IASI on METOP
On-Ground Calibration of the FM2 Instrument

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Outline

- Key Performance specifications
- On-ground characterization of IASI FM2
  - First IASI instrument in flight (on METOP 2)
- IASI Program Status

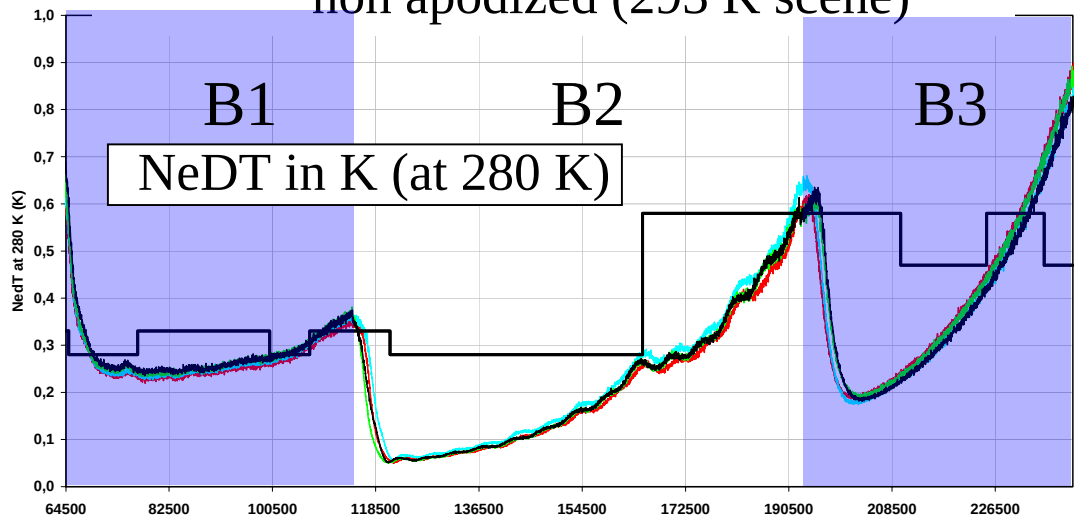
Key performances specifications

- Radiometric sensitivity
  - Apodized and non-apodized spectra
- Radiometric accuracy
  - Absolute accuracy
  - Relative accuracy (at a given time)
    - Between pixels, channels, viewing direction
  - Stability
- Spectral & geometry
  - Spectral calibration
  - Spectral response function
  - Point Spread Function (& interband registration)

Measured radiometric sensitivity

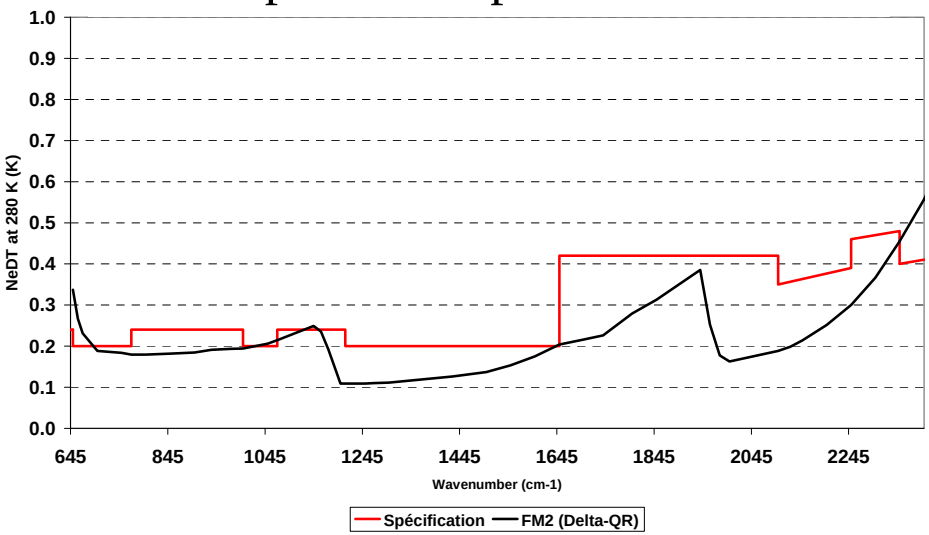
- IASI FM2 testing in vacuum
  - Detectors temperature 91.7 K
  - Measured on blackbody
  - No evolution of noise (ice cont.)
    - Loss of transmission : 1.5 % at 850 cm^{-1} over a period of 6 days
    - Equivalent to the absorption by a 40 nm thin film of water ice

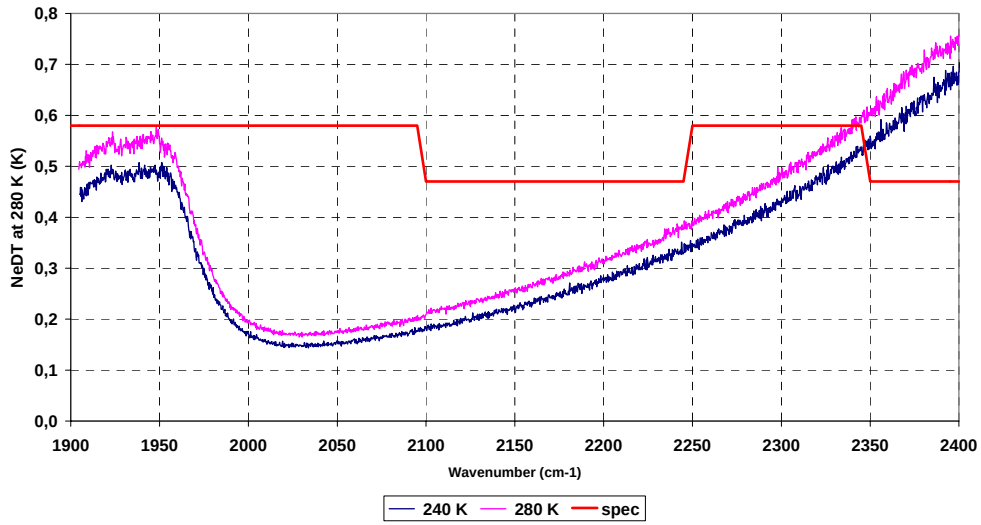
non apodized (293 K scene)



Measurement SM0410111609 — Pixel 3
Effect of scene temperature on B3 noise (scene at 240 & 280 K)

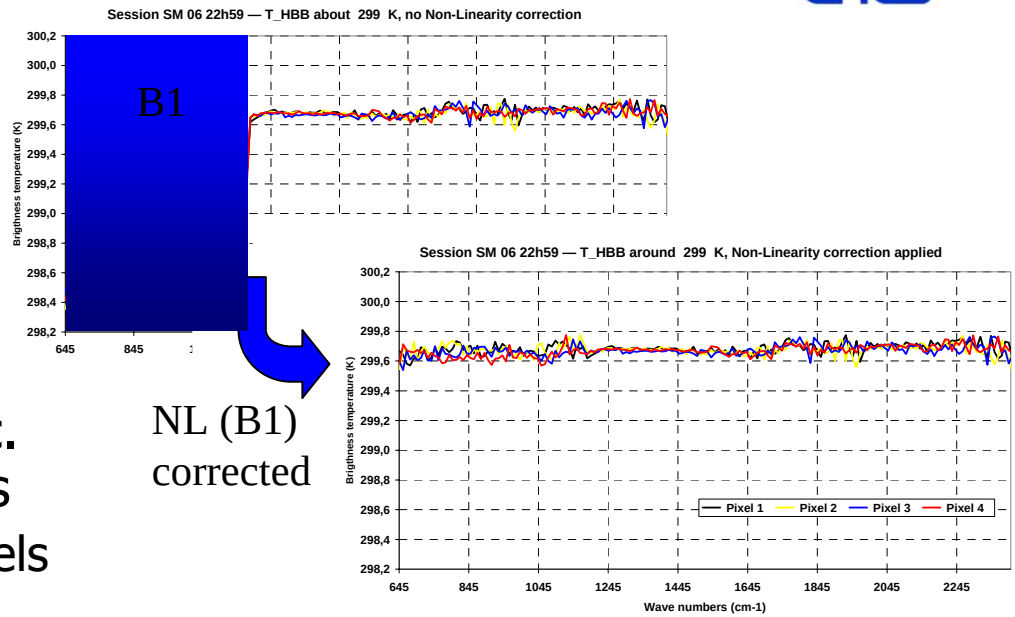
apodized + pseudo-noise



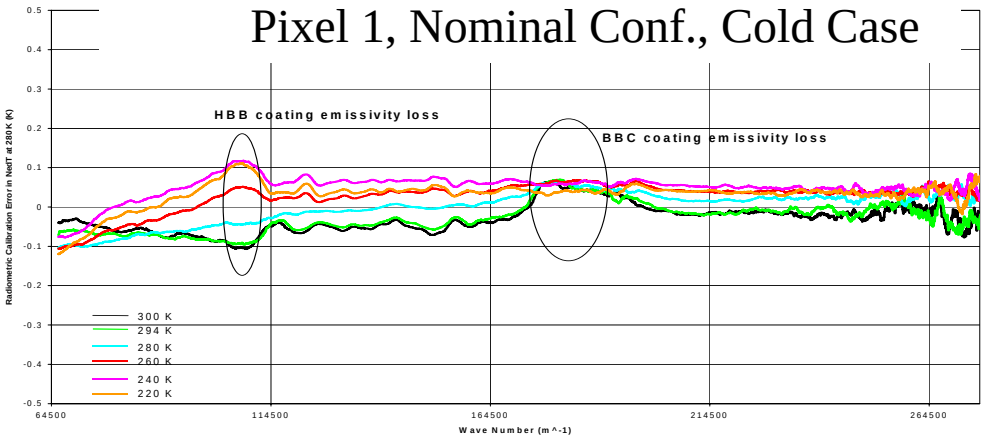


Measured radiometric accuracy (1/4)

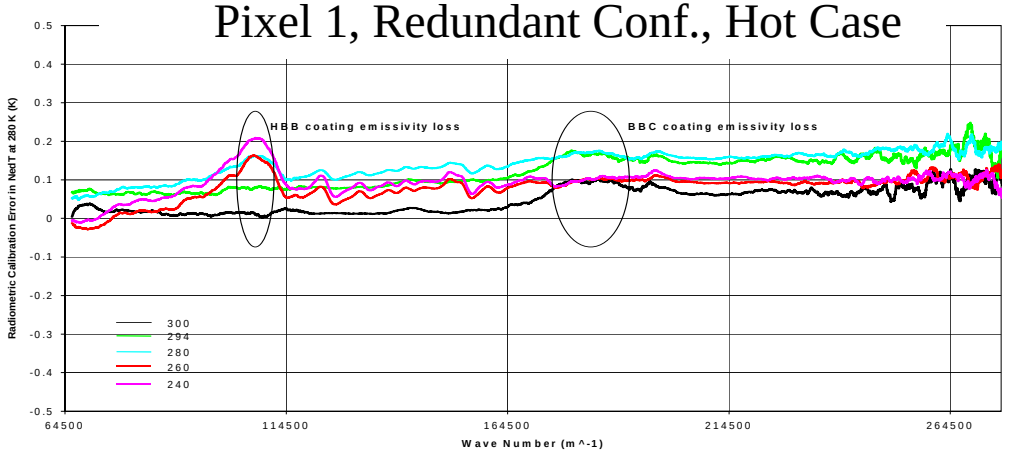
- IASI FM2 testing in vacuum
  - Need for NL correction in B1 band
  - DT < 0.25 K
  - Target in nadir position
    - Result valid for other incidences
  - Post-calibration done by Level 1 proc. to achieve "differential" requirements
    - Between pixels, scan views or channels



Tscene : 220 – 300 K
Pixel 1, Nominal Conf., Cold Case



Tscene : 240 – 300 K
Pixel 1, Redundant Conf., Hot Case



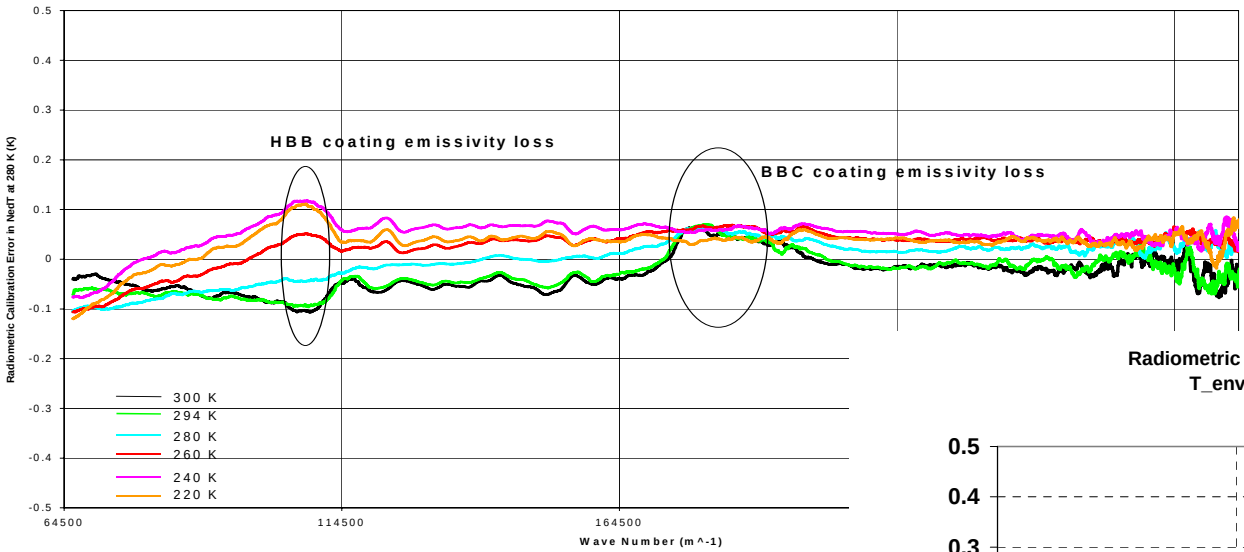
Measured radiometric accuracy (2/4)

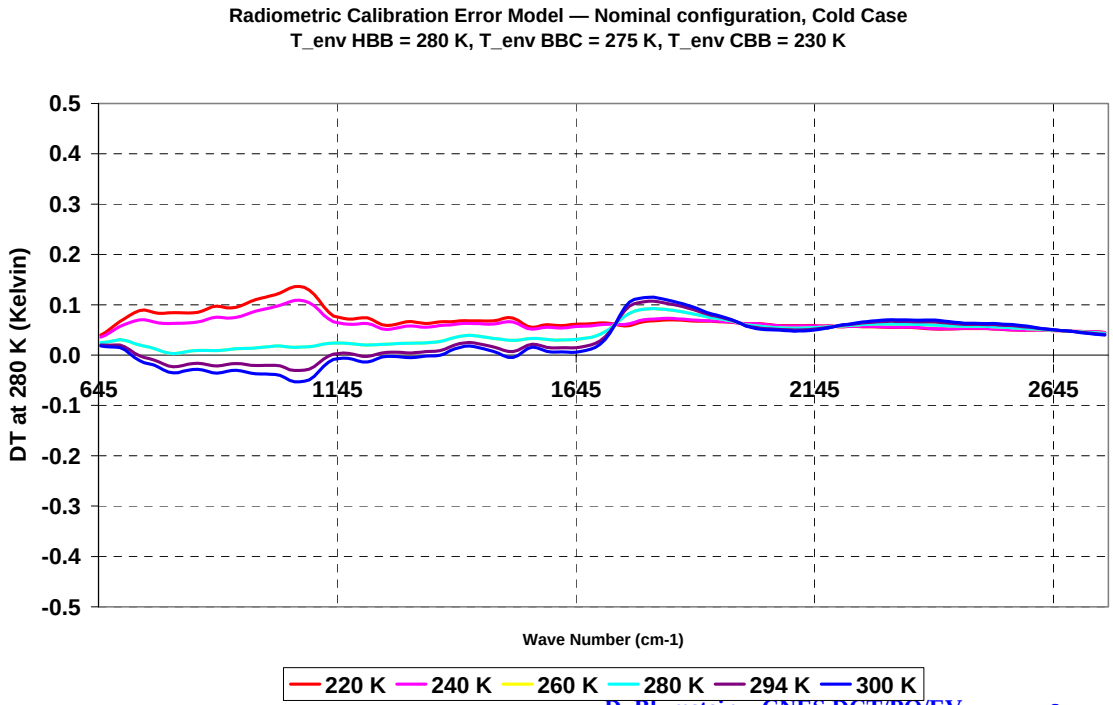
- Raw measurements versus model comparison

Pixel 1

Nominal Conf.

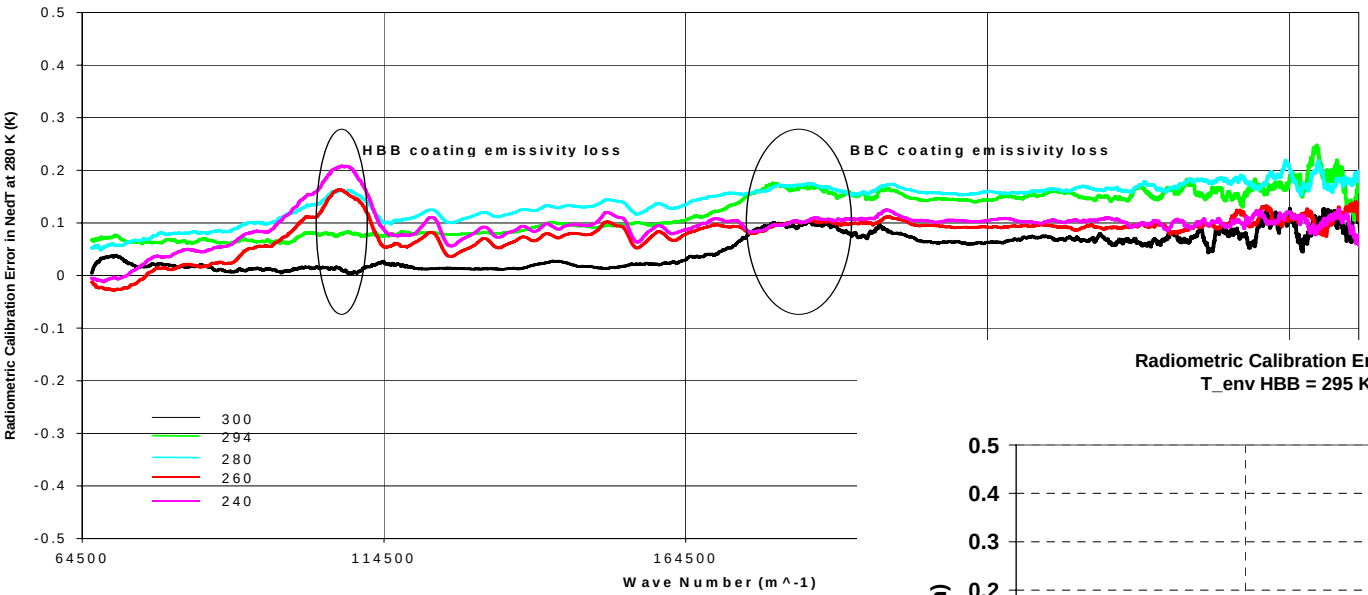
Cold Case

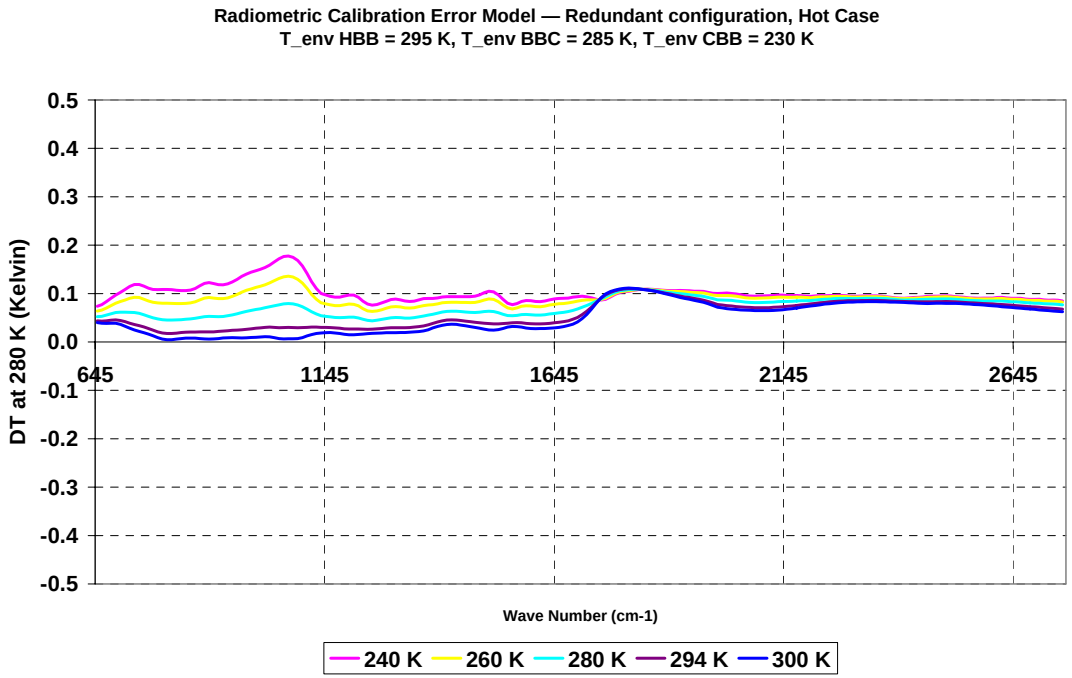




❑ Raw measurements versus model comparison

Pixel 1
Redundant Conf
Hot Case





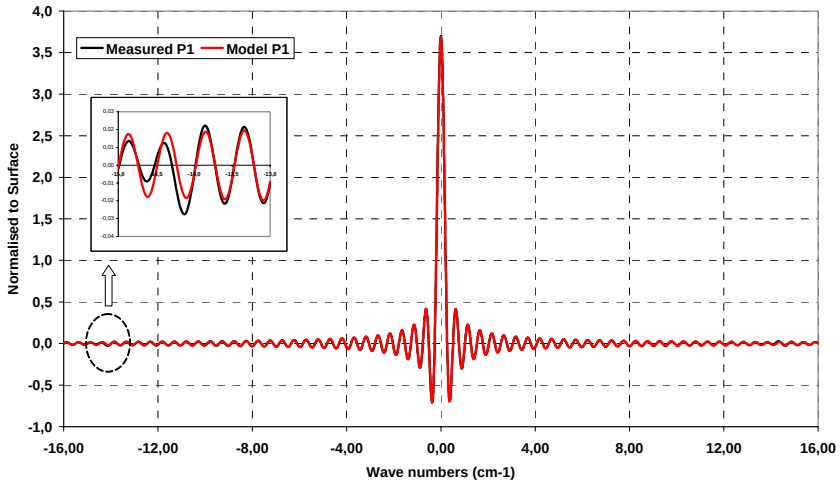
Measured radiometric accuracy (4/4)

- More in-depth verifications performed during the test
  - Scan angle effect verified
  - Interpixel & interscan calibration
  - Sensitivity to thermal drifts
    - Simulation of Entry/Exit of eclipse

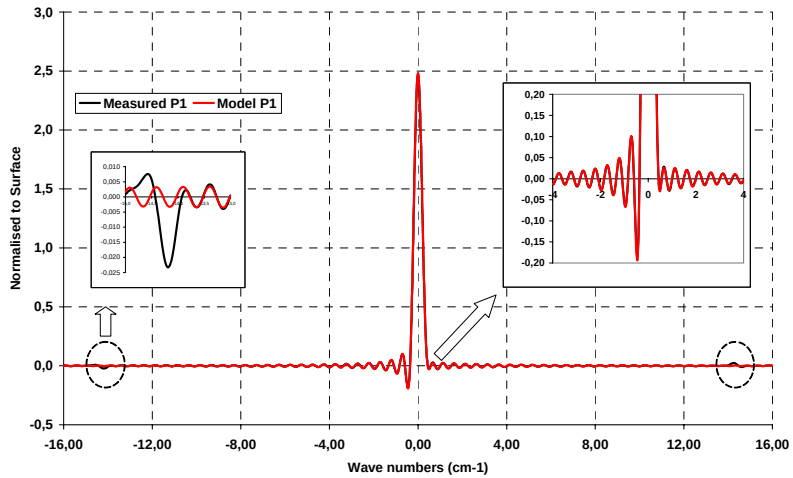
- Mission Objectives on radiometric calibration are expected to be achieved in orbit
  - Absolute Calibration Error : < 0.5 K
  - Intercalibration error at a given time : < 0.2 K
    - All geophysical conditions
    - 4 pixels, all viewing directions, all channels
  - Intercalibration error over time : < 0.3 K
    - Short term (orbital period)
    - Long term

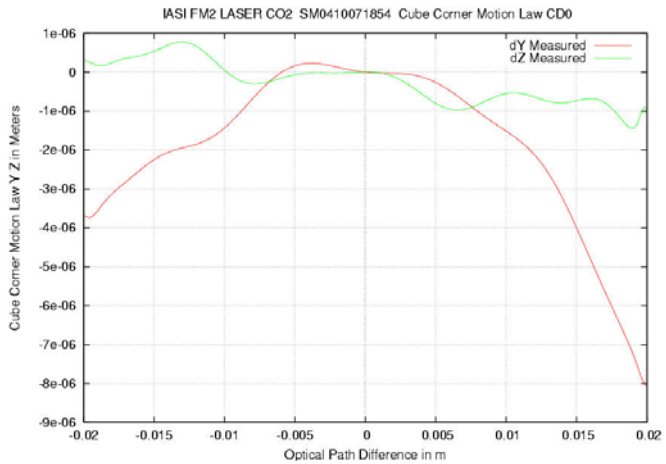
- IASI PFM testing in vacuum
  - 2 laser beams (B1:CO2, B3:HF/DF)
    - Field and Aperture illuminated
  - ISRF measured on +/- 16 cm-1 (+)
    - Resolution (FWHM) compliant (w. margins)
    - ISRF Model accuracy achieved
    - ISRF Model input are precisely measured
      - Instrument Point Spread Function
      - Interferometric axis and shear
      - Corner Cube trajectory

B1 ISRF (944 cm-1)

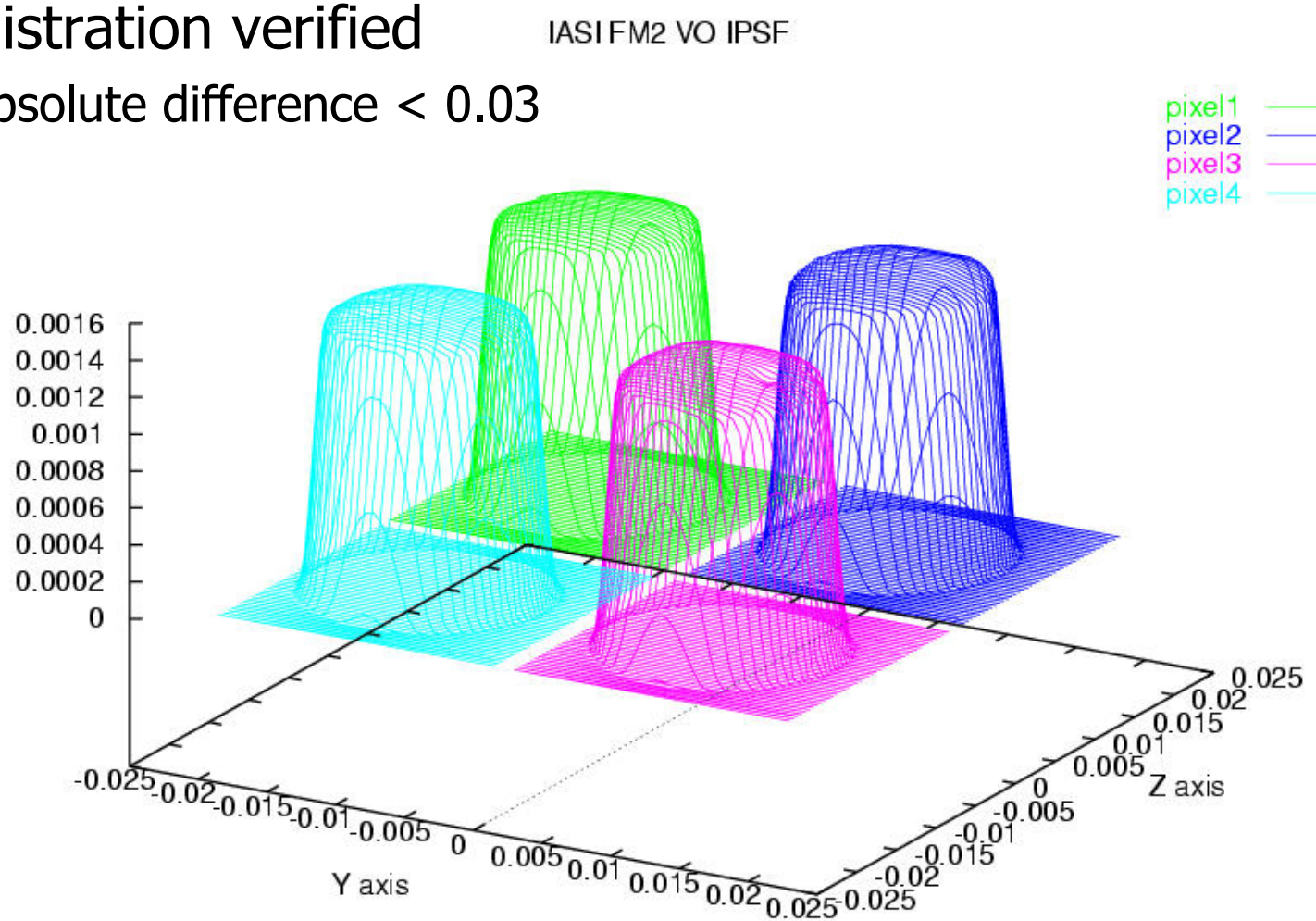


B3 ISRF (2655 cm-1)





- Point Spread Function (IPSF) measured for the 3 IASI bands
- Interband registration verified
  - Integrated absolute difference < 0.03
- 12 km FOV (at nadir)



- First assessment done on few parameters
  - $D\nu/\nu$ with respect to nominal instrument
  - Spectral resolution (Full Width at Half Maximum)
    - At 944 cm-1 (B1) and 2655 cm-1 (B3)
  - Shape error index Epsilon2 = variations of the ISRF
    - Absolute difference between average and instantaneous
    - Summed over +/- 16 cm-1

Band 1		P1	P2	P3	P4	Specification
$D\nu/\nu$			$1\ 10^{-5}$			$2\ 10^{-4}$
FWHM	cm^{-1}	0.32	0.32	0.32	0.32	0.35
Epsilon2	cd0	0.014	0.014	0.010	0.011	0.026
	cd1	0.015	0.013	0.009	0.012	

Band 3		P1	P2	P3	P4	
$D\nu/\nu$			$1\ 10^{-5}$			$2\ 10^{-4}$
FWHM	cm^{-1}	0.43	0.40	0.43	0.42	0.48
Epsilon2	cd0	0.020	0.025	0.015	0.019	0.042
	cd1	0.020	0.023	0.011	0.014	

- Spectral stability over 80 sec. Spec = 1.10^{-6}
  - Standard deviation of the position of the quadratic barycentre of the ISRF

Band 1	P1	P2	P3	P4
cd0	8.27E-08	8.30E-08	7.70E-08	7.36E-08
cd1	7.66E-08	7.46E-08	4.79E-08	8.08E-08

Band 3	P1	P2	P3	P4
cd0	1.67E-08	2.29E-08	2.36E-08	1.66E-08
cd1	1.58E-08	2.55E-08	2.09E-08	1.49E-08

- + very good long term stability between measurement sessions
  - Observed $D\nu/\nu$ (average of the 4 pixels) < 1.10^{-6}
  - Hot Case / Cold Case
  - 14 days between first and last measurements

- Shape error index 1 **Spec b1 < 0.02, Spec b3 < 0.05**
  - ISRF knowledge errors
  - Shape_index_1 = Σ(abs(Isrf_Model(n) – Isrf_Average(n)) * dn)
    - Ghost has to be removed from the averaged ISRF (computation on 13 cm-1)

Band 1		P1	P2	P3	P4
+/- 13 cm	cd0	0.025	0.023	0.023	0.023
	cd1	0.029	0.023	0.021	0.022
+/- 16 cm	cd0	0.034	0.031	0.026	0.027
	cd1	0.034	0.028	0.023	0.024

Band 3		P1	P2	P3	P4
+/- 13 cm	cd0	0.029	0.042	0.026	0.049
	cd1	0.032	0.046	0.019	0.050
+/- 16 cm	cd0	0.043	0.053	0.030	0.056
	cd1	0.039	0.056	0.021	0.053

- Excellent performances measured on 2nd IASI model (FM2)
  - The instrument ran flawlessly for the 3 weeks of test
  - Design modifications decided after PFM testing (ice contamination) successfully implemented on FM2 & FM3
    - PFM model will be refurbished to benefit from these modifications
  - Big investment put into the on-ground calibration (human & financial)
  - Excellent stability of the instrument (spectral & radiometric)
  - Spectral Response Function of the instrument
    - Accurately measured at 2 wavenumbers (use of 2 laser beams for test)
    - Model accuracy verified at these 2 wavenumbers

IASI Project Status : instruments (1/2)

- FM2
  - On-ground calibration completed (TVAC test in October 2004)
  - Integration & tests on METOP 2 completed
  - Launch planned April 2006
- FM3
  - Subsystem Integration & Test completed
  - Thermal Vacuum Test planned in October 2005
- PFM
  - Instrument TVAC test in June 2003
  - METOP Payload TVAC test in February 2004
  - Now dismounted from METOP 2
  - Detectors refurbishment planned end of year 2005

- OPS software (Level 1 processing)
  - Delivered by CNES to EUMETSAT : Sept. 2004
  - Now integrated & tested in CGS
  - Delivered to METEO FRANCE for integration in direct readout software
- TEC (IASI Technical Expertise Center)
  - Acceptance test completed : Feb. 2005
  - NRT terminal installed. First tests completed
  - TEC ready for system level testing with EPS/CGS
- Participation of IASI Instrument team to EPS system level tests with METOP 2 (SSVT4a, May 2005)
- In-flight commissioning preparation
  - Instrument on-orbit Verification Plan completed
  - Level 1 Cal/Val Plan completed (see poster B20), implementation on-going

Aknowledgements

- The authors would like to express their thanks to the many people involved in the development, integration and test of the IASI instruments either in the industry, in the space agencies or in the universities for their efforts which made IASI a reality.

- A special thought goes to F.R.Cayla who has been so involved with IASI project since the beginning and is still very close from us in spite of his retirement four years ago.