INTEGRAL/IBIS calibration status

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On behalf of the IBIS team

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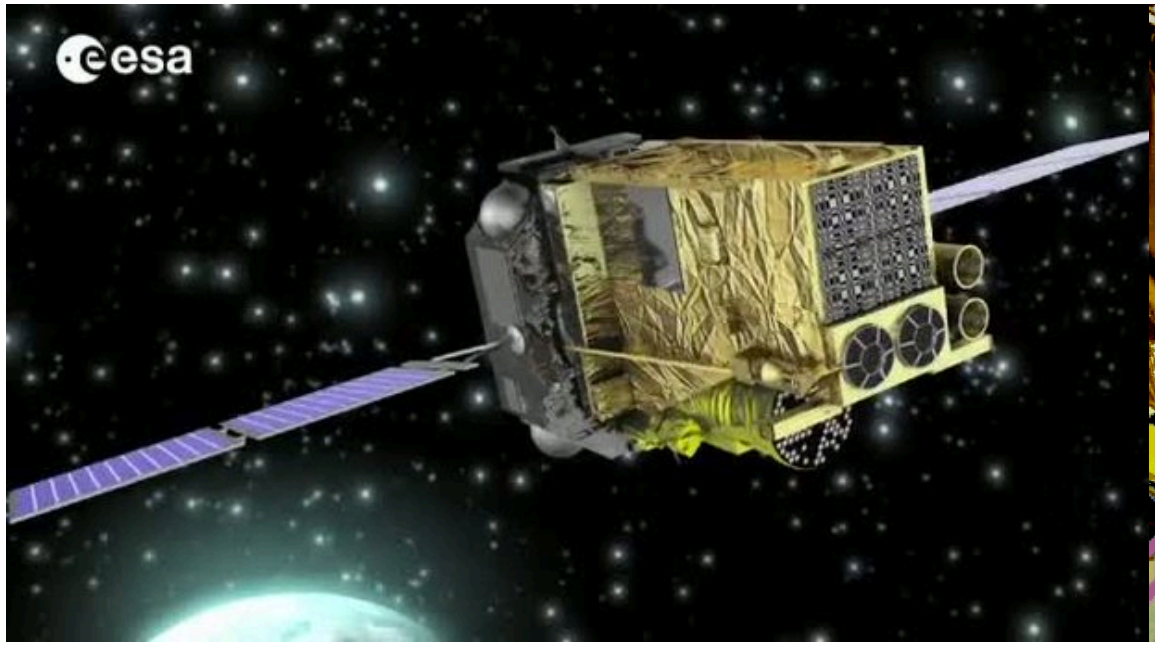
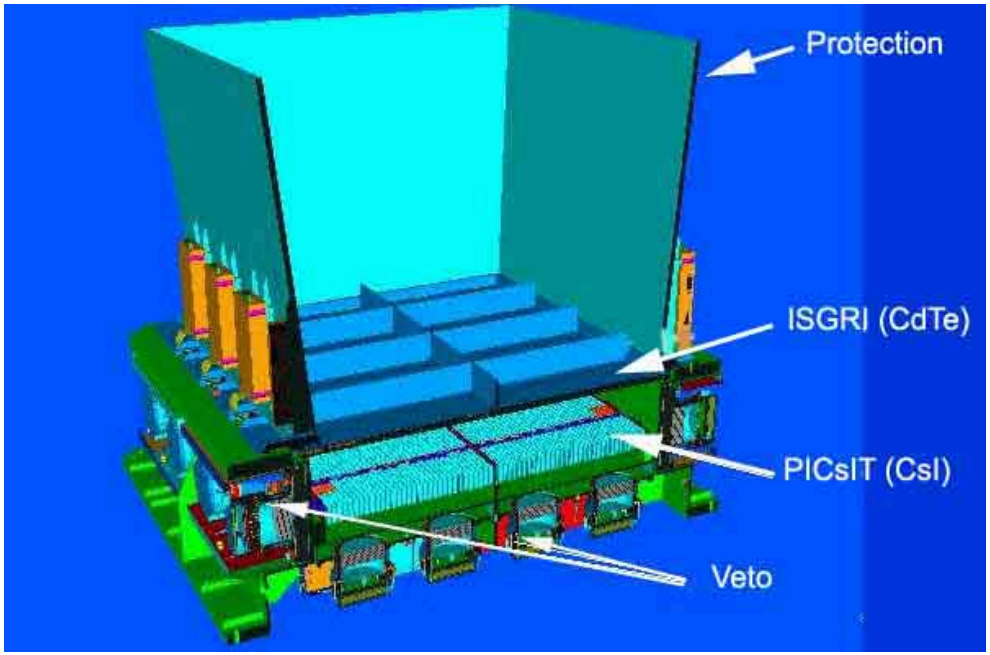


News and recent Activities

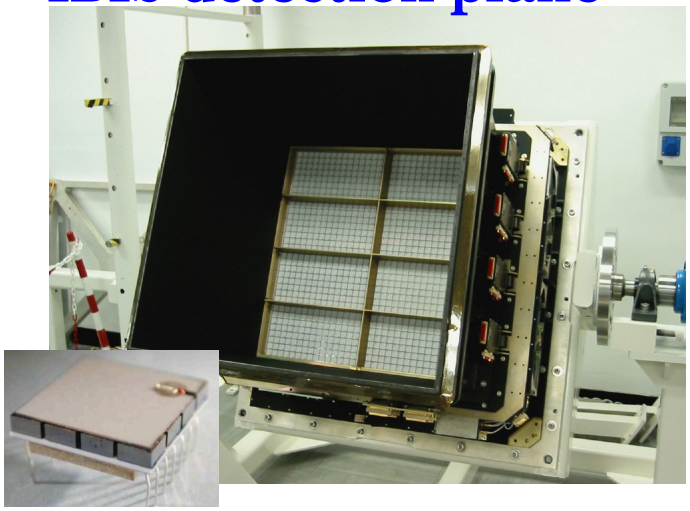
- INTEGRAL calibration continues to be supported by the teams in Saclay, ISDC and INAF. Shortage of funding for contracts is replaced by staff manpower in the institutes.
- Volodymyr Savchenko moved to ISDC/Geneva from APC/Paris
- A new postdoc started at INAF/IAPS (~2 years)
- Current S/W implementation is still OSA-10 (version 10.2). Minor updates respect to OSA10.1, but there are improvements in the low energy response
- Calibration files are being updated on bi-annual basis using the Crab observations
- Investigation of several anomalous effects; to take care for future implementation in OSA11
- Implementation of ISGRI effective area at high energies (up to 600 keV) using long-term Crab spectrum
- On going work for OSA-11: detailed development schedule and test plan, testing currently identified methods for response corrections

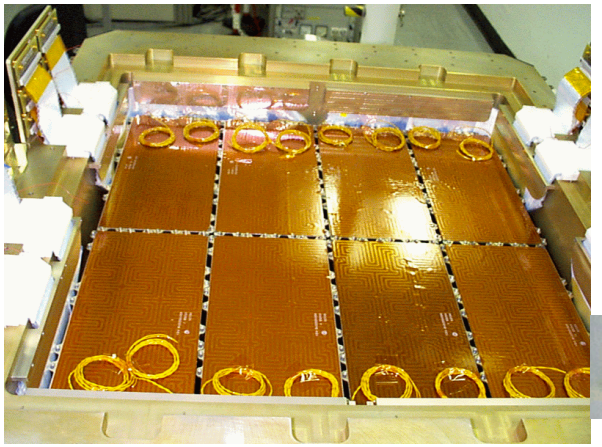
The IBIS instrument

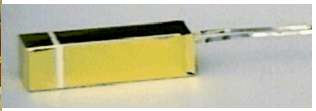
The IBIS coded mask, placed at 3.2m from detector. Built using 16mm thick W blocks, min.size 11.2mm



IBIS detection plane







ISGRI: 2mm thick CdTe, 8 modules, total of 128x128 pixels, 4 mm resolution, energy range 15-1000 keV

PICSiT: 3cm thick CsI bars, 8 modules, total of 64x64 pixels. Energy range 0.2-10 MeV

Energy computation in ISGRI

For a given energy deposited in ISGRI, , the pulse height is function of the detector position, which is encoded by the pulse rise time.

For interaction at significant depth there is significant charge loss, due to the reduced mobility of charges compared to electrons.

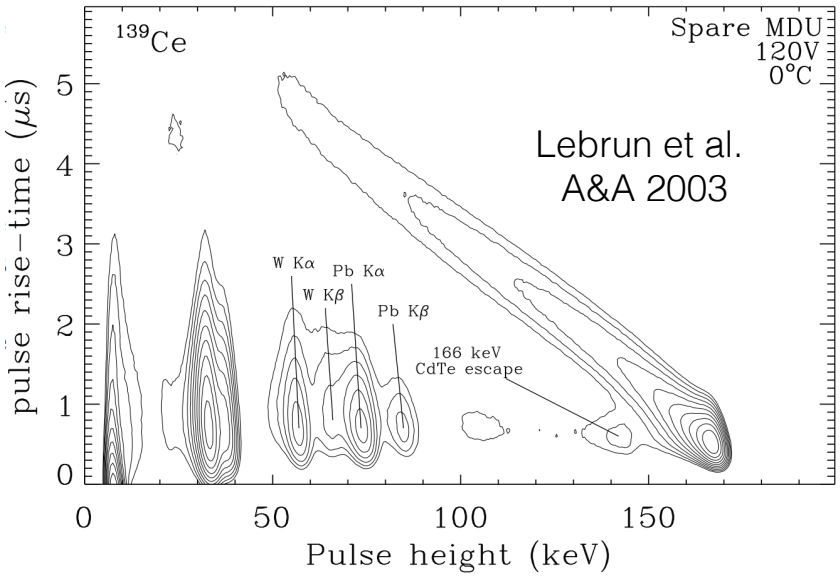
The correction is done in two steps:

(1) Gain/offset (LUT1):

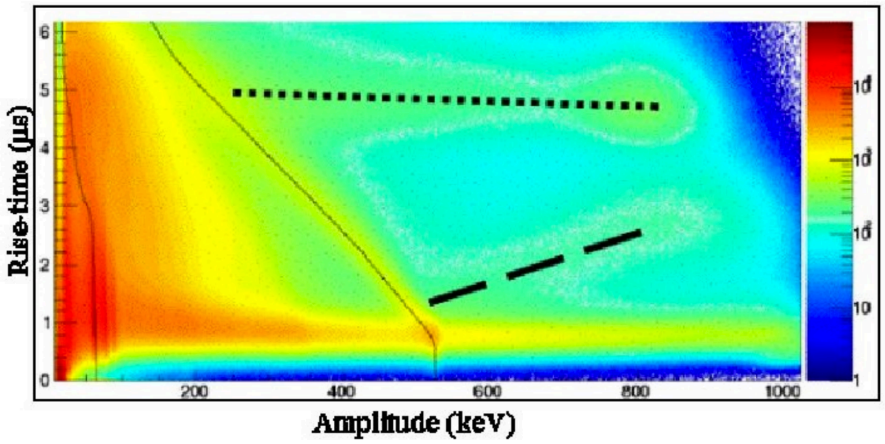
Correction against temperature, voltage and rise time

(2) PHA/Rise Time correction (LUT2)

After step 1, reconstruct the energy by using the PH-RT probability distribution contained in LUT2



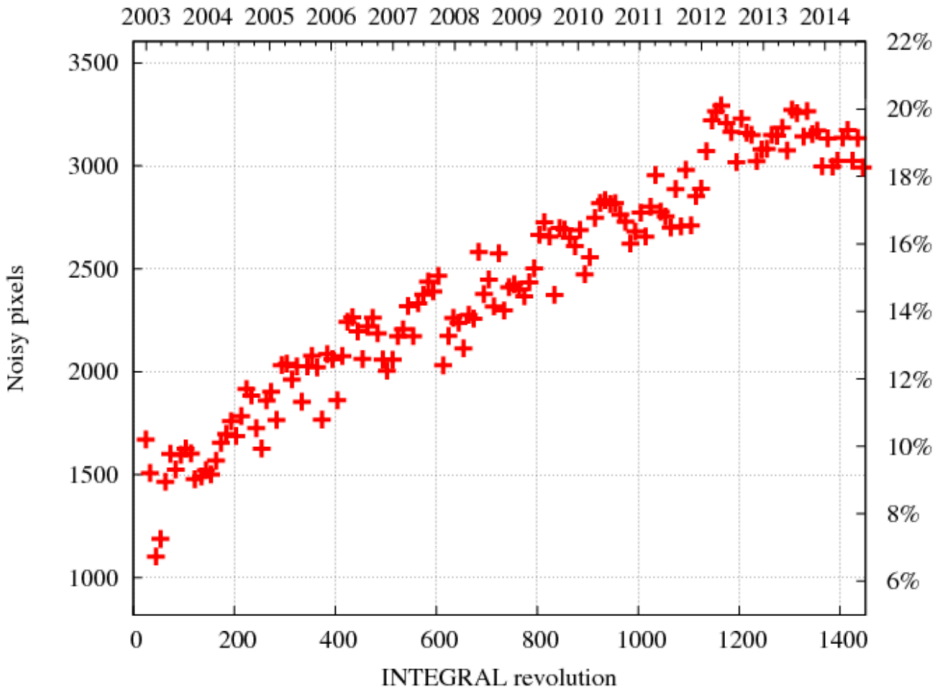
Bi-parametric diagram from laboratory measurement with radioactive source (166 keV)



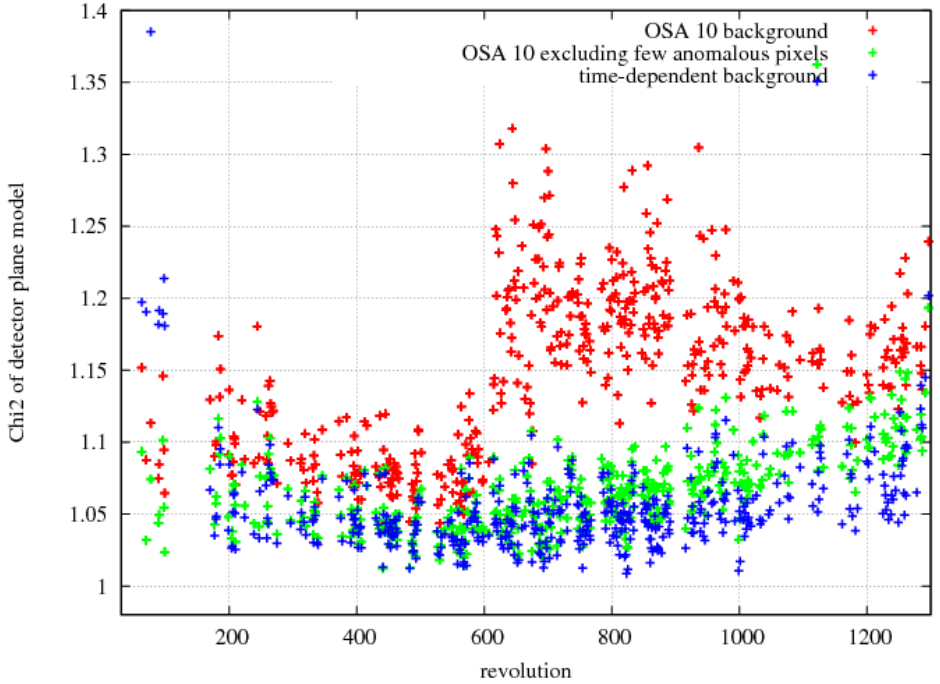
In flight bi-parametric diagram from the on-board calbration source

ISGRI noisy pixels

The configuration of the ISGRI pixel thresholds is upgraded each orbit. Noisy pixels are controlled by the on-board NPHS.

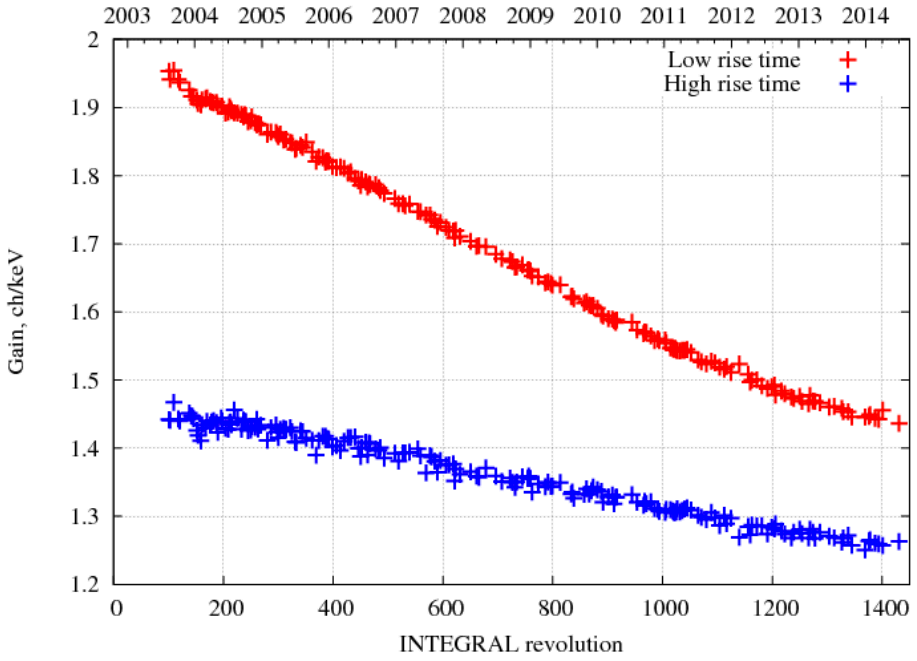


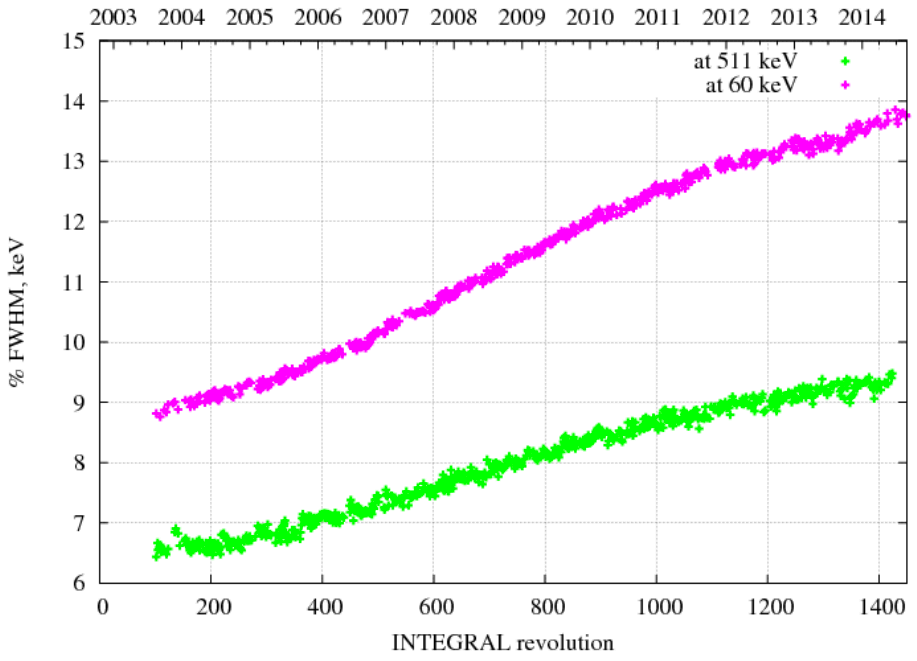
No.of of noisy pixels against time



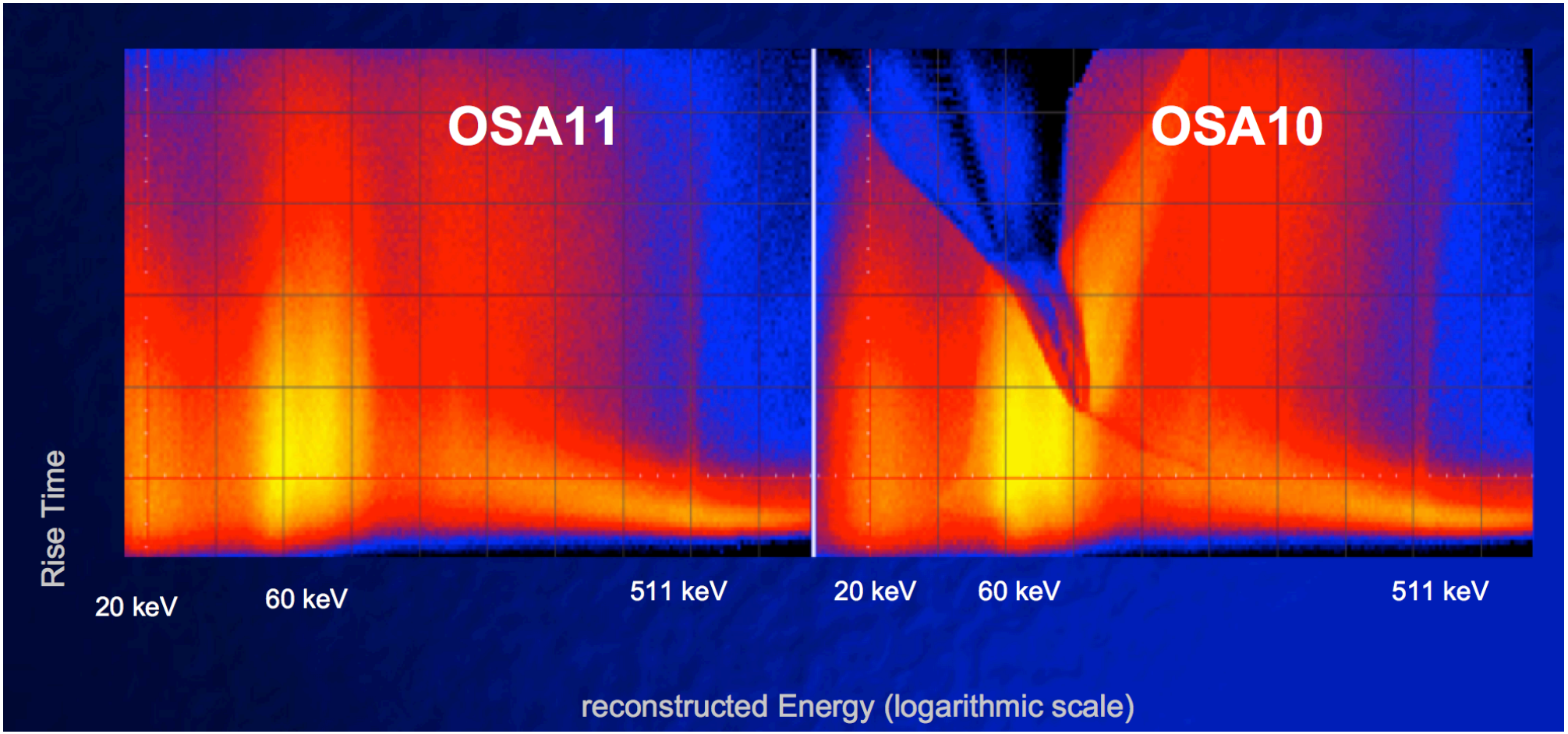
Effect of anomalous pixels on background stability. OSA11 will improve

Evolution of gain and energy resolution





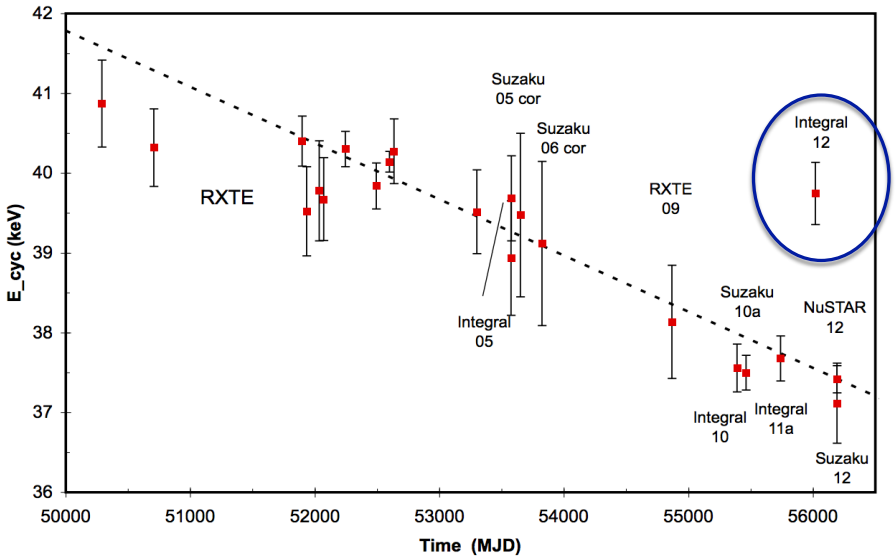
Bi-parametric diagram Energy vs rise Time



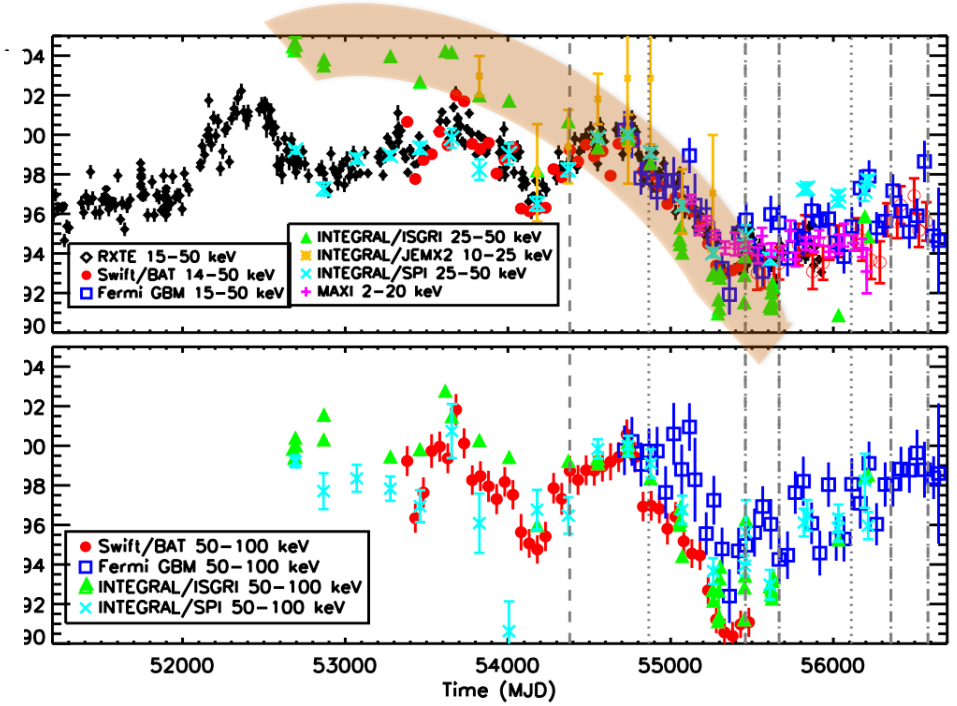
Savchenko 2014 (Proc. INTEGRAL)

Anomalies in OSA10

- Anomaly in ISGRI data 2012 caused by the break between two OSA10 correction laws moving close to the Her X-1 physical line
- Bias in the count rate reconstruction as showing up in Crab light curve (does not actually affect spectra reconstruction)

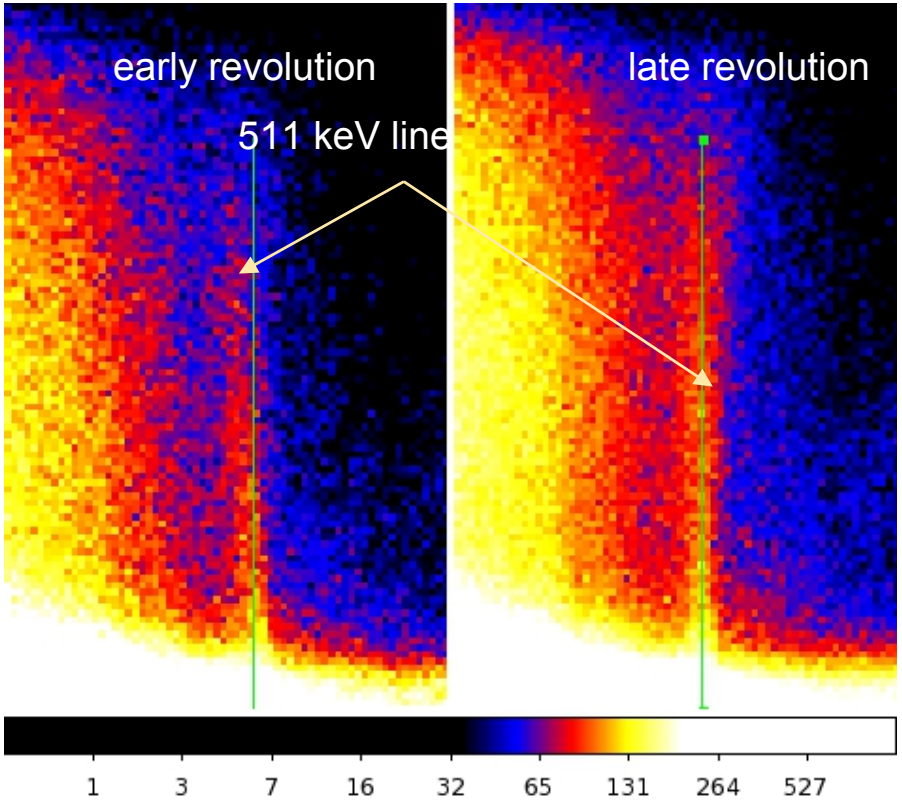


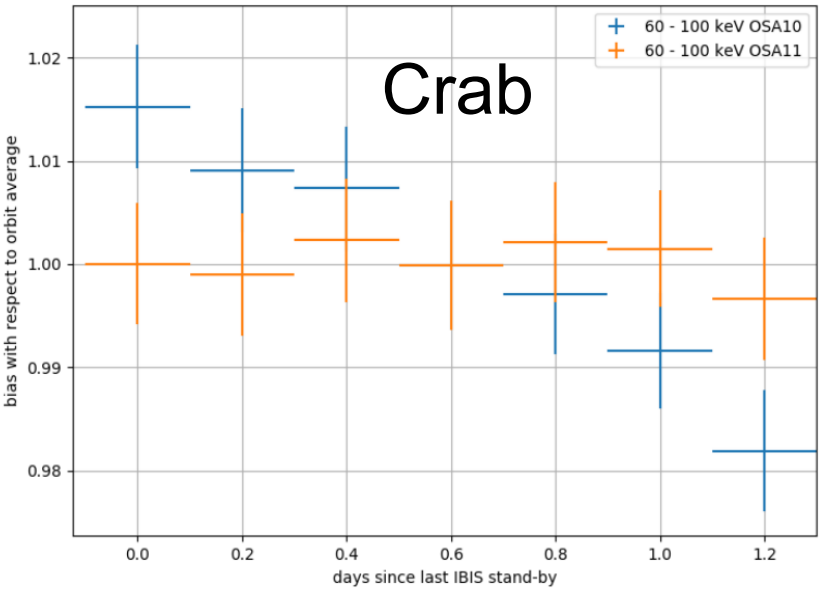
R. Staubert, arXiv:1412.8067



Crab light curve by G.case, 9th IACHEC

“Post stand-by” orbital evolution





It is strongly enhanced by long-term irradiation

Towards OSA-11

Many systematic effects will be corrected with the new release of OSA-11. The basic S/W implementation is ready, however, it needs to be tested against a consistent set of observations.

About 30 observation datasets have been identified, a subset include simultaneous observations with SPI, NuSTAR & XMM for cross-cal checking.

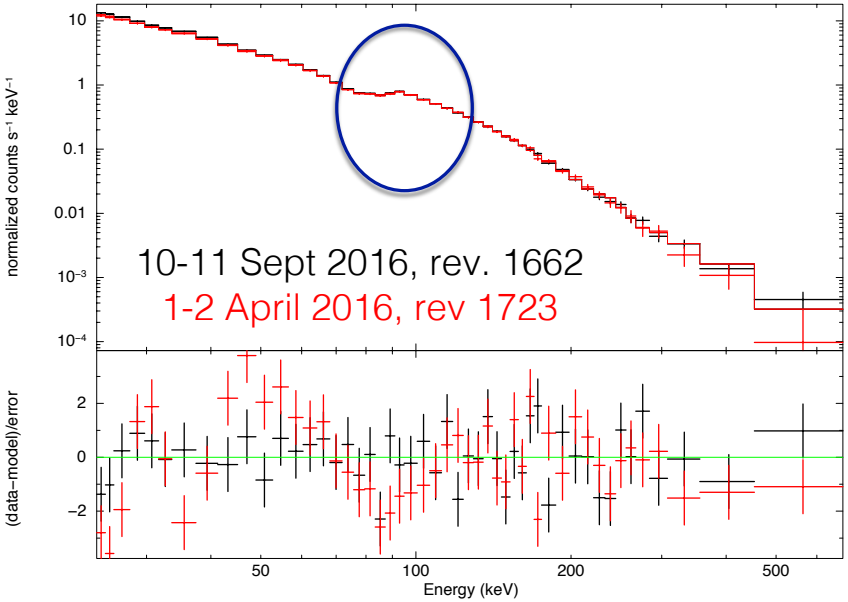
The list of foreseen corrections includes:

- 60-200 keV LUT2 anomaly (up to 100% flux mismatch)
- ~50 keV artifact and previously moving energy jump
- >60 keV flux absolute calibration of spectral shape
- >60 keV flux evolution caused by non-trivial LUT2 evolution
- polarization effect (transient field inhomogeneities)
- low threshold efficiency dispersion (relative LT shape)
- ISGRI Module Detector Unit and polycell bias glitches and anomalies
- unstable pixels
- background evolution

The corrections are implemented as seto of calibration files for each orbit (LUT2 & spectral response files)

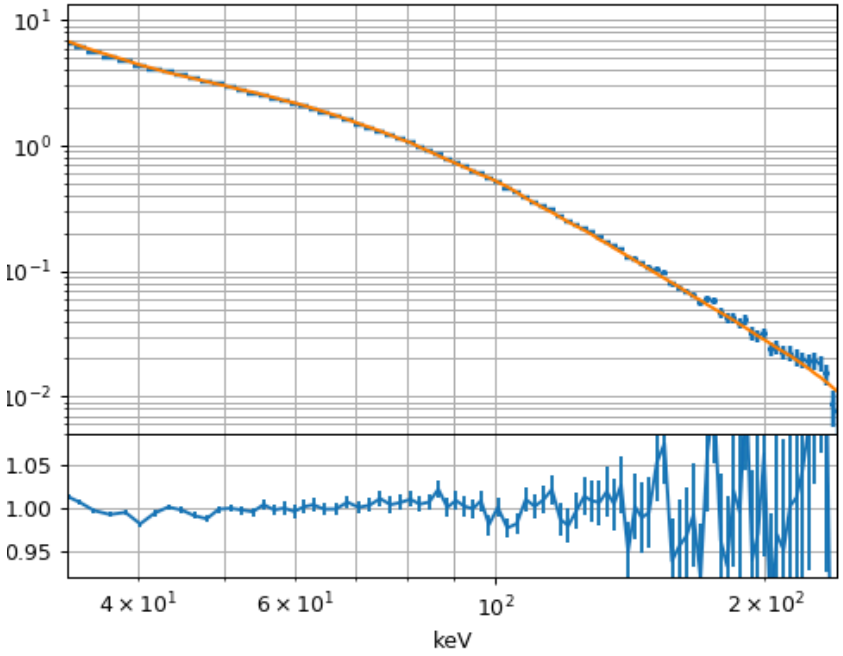
Crab Nebula spectrum

OSA10.2



Two recent observations of Crab taken a few months apart. The IBIS response function includes high energy correction of the effective area.

OSA11



Crab spectrum obtained with recent OSA-11 test version (preliminary).

Rev 665, effective exposure 99ks. Fit with broken PL

Summary

- Detailed plan for OSA-11 is now established. Test cases identified. After the tests we will start mass-production of the calibration files for each revolution.
- The new S/W will contain corrections to many systematic effects still present in the current OSA version. This will result in sygnificantly better quality of the analysis products.
- High energy response of ISGRI (up to 600 keV) to be also incorporated. Any absoulute measurements will be tested against Crab

New (ongoing) projects

- New effort started for PICSiT data analysis. Planning update of imaging S/W and calibration files. The final goal is to update the pipeline in the OSA (not yet for OSA-11)
- Cross-cal of PICsIT vs ISGRI and SP I foreseen suing Crab and V04 Cygni
- Efforts on PICsIT pushed up after the new activity of counterpart searches for GW, neutrinos etc (see Savchenko's talk on Wednesday)
- Cross calibrations of INTEGRAL with NuSTAR and XMM instruments using archival observation data