# Fermi LAT data reprocessed with updated calibration constants

Johan Bregeon[1] and Eric Charles[2]
on behalf of the Fermi Large Area Telescope Collaboration
[1]Istituto Nazionale di Fisica Nucleare, sezione di Pisa, Italy
[2]SLAC National Accelerator Laboratory, Menlo Park CA, USA

**Summary: The first four years of the Fermi LAT data have been reprocessed with updated calibration constants leading to improved data quality and reduced systematic uncertainties.**

*Four years into the mission, the understanding of the Fermi LAT detectors properties and data analysis is now far beyond the required initial specifications. Thanks to a careful analysis of flight data, we were able to trace back some of our major sources of systematic uncertainties to the use of not optimal calibration constants for some of the detectors. In this poster, we report a major collaboration effort to update these constants, to use them to reprocess the first 4 years of raw data, and the improvements observed for low and high–level analysis. The Pass 7 reprocessed data, also known as Pass 7 'P7_REP' data, are still being validated against the original Pass 7 'P7' data by the collaboration and should be made public by the end of 2012.*

## LAT calibration constants

The Fermi LAT sub-system DAQ electronics relie on a number of calibration constants [1]:

- ACD: pedestals, low and high range gains
- CAL: pedestals, gains, electronic non linearity and light asymmetry
- TKR: hot and dead strip, time over threshold charge scale, alignment constants

Most of the LAT constants are either stable or drift very slowly ($\sim$1% per year). We keep track of the adequate calibration constants for a definite time span by using a `MySQL` meta data base.

## CAL light asymmetry

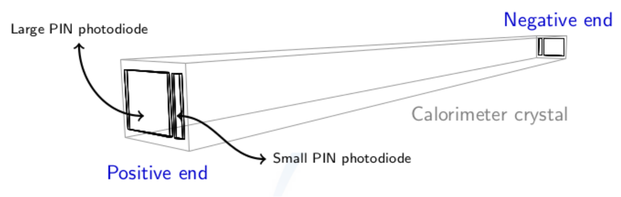


**Figure 1:** *Schematic view in perspective of one out of the 1536 CsI(Tl) crystals of the calorimeter*

- Asymmetry is used to reconstruct the location of the energy deposit
- Light asymmetry is calibrated on–orbit with heavy cosmic rays
- CAL energy centroid anchors the tracking and has a direct impact on the PSF

## Energy scale

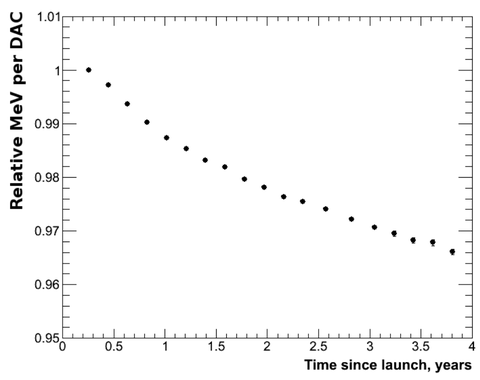


**Figure 2:** *Relative light yield for the energy deposit of minimum ionizing protons on–orbit*

- CsI(Tl) suffers radiation damage on–orbit
- Scintillation has decreased by $\sim 1\%$/year

## Events switching event class

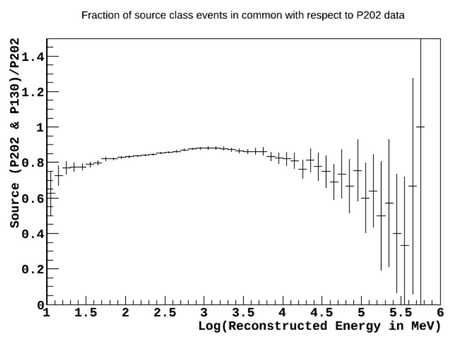


**Figure 3:** *Fraction of events in the Source class of both 'P7_REP' and 'P7' data w.r.t 'P7_REP' data: Up to 25% of Source class events change class*

## New IRFs P7V9

Point spread function:

- the new on–orbit PSF P7_V9 is significantly better above few GeV than the P7_V6 PSF (see poster by M. Wood)

Effective area:

- the 'P7_REP' Aeff is identical to the 'P7_V6' Aeff [2]

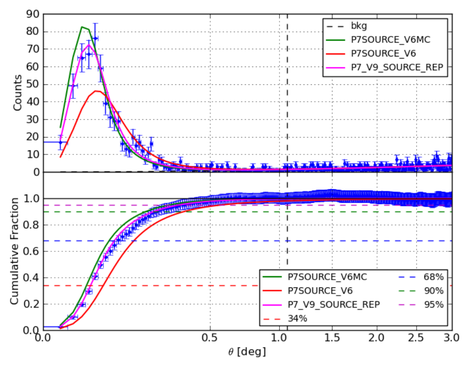


**Figure 4:** *Angular distribution of counts around the AGN sample at $\sim 20$ GeV*

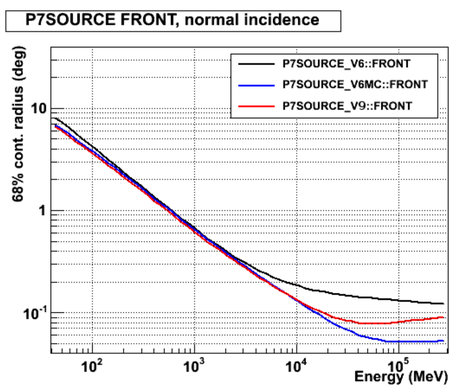


**Figure 5:** *Point spread functions for the Source event class*

## Validation and performance

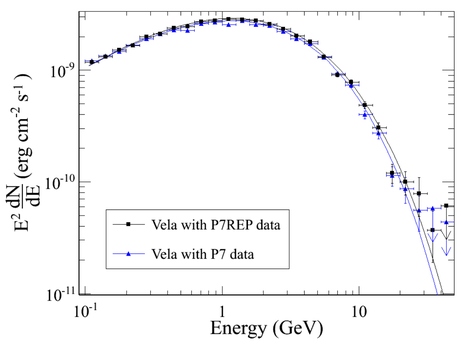


**Figure 6:** *Vela phase–averaged spectrum (Source class events, 1st year of data)*

Vela spectral analysis

- Fit with a power–law with an exponential cutoff
- Flux is only slightly higher by a few percent

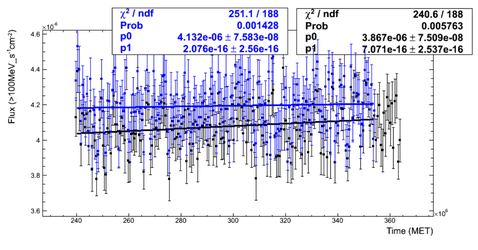


**Figure 7:** *Geminga weekly flux trending with Source class events: 'P7' (black) and 'P7_REP' (blue) data*

Geminga flux stability

- 'P7' data: the flux has a significant increasing trend
- 'P7_REP' data: the flux is stable within $\sim$1% over 4 years

$\Rightarrow$ 'P7_REP' data have reduced systematic uncertainties

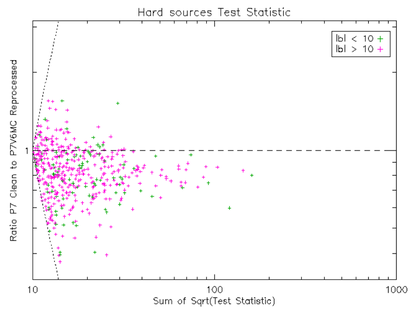


**Figure 8:** *Hard source list TS ratio 'P7'/'P7_REP', Clean class events*

Hard source list

- comprehensive (re)analysis of $\sim$ 1300 candidate sources with TS$>10$
- higher TS measured, in average the TS ratio 'P7'/'P7_REP' is 0.82

## Conclusions

- Data have been reprocessed with up–to–date calibration constants
- The main improvement is a better on–orbit PSF above few GeV
- Validation is ongoing within the collaboration and data release through the FSSC is foreseen by the end of 2012

## References

[1] Abdo, A. A. et al., *The on-orbit calibration of the Fermi Large Area Telescope*, Astropart.Phys. 32 (2009).

[2] Ackermann, M. et al., *The Fermi Large Area Telescope on Orbit: Event Classification, Instrument Response Functions, and Calibration*, ApJS, 203, 4 (2012).