Crab phase spectroscopy

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Summary

ISGRI calibration

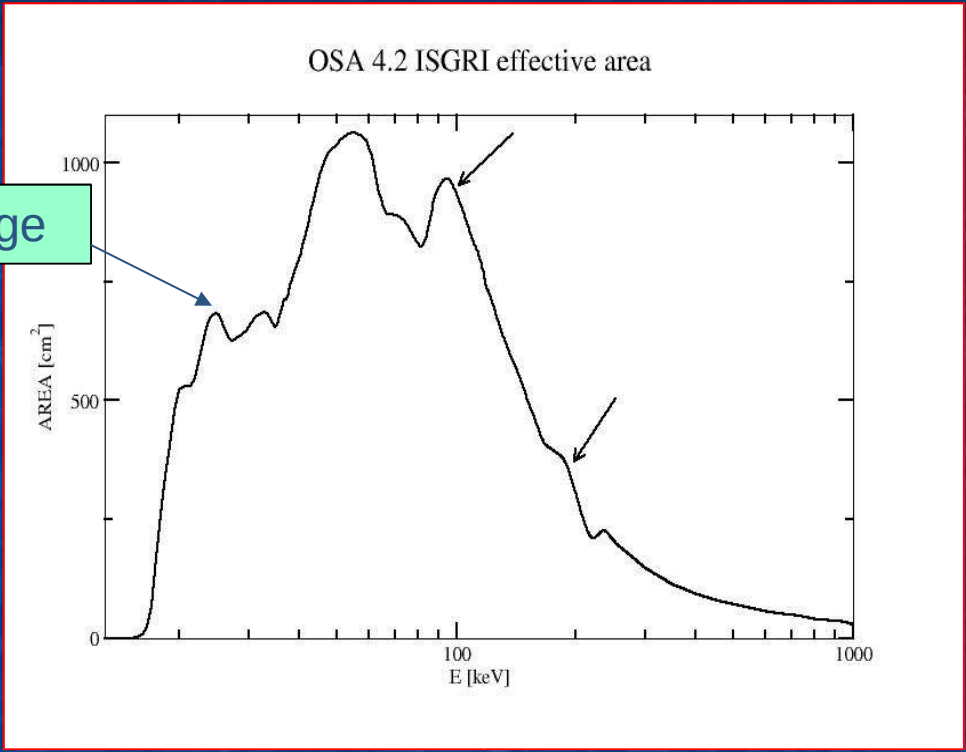
- Improved ISGRI Charge Loss Correction Table
- Response Matrix

Crab Nebula and Pulsar spectra

Fine phase resolved spectroscopy of the Pulsed emission

OSA 4.2 ISGRI effective Area

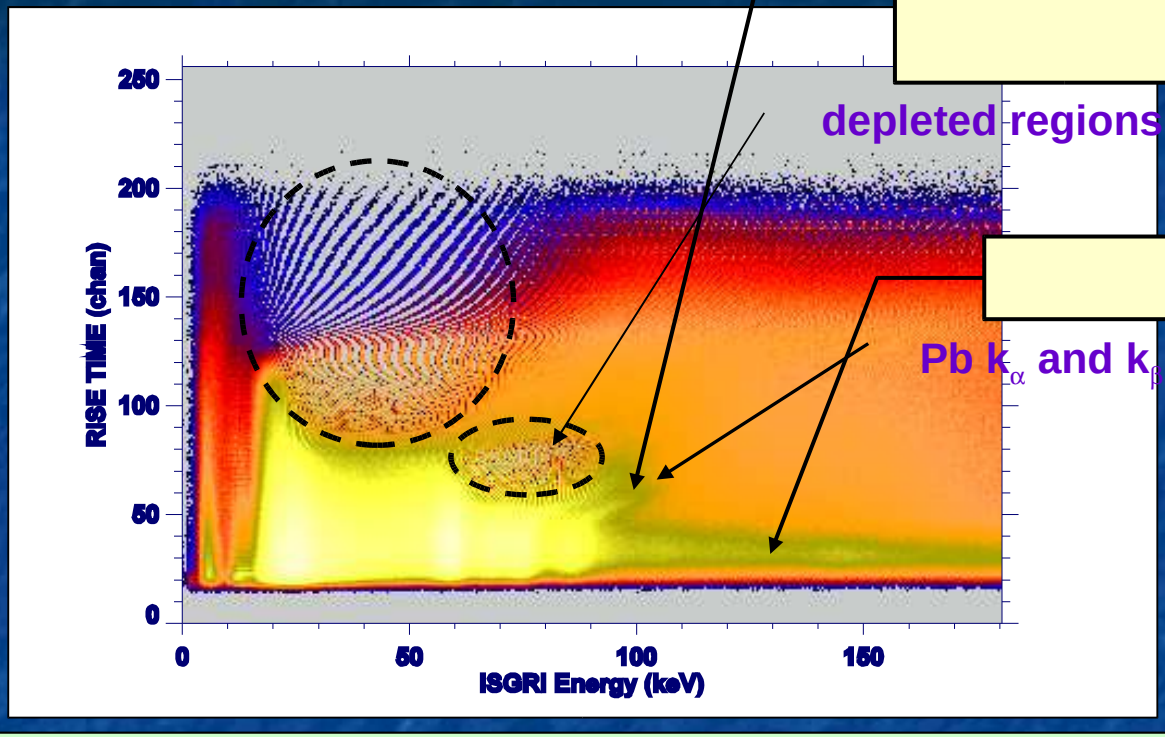
Absorption edge



The ISGRI effective area distributed with OSA 4.2 has been obtained using the Crab spectrum as reference.

Several strong spectral features are evident: the one in the low energy region (20 - 30 keV) is due to the presence of absorbing edges in the detector materials, but the wiggles and bumps at higher energy (> 60 keV) cannot be associated to any physical origin.

ISGRI 'Energy-RiseTime' di



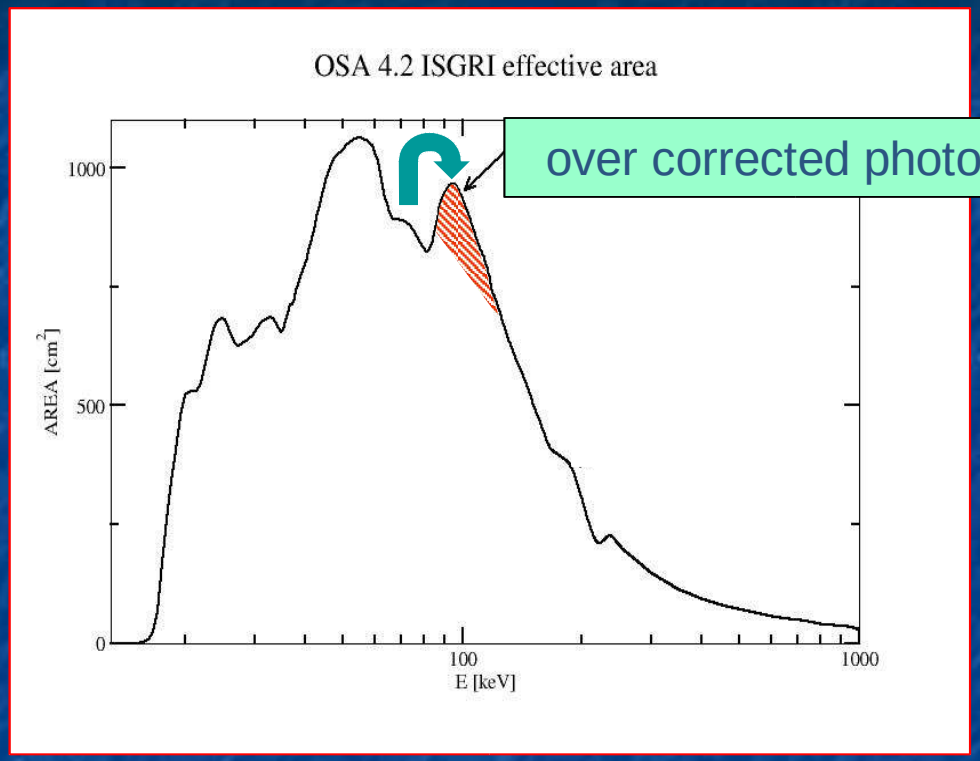
In order to compensate the dependence of the measured event energy from the pulse Rise Time, a Charge Loss Correction is applied to ISGRI data. The energy correction coefficients are stored in a Look Up Table (LUT2).

In the 'Energy - Rise Time' diagrams obtained from ISGRI data after the Charge Loss correction, there are regions where the event distribution appears anomalous, in particular:

- There are extended regions almost completely depleted of events
- The Pb fluorescence lines (at 74 and 84 keV) appear bent toward higher energies at long Rise Time values

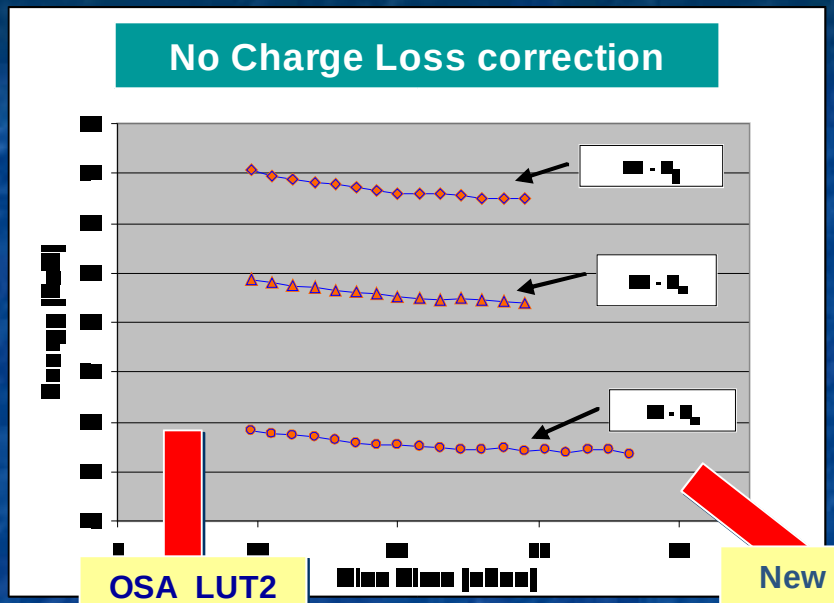
It is due to the presence of regions of anomalous energy correction that causes bumps and wiggles in the ISGRI spectra.

Side effects of the Charge Loss correction

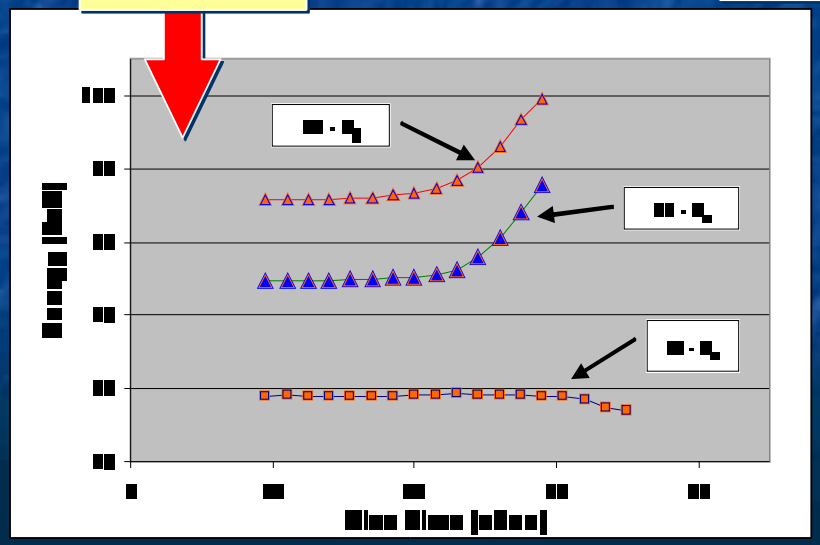


The presence of the '100 keV peak' in the OSA 4.2 ISGRI effective area is not due to a real increased detection efficiency at 100 keV, but to lower energy photons whose energy has been over-corrected by the LUT2

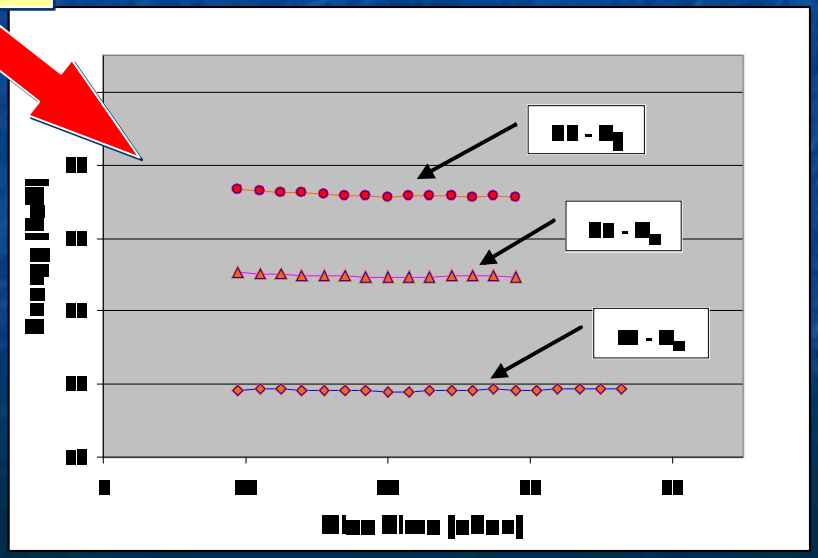
The new Charge Loss Correction Table



OSA LUT2



New LUT2

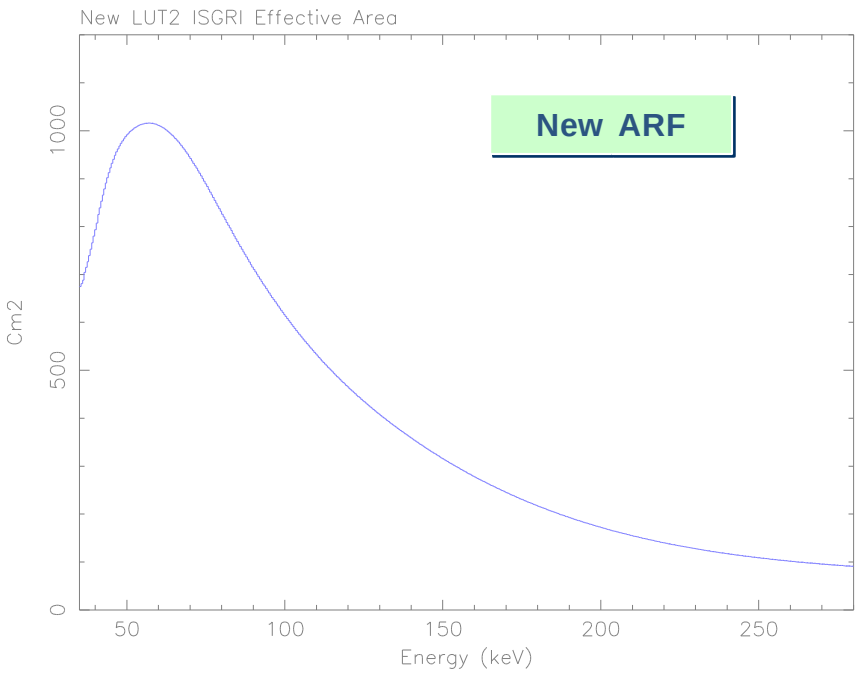


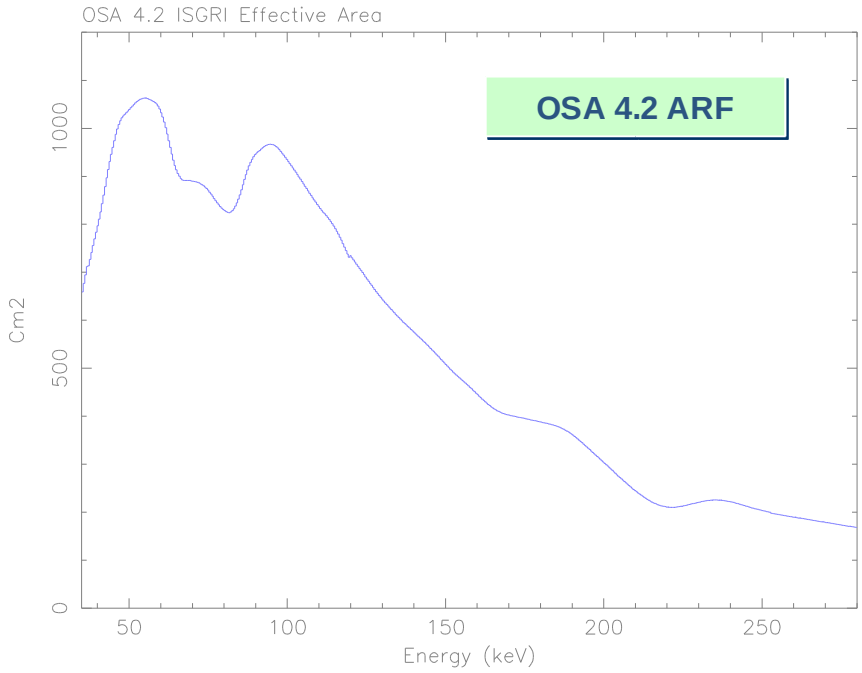
A new Charge Loss Correction Look Up Table (LUT2) has been determined from the analysis of

- ground calibration (^{133}Ba,^{139}Ce, ^{241}Am, …)
- flight background (W, Pb fluorescence)
- On-board Calibration Unit (^{22}Na)

Using the new LUT2 for the energy correction the background fluorescence lines are independent from the Rise Time channel.

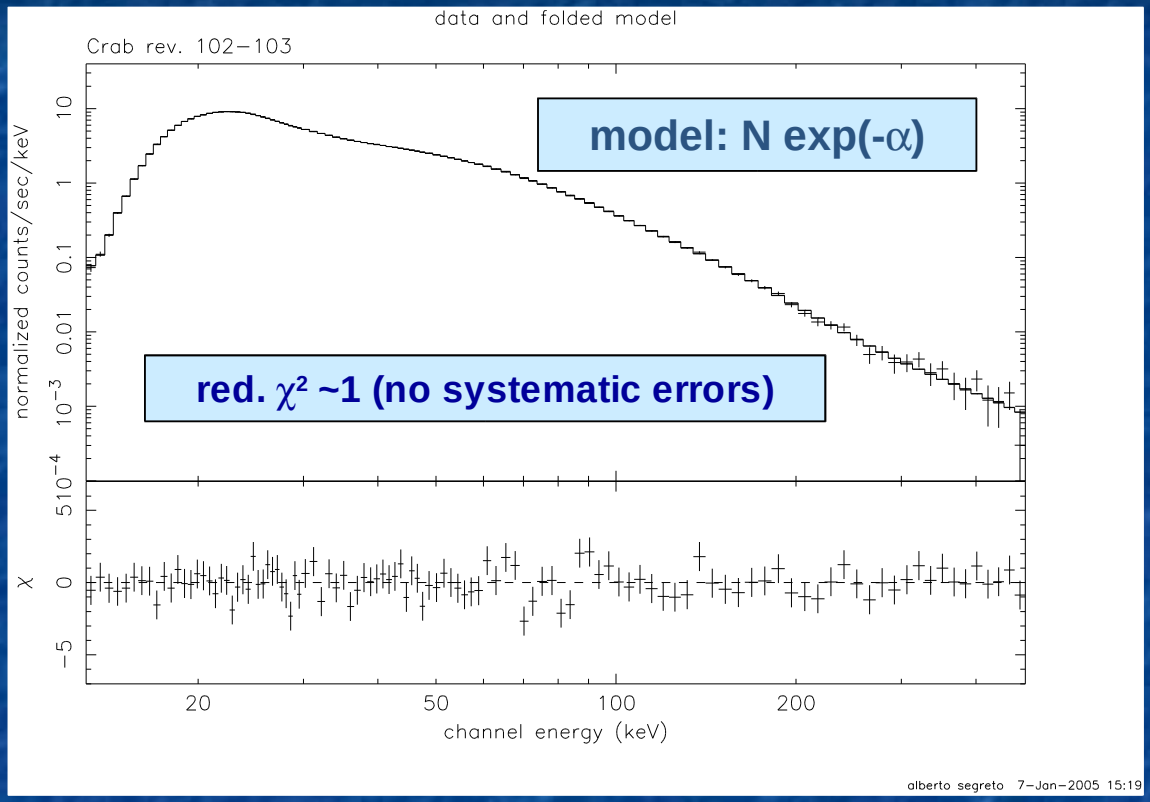
New ISGRI Effective Area





The ISGRI effective area (ARF) generated using as reference a Crab spectrum corrected using the new LUT2 do not show anymore the wiggles visible in the OSA 4.2 Effective Area.

Crab total spectrum



Crab spectral parameters:

N=9.7 phot/cm²/sec/keV

α = 2.10

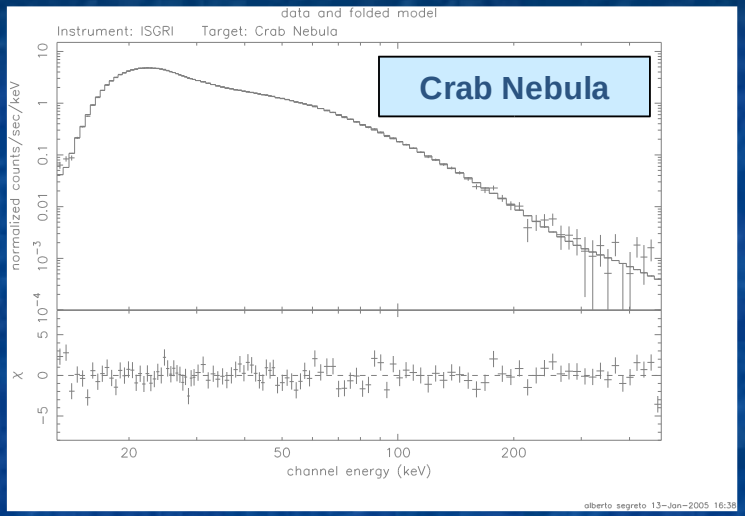
Crab data:

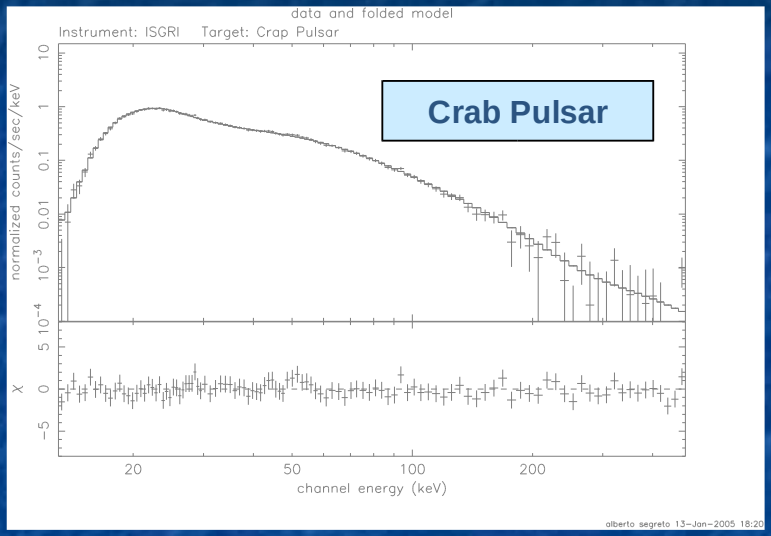
- **rev. 102-103**
- **on-axis**
- **50 ksec.**

Using the New Effective Area, a very good fit of the Crab spectrum in the 15 – 500 keV energy range can be obtained without adding any systematic errors to the data.

The Crab spectral model obtained from the fit is, of course, exactly the same model chosen to generate the Effective Area.

Crab Nebula and Pulsar spectra





Crab Nebula spectral parameters:

N=9.28 phot/cm²/sec/keV

α = 2.13

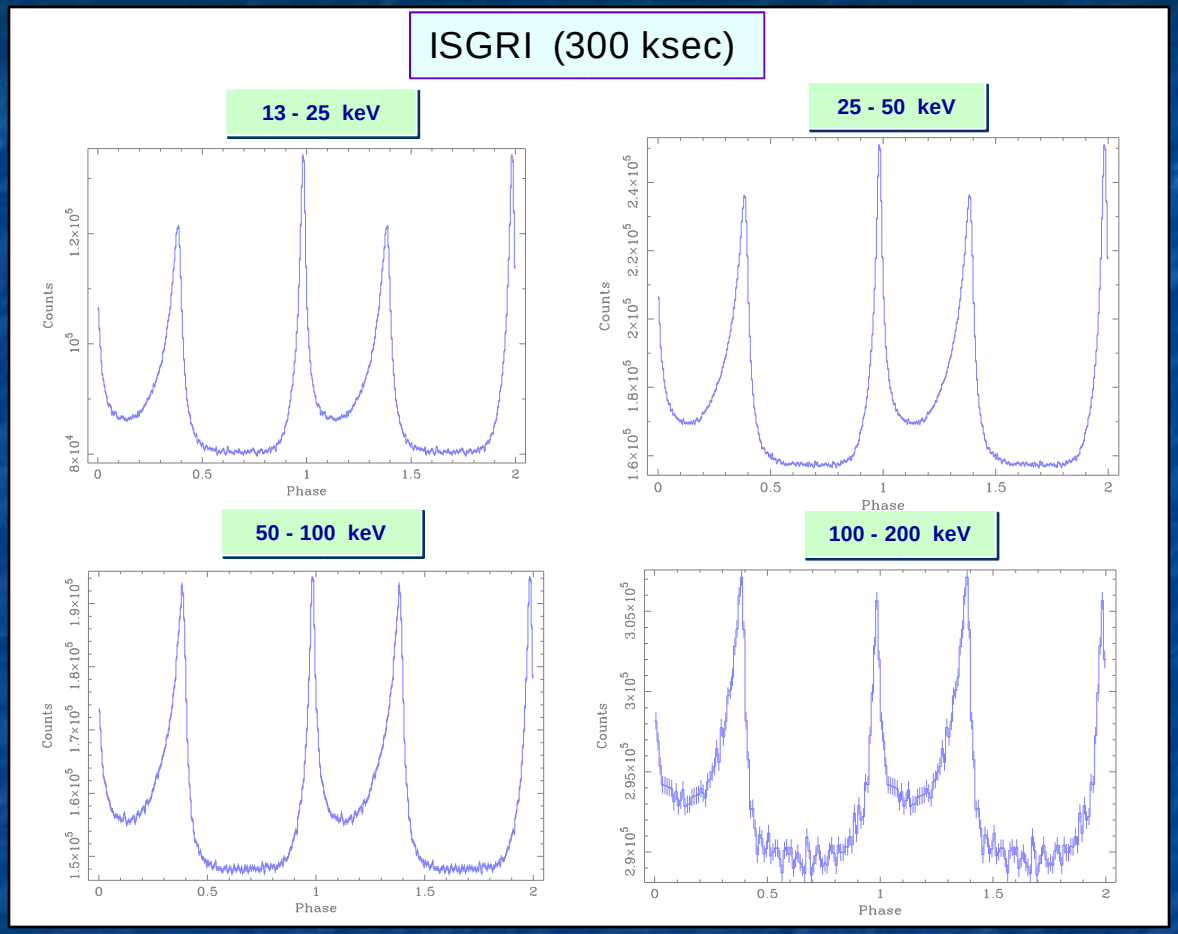
Crab Pulsar spectral parameters:

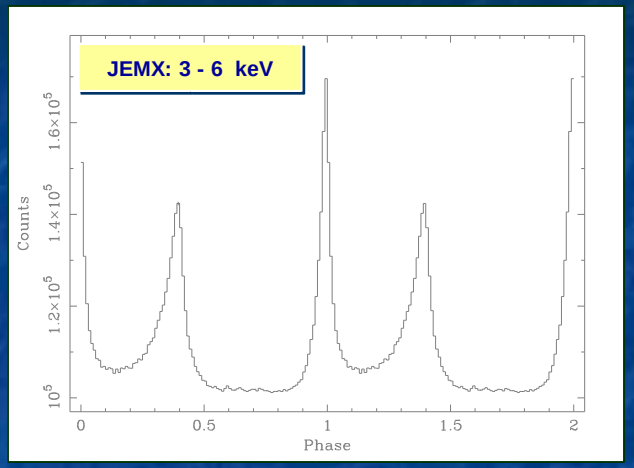
N=0.88 phot/cm²/sec/keV

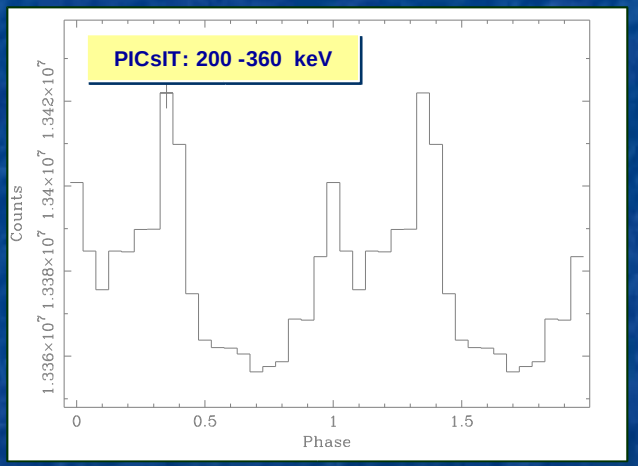
α = 1.91

- **The spectra of the Crab Nebula and of the Crab Pulsar can be easily separated by phase selection.**
- **The Nebula can be fitted by simple power-law with a spectral index slightly higher than the total spectrum.**
- **The Crab pulsed emission (which is 9% of the total) can be fitted with a power-law whose spectral index is lower than the total spectrum.**

Crab pulse profiles



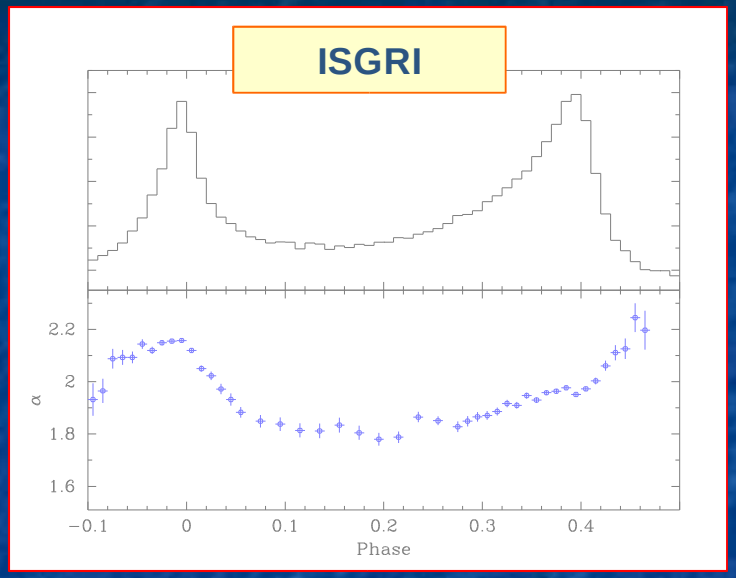


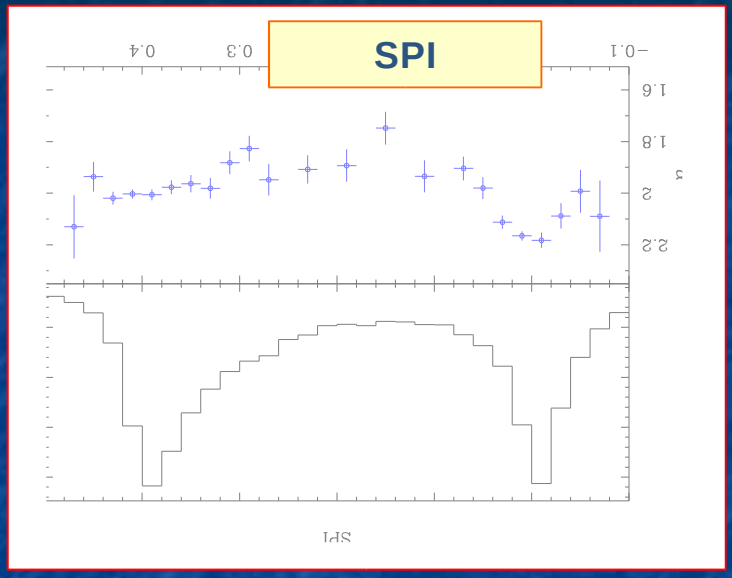


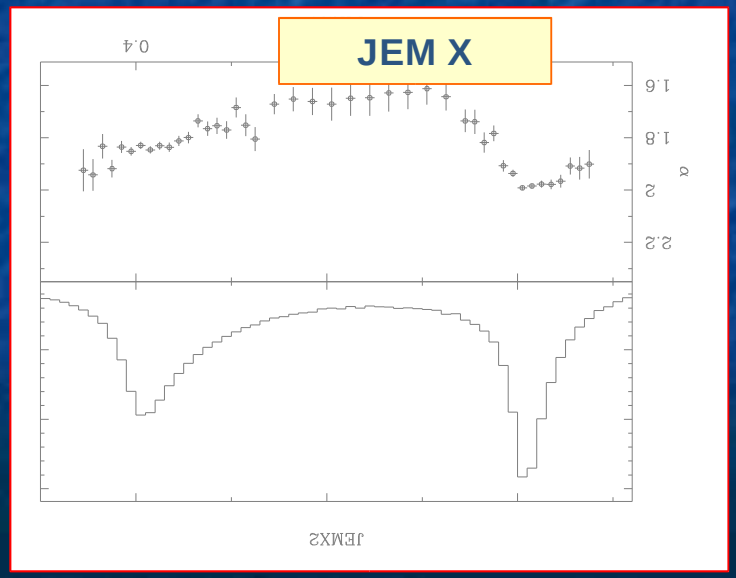
The shape of Crab pulse profile shape is strongly energy dependent.

At low energy the 1st peak is higher than the 2nd while at high energy the 2nd peak become dominant.

Fine phase spectroscopy of the Crab pulsed emission







The fine spectroscopy of the Crab pulsed emission is performed extracting spectra in small phase ranges, and using the Nebula spectrum as background.

Each spectrum is fitted (separately from the other instruments) with a single power-law.

The spectral index is strongly dependent on the pulse phase.

JEM X results are in some phase ranges lower than the ISGRI results. This is expected as it is known that a single power-law model cannot describe the pulsed emission in a very broad energy range.

Conclusions

ISGRI calibration:

The ISGRI spectral performances in the high energy region (>70 keV) are sensitive to the Charge Loss Correction; the introduction of artificial wiggles in the ISGRI Effective Area does not fully correct the problem.

We have performed analysis of the ground calibration and flight data in order to obtain an improved Correction Table (LUT2).

Using the new LUT2 no wiggles are visible in the corrected spectra and no anomalous features are present in the Effective Area obtained using the Crab spectrum as reference.

The new LUT2 is currently under evaluation by the ISGRI team. Report is expected by the next IBIS co-I meeting (March).

CRAB phase analysis:

We have performed phase resolved spectroscopy of the Crab, separating the Nebula from the Pulsar emission, and performed the fine spectral spectroscopy of the pulsed emission.

The observed spectral index variation of the pulsed emission with phase and energy is in good agreement with previous missions results.