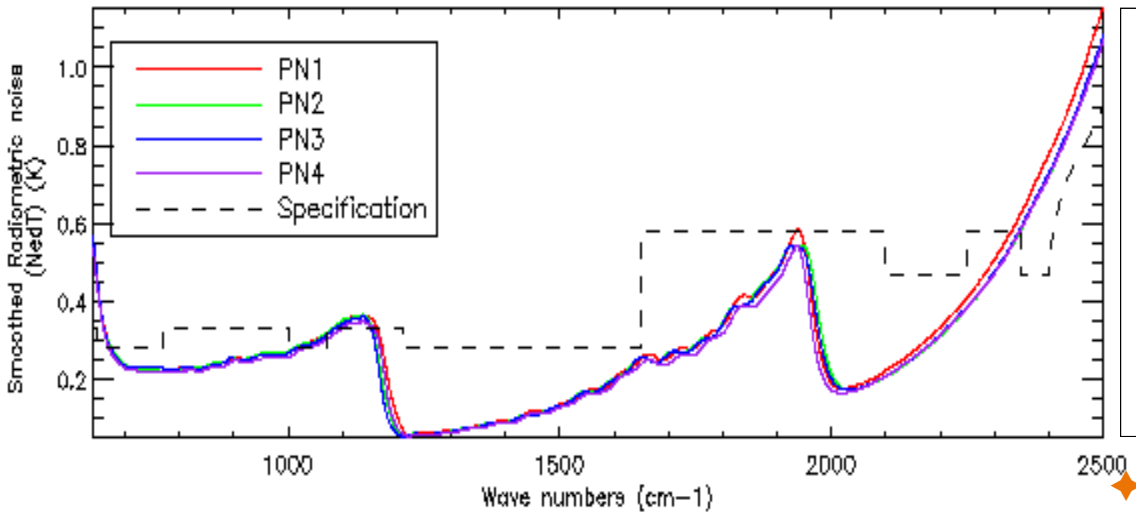




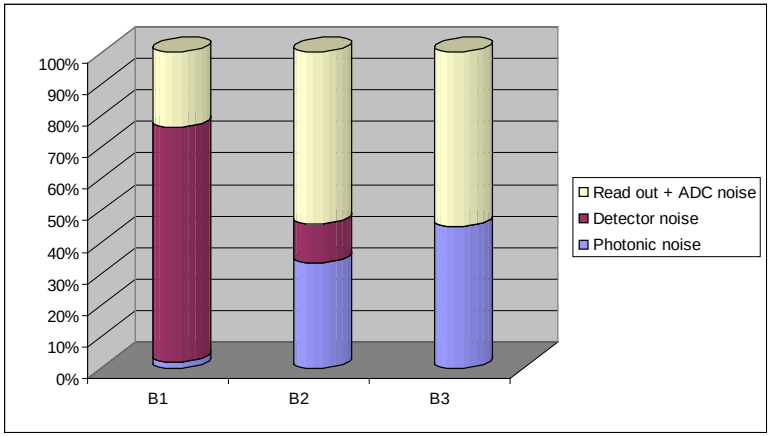
Sounder radiometric noise

- L0 noise
  - Evaluation of noise using BB target

Radiometric noise



Noise budget



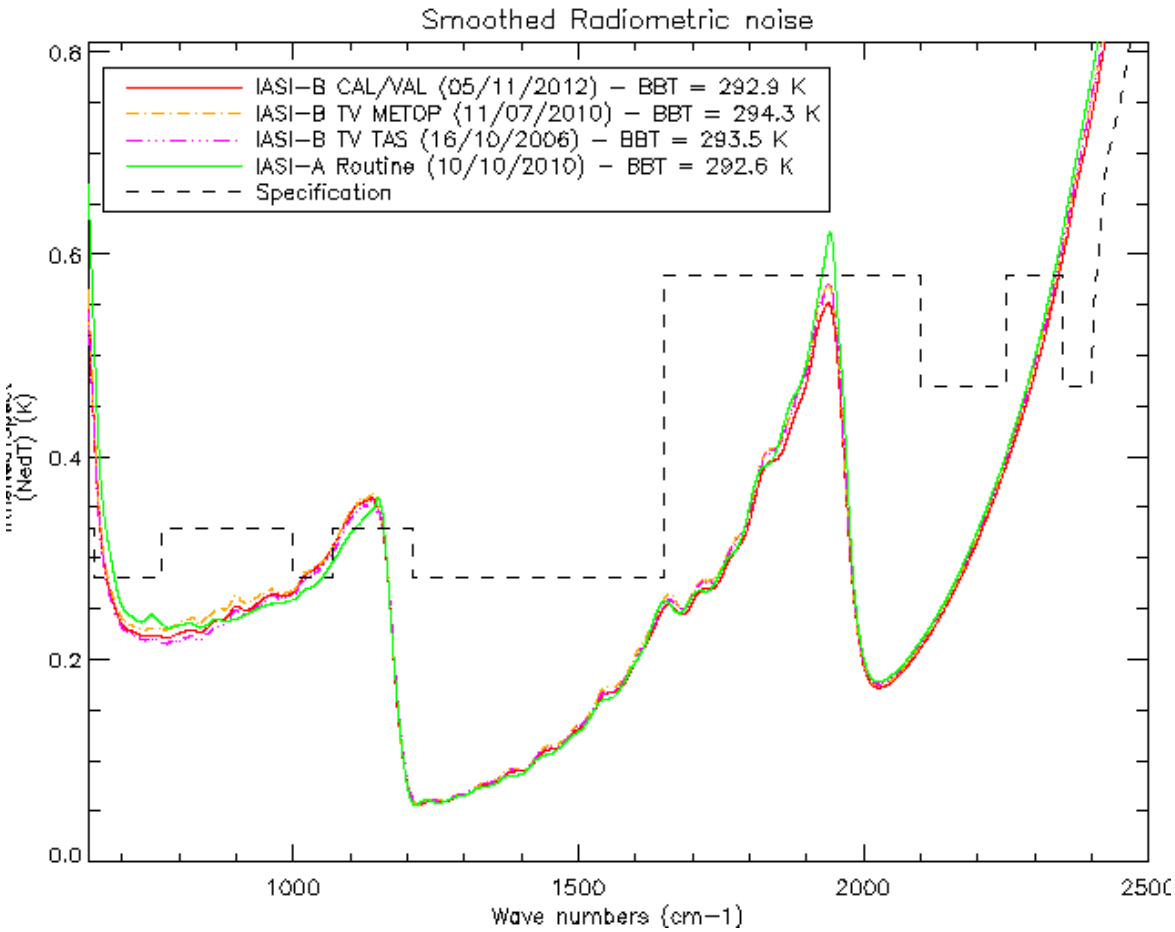
- **Noise level within specifications**
  Except in the B1/B2 interband and at the end of B3

- Optimization of spectral band limits in Cal/Val phase B to decrease noise in the interband regions (B1/B2 & B2/B3)

- Photonic noise depends on :
  - » Scene temperature
  - » Background temperature
  - » Surface of pixel and pupil
- Detector noise depends on :
  - » Focal plane temperature
- Readout noise + ADC noise : constant

Sounder radiometric noise

- L0 NEDT



- IASI-A and IASI-B noise levels have the same order of magnitude
  IASI-B slightly lower than IASI-A (except between 850 and 1150 cm^{-1})

- Good agreement between IASI-B noise measured on ground and in flight

Sounder radiometric noise

- Noise covariance matrix (NCM)
  - The NCM is a characteristic of errors distribution ε_i (**amplitude** and **correlation between errors** observed on different channels of the same spectrum) :

$$NCM = E\left(\varepsilon\varepsilon^t\right)$$

With : $\varepsilon^t = \left[\varepsilon_1, \varepsilon_2, \varepsilon_3, \ldots, \varepsilon_N\right]$ white noise of the 8461 IASI channels

E : expected value

  - Estimation of the NCM :

L0 NEDT

+ **pseudo-noise** (pointing stability, field homogeneity, coding noise, …)

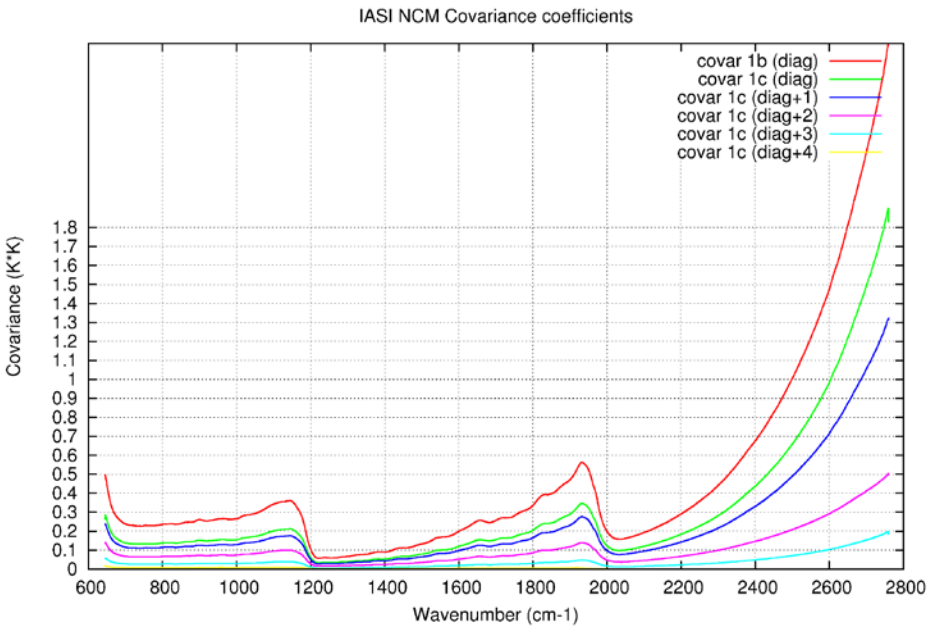
→ **NCM_{L1B} is diagonal**

NCM_{L1B}

cross-correlation between channels due to apodisation

→ **NCM_{L1C} is symmetric and band diagonal**

NCM_{L1C}

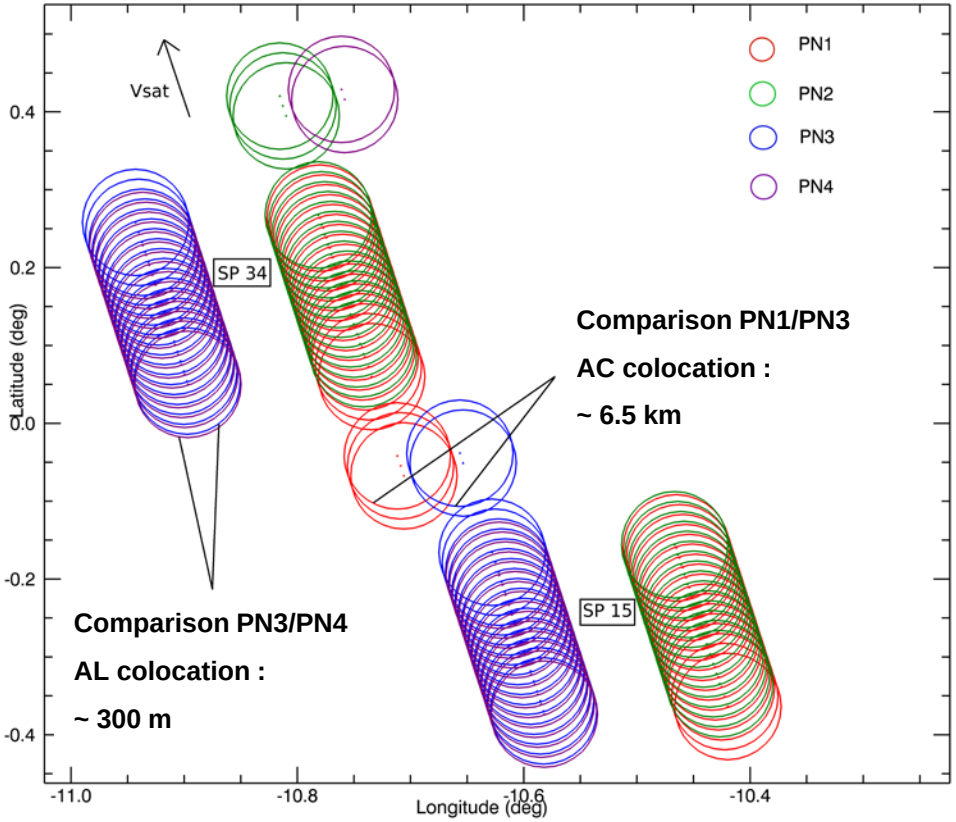


  - Delivered to the L1 users in January 2013

Interpixel radiometry

- External calibration sequence using 2 alternating scan positions :
  SP 34 (0° = **Nadir**) / SP 15 (1.7° = **quasi Nadir**)
  - ✦Aim : compare measurements performed by the different pixels on Earth View targets

SP	LN	Time (sec)
15	1	8
34	2	16
15	3	24
34	4	32
…	…	…



✦**Matching strategy**:

» **Along track (AL)** : we match 2 pixels acquired on the same scan line on a given SP (SP15 or SP34)

» **Across track (AC)** : we match a pixel acquired on SP15 with a pixel acquired on SP34

✦Collection of colocated soundings
→ evaluation of interpixel radiometric differences on :

» **Broadband pseudo-channels**

» **Full spectra**

✦Results are **filtered** using :

» Data quality

» Spatial radiometric homogeneity

» Apparent scene temperature

» Cloud coverage

Interpixel radiometry

- Interpixel on broadband pseudo-channels
  - 19 orbits L0 (from 4/12/2012 20:57 to 6/12/2012 5:08)
  - Filtering conditions (**homogenous** and **cloudless scenes**)
    - » Homogenous scenes (standard deviation IIS = [0.0 K, 1.0 K]
    - » Cloud coverage = [0 %, 5 %]
    - » No filtering on the scene temperature

Definition of the pseudo-channels

	Effective v (cm-1)	Min v (cm-1)	Max v (cm-1)
Middle **B1**	903.3	778.2	1052.2
Middle **B2**	1515.5	1352.9	1767.0
Middle **B3**	2289.9	2134.2	2554.2

Interpixel statistics

	Bias (K)	**Std (K)**	**Min (K)**	**Max(K)**
P2-P1 AL	**0.014**	0.031	-0.322	0.506
P4-P3 AL	**0.002**	0.032	-0.348	0.642
P3-P1 AC	**-0.011**	0.139	-0.806	0.482
P4-P2 AC	**-0.013**	0.149	-0.774	0.539

Interpixel radiometry

- Interpixel high resolution
  - 1 orbit L1C (from 4/12/2012 20:57 to 4/12/2012 22:37)
  - Filtering conditions (**homogenous** and **cloudless scenes**)
    - » Homogenous scenes (standard deviation IIS = [0.0 K, 1.0 K]
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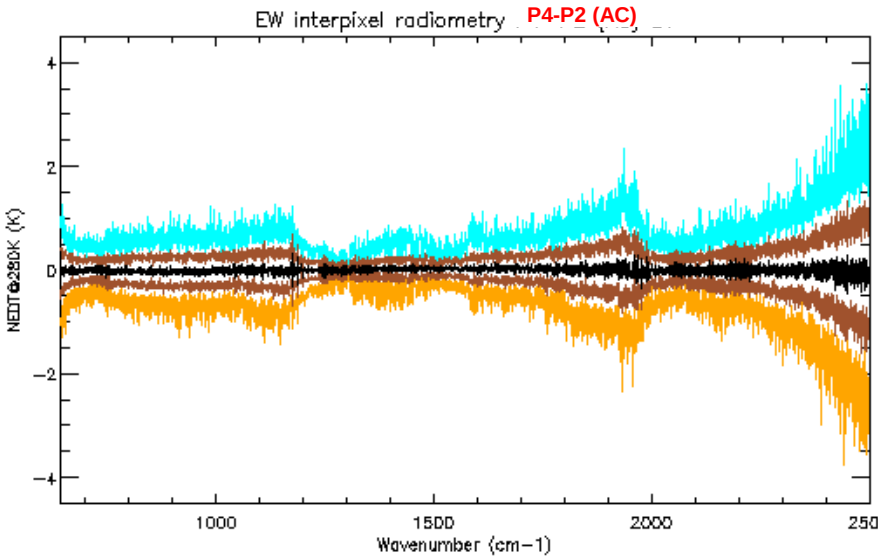
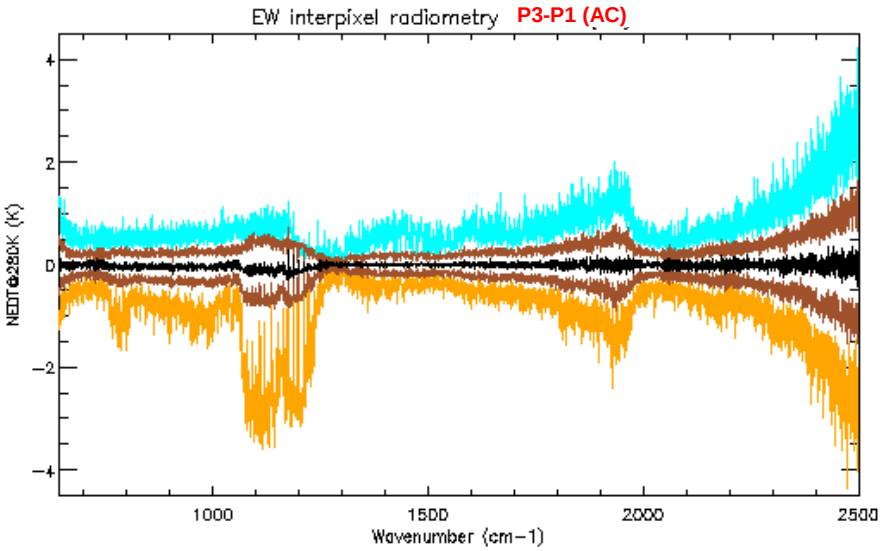
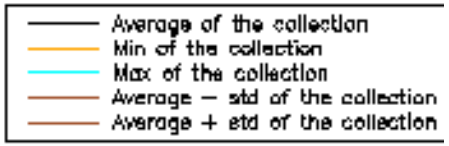
    - » No filtering on the scene temperature
  - **Across track** results:







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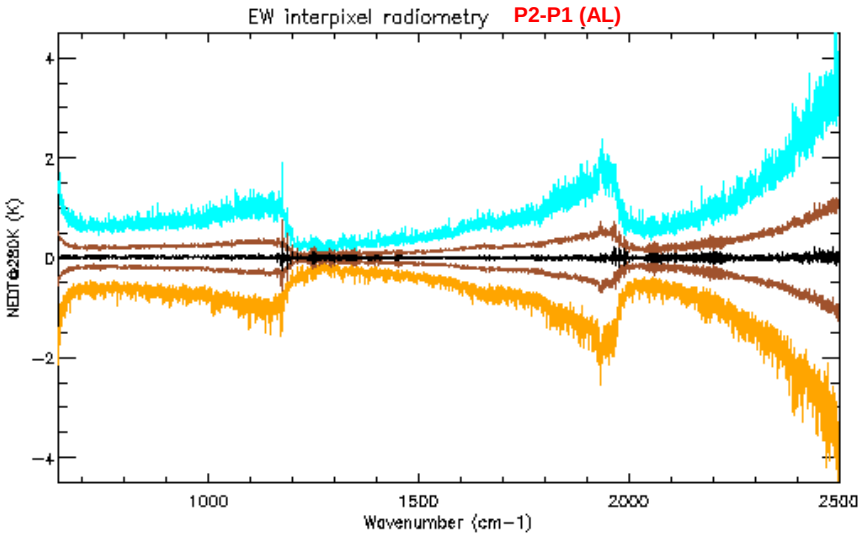

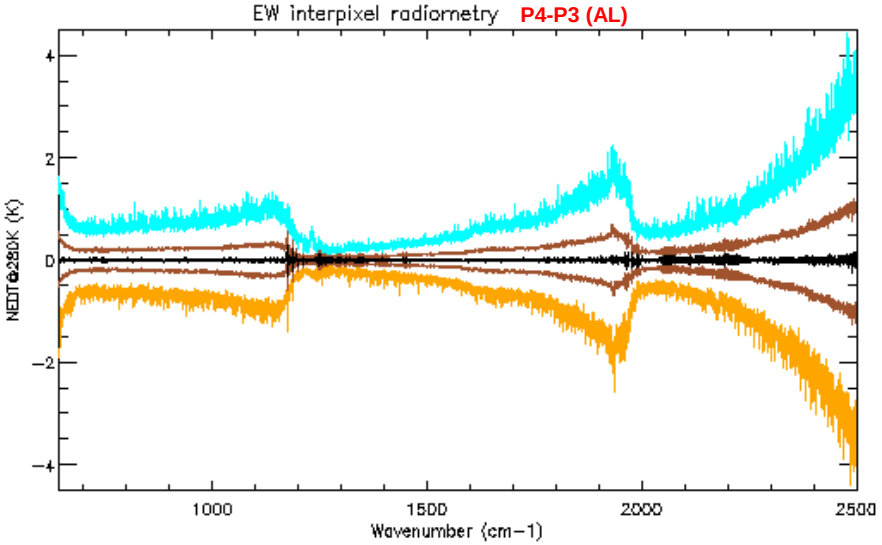

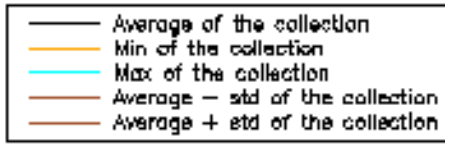

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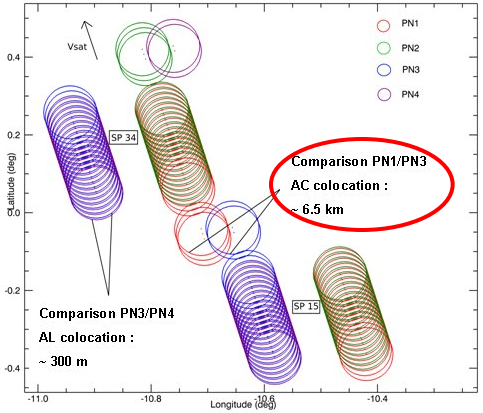

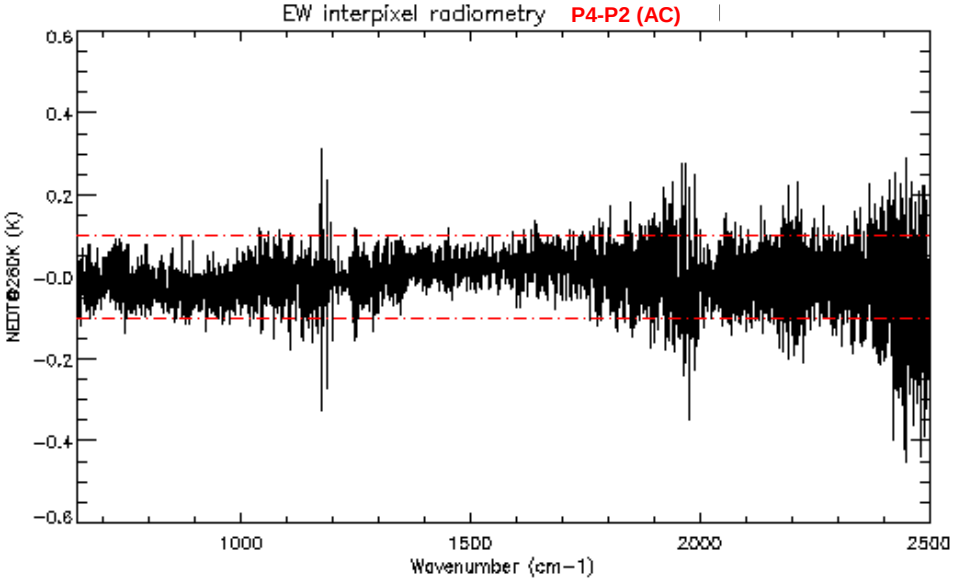

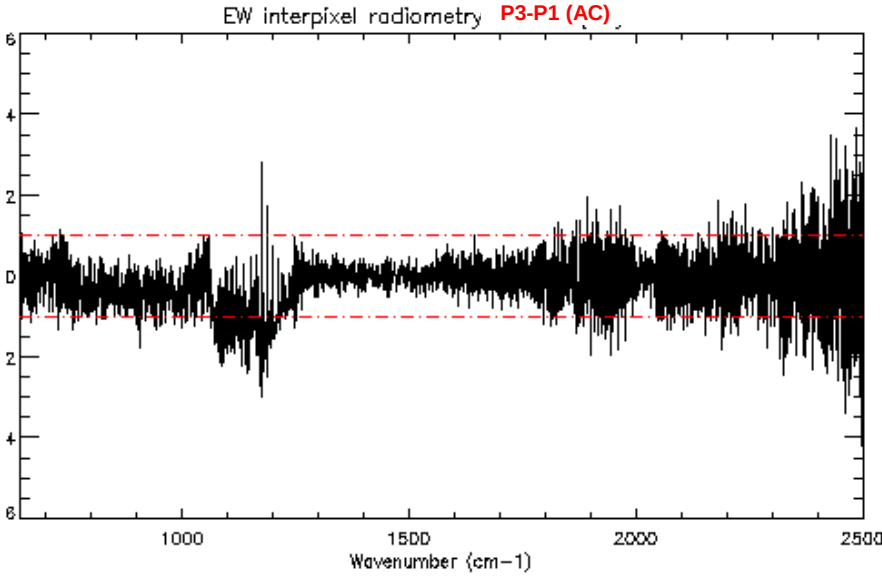

Average of the collection
Specification

Interpixel radiometry

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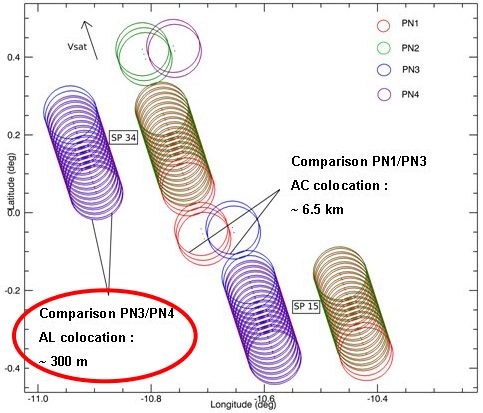

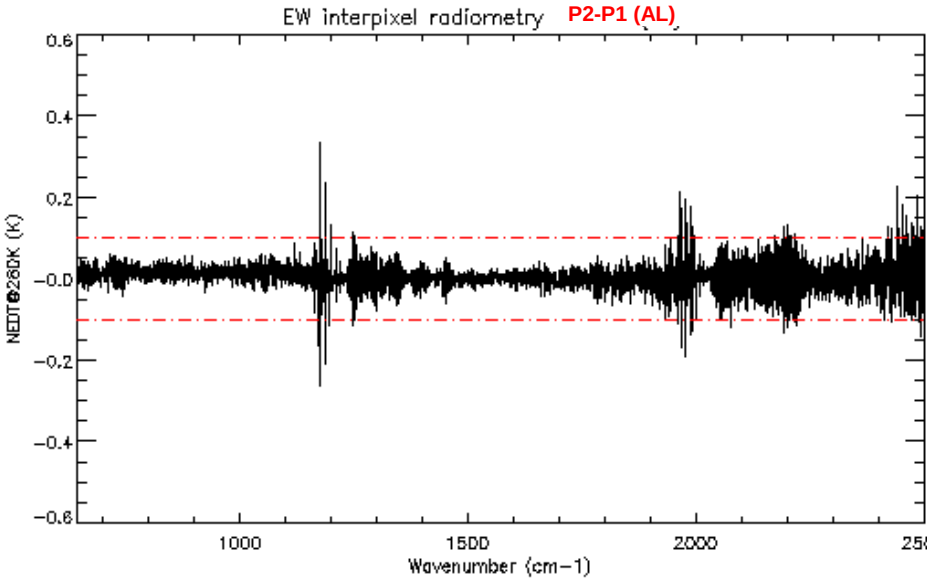

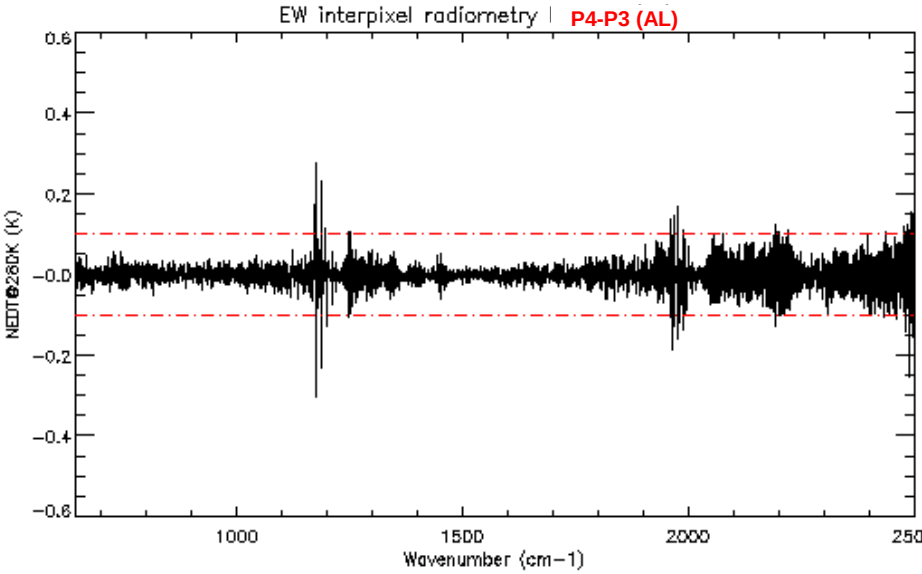

Average of the collection
Specification

Conclusion

After 3 months of Cal/Val :

- The noise level is fully acceptable:
  - Within specifications except in B1/B2 interband region and at the end of B3
  - Consistent with the noise measured on ground (during TV tests)
  - Same order of magnitude as IASI-A

- Instrument transmission, interferometric constrast, detector temperature,… are monitored → their behaviour is nominal.

- The Earth View interpixel radiometric bias is within specification (**<0.1 K**) except in the interbands