Status

GSI-CERN data, atmosperic muons:
different L(ΔE,E) functions observed for different particles.
L: light amount, ΔE: deposited energy, E: incident energy

Current calibration based on energy deposited by atmospheric muons
Leads to an overestimate of the energy of gamma-ray/electrons of about 7%.

Situation must be dealt with before launch so as to meet two requirements:
- **Energy calibration is correct for EM showers (to the largest possible extent)**
- **MC data match real ones.**

Proposal:
- **get the calibration « right » for EM showers**
- **adjust the Monte-Carlo code accordingly**

Impact on energy reconstruction, background rejection, on-orbit calibration…

Quenching factors (≡light yield ratios)

One observes: $L_\mu(\Delta E, E) = L_\pi(\Delta E, E) = L_p(\Delta E, E)$

Assuming a negligible dependence of L(ΔE,E) on E over the energy ranges considered by GLAST, one defines ($E_0 = E_{MIPS}$; ΔE_0 =11.2 MeV):

$$Q_{i/\mu}(\Delta E) = \frac{L_i(\Delta E)}{\Delta E} \frac{\Delta E_0}{L_\mu(\Delta E_0)}$$

If *L(ΔE)* is a linear function of ΔE, $Q_{i/\mu}$ is independent of *ΔE (more below)*
One has: $Q_{C/\mu}$ =1.23, $Q_{He/\mu}$ =1.09, $Q_{e/\mu}$ = $Q_{\gamma/\mu}$~1.07

for the energy ranges explored in the different experiments performed.
No understanding of these values (even on a qualitative basis).

If $Q_{e/\mu}$ is not constant as a function of energy, this effect is *only* due to either:
- **discrepancy between MC and data for electrons;**
- **non-linearity of the calorimeter response.**

New scheme

In the current scheme, the measured energy is:

$$E^{meas}_{\gamma,e} = Q_{e/\mu} \times E^{true}_{\gamma,e}$$

and doesn't match the predicted (« true ») energy. That's not acceptable.

« Minimal » modified scheme

1) Rescale the calibration coefficients by:

$$1/Q_{e/\mu} = Q_{\mu/e}$$

The relevant correction factors are now: $Q_{i/e}(=Q_{i/\mu} \times Q_{\mu/e})$

The MIP Landau distribution now peaks at: $Q_{\mu/e} \times \Delta E_0$

Is that a problem? No, if one realizes that the parameter is not « deposited energy », but « apparent deposited energy » (which is what the CAL measures). The unit is MeVee (« MeV equivalent electron ») , commonly used in scintillator technic.

Handling of Monte-Carlo code

2) Modify the Monte-Carlo code in the « digi » stage.
Currently the MC energy is divided by « MeV/DAC » in the « digi » stage, then is multiplied back by the same factor in the « recon » stage to retrieve the true energy.

One needs to multiply the deposited energy by $Q_{i/e}$ in the « digi » stage to get agreement between MC data and real ones.

Complication arises when dealing with nuclear reactions (several particles involved). Single $Q_{i/e}$ or one per particle? I lend toward using a single one.

The on-orbit calibration with protons, HI, will be relative to the initial (pre-launch) calibration, so no action is necessary (although we might want to do it anyway) to correct the apparent deposited energy for quenching effects, once the particle nature is clearly identified .