IASI-NG : OVERVIEW L1 Processing Performances

QUENTIN CEBE . IASI-NG SYSTEM PERFORMANCES MANAGER

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IASI & IASI-NG MISSIONS

NUMERICAL WEATHER PREDICTION

- Temperature
- Water Vapour

CLIMATE MONITORING

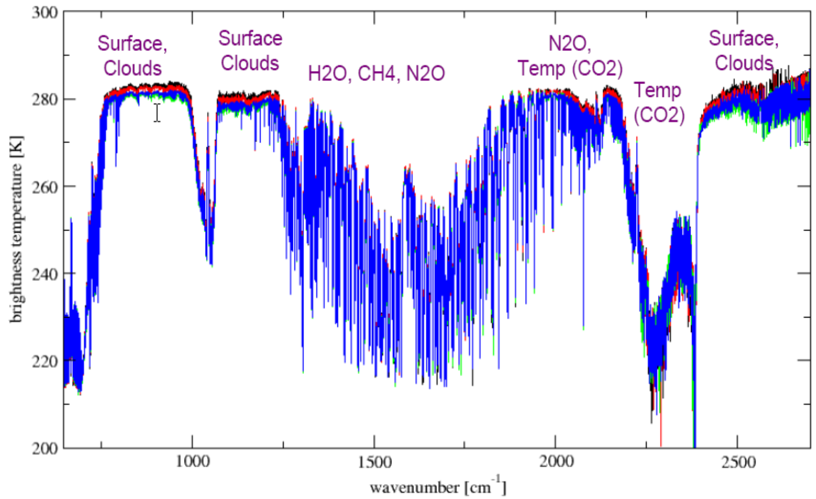
- Greenhouse gas

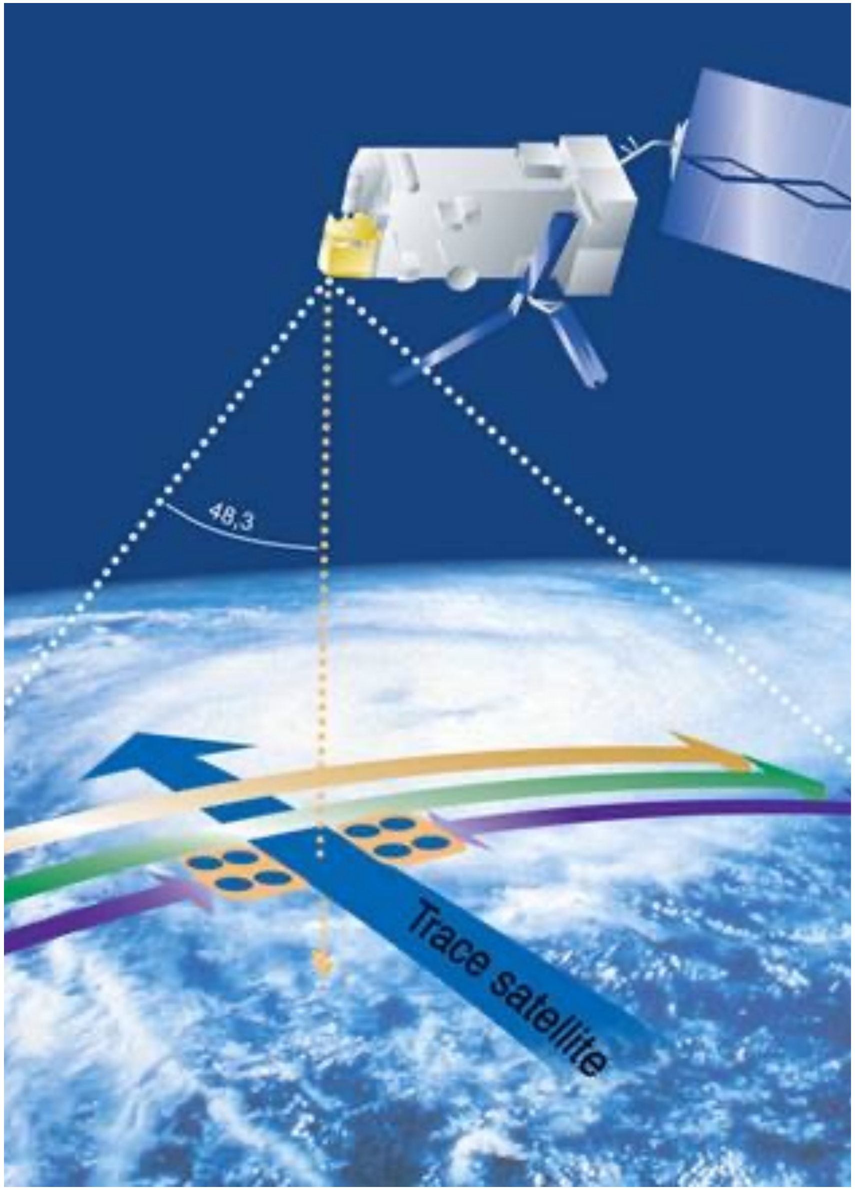
ATMOSPHERIC CHEMISTRY

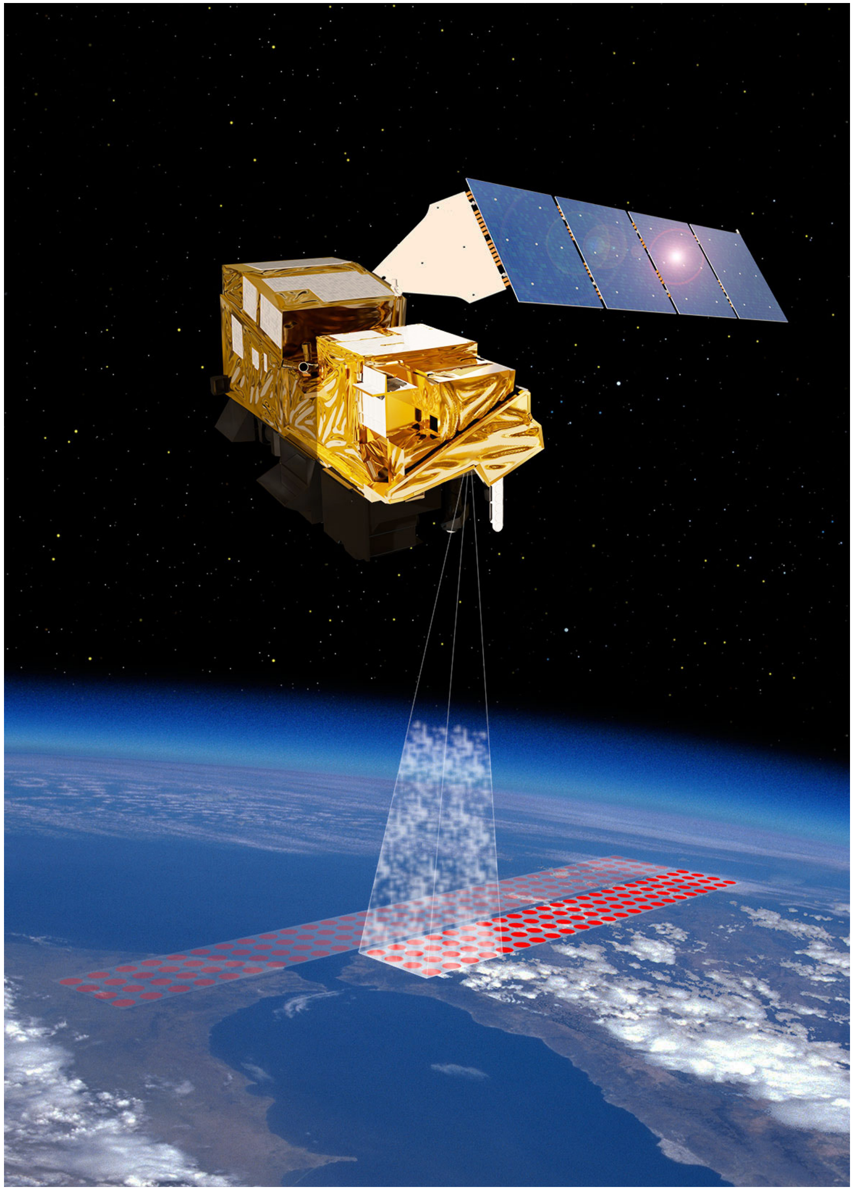
- Aerosols
- Polluants
- Nuages volcanic Ashes

IASI

- 3 instruments aboard 3 satellites
  - MetOp A/B/C – 2006/2012/2018
    - 18 years of mission and counting
  - MetOp-A decommissioned in 2021
  - Continuous spectrum of 8461 channels

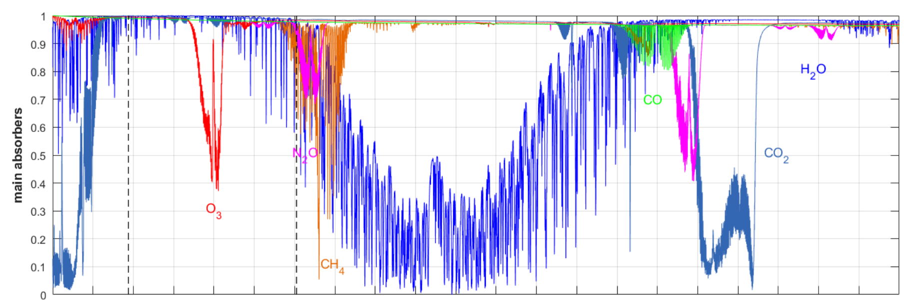






IASI-NG

- 3 instruments aboard 3 satellites
  - MetOp-SG A 1/2/3 – 2025/2032/2039
  - Same number of products per day
  - Same pixel sizes
  - Same spatial sampling
  - Same wavelenght coverage
    - 645 – 2760 cm^{-1} / 3.6 – 15.5 µm



RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité
cnes
IASI-NG

MAJOR REQUIREMENTS

- **Afocal and Imaging Telescopes**
- **Mertz Interferometer**
- **Focal Plane :** 4 detectors for 4 spectral bands /16 sounding pixels per detector
- **5 metrology lasers:**
  - 1 central metrology to give the Optical Path Difference constant triggering
  - 4 lateral lasers to monitor in real time the pupil effects (tilt, focus and astigmatism) for correction through on ground processing

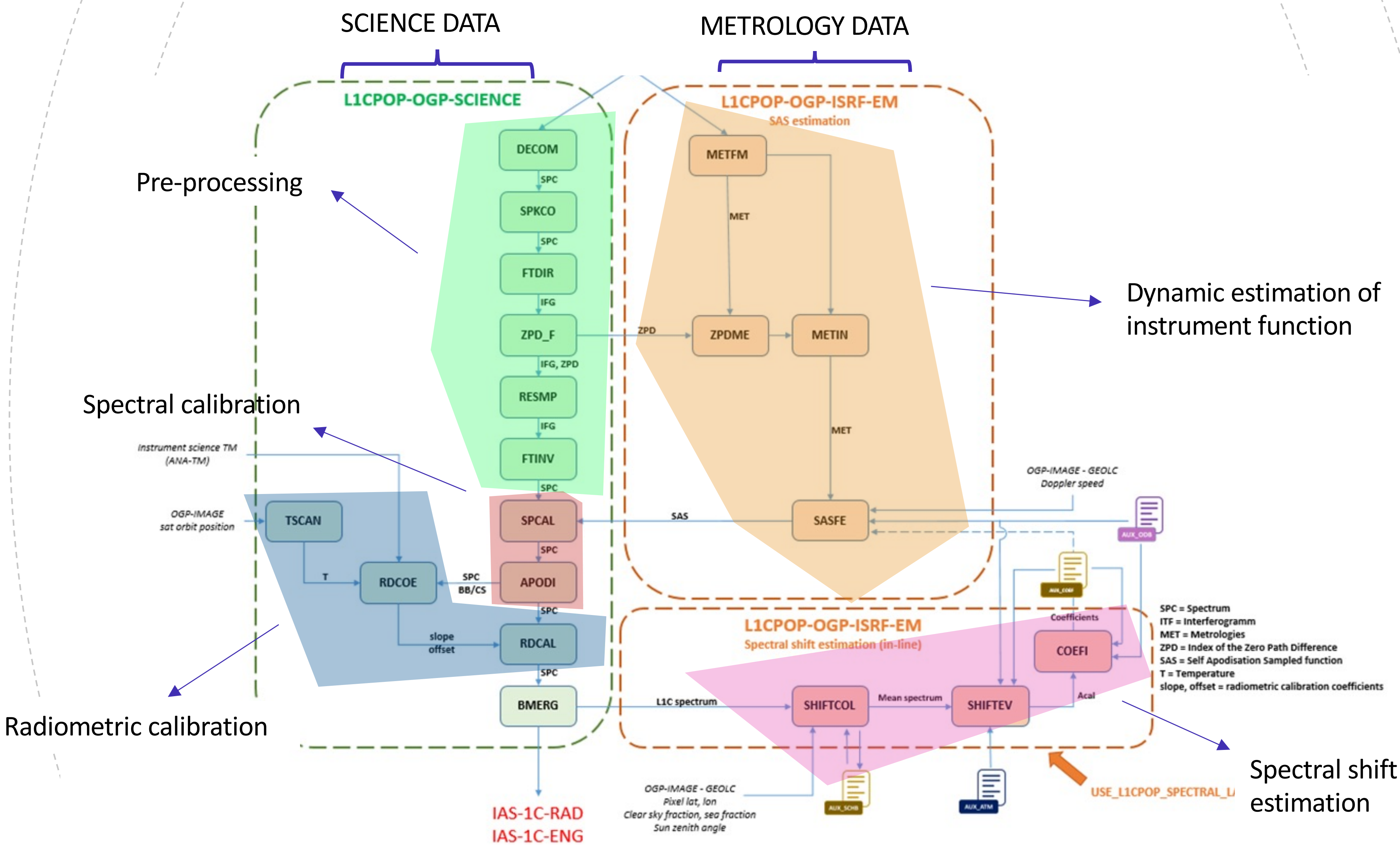
SPECIFICATIONS

GEOMETRY	SOUNDER PIXEL SIZE	~12 km	SAME AS IASI
	SPATIAL SAMPLING	~25 km	
	GEOLOCATION ERROR	0.5 km	
SPECTRAL	BAND	645 cm-1 to 2760 cm-1	
	RESOLUTION	0,25 cm^{-1}	2 TIMES BETTER THAN IASI
	SAMPLING	0,12 cm^{-1}	
	CALIBRATION ERROR	$d\sigma/\sigma = 5.10^{-7}$	
RADIOMETRY	CALIBRATION ERROR	0,25K @ 280 K	
	NEDT	NedT ~0.1 K to 0.4 Kwithin spectrum	

MAIN CHARACTERISTICS

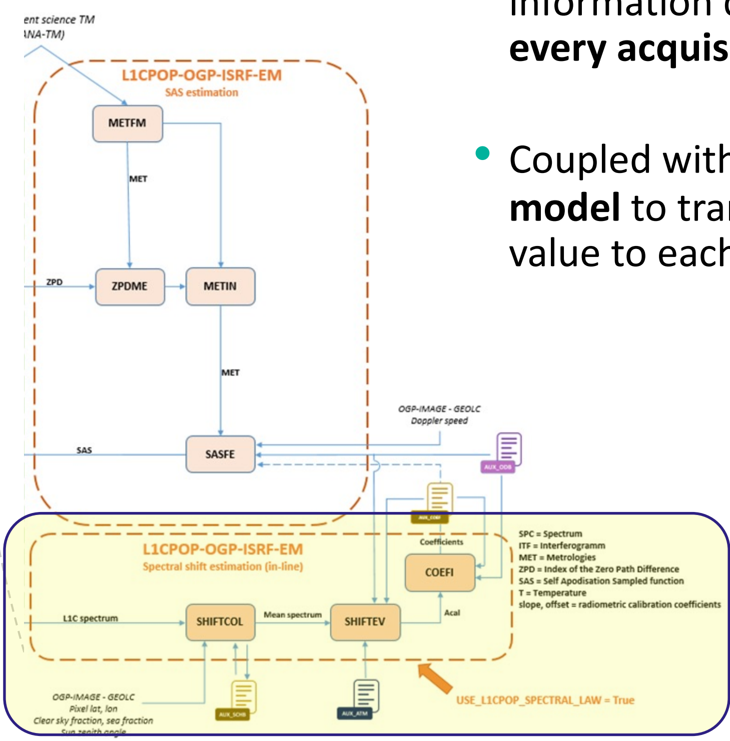
SWATH	~ 2000 KM
FOR	+/- 3°
PUPIL DIAMETER	~ 90 MM
ATA MAGNIFICATION	2.3
MAXIMUM OPTICAL PATH DIFFERENCE	4,2 CM
ACQUISITION DURATION	~730 MS
SCAN LINE DURATION	15.6 s : 14 EARTH VIEWS + 1BB + 1CS
CO-REGISTRATION	INTEGRATED IMAGER
SPECTRAL CALIBRATION	FABRY PEROT SOURCE

L1 SOUNDER PROCESSING

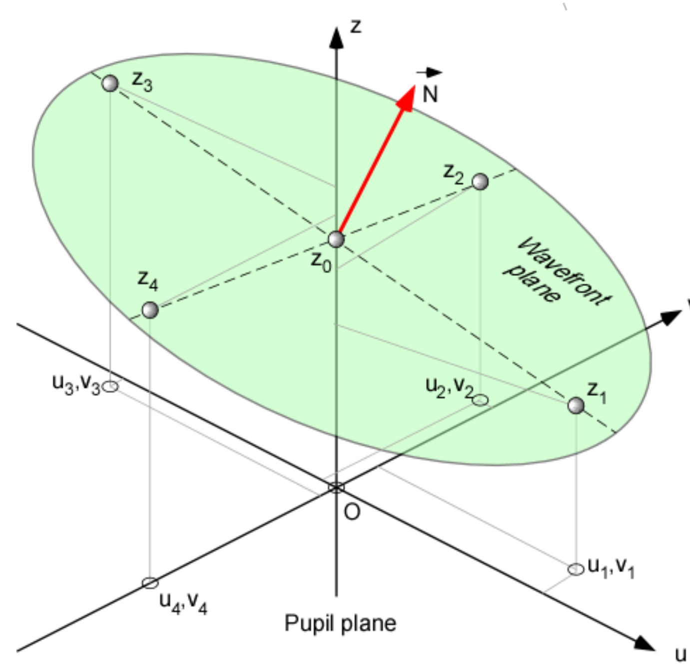


SPECTRAL CALIBRATION

ISRF estimation is a mix of measurement and modelisation



- **5 lasers :** dynamic information during **each and every acquisition**
- Coupled with an **instrument model** to translate the ISRf value to each wavenumber



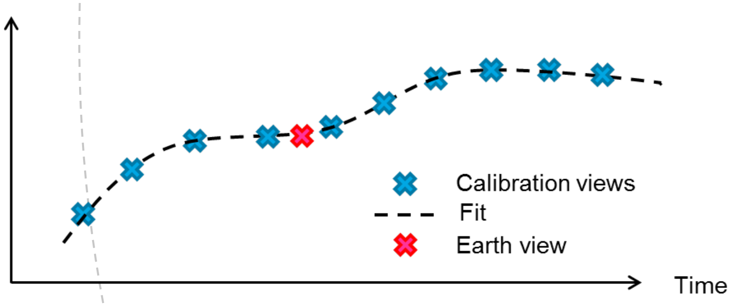
Re-estimation of the instrument coefficients using calibrated data on-flight

Asynchronous with the rest of the processing

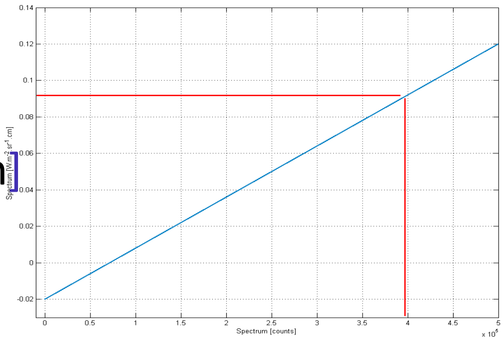
RADIOMETRIC CALIBRATION

Radiometric calibration is the **same as IASI**

- 1 acquisition of cold and hot views **every 14 Earth View** acquisition
- Temporal smoothing to reduce noise



$S_{\text{physical}}(\sigma)$
[W.m^{-2}.sr^{-1}.cm]



$S_{\text{numeric}}(\sigma)$
[counts]

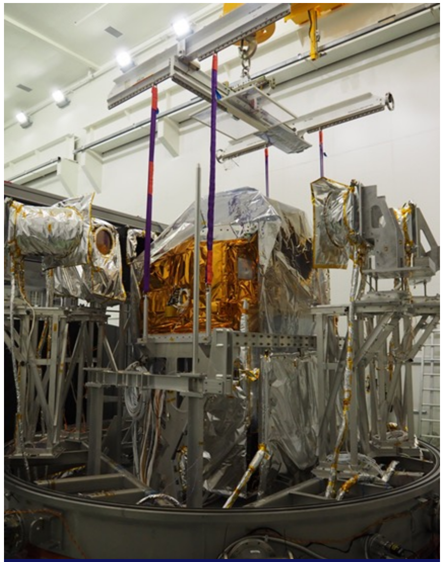
- **Internal black body** is maintained at **300K**
- **2 outside views** to acquire the **cold reference**
  - Nominal view for normal acquisitions
  - One additional view for **moon avoidance**

PERFORMANCES VERIFICATION

- **Performance verification is done in two steps**

- **TVAC for assessment of spectral and radiometric fine performances**
  - 2 external warm black bodies and 1 cold black body for radiometric performances
  - 4 lasers for Instrument Spectral Response (+spectral calibration stability)
  - Gas Cell (+cold black body) for spectral calibration
  - Cold black body in front of Fabry Perot view

- **Ambient test for geometric performances (LOS, IPSF, crosstalk)**
  - Warm black body and collimator OGSE



FM2 INSTRUMENT IN TVAC CHAMBER
(COURTESY OF AIRBUS)

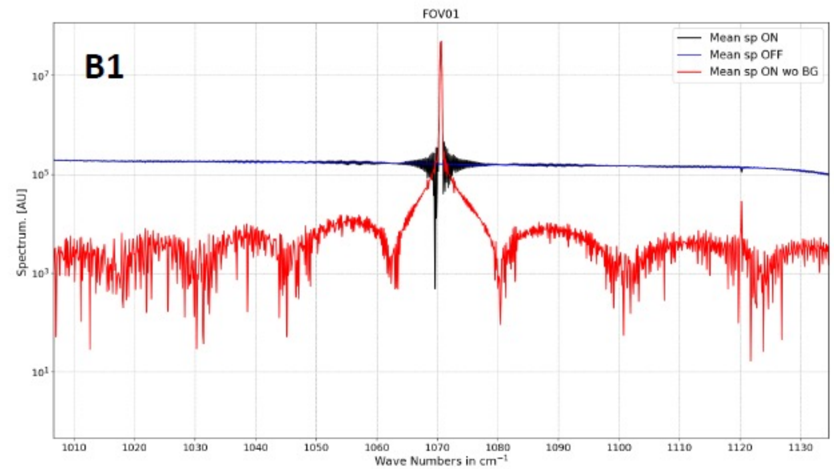
THERMAL TENT INSTALLATION
(COURTESY OF AIRBUS)

AMBIENT TEST SET-UP
(COURTESY OF AIRBUS)

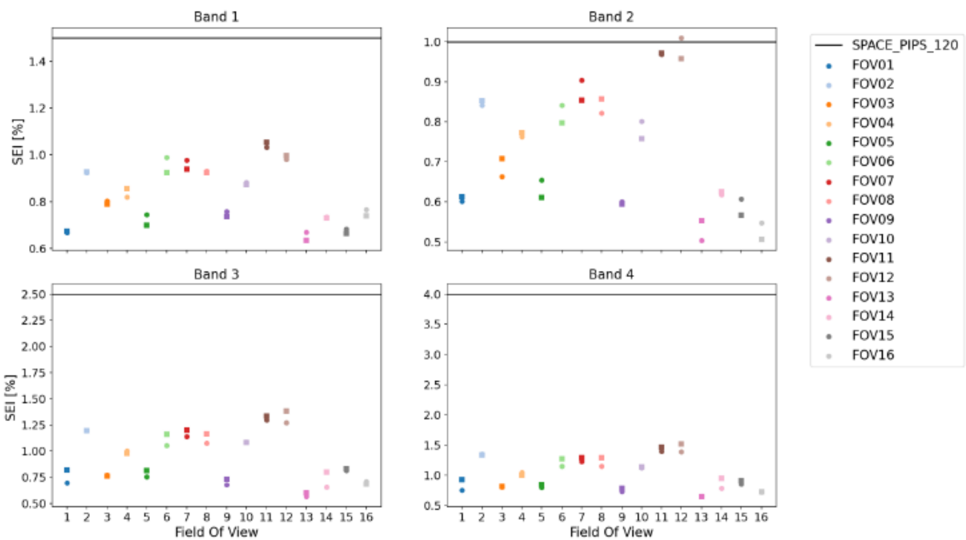
SHAPE ERROR INDEX

ISRF shape is measured against a **reference ISRF**

- **4 lasers**
- Middle channel of **each band**



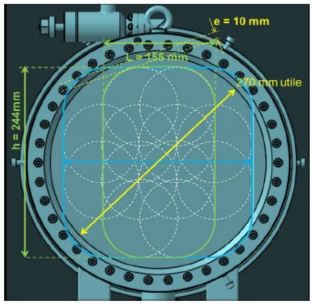
Laser test spectra with laser (black) without (blue) and background removed (red)



$$\varepsilon = \int_{-\Delta\nu_{ISRF}}^{\Delta\nu_{ISRF}} \left| \mathrm{Re}\left[ISRF_2(\nu-\nu_{c_2},\nu_0)\right] - \mathrm{Re}\left[ISRF_1(\nu-\nu_{c_1},\nu_0)\right] \right| d\nu$$

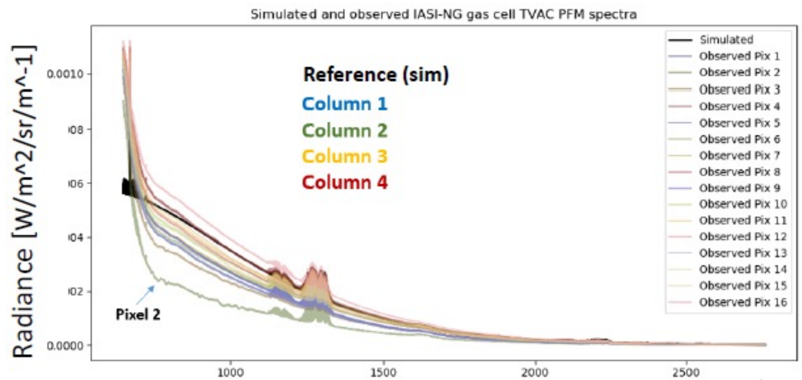
SPECTRAL SHIFT

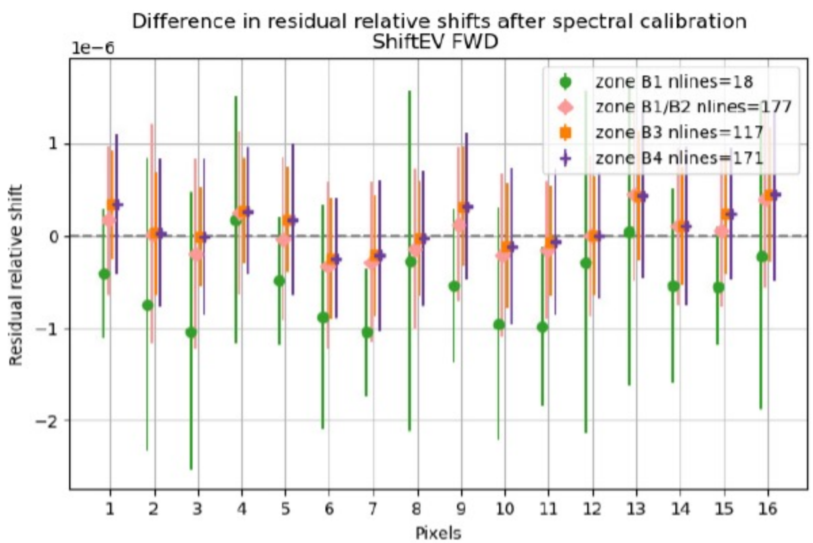
Gas cells setup to calibrate the spectral shift on **spectral lines**



Pixel field of view projected onto the CAG (courtesy : ADS)

- Known concentration and pressure
- Refraction index modelled on all 4 bands at once





$$\frac{(1+\alpha).\sqrt{n(\sigma)^2 - \left(\vec{r}_{\text{field}} \wedge \vec{N}\right)^2 - \left(\vec{r}_{\text{field}}.\vec{N}\right)^2}}{(1+\alpha).\sqrt{n(\sigma_{\text{met}})^2 - \left(\vec{r}^{\,\text{met}}_{\text{field}} \wedge \vec{N}\right)^2 - \left(\vec{r}^{\,\text{met}}_{\text{field}}.\vec{N}\right)^2}}$$

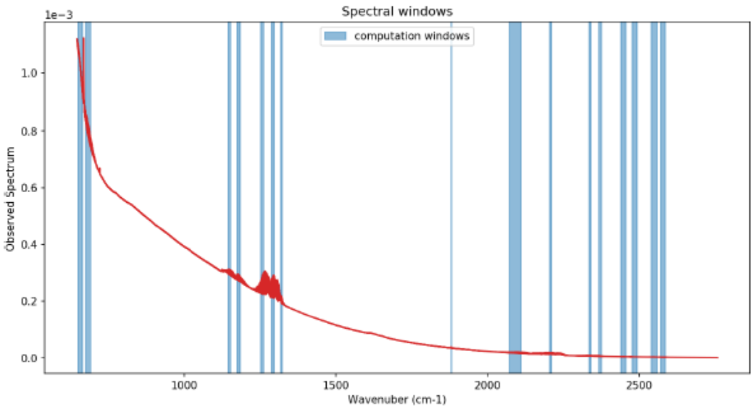
$$n(\sigma)^2 = A + \sum_{i=0}^{4} \frac{B(i)}{1 - C(i)^2 \times \sigma[\mu m^{-1}]^2}$$

SPECTRAL SHIFT

The complete performance however is estimated by **analysis and simulation**

- Using contributions from **doppler residual**, **algorithm error**, **refraction index residual**, **reference precision**, **stability measurements**

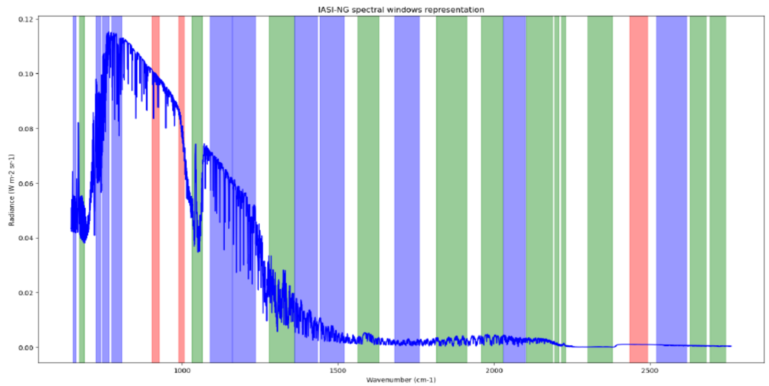
During TVAC



Gas Cells measurements

VS

In-flight



Atmospheric simulations

Greater number of lines = Better estimation

		B1	B2	B3	B4
Specification : 1.10^{-6}	**Total**	**$1.00\ 10^{-6}$**	**$0.74\ 10^{-6}$**	**$0.85\ 10^{-6}$**	**$0.82\ 10^{-6}$**

RADIOMETRIC NOISE AND BIAS

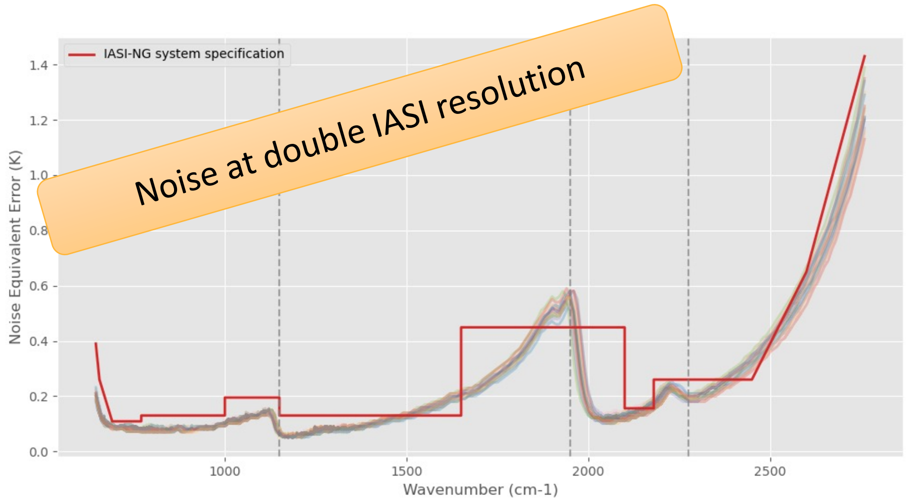
Radiometric characteristics are measured with **calibrated Black Bodies** of various temperatures

- Verification temperature range from **217K** to **310K**
- Evaluation of instrument noise and calibration bias
  - Including processing noise
  - For the complete picture, **equivalent radiometric errors** are **simulated** using spectral performances values (shape, shift, crosstalk, stability, …)

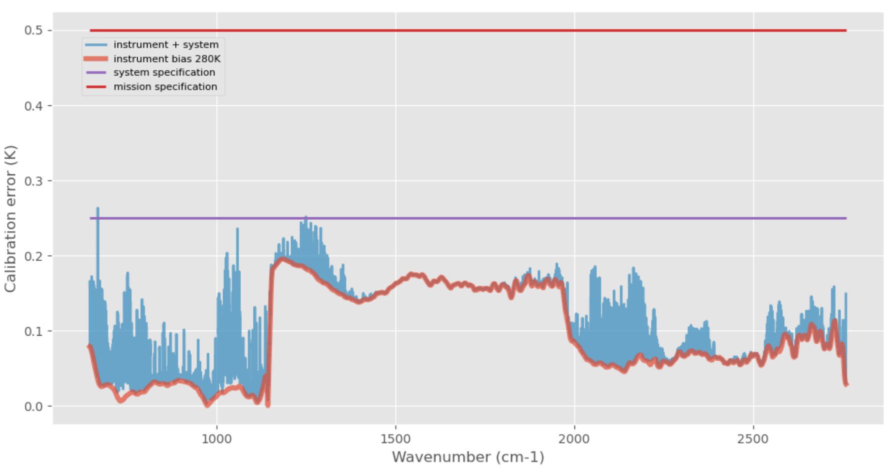
OGSE sur les vues Terre

Courtesy : ADS

NEdT estimation with system contributors - 280K



System absolute radiometric bias at 280K - Pixel 4 (worst pixel)



SIOV/CALVAL GLOBAL OVERVIEW

Launch | 1st Spectra | Start of L1 early dissemination | Toward Level 1 nominal dissemination

SIOV	CAL/VAL PART A TECHNICAL EVALUATION + EARLY VALIDATION OF L1 PRODUCTS	CAL/VAL PART B IN DEPTH VALIDATION OF L1 PRODUCTS
		IASI TANDEM FLIGHT
9 WEEKS	**16 WEEKS**	**15 WEEKS.**

SYSTEM IN ORBIT VERIFICATION MAIN OBJECTIVES :

- Instrument Switch On : cryostat decontamination, alignment of the interferometer beam splitter …
- First instrument health checks in orbit

- **End of the SIOV activities : 1st IASI-NG spectra**

CAL/VAL PHASE A MAIN OBJECTIVES :

- Update of the Instrument on board parameters
- Preliminary instrument performances
- L1 processing parameters test and update

- **End of phase A : start of early dissemination of L1 products to selected users**

CAL/VAL PHASE B MAIN OBJECTIVES :

- Final assessment of the instrument performances
- Fine-tuning the L1 processing parameters
- To perform the intercalibration between IASI and IASI-NG (tandem Flight with Metop C)

- **End of phase B : Conclusi… of IASI-NG Cal/Val activities and start of the nomina… semin…on of data**

End of Q2 2026

THANK YOU

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