# Development and Verification Challenges of IASI-NG System

E. Jurado, C. Le Fèvre, F. Bermudo, F. Bernard, C. Luitot, A. Deschamps, S. Guibert
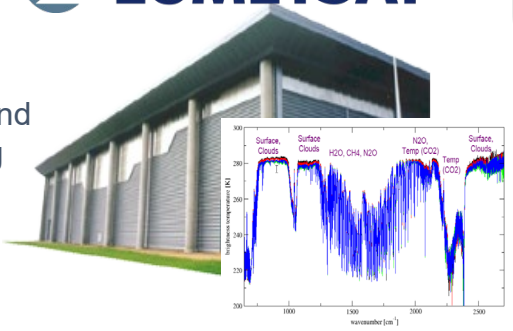*CNES IASI-NG TEAM*

❑ IASI-NG geophysical products will be elaborated under EUMETSAT responsibility, considering algorithms and methods developed by scientific community. **The IASI-NG System is in charge of providing geo-localized, calibrated (spectrally and radiometrically) and apodized radiances** to be used in the elaboration of these geophysical products.

❑ EPS-SG program relies on a cooperation between different agencies, which induces specific development and validation strategies for IASI-NG system.

IASI-NG instrument: IASI-NG instruments will fly aboard METOP-SG A satellites.
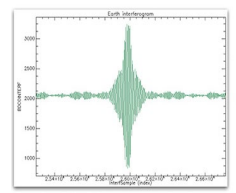
L1C POP: CNES provides EUMETSAT with a L1C Product Operational Processor to be included in the global Payload and Data Acquisition and Processing (PDAP) facility.
The need to deliver a dedicated processor for local users is currently studied/discussed.

IASTEC: CNES IASI-NG technical expertise center is in charge of monitoring the performances of both the instrument and the L1C Product Operational Processor

IASI-NG System functional verification
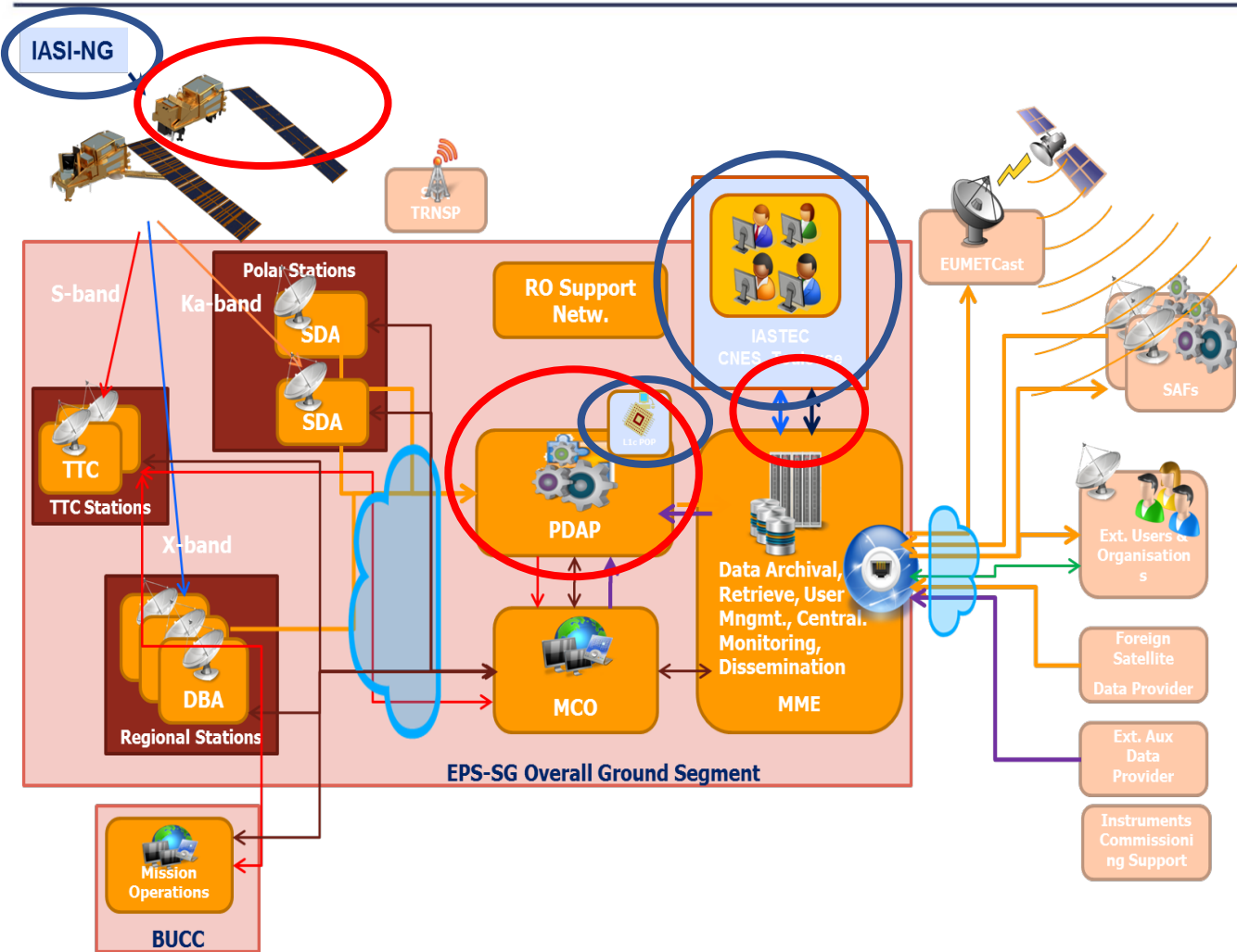
CNES internal validation:
The different parts of the IASI-NG system are validated internally at CNES.

Support to integration and validation of IASI-NG sub-systems in EPS-SG system:
CNES participates to the satellite test campaign for the tests that concern IASI-NG, and support the integration and validation of L1CPOP in PDAP.
For local processing, verification that the results of the local processor are comparable to results of the global one. Compatibility tests are also performed between CNES and EUMETSAT to check the interfaces exchange between IASTEC and EPS-SG distribution system

System End-to-End tests:
System end-to-end tests are performed under EUMETSAT responsibility and aim at ensuring that the whole chain is operational.

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Electrical and Functional tests of IASI-NG on MetOp-SG have been successfully performed in July 2019 to validate science data rate allocation :
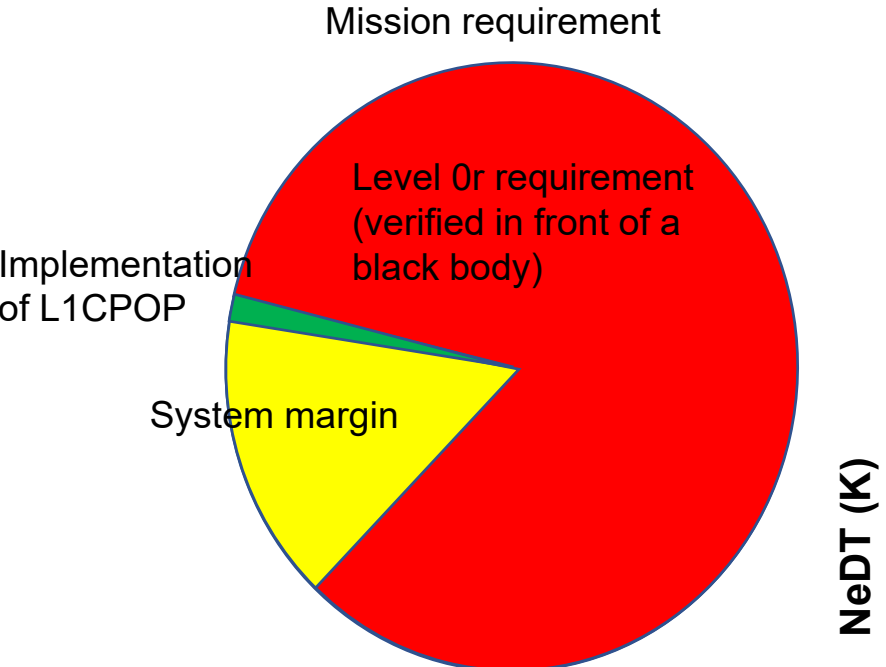
- Nominal science data: → 6 Mb/s averaged, 7 Mb/s max :
    - Reduced spectra
    - IASI-NG images
    - Metrology and processing data (e.g. black bodies temperature…)

- Additional science data, stored on-board and distributed on specific orbits (Ka-band, Svalbard station) → 3 Mb/s averaged, 5 Mb/s max:
    - raw spectra and interferograms
    - Raw images
    - Diagnostic mecanisms data (scan and interferometer, beam splitter) for diagnostic verification data (black bodies temperature…)
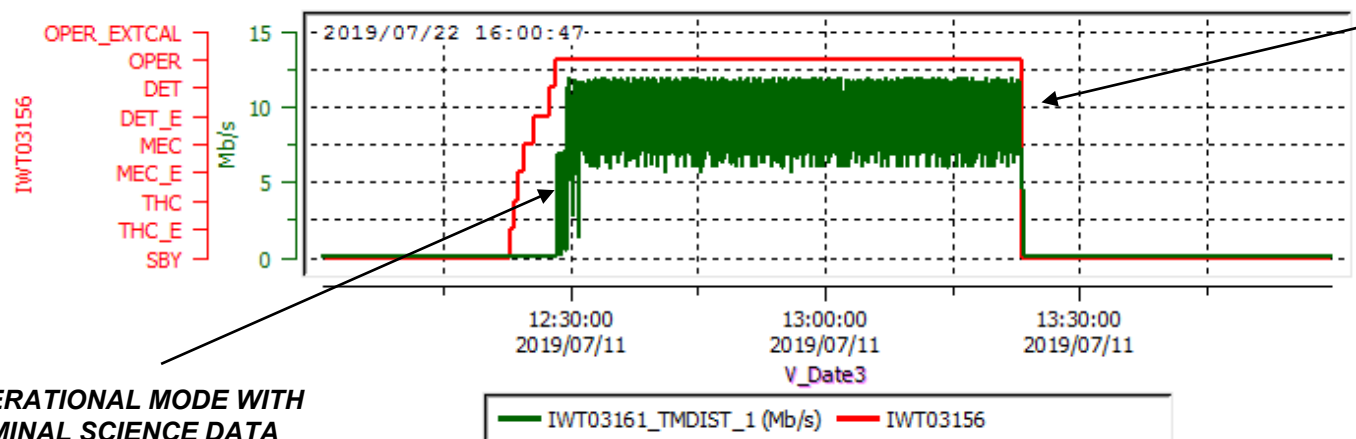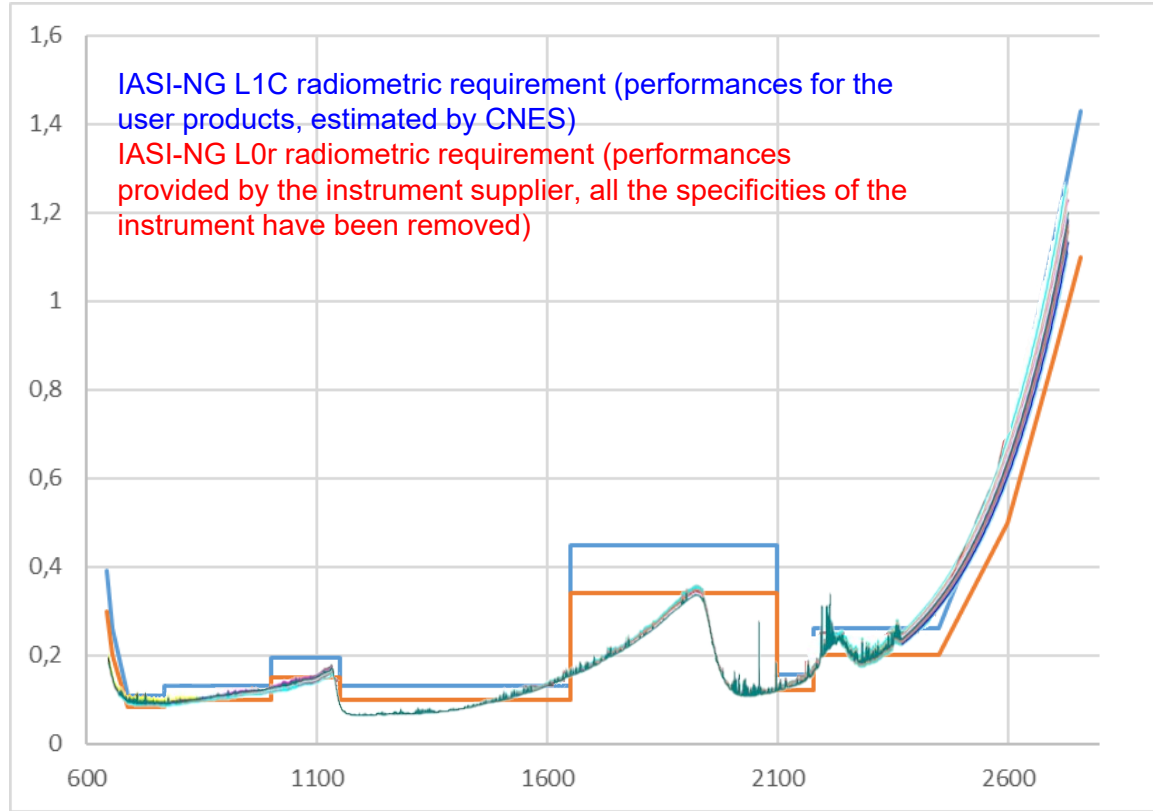

OPERATIONAL MODE WITH ADDITIONAL SCIENCE DATA
Averaged data rate ~ 9 Mb/s (6+3)
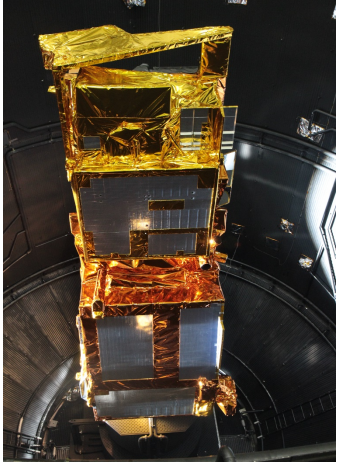*Max peak data rate with ASD ~ 12 Mb/s (7+5)*

OPERATIONAL MODE WITH NOMINAL SCIENCE DATA
Max peak data rate with ASD ~ 7 Mb/s

Mission requirement

Level 0r requirement (verified in front of a black body)

Implementation of L1CPOP

System margin

On top of IASI-NG space segment L0r requirements, margins are accounted at system level (effects of the ISRF on non-homogeneous scenes, errors in the radiative transfer models etc…) for L1C products performances requirements.
The errors linked to the implementation in the L1C processor is considered negligible.

IASI-NG radiometric performances requirements

IASI-NG L1C radiometric requirement (performances for the user products, estimated by CNES)
IASI-NG L0r radiometric requirement (performances provided by the instrument supplier, all the specificities of the instrument have been removed)

NeDT (K)

ν **(cm-1)**

MetOp-SG Structural and Thermal model in vacuum chamber. Credit ESA/ETS

Tests at instrument level
- Sub-system testing (detectors, focal plane, interferometer…)
- Instrument testing in vacuum with the highest level of accuracy.
  - Internal calibration sources : metrology (lasers), Wave Front Sensor (WFS), Fabry-Pérot interferometer data, black bodies
  - External calibration sources : lasers, black bodies at different temperature, gas cell
- Acquisition of Sun spectra is also considered

→ **Performance qualification before integration on-board MetOp-SG-A satellites**

Tests at satellite level
- Thermal vacuum testing, incl. microvibrations and electromagnetic emissions from the platform (e.g. reaction wheels) and other instruments embarked on MetOp-SG-A.
- For second and third Flight Models, performance check during long term storage and at destorage, to check potential impact of ageing

→ **Performance estimation and check of non-regression versus instrument qualification**

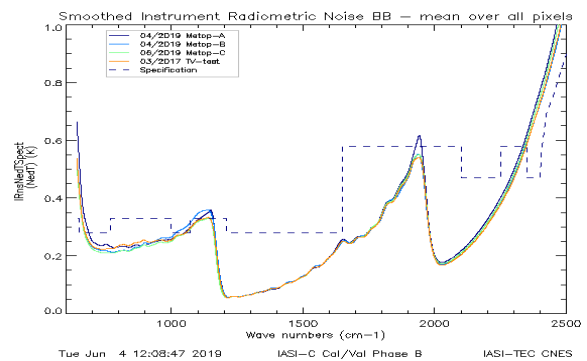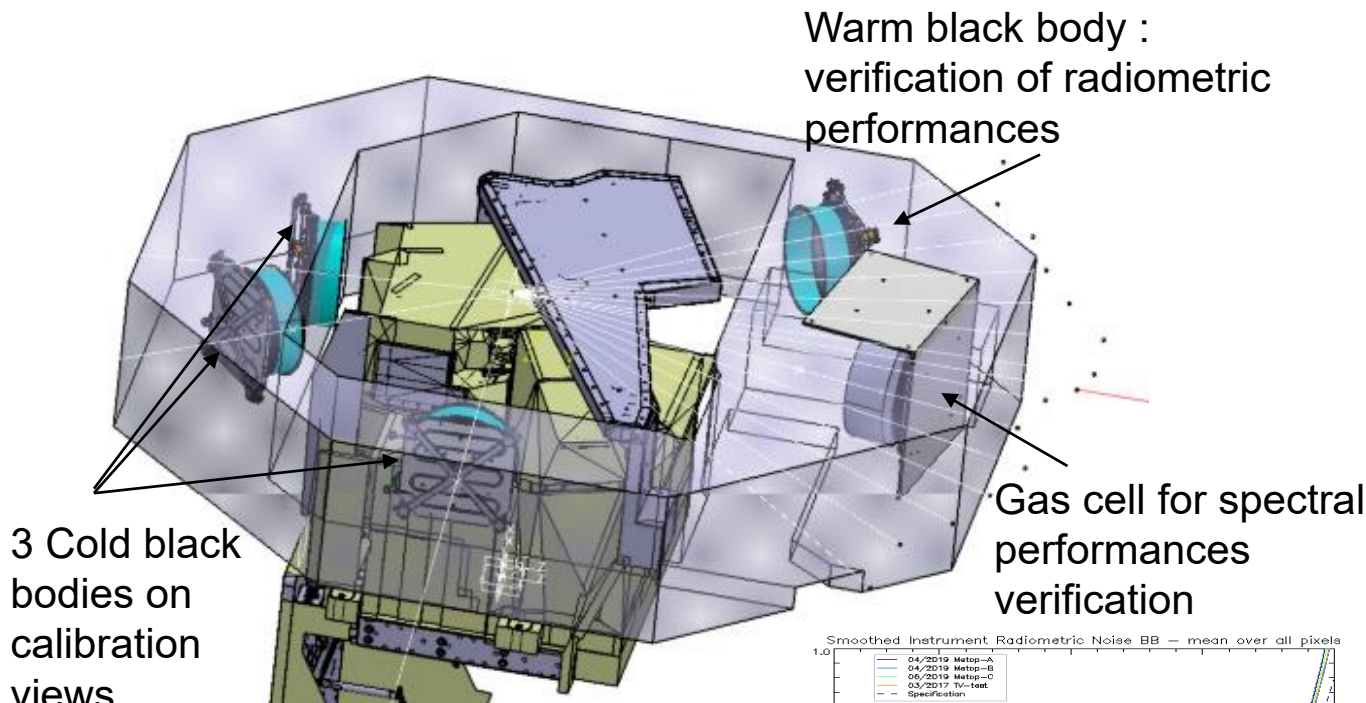**Scientific algorithms verification**
- By simulation with IRIS tool (see dedicated slide)
- Using various test data: monochromatic sources, black bodies, atmospheric scenes from TIGR database (Thermodynamic Initial Guess Retrieval) combined with radiative transfer model (4AOP from LMD)
- By consolidation with data from instrument testing

→ **Performance verification of Level1 products.**

Airborne validation campaign
Additional test campaign with IASI-NG engineering model, planned either on-board an aircraft or a CNES stratospheric balloon

→ **Consolidation of scientific algorithms with real atmospheric scenes.**

Warm black body : verification of radiometric performances

3 Cold black bodies on calibration views

Gas cell for spectral performances verification

Smoothed Instrument Radiometric Noise BB — mean over all pixels

04/2019 Metop–A
04/2019 Metop–B
06/2019 Metop–C
03/2017 TV–test
Specification

IRnsNetTSpect (NedT) (K)

Wave numbers (cm–1)

Tue Jun 4 12:08:47 2019   IASI–C Cal/Val Phase B   IASI–TEC CNES

IASI first generation – METOP-C Thermal vacuum – credit ESA/ETS

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The Infra-Red Interferometer Simulator (IRIS) is the tool jointly used by IASI-NG performance and instruments experts

## Assessing IASI-NG system performance

- Simulation of the complete performance chain: modelling of inputs radiance, instrument model, on-board processing, on-ground processing, including uncertainties
- Representative of data acquisition: 16 sounder pixels, multiple scenes (Earth & calibration views)
- Analysis of IASI-NG tests using real science telemetry data

From prototypes to operational processing modules

- Framework to develop scientific algorithms, and increase their level of maturity
- Reference tool to validate Level1C operational processor and to support IASTEC expertise center
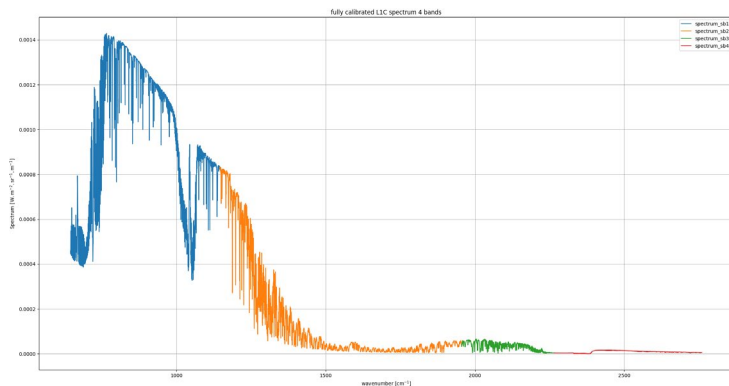
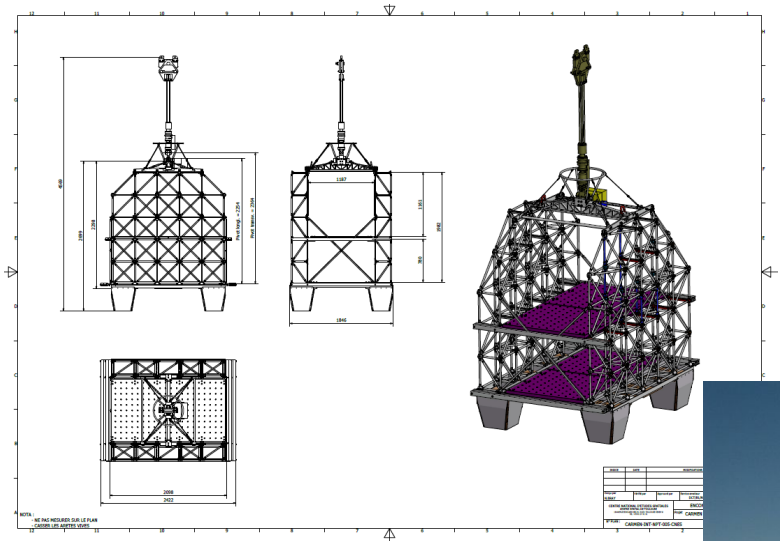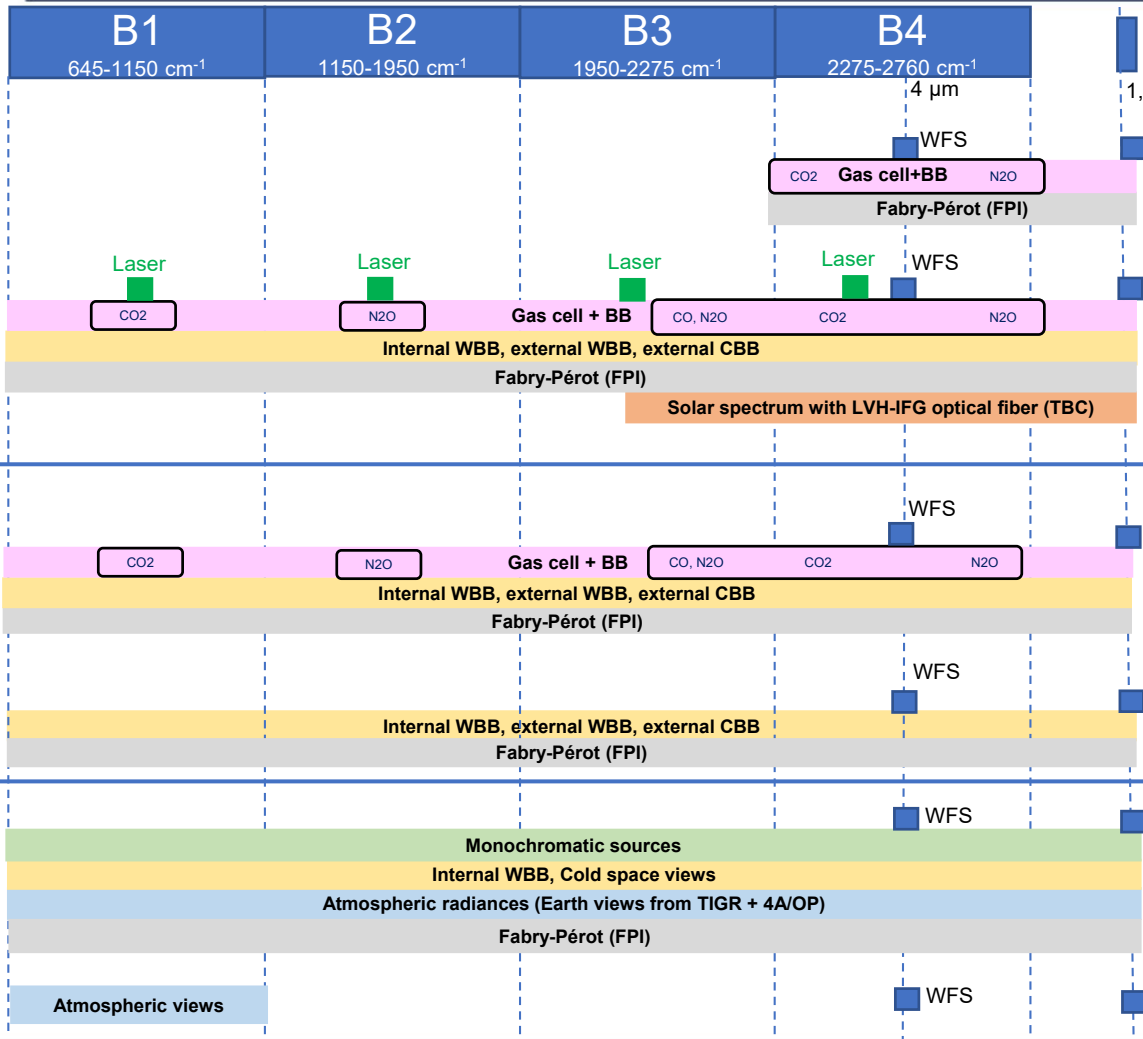Calibrated atmospheric spectra at level1C for the four spectral bands
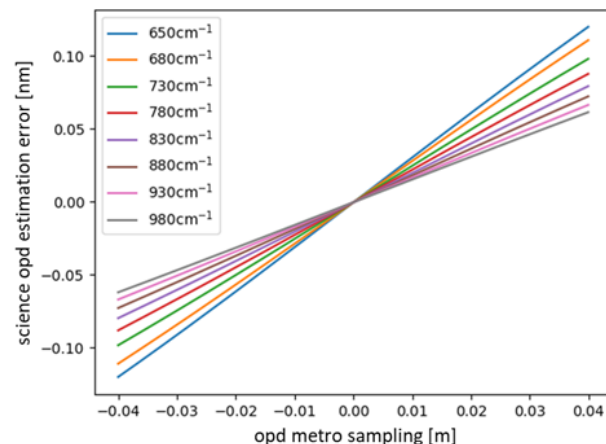
Error on optical path difference in B1 band, computed with metrology signal and IASI-NG ISRF-generator model

Atmospheric measurements

The objective is to verify, by measuring actual atmospheric scenes, that the instrument model is sufficiently representative to predict the measurements, and that the L1C products performances are in line with the expectations.

Potential opportunity to validate some Level 2 products, discussion on-going with the scientific community.

→ **Adaptation of the IASI-NG Engineering Model to be embarked on either a plane or a stratospheric balloon.**

IASI-NG performances verification: synthesis
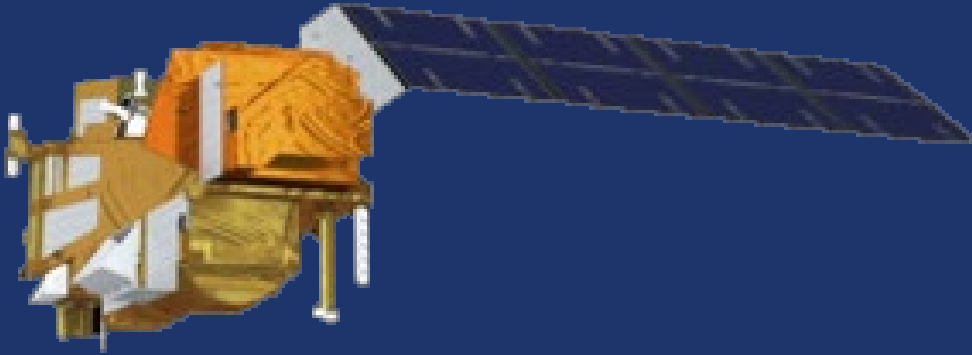
Merci pour votre attention !