

# **IASI FM2 Commissioning on METOP-A**

## **Level 1 Cal/Val Description**

**IASI L1 Cal/Val Team**

## Outline

- **Introduction**
- **Overview of the IASI key performances**
- **Level 1 Cal/Val Plan**
- **IASI modes of operations**
- **Overview of the processing**
- **Parameters updates during Cal/Val**

## Introduction

- **Metop-A launch** **19<sup>th</sup> of Oct 2006**
  
- **IASI first interferograms** **27<sup>th</sup> of Nov 2006**
- **IASI first spectra computed on-board** **29<sup>th</sup> of Nov 2006**
  - **L1 spectra (calibrated on ground)** **29<sup>th</sup> of Nov 2006**
  
- **IASI data trial dissemination in Near Real Time** **24 of May 2007**
- **IASI radiances Operational at ECMWF** **12<sup>th</sup> of June 2007**
  - **Medium Range Numerical Weather Forecast**
- **IASI data operational dissemination in NRT** **19<sup>th</sup> of July 2007**

## The teams

### CNES teams

- **Cal/Val & TEC teams**

- B.Tournier, F.Cayla, R.Fjortoft, T.Phulpin, C.Buil, D.Coppens, D.Blumstein
- I.Gaudel, C.Baque, R. Bach, D. Saïd

- **Balloons team**

### Partnerships

- LPMAA : C.Camy-Peyret et al.
- METEO FRANCE CMS Lannion : L.Lavanant, P.Brunel
- ECMWF : A.Collard, T.McNally
- UK MetOffice : F.Hilton
- The instrument is operated by EUMETSAT Team in Darmstadt

## Main Performances

- IASI sounder : 4 pixels, 3 bands

- 12 detection chains
- Must be perfectly registered, calibrated and intercalibrated

- Radiometry

- Noise
- Calibration : absolute, stability

- Spectral

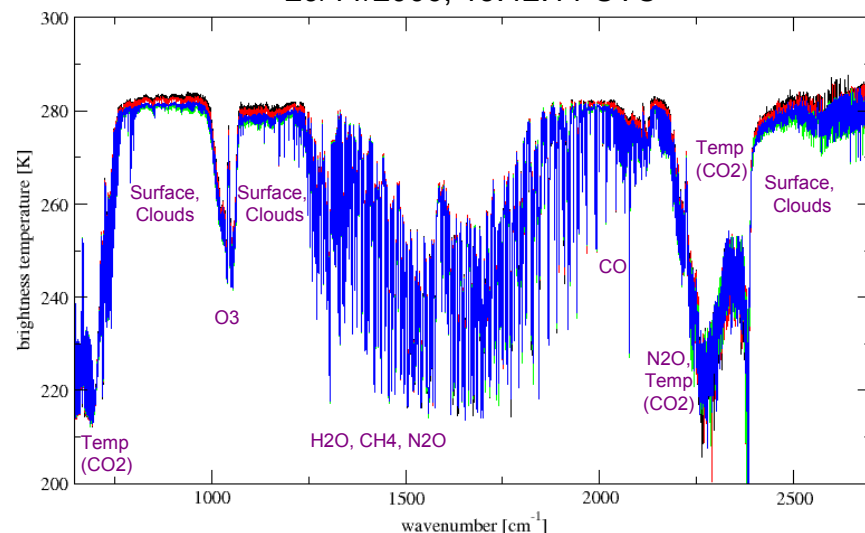
- Calibration : absolute, stability
- Spectral Response Function

- Geometry

- Location
- Point Spread Function

### First IASI Level 1C Spectra

29/11/2006, 13:42:11 UTC



EUMETSAT



CNES  
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Generated by the IASI L1 PPF and Cal/Val Facility

**==> contribute to the accuracy of the “forward” model**

## Overview of main performance specifications

### Radiometry

- **Noise**

- 0.28 Kelvin : at instrument level,
- 0.2 Kelvin : L1C products (apodised spectra)

- **Calibration :**

- 0.5 Kelvin : absolute
- 0.15 K : orbital stability, 0.15 K long term stability
- 0.1 K : intercalibration (pixels, viewing angle, spectral channels)

### Spectral

- **Calibration : relative error  $dv/v < 2 \cdot 10^{-6}$**
- **Spectral Response Function**

### Geometry

- **Location : relative to AVHRR products (0.3 pixels, around 0.3 km)**
- **Point Spread Function**
  - Uniformity
  - interband registration

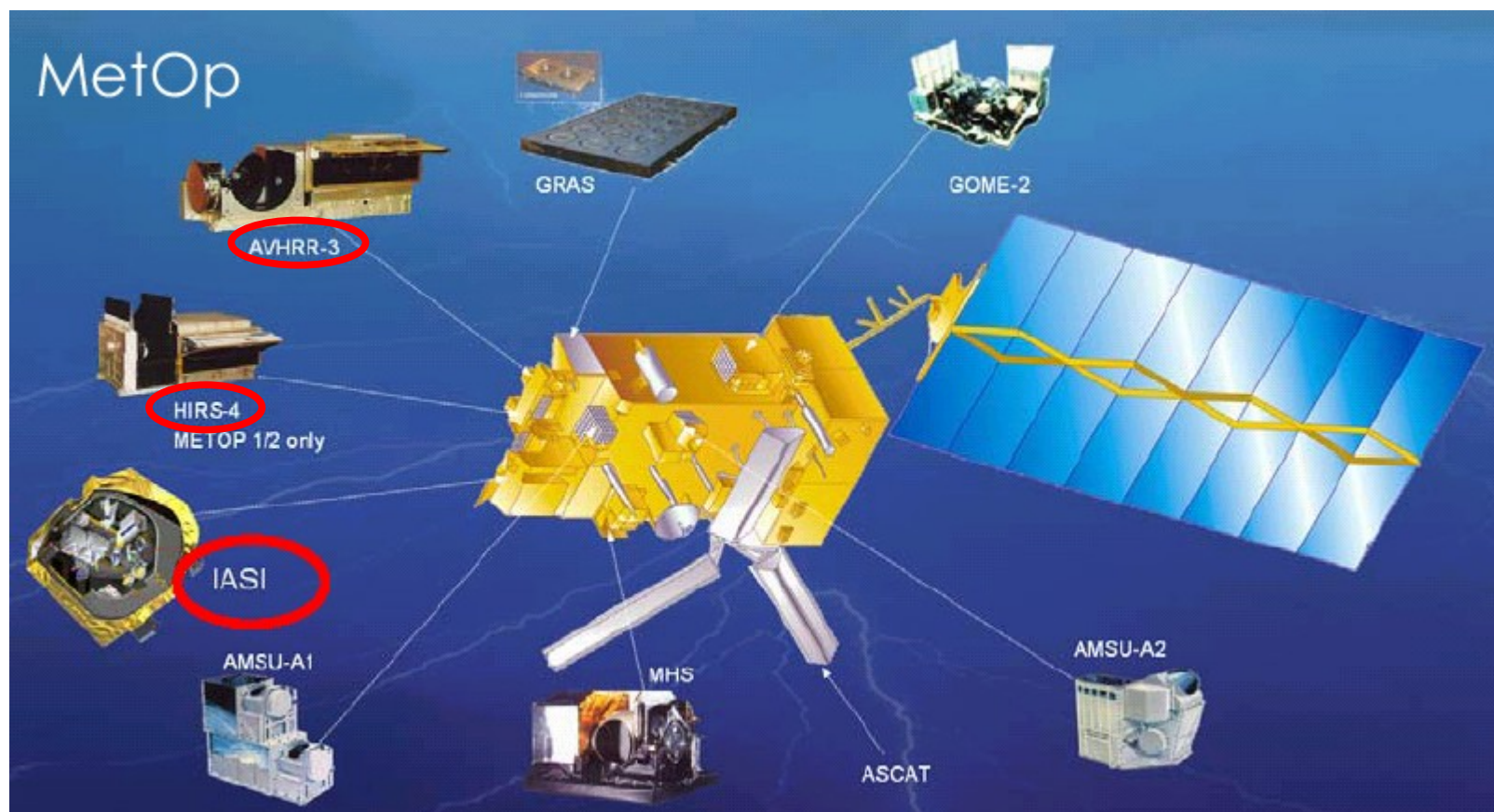
## IASI Level 1 Cal/Val Plan

- **The IASI L1 CalVal Plan describes the process, methods and data**
  - To obtain the ultimate performances of Level 1 IASI products (calibration),
  - To demonstrate these performances (validation) during flight operations
- **General goal of the Level 1 Cal/Val activities is to ensure that**
  - after the commissioning and thereafter during the mission lifetime,
  - the IASI Level 1 products are compliant with their specifications
    - radiometric, spectral and geometric performances
- **In-flight Cal/Val activities broken in 3 successive phases**
  - **Accuracy of the validation and diversity of the conditions in which the validations are performed increase with time**
    - Phase A (2 K), Phase B and C (0.5 K) typically
  - **Type of reference measurements and their accuracy evolve accordingly**
    - stand alone IASI measurements
    - comparison with other spaceborne instruments
    - meteorological soundings and dedicated correlative measurements

[illegible]

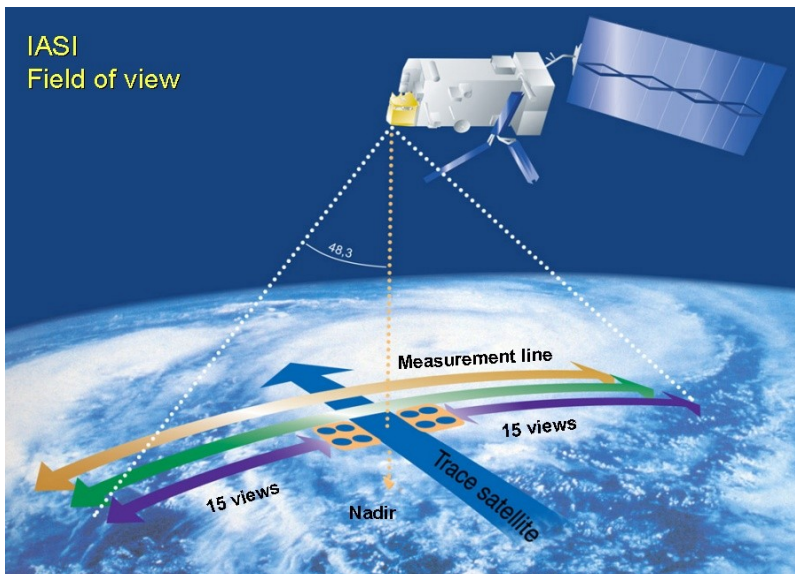
- D. Blumstein CNES – IASI L1 Cal/Val Team 8

## Use of other MetOp instruments during IASI Cal/Val



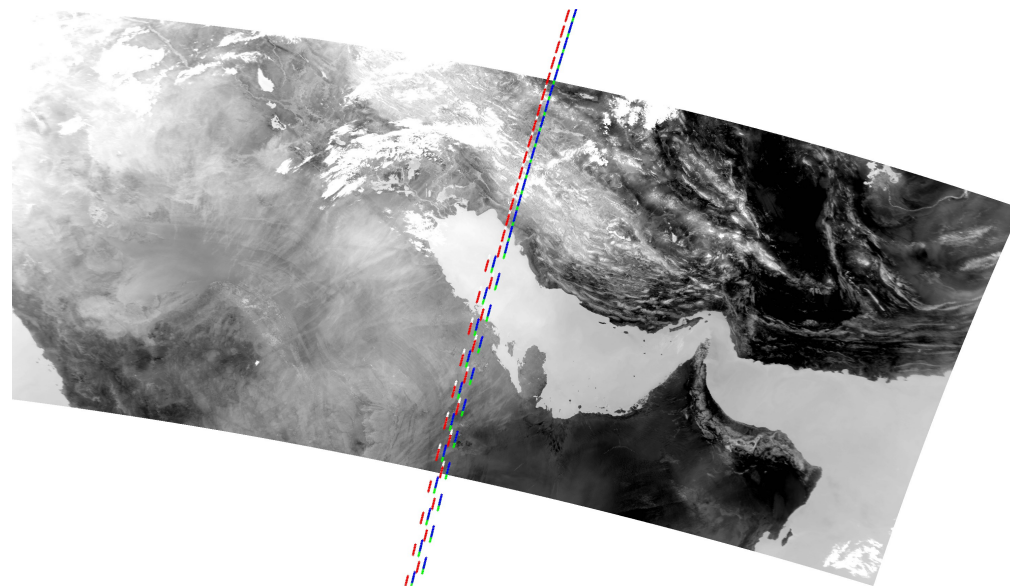
- Inter calibrations done with respect to AVHRR and HIRS

## IASI : 2 operational modes



### Normal Operation Mode

- Scanning the swath
- 30 views / 8 sec



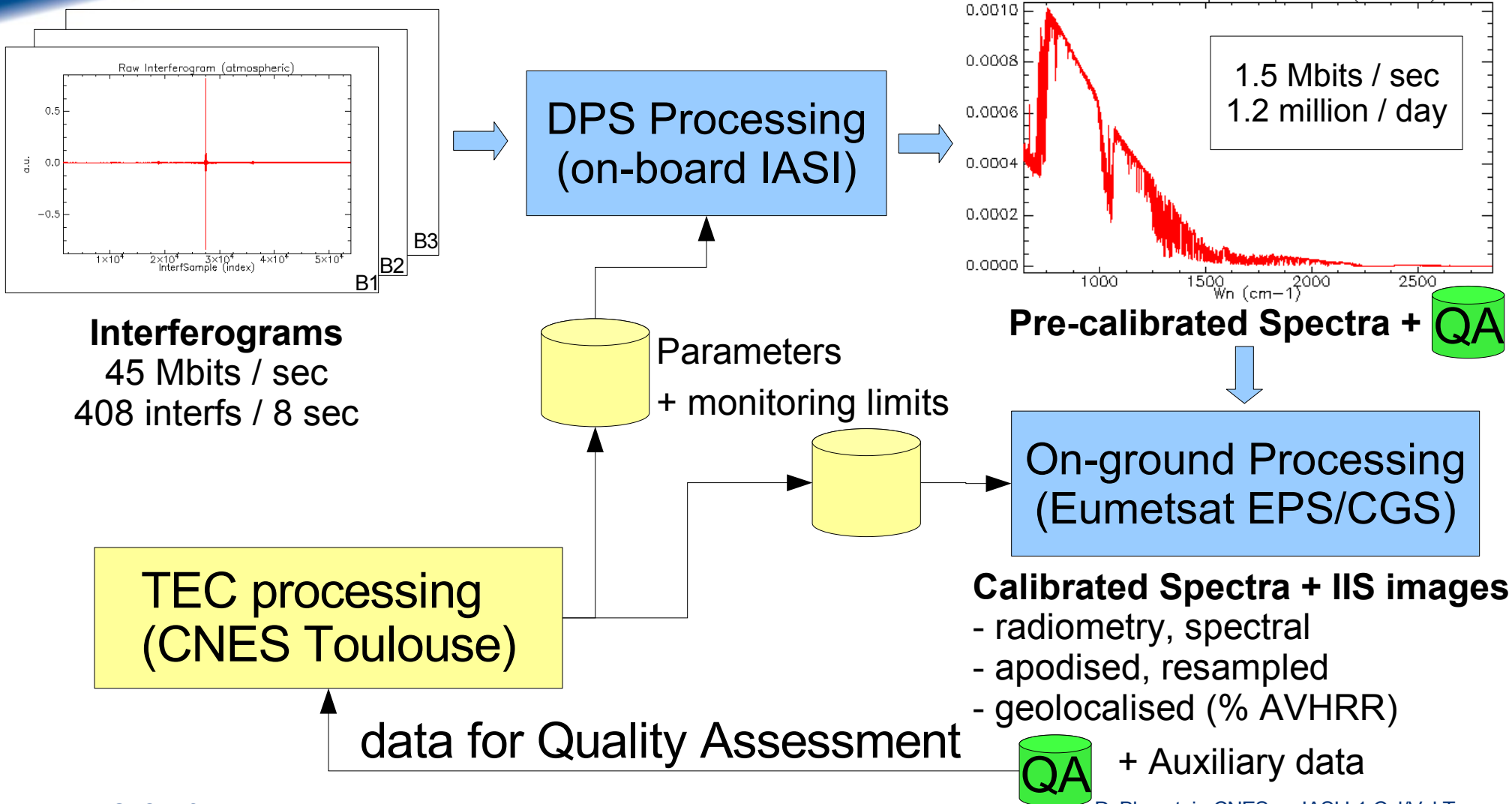
### External Calibration Mode

(here quasi-nadir looking)

- Fixed viewing direction for 8 sec
- 27 views / 8 sec

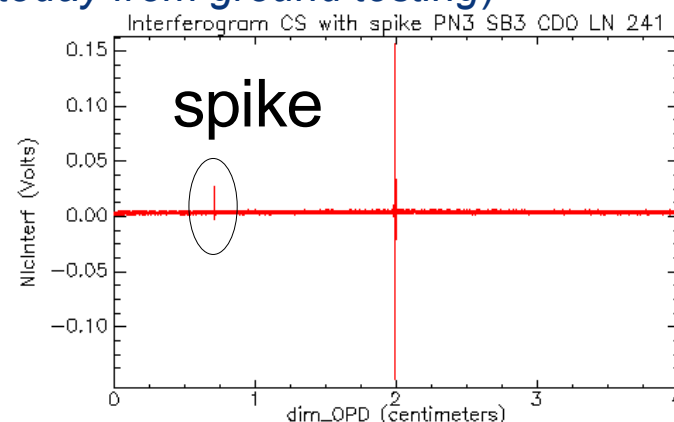
+ 1 raw interferogram available on ground every 8 seconds (over 408)  
 ► selection fully programmable

# Overview of IASI processing



## Overview of on-board processing

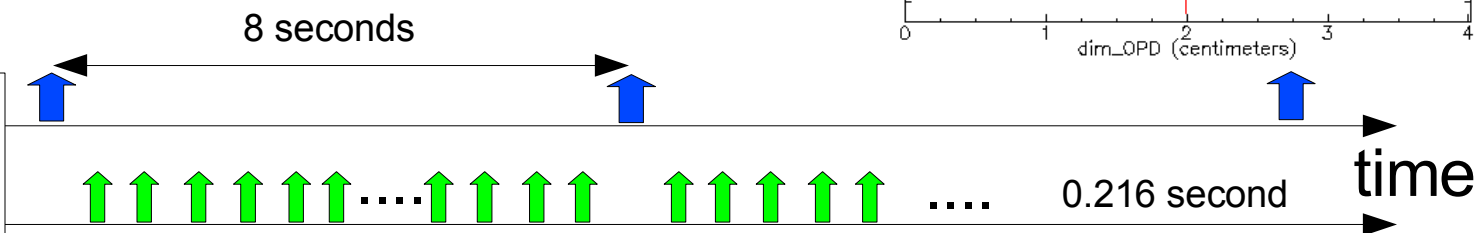
- **8 seconds cycle**
  - 30 views (times 4 pixels) for the Normal Op. Mode (27 in Ext.Cal Mode)
  - 2 x 2 calibration views : hot (Black Body), cold (space), 2 scanning directions
- **Main functions**
  - **Preprocessing of the interferograms (raw measurements of the interferometer)**
    - Integrity checks (spikes detections, etc.) : limits provided by the ground
    - Non-Linearity correction : tables provided by the ground (*today from ground testing*)
  - **Computation of calibrated spectra (radiometry)**
    - Internal tables used by calibration updated every 8 sec
      - **Reduced spectra** Initial values provided by the ground
      - Integrity checks : limits provided by the ground
  - **Spectra encoding to reduce data rate**
    - Programmable Coding Tables provided by the ground



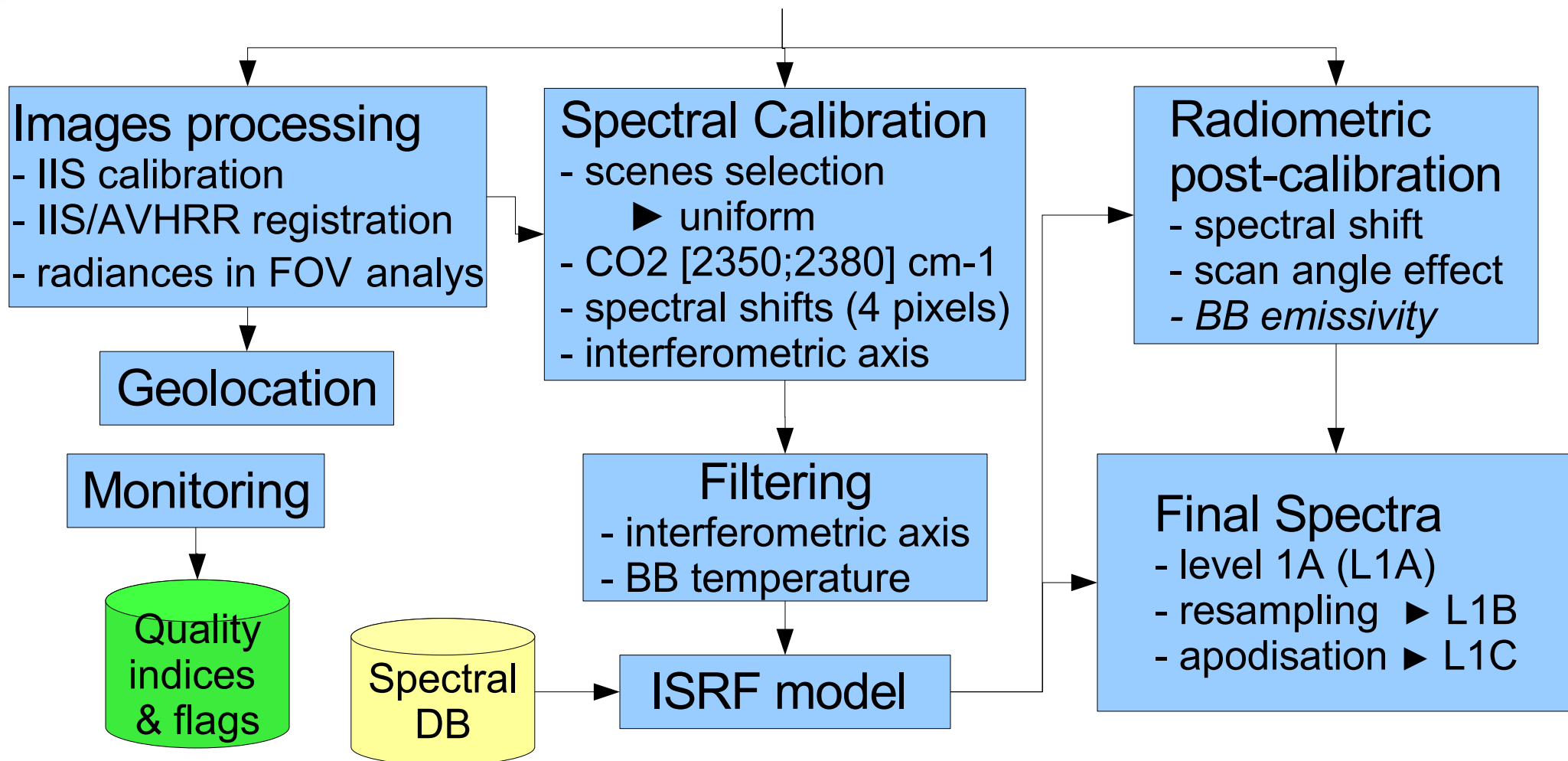
Processing

Calibration views

Earth views



# Overview of ground (Level 1) processing IASI science data



## Parameter updates

- **General philosophy**
  - Batches of modifications delivered to EUMETSAT
  - Relatively low frequency of modifications
  - Validation of the modifications in short loop using the copy of the L1 processing chain available in the IASI TEC
  
- **4 sets of parameter delivered to EUMETSAT during the Cal/Val**
  - Set 1 operational: 15<sup>th</sup> of January
  - Set 2 operational: 2<sup>nd</sup> of April
  - Set 3 operational: 27<sup>th</sup> of June (1<sup>st</sup> part) & 5<sup>th</sup> of July (2<sup>nd</sup> part)
  - Set 4 operational: 11<sup>th</sup> of July
  
- Set 1, 2 and Set 4: with L1 (ground) processing minor updates

## Update Set 1 – 15<sup>th</sup> January

- **On-board processing parameters**
  - Limits set for integrity check of the Reduced Spectra updating
  - Limits set for spikes detection
  - Modification of Coding Table for Earth View (EW) spectra coding
- **On-ground processing parameters**
  - Optimised filtering parameters
    - black Body temperature
    - interferometric axis
    - Rejection of measured spectral shifts
- **Benefits**
  - Return to nominal on-board calibration after the “loss” of half of the Reduced Spectra during the Christmas period + protection against such events
  - Improved coding resolution by reducing margins on the dynamic of spectra
  - Large improvement of the number of badly flagged spectra (false alarms due to IIS / AVHRR coregistration failure)

## Update Set 2 – 2<sup>nd</sup> April

- **On-board parameters**
  - **New Reduced Spectra**
    - Needed because of small changes of the instrument alignment (around 0.04  $\mu\text{m}$ )
  - **New limits set for radiometric calibration integrity checks**
  - **Increase of the filtering length for radiometric calibration**
- **On-ground processing parameters**
  - **Spectral database update using Cube Corner offset (shear) measured in-flight**
  - **Optimised filtering parameters**
    - black Body temperature
    - interferometric axis
    - Rejection of measured spectral shifts
  - **Optimized parameters for IIS / AVHRR coregistration**
- **Benefits**
  - **Large improvement of the spectral calibration (around  $3 \cdot 10^{-5}$ )**
  - **Return to nominal calibration for pixel 3**
  - **Improvement of the stability of the calibrations (spectral and radiometric)**

## Update Set 3 – 27<sup>th</sup> June & 5<sup>th</sup> July

### On-board parameters + L1 parameters

#### Benefits

- **Reduction of rejected spectra**
  - spike reason
  - NZPD reason
- **Increase of the margin for coding spectra**
  - **Nb of Overflows** began to increase in June over hot regions
    - (Iran, Turkmenistan, etc. )
  - **Maximum coding temperature** in atmospheric windows around 335 K
- **Improvement of the radiometric calibration**
  - **Post-calibration** for scan mirror reflectivity change with incidence
  - **Optimisation** of the on-board filtering length
- **Reduced Spectra update**
  - **stability** expected for the next 3 months at least
- **Reduction of the width of overlap regions (B1/B2) and (B2/B3)**

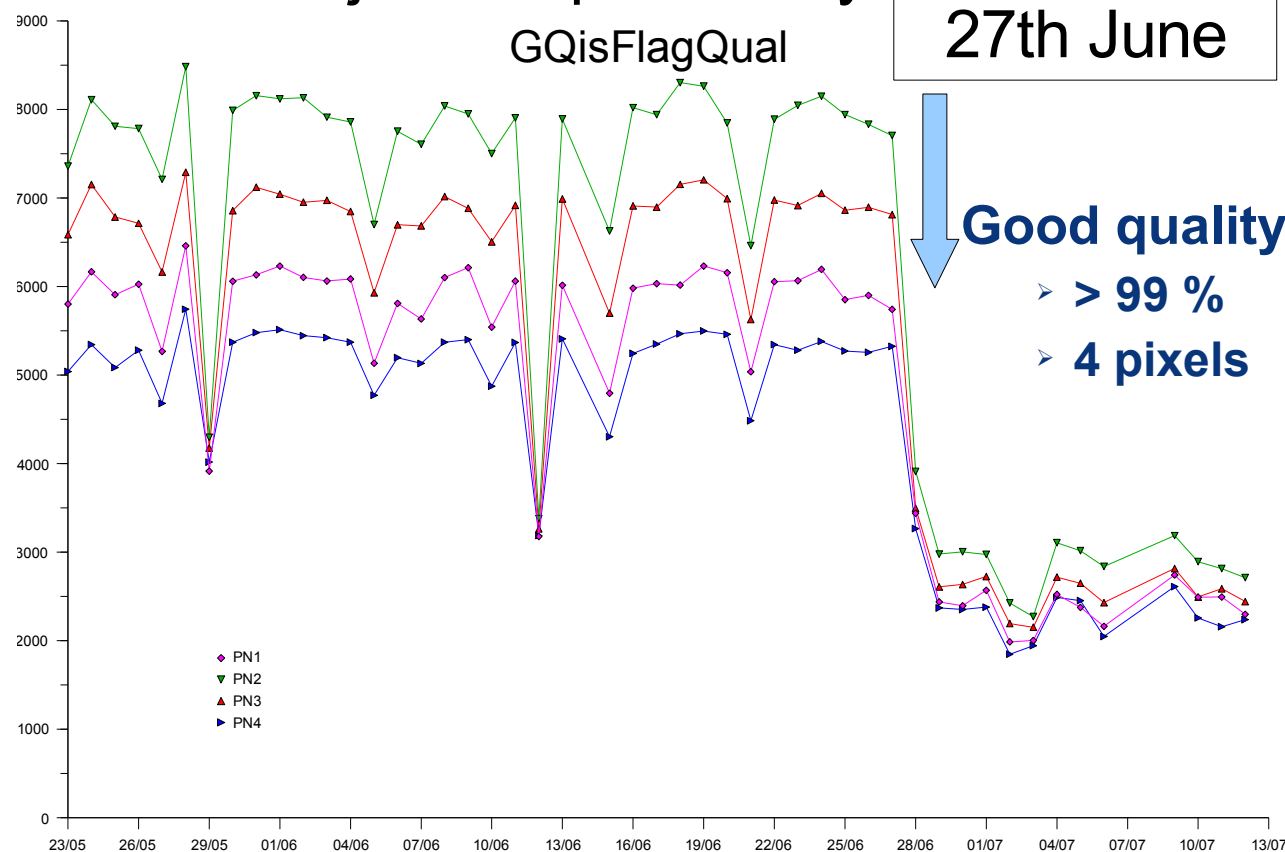
## Update Set 4 – 11<sup>th</sup> July

- **L1 Processing parameters + associated Level 1 processing update**
  - Update of IPSF
  - Pixel dependency of the “natural phase”
  - IIS / AVHRR Nominal Offset
  
- **Benefits**
  - **Improved spectral calibration**
    - Reduction of interpixel spectral shift
    - Slight improvement of the absolute spectral shift error
  - **Localisation when IIS/AVHRR co registration fails**
  - **Strong decrease of the number of L1 radiances “overflows”**
    - During encoding of radiances into 16 bits integers
  - **Quality indices in Level 1 products**

## Parameters update : on-board limits

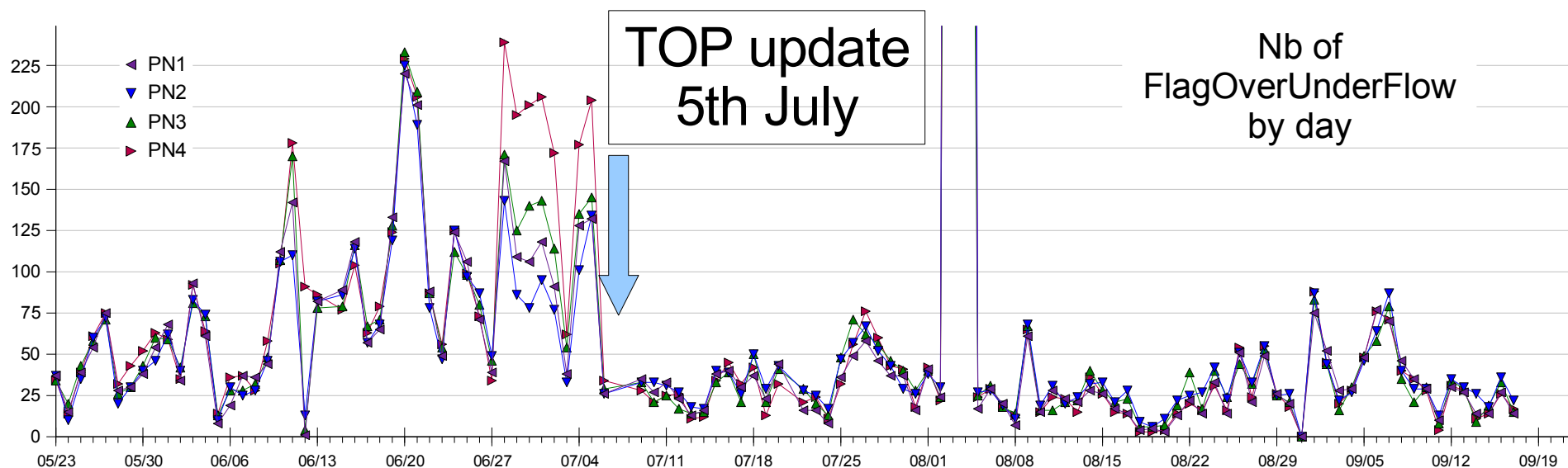
- **Relaxation of 2 limits**
  - Spikes detection
  - NZPD quality index EW
  
- **Careful analysis of impact on product quality done during Cal/Val B**
  - Tolerable spikes effect on the noise
  - **No Compromise**
    - False Alarms
    - Non detection of errors
  - **2 levels of monitoring keep the non detection rate to 0**

Number of rejected spectra/day



## Parameters update : spectra coding tables

- **Nb of overflows in coding spectra began to increase beginning of June**
  - Small fraction of the spectra : 225 /day < 0.1 % of the spectra
  - Location : middle east (Iran, Turkmenistan, deserts ...)
  - Observed spectra are warmer than the ones in Southern hemisphere summer
- **On-board coding tables optimization : updated 5<sup>th</sup> of July**
  - Tables suitable for the current northern summer period



## Lessons learned (1/2)

- **Instrument design provides good stability**
  - **In-flight behavior very close to the one measured on-ground**
  - **Optical bench accurate thermal control (at ambient temperature)**
    - Dimensional stability (hence spectral calibration stability)
    - Radiometric calibration stability
    - But effect of “warm” optical bench on noise in band B3
      - Could be mitigated (background flux reflected in anti-contamination window)
  - **Modifications after PFM ground testing against ice contamination**
    - In-flight confirmation of good results obtained on ground
  
- **Instrument design provides good testability**
  - **External Calibration Mode**
  - **Verification Data Selection (raw interferograms)**
  - **Redundancy (e.g. Spectra in interband B1/B2, B2/B3)**

## Lessons learned (2/2)

- **Integrated Imager very valuable**
  - Easy registration with sounder and AVHRR
  - Very useful for test scenes selections
  - Provide images for calibration views (CS1,CS2, ... moon)
  - Provide images during the ground testing
  
- **Use of spectra in the interbands B1/B2 and B2/B3 should be avoided by the users for precise analysis**
  - Insufficient knowledge of Instrument Spectral Response Function (ISRF)
  - But very useful for performance verifications
  
- **On-board processing working flawlessly**
  - All on-board monitoring algorithms proved useful to cope with real data
    - Spikes detection, Reduced Spectra and Radiometric Calibration integrity checks

# Thank you

- Visit the CNES IASI Web site
  - <http://smcs.cnes.fr/iasi>