A new profile fitting above 5 GeV

- Principles
- Shower Parameterization
- Shower Development description
- Results

Principles

- Because of the cracks between the towers and the limited size (in x,y,z) of the calorimeter, the deposited energies in the layers depend strongly on the trajectory of the incoming gamma;
- The profile fit should convolute :
  - the parameterization of the shower profile
  - the history of the trajectory in X0 units (i.e. what material has the particle seen)
- Letting the parameters of the profile completely free should allow us to get the best resolution...
- ... but because of the limited size of the calorimeter, the showers are not always fully contained. It implies that the parameters should be constrained during the fit.

The shower parameterization

- 3 parameters : α (shape parameter),T (depth of the maximum),E (energy)
- use $(\beta t)^{\alpha-1}\beta \exp(-\beta t)/\Gamma(\alpha)$ with $\beta = (\alpha - 1)/T$

How to constrain α and T ?

- add a term to the χ^2 (with a chosen weight W):
- $\chi^2 = \sum_{layers}[(e_{dat} - e_{fit})/\delta e_{fit}]^2 + W \times f(\alpha, T, E)$

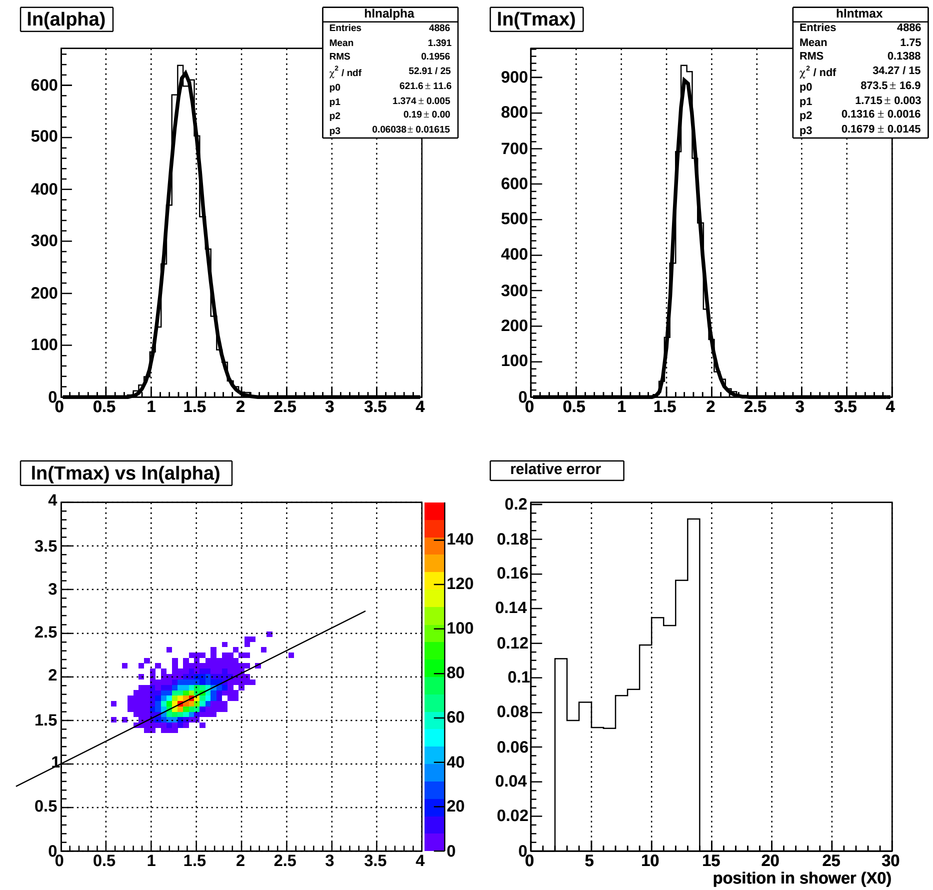
$$f(\alpha, T, E) = \left(\frac{\ln(\alpha) - \overline{\ln(\alpha)}}{\sigma(\ln(\alpha))}\right)^2 + \left(\frac{\ln(T) - \overline{\ln(T)}}{\sigma(\ln(T))}\right)^2$$

$$-2 * \rho \left(\frac{\ln(\alpha) - \overline{\ln(\alpha)}}{\sigma(\ln(\alpha))}\right)\left(\frac{\ln(T) - \overline{\ln(T)}}{\sigma(\ln(T))}\right) / (1 - \rho^2)$$

- Where $\overline{\ln(\alpha)}, \sigma(\ln(\alpha)), \ldots$ are functions of E

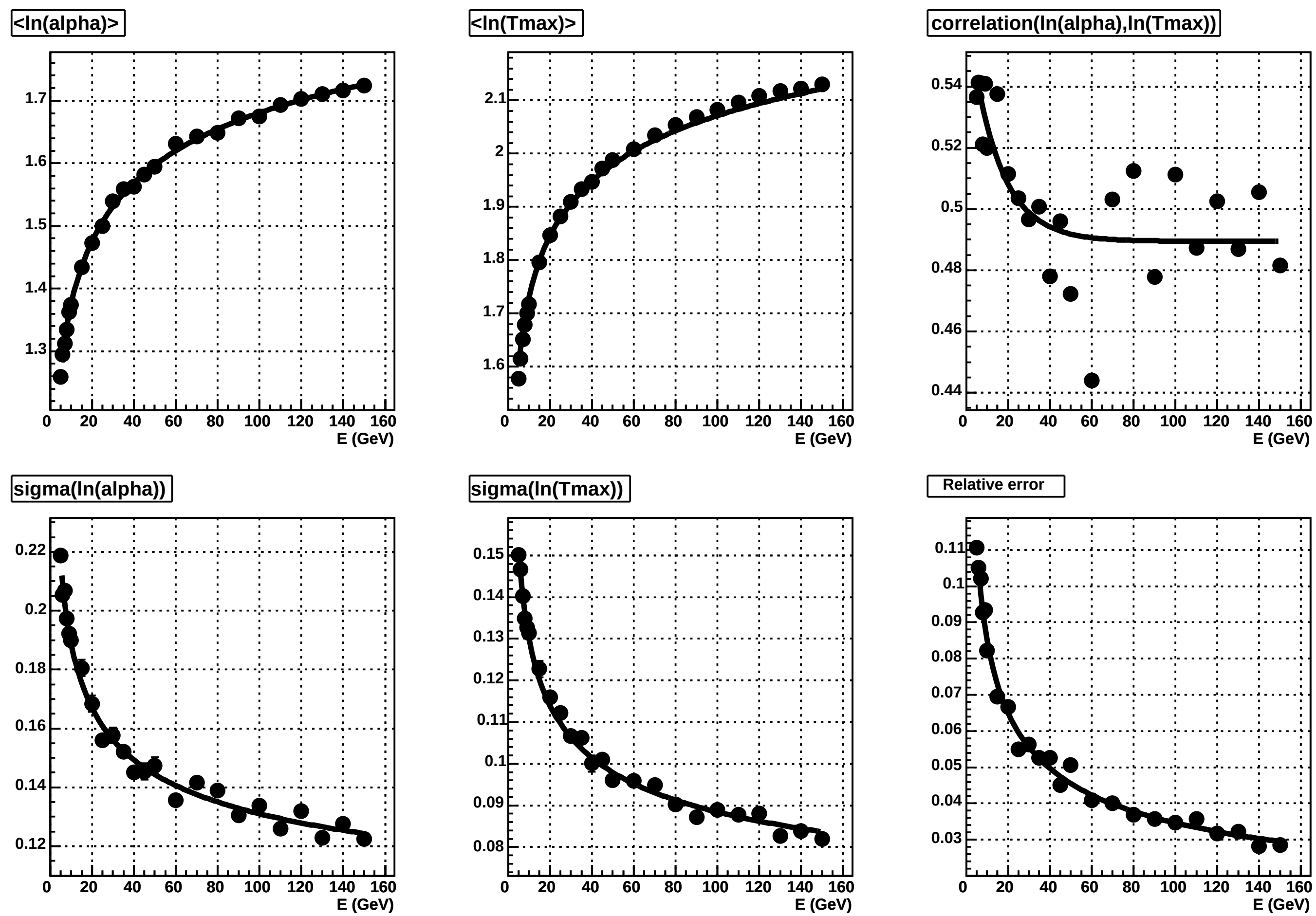
Parameterization of the parameters

- with Geant4 : an ∼ infinite CsI calorimeter made of 0.1 X0 slices
- the conversion point gives the start of the shower (as the vertex in GLAST)
- the residuals give the error of the model



Parameterization of the parameters

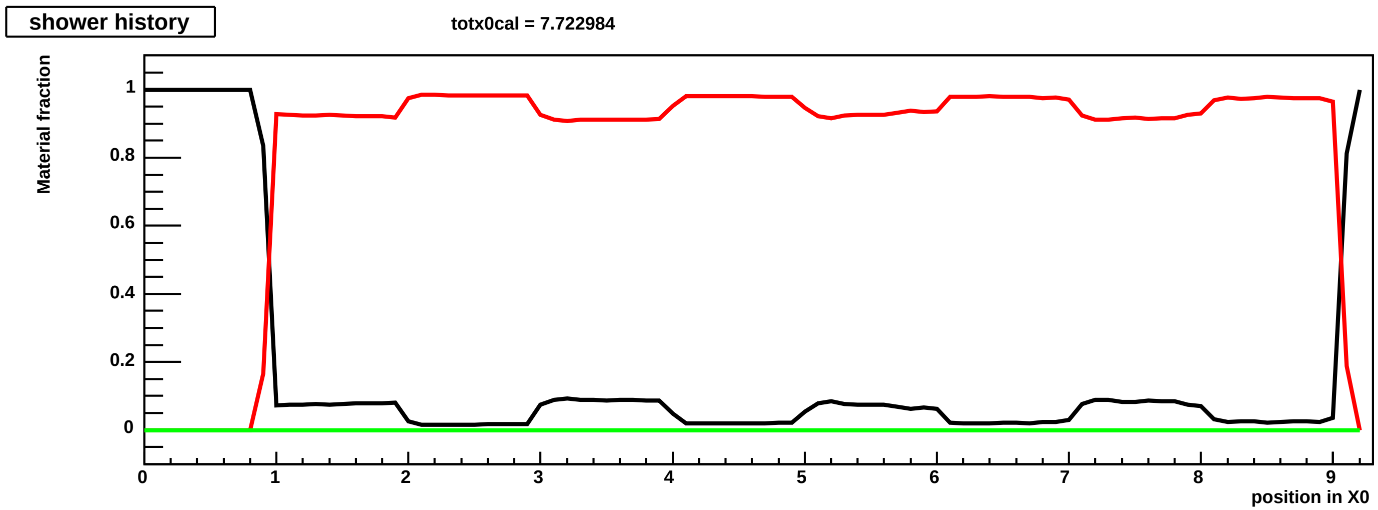
with G. Grindhammer and S. Peters parameterization functions

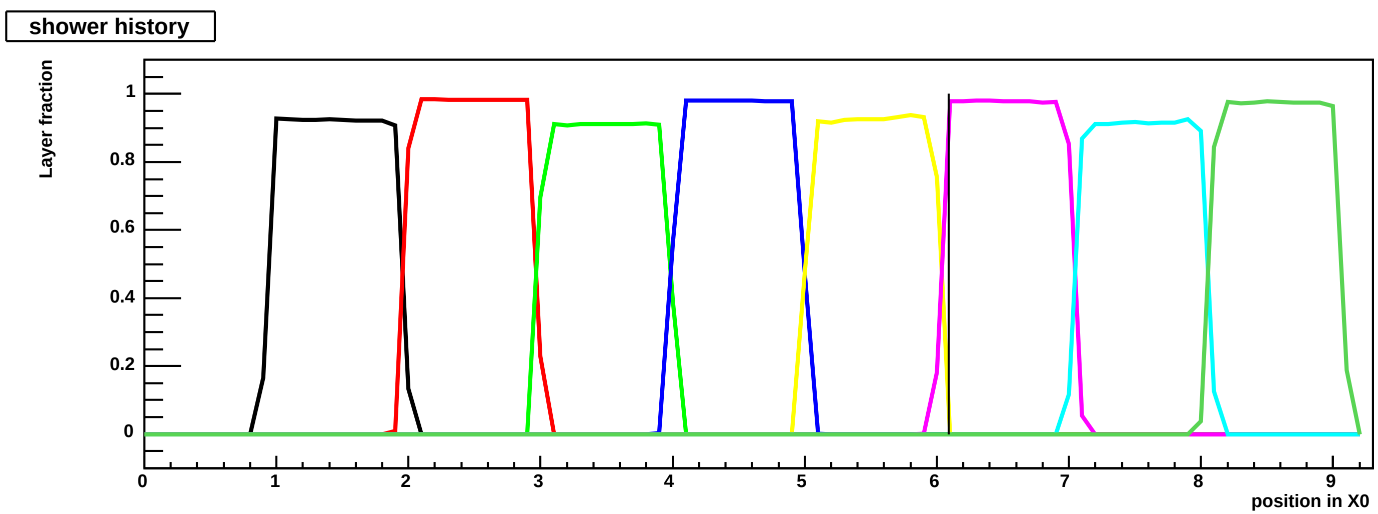


The development of the shower

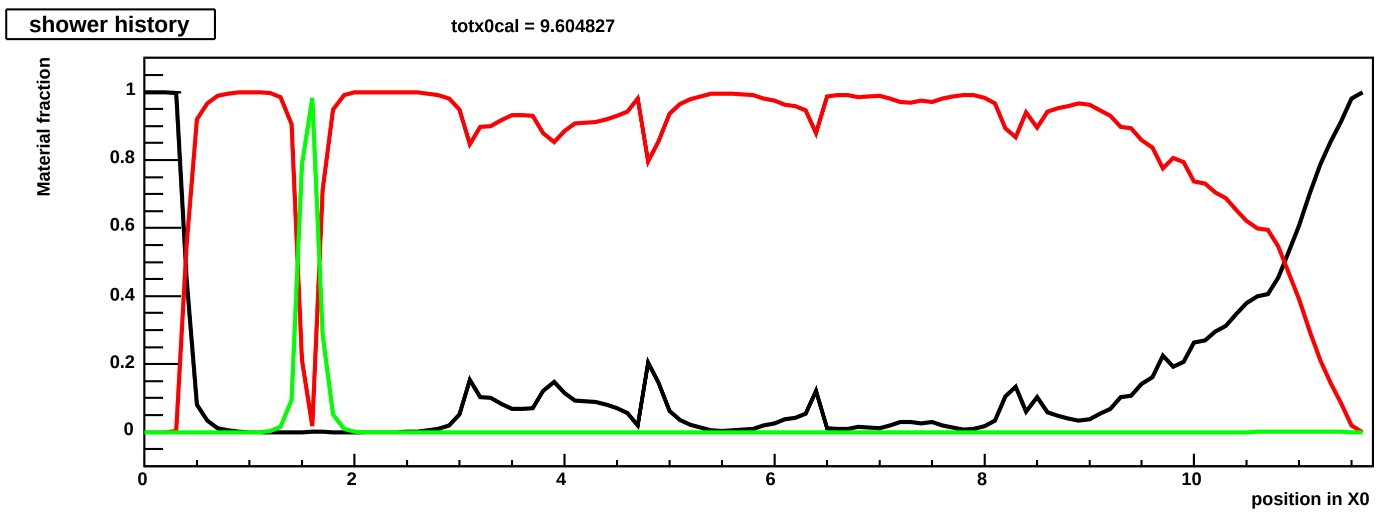
- This is computed with a propagator using the radial density function
- which depends on the relative position in the shower (t/T)
- (three parameters : $R_{core}, R_{tail}, p_{core}$)
- We propagate along the trajectory in millimeters steps
- determining the material fractions seen by the shower (void, cracks, CsI) and the fraction of the energy deposited in each layer

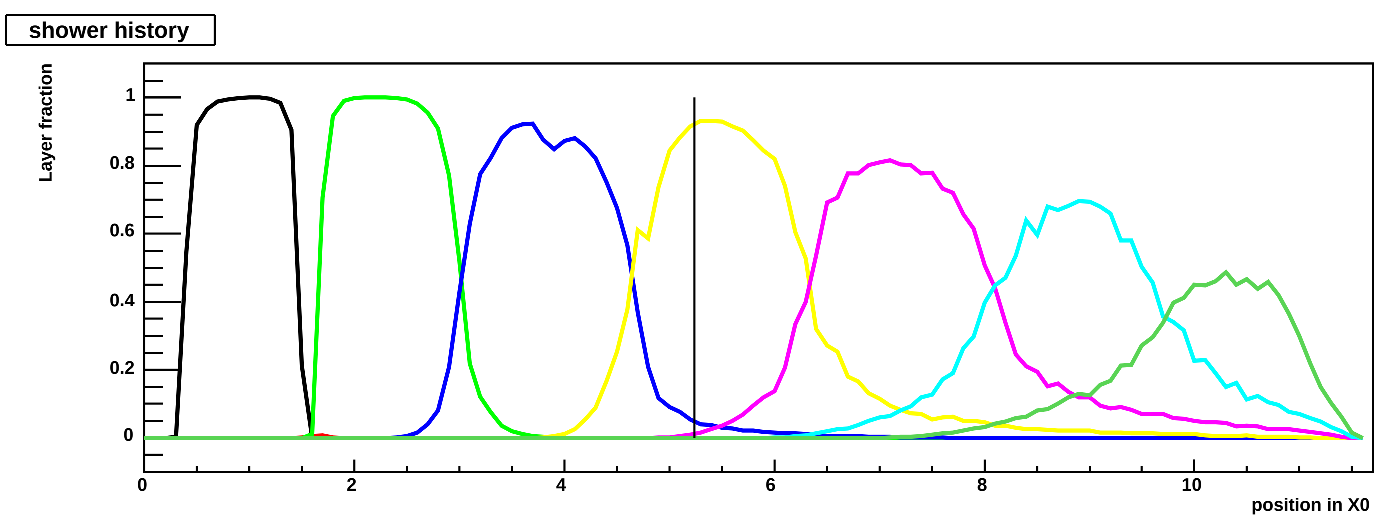
An event at 0 degrees





An event at 50 degrees



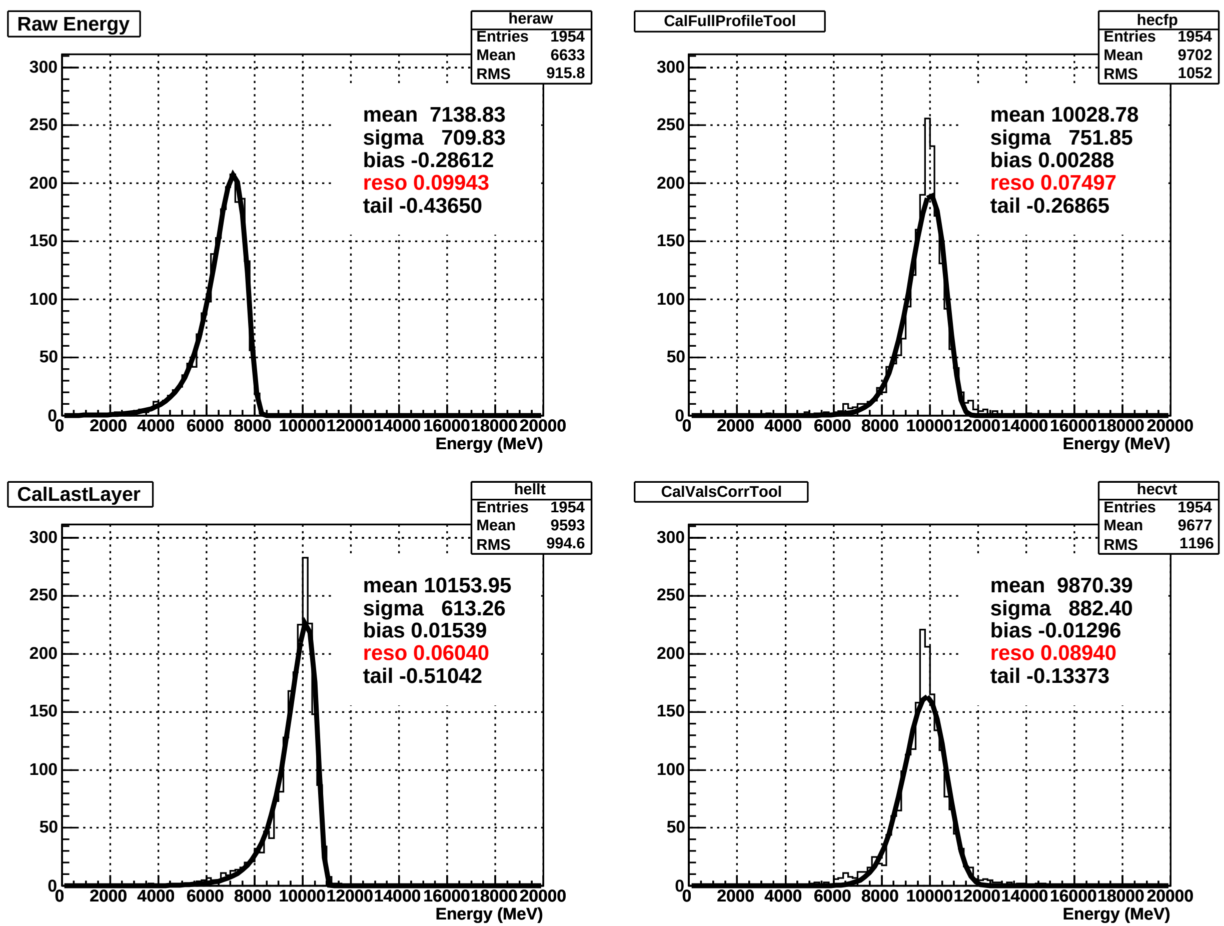


What's done during the fit

- use E to retrieve $\overline{\ln(\alpha)}, \sigma(\ln(\alpha)), \ldots$
- use T to describe the shower development
- compute the deposited energy in each layer
- use E to determine the model error and thus δe_{fit}
- compute the standard χ^2 and add the contribution due to the constraint on the parameters

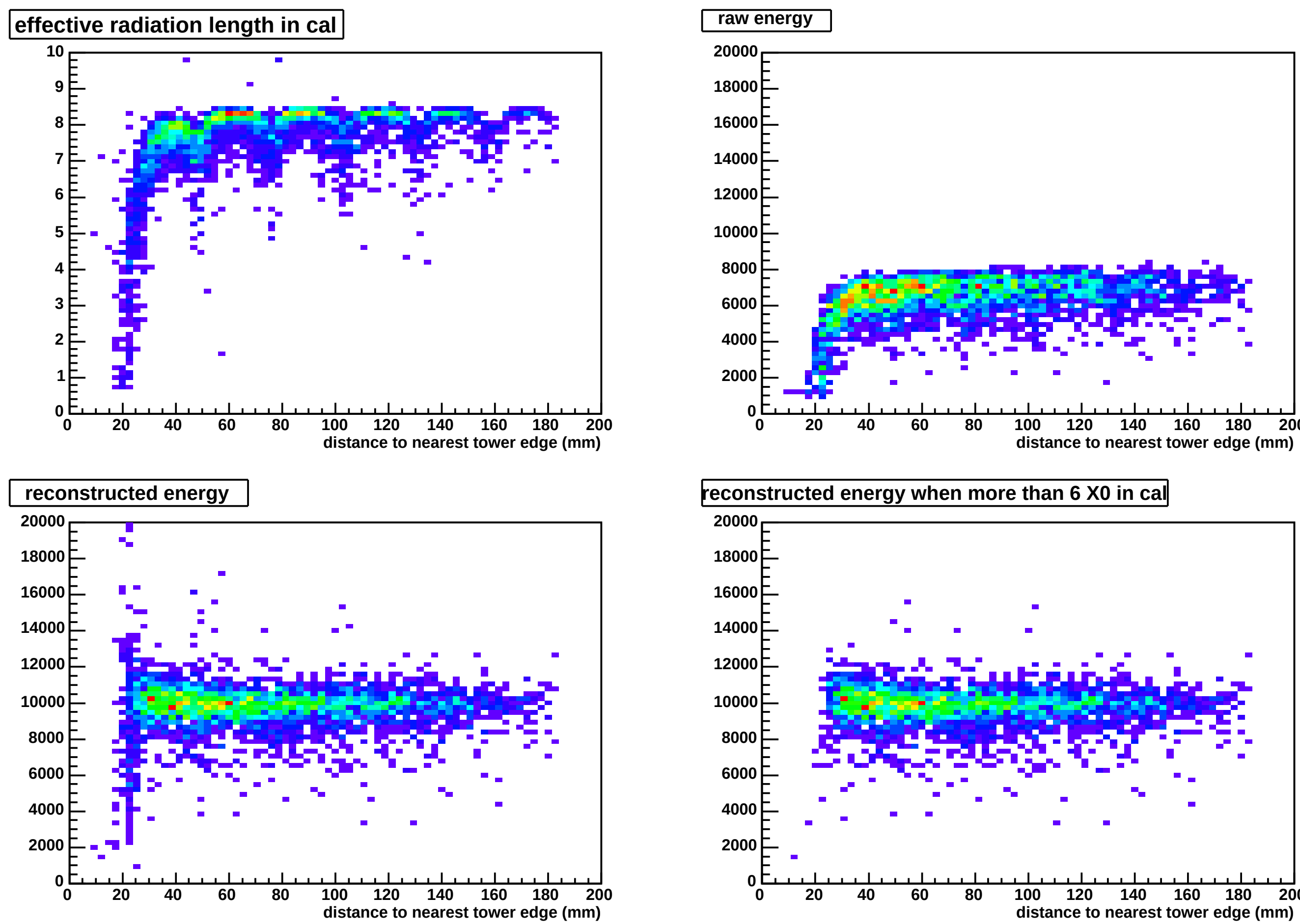
Results

10 GeV gammas on axis. events with tracker information and 60 mm away from tower edges



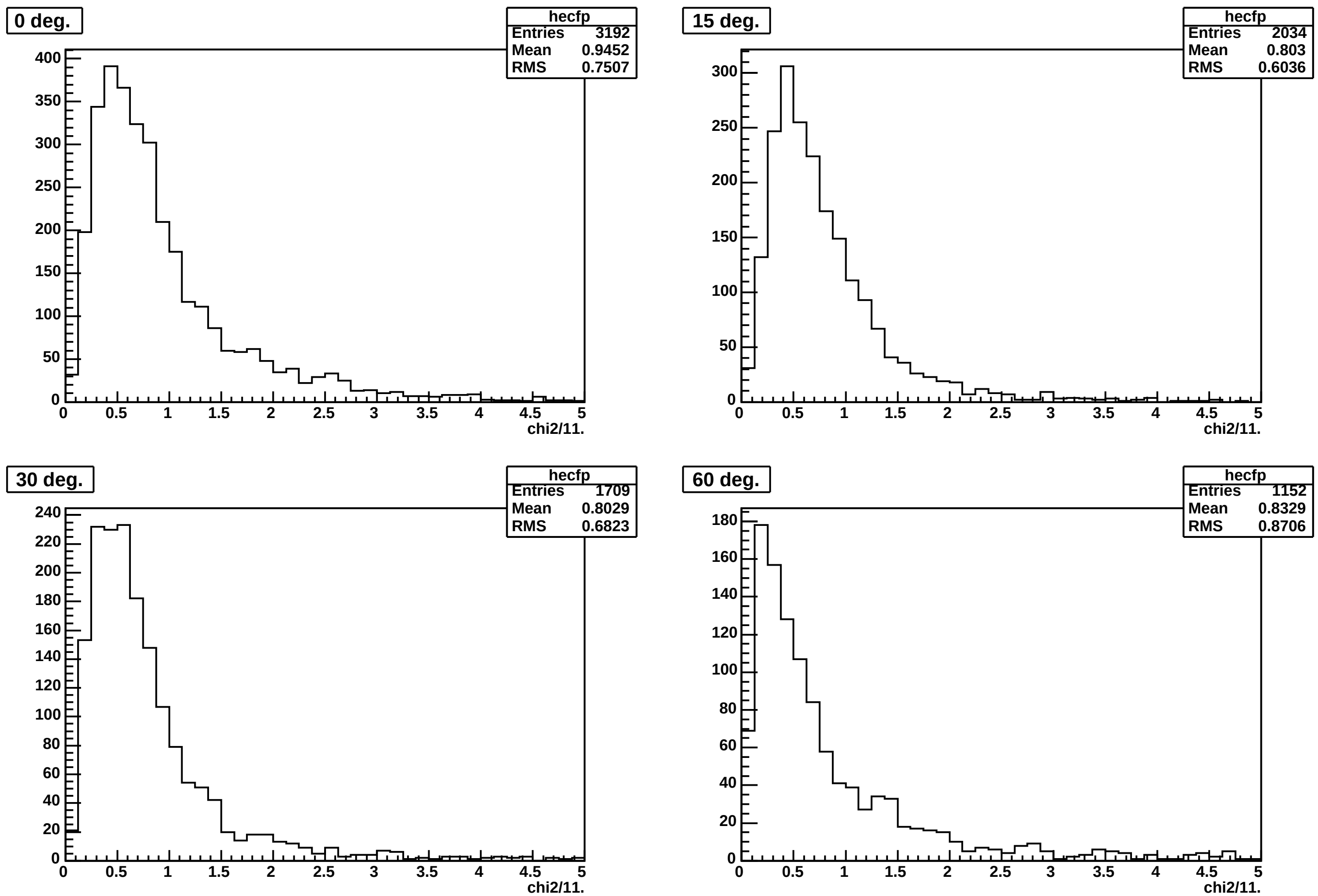
Near tower edges (10 GeV, on axis)

For events with tracker information



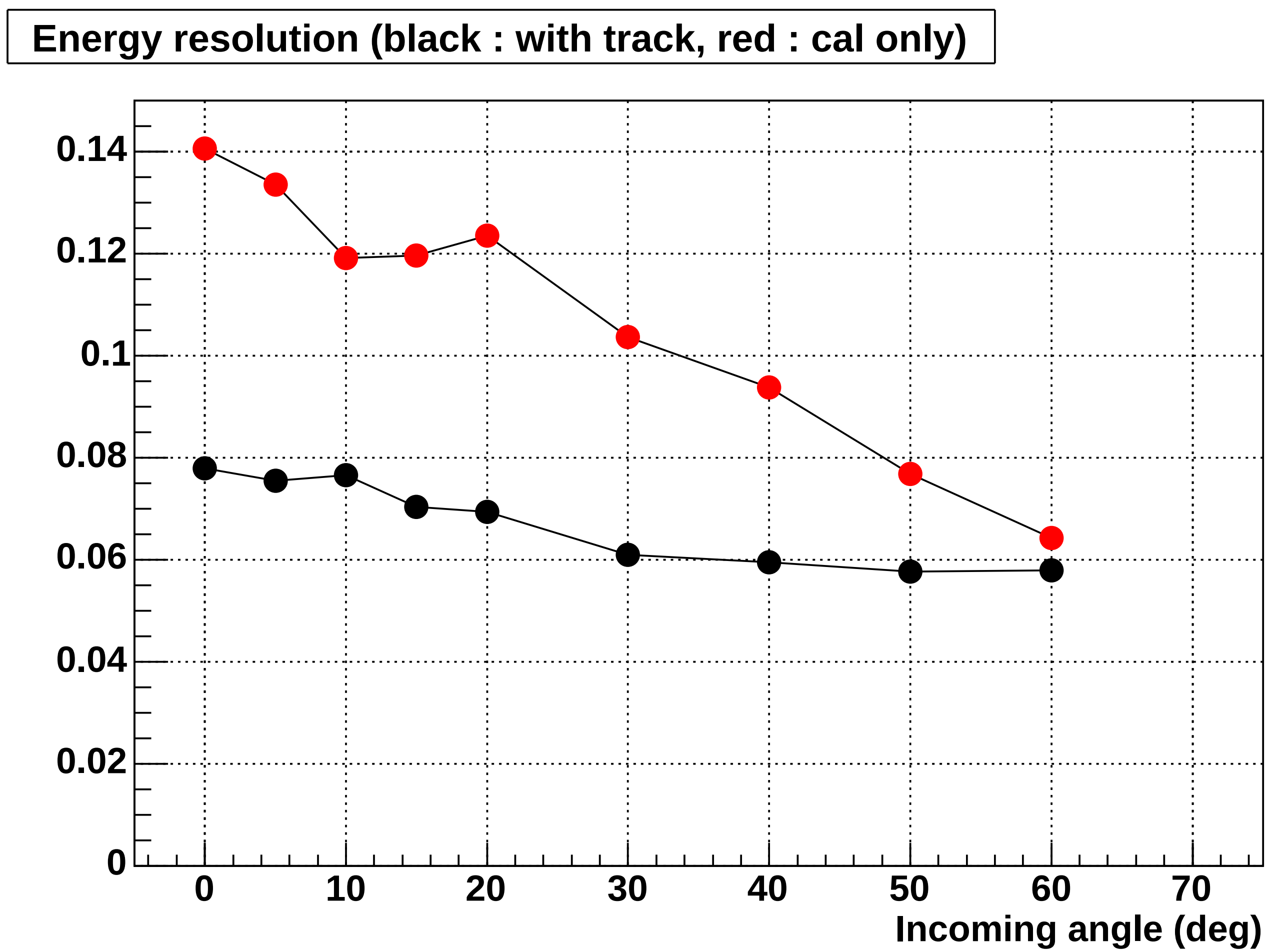
chi2

$\chi^2/11$ is a good rejection variable (especially for cal only events where the direction information is bad)



Resolution (10 GeV)

above 50 degrees for tracker events, taking into account the widening of the shower will improve the resolution



Other results

- With tracker :
- 50 GeV : 9.5% (0 deg), 8.2% (30 deg), 5% (60 deg)
- 100 GeV : 11% (0 deg), 9.5% (30 deg), 6% (60 deg)
- Constraining the parameters during the fit $\longrightarrow$ no high energy tail

Status

- a beta version of CalFullProfileTool is in CVS
- a alpha version in CVS today
- results can be retrieved as a Event::CalCorToolResult
- CPU intensive method
- Cal only direction reconstruction included soon