## Long term variation of calorimeter energy scale.

I've made a fit of the histograms of pathlength corrected crystal energies of four biggest GCR peaks( B, C,N and O) for 5 time periods with distance ~4 month between periods (oct 2008, feb2009, jul2009, nov2009, mar2010).

The histograms with fits are shown on the following plots:





The fitting function contains for each peak a gaussian convolved with two exponential tails (the slope of left tail was fixed during fitting).

The following plot show the time evolution of peak positions for B, C, N and O peaks:





All four peaks show linear decrease with very close relative slope:

- B: 1.49+-0.05% per year
- C: 1.60+-0.04% per year
- N: 1.50+-0.06% per year
- O: 1.46+-0.03% per year

This signal decrease is probably explained by radiation damage to CsI crystals and has the value consistent with pre-launch expectations ~1% per year

I've done the proton calibration of individual crystals for the same time periods and compared the results with the initial on-orbit calibration done on June 28, 2008 and used of reconstruction so far.



The results are shown on the following plot: Each histogram shows the histogram of ratios of calibration coeffient of each crystal at some time period to its initial value on June 28, 2008.

Last plot shows the evolution of the mean value of the histograms and has the linear decrease of 1.35+-0.02% per year, consistent with the slope determined form GCR peaks.

We have to correct this calibration change by using new calibration made recently and by recalibrating the CAL every 6 month.

To correct the data already processed possible solution is to introduce energy correction to reconstructed energies linear with time.

The evolution of calibration coefficients for each individual crystal since launch was fitted by linear function, the slopes obtained from these fits for all proton calibration drift for individual crystals



crystals are shown on the following histogram:

As one can see, the spread of these slopes are very substantial and much bigger than the statistical error (~0.2%).

The time eveolution of the calibration coefficient for typical channel (tower=0, layer=0, col=0) and two channels from the "left tail" of the histogram (tower=11, layer=1, col=11 and tower=15, layer=0, col=4) are show below:



It is evident that for the crystals with big change in calibration the evolution is not linear with time.

The fact that the calibration coefficients evolve differently for different crystals and in general not linearly with time requires that we use up-to-date set of calibration coefficients for pipeline processing.