IASI-NG Level 1 processing and system performances budget

Deschamps A.[1], Luitot C. [1], Peus A. [1], Guibert S. [1], Petrucci B.[1]

[1] CNES, Centre Spatial de Toulouse

**A more precise look on the Earth Athmosphere**

The IASI-NG mission

After the success story of IASI, CNES and EUMETSAT have decided to develop the next generation of atmospheric sounder, in the frame of the EPS-SG program. IASI-NG is an interferometer, that will scan the atmosphere in the infrared wavelengths with a radiometric noise and a spectral resolution twice smaller than for IASI.

IASI-NG on Metop-SG

See F. Bermudo's poster for IASI-NG program overview

In this collaboration, CNES is in charge of the development of the IASI-NG system, including the instrument but also the processing chain (in the space and ground segments). This Level 1 processing enables the transformation of raw interferograms to fully calibrated spectra (level 1C), correcting various instrument effect.

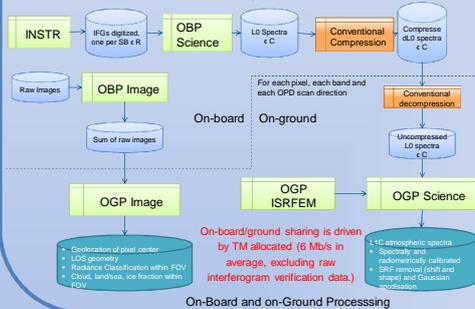interferogram → L1C spectrum
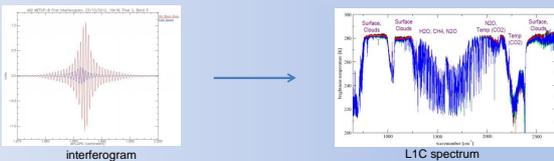
Development of the Ground Segment

The IASI-NG Ground Segment is composed of:
- IDS, a functional simulator of the instrument (dev[t] started in May 2016)
- IRIS, the scientific simulator of the system (dev[t] started in May 2016) used for prototype and validation purposes
- L1cPOP, the operational Level 1 processing (dev[t] started in January 2017)
- IASTEC, the Technical Expertise Center
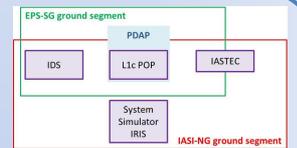
L1cPOP decomposition:
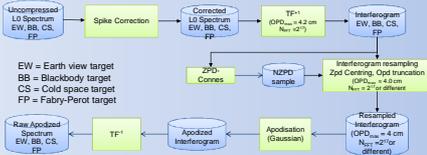The L1cPOP is composed of three processing chains:
- **On-Ground Processing science**, in charge of corrected the acquired spectra
- **On-Ground Processing ISRF-Estimation Model**, will estimate the Instrument Spectral Response Function of the instrument for each acquisition
- **On-Ground Processing image**, dedicated to the processing of the image data

On-board/ground sharing is driven by TM allocated (6 Mb/s in average, excluding raw interferogram verification data.)

On-Board and on-Ground Processsing

The Level 1 processing chain

On-Ground Processing - science:

1) **Pre-processing part**

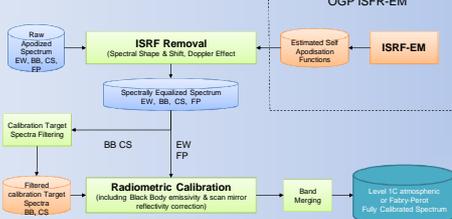EW = Earth view target
BB = Blackbody target
CS = Cold space target
FP = Fabry-Perot target

The main goal of this pre-processing part is to "regularize" the acquired spectrum, in
- Correcting the spike when possible
- Accurately estimating the Zero Path Difference of the corresponding interferogram
- Apodizing the interferogram

2) **Core part**

OGP ISFR-EM

In the core part of the OGP science, the ISRF (estimated by the ISRF-EM chain) is removed and the radiometric calibration of the spectrum is performed, using Black Body and Cold Space views.

### Instrument Spectral Response Function – Estimation Module (ISRF-EM):

1) **Principle of the instrumental response removal**
In the IASI-NG level 1 processing, the ISRF is estimated for each spectrum acquisition through the SAS function (which is the Fourier transform of the ISRF)
This estimation is based on:
- A model of the instrument, called ISRF-Generator
- The exploitation of 5 metrology beams
- A Fabry-Perot interferometer and a database of atmospheric spectra, enabling the estimation of the spectral shift of the instrument
- A Doppler correction, based on the exploitation of Navatt data and a prediction model

2) **Schema**
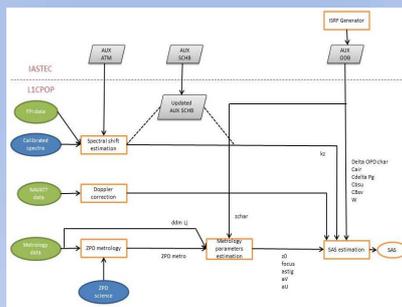
3) **SAS estimation**
The estimation of the SAS function is based on the following equation:

$$OPD_{em}(\sigma, \theta, r, X)$$
$$= \frac{kz(\sigma, \theta)}{kz(Laser_0)} \times ddmZ_0(r) + \delta OPD_{char}(\sigma, \theta, r, X)$$
$$+ C_{air(\sigma,\theta)} \times focus(r) + C'\Delta Pg(\sigma, \theta) \times astig(r)$$
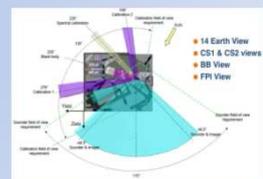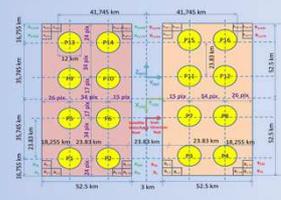$$+ CBS_u(\sigma, \theta, r, X) \times aU(r) + CBS_v(\sigma, \theta, r, X) \times aV(r)$$

On-Ground Processing - image:

The IASI-NG instrument embarks an internal imager IMA to:
- perform the co-registration of the sounder pixels (through a co-registration between IMA and Metimage, which is on the same platform on Metop-SG)
- be able to detect clouds in case of loss of Metimage.
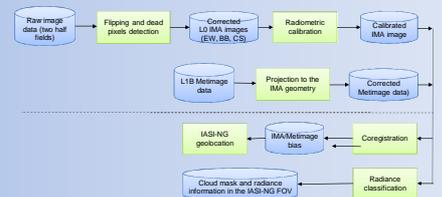
- Internal imager geometry and acquisition modes

Current system performances budget

System Performances Budget

The System performance budget includes contributions coming from the instrument, the satellite, the on-board and on-ground processing.
The imperfection of the data are assessed at level 1C and are compared to the mission requirements, in terms of:
- Radiometric performances
- Spectral performances
- Geometric performances

This current budget is based on the best knowledge of the instrument design given by Airbus Defense and Space.
It has been established for a typical case, over an homogeneous scene.
A future version of this budget should be provided early next year, with updated performances of the detectors and for heterogeneous scenes as well.
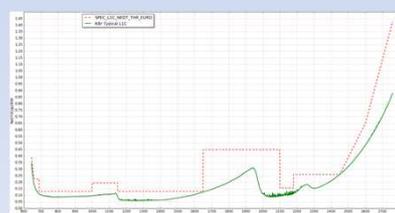
IASi-NG NeDT@280K for an homogeneous scene and a typical case at Level 1C

Synthesis:

Mission requirement	Specified value / calculated value	Status
ISRF shift knowledge	3E10-6 / 1E10-6	compliant
ISRF shape error index	0.25% / 0.27% (parasitic contribution)	Marginally NC
Interpixel ISRF stability	1E10-4 / 3.3E10-5	compliant
Radiometric noise	See Figure 5	compliant
Absolute radiometric calibration	0.25 K (O) and 0.5 K (T) / 0.24K	compliant
PSF uniformity knowledge	+/- 10 % / 14%	compliant
PSF characterization		No budget available
Spatial resolution	11.5 +/- 0.5 km / 11.8km	compliant
Off nadir resolution		No budget available
Ground sampling	3mrad / 3.2mrad	NC in NC (compliant in typical case)
Yaw steering		No budget available
Off nadir sampling		No budget available
Pointing knowledge	+/- 3 mrad / 0.9mrad	compliant
Pointing accuracy	+/- 3 mrad / 0.91mrad	compliant
Pointing stability	0.1 mrad / 0.062 mrad	compliant
Sounder geolocation	1km / 949 m	compliant
Geolocation in degraded case	5km / 1108 m	compliant
Internal imager		No budget available