Science for Earth care

Overview of geometry in IASI-NG processing

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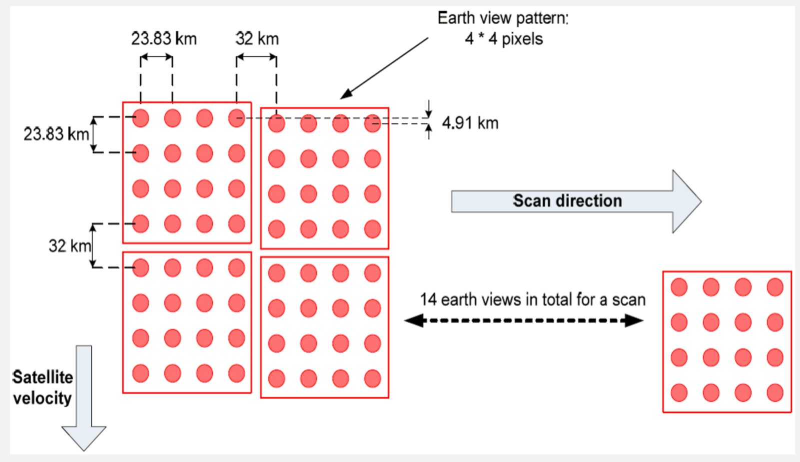
IASI-NG fields of view

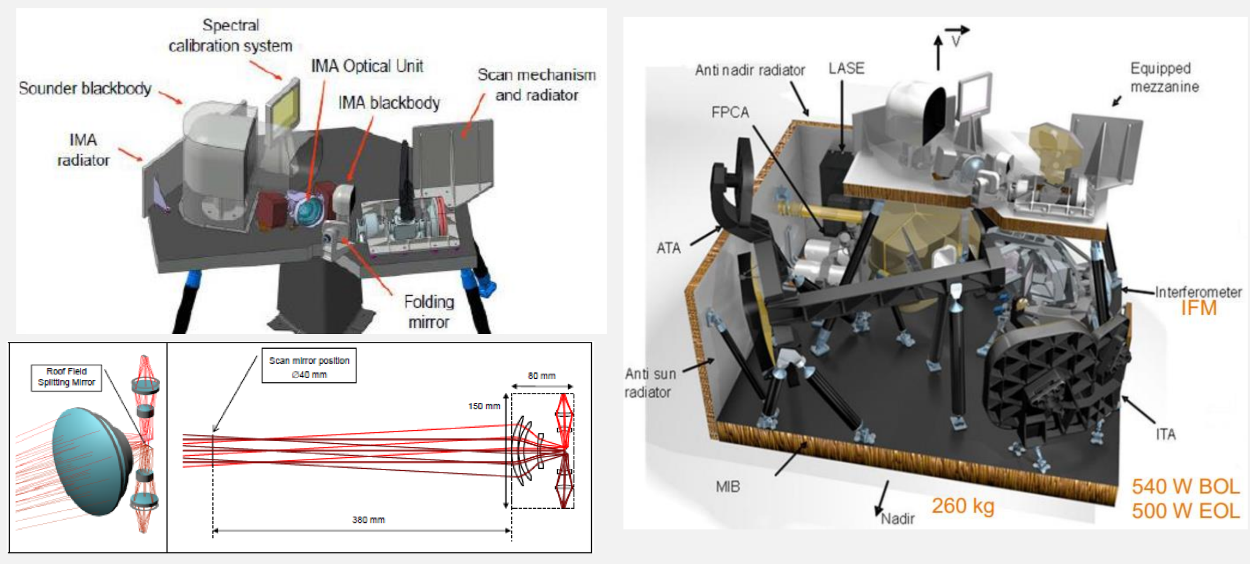
The IASI-NG instrument is made of a Fourier Transform Spectrometer (IASING sounder) and an associated 2D imager (IMA)

Using a scanning mirror, both acquire the signal from the Earth surface and atmosphere on 14 different Earth Views FOR encompassing a global swath of 2200 km. On each FOR, 16 sounder pixels of 12km diameter (at nadir) are acquired with a spatial sampling of about 25 km (at nadir).

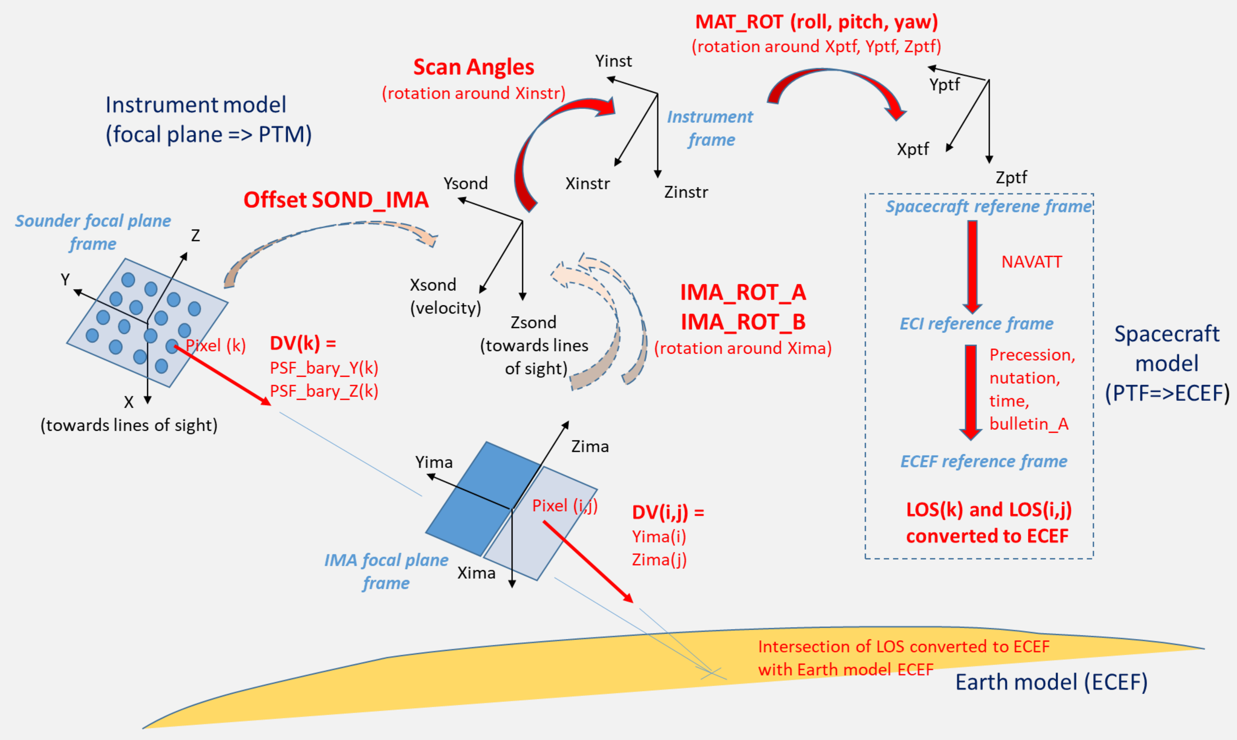


IASI-NG geometric model in L1C processing and IASTEC

IASI-NG Instrument (courtesy ADS ICSO 2014)



Imager: 2 half-images on different focal planes (2 *150x75 pixels)
Sounder: 16 sounder pixels on the same plate
Common sounder/imager scan mirror

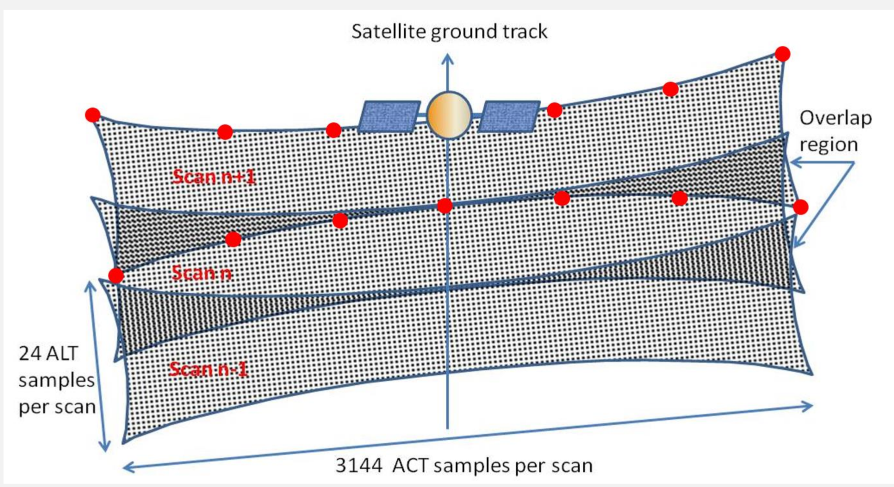


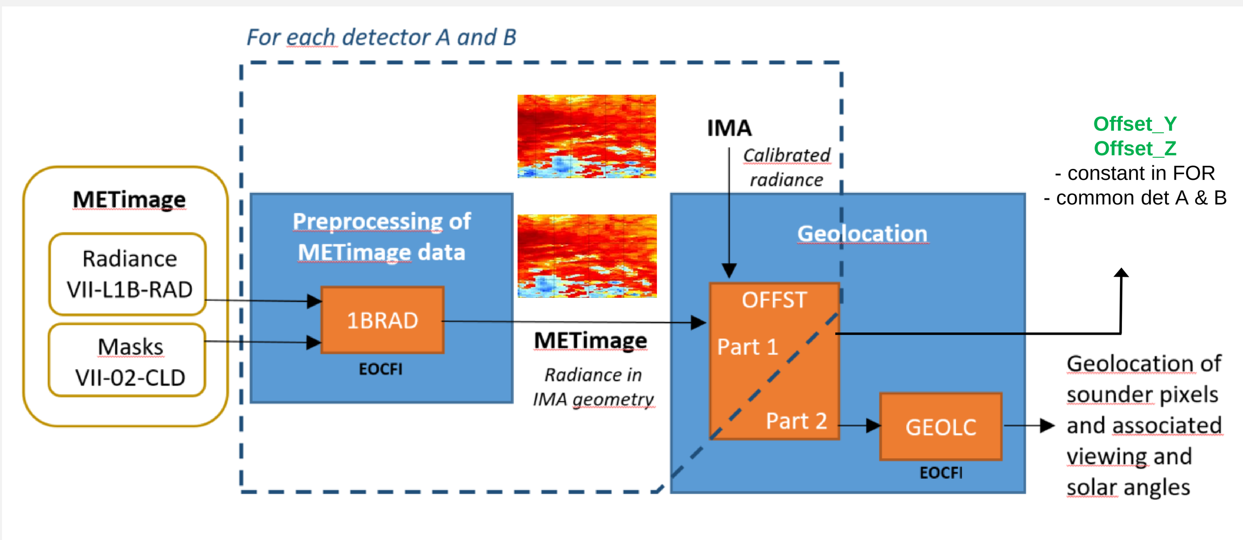
The IASI-NG geometric model is a simplified description of the instrument optics and mechanics aiming at establishing the link between the imager and sounder pixels viewing directions in their respective focal planes and the location of these pixels on the Earth surface (lat/ lon coordinates).

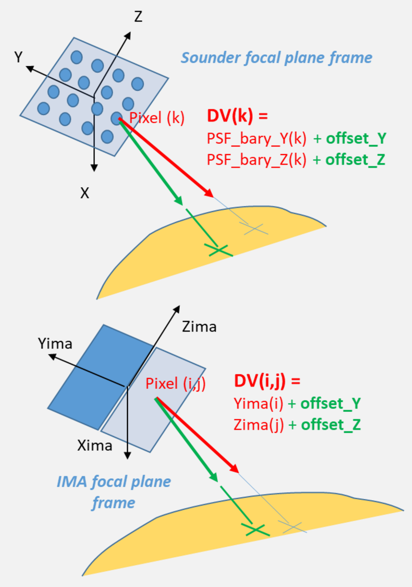
The breakdown of the geometric IASI-NG model features a series of reference frame conversions based on a limited number of rotation and offset parameters. These geometric parameters have been chosen in such a way that they can be verified and calibrated in flight during Cal/Val and the mission operational phase using the available observables : IMA and METimage images together with IASI-NG sounder measurements).

METImage / IMA offset calibration (dynamic, L1C processing nominal mode)

METImage viewing geometry and sampling (courtesy EUMETSAT)







A dynamic adjustment of the sounder and IMA viewing directions is performed at each acquisition using as a reference concomitant METimage L1B radiance in the 10.69 µm channel and L2 CLD products, with a supposedly perfect geolocation.

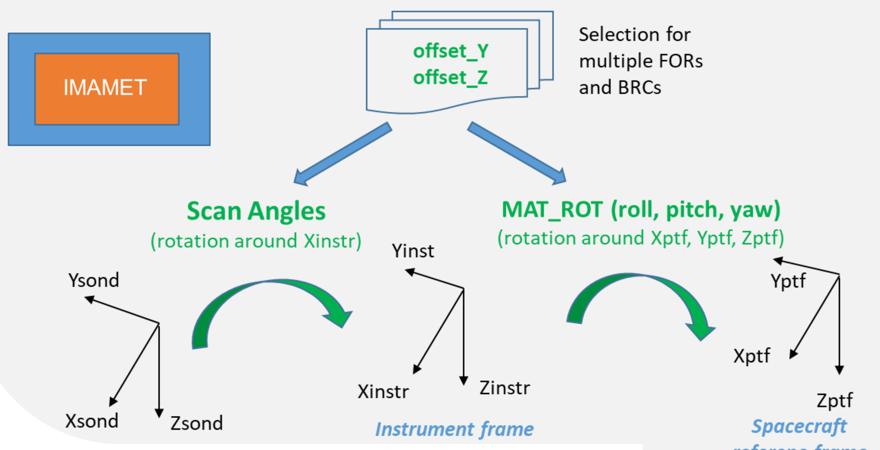
The corrective viewing direction bias is obtained by identifying a global offset in Y and Z in each FOR between the radiance of IMA and the resampled METimage image (1BRAD and OFFST). After the viewing direction corrections are applied, the geolocation data of the IMA and sounder pixels are determined using pointing calculation (GEOLC)

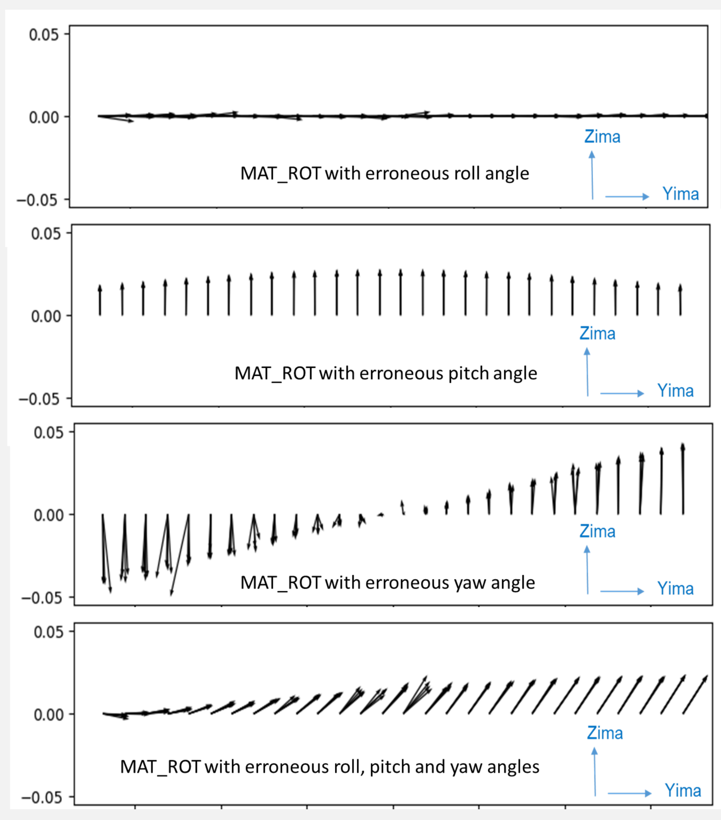
MAT_ROT & Scan calibration (static, IASTEC)

The IMAMET module is used to estimate corrections to the MAT_ROT matrix and scan angles of the various FORs, based on the different offsets routinely estimated from correlations between IMA and METImage in the operational L1C chain, and possibly filtered (without DEM, without clouds, with a correlation coefficient above a certain threshold).

These offset estimates can be made globally (taking into account all estimated offsets, regardless of orbital position or date/season), or on reduced ranges of BRCs, in order to capture possible orbital variations.

The general equations of the geometric model allow us to calculate the dY, dZ offset in the IMA detector geometry as a function of deltas [dRoll, dPitch, dYaw] of the MATROT matrix, or scan angle deltas. The system resolution seeks to find the value of the unknown vector (3 dimensions in the case of MATROT calibration) which minimizes the residuals.





Retrieved offsets in (Y,Z) plane for the 14 IASI-NG scan angles, 2 detectors and 4 BRCs. The offsets are obtained using different configurations of MAT_ROT combining errors in roll, pitch and yaw
Source : outputs of OFFST (COREG) simulations in IRIS

SOND_IMA & PSF calibration (static, IASTEC)

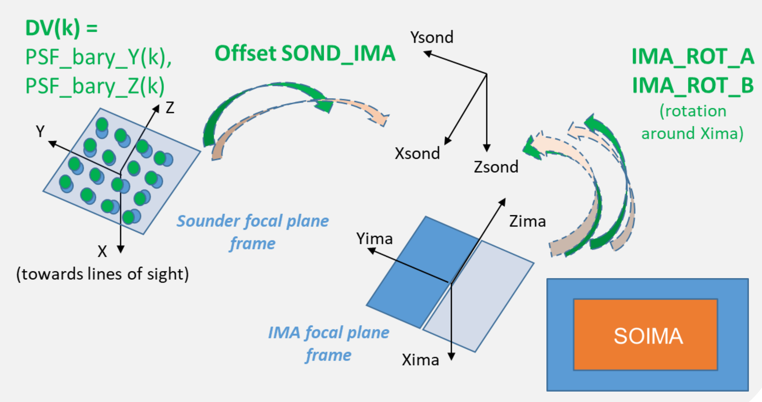
When the IASI-NG sounder and IMA imager are correctly registered, the IMA radiance spatially integrated in the sounder FOV is representing the same quantity as the sounder radiance spectrally integrated in the IMA ISRF for a set of observations.

We choose a collection of observations (index i) for which there is a radiometric gradient ("bord de plage") such that a geometric offset of δl,δc is visible in the correlation map. The collection will either target a given sounder FOV if the barycenter of FOV is to be calibrated (PSF_bary_y and PSF_bary_Z), or include the 16 sounder FOVS to reach the global sounder IMA offset, both detectors taken together (parameter SOND_IMA).
The optimum subpixel offset is found in the correlation map by identifying the position of the maximum correlation coefficient (R[δl,δc]).

$$RadImag[i,\delta l,\delta c] = \sum_{pixel\ s\ IMA\ [l,c]} IMA\_RAD[i][l,c] * PSF[FOV[i],\delta l,\delta c][l,c]$$

$$RadSond[i] = \sum_{channels\ \ k} SondRadianceSpectum[k] * ISRF[k]$$

$$R[\delta l,\delta c] = \frac{\sum_{i=1}^{Nec}(RadImag[i,\delta l,\delta c] - RadImagMean[\delta l,\delta c]) * (RadSond[i] - RadSondMean)}{\sqrt{\sum_{i=1}^{Nec}(RadImag[i,\delta l,\delta c] - RadImagMean[\delta l,\delta c])^2 * \sum_{i=1}^{Nec}(RadSond[i] - RadSondMean)^2}}$$



Conclusion

The IASI-NG viewing model used in the L1C chain and in IASTEC provides a consistent yet simplified description of the instrument's optics and mechanics, relying on a set of geometrical parameters to be calibrated in flight.

The coregistration between METImage and IMA will be ensured over time during the operational processing.

Calibration of all other parameters (MAT_ROT, Scan Angles, SOND_IMA, PSF barycenters, IMA_ROT) will be performed statically using expert tools at IASTEC.

For the MAT_ROT and Scan Angles parameters, the METimage / IMA offsets (OFFST outputs) routinely computed in the operational processing are collected and used as calibration observables, providing a large amount of statistical data for the detection and correction of various effects (instrumental, orbital, seasonal).

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SCAN ME