Some thoughts about the Rotation Method

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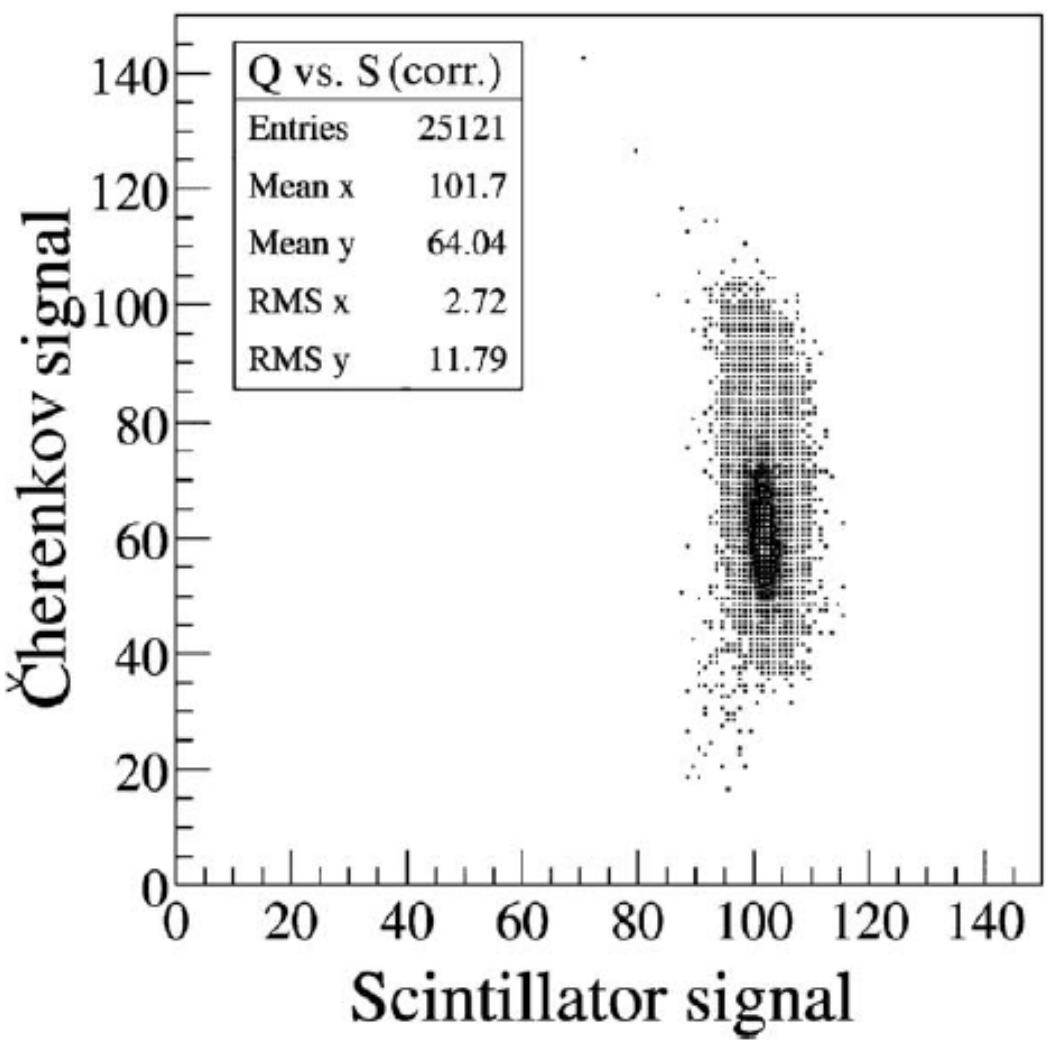

Fig. 15. Cherenkov signals versus scintillator signals for 100 GeV π^- in the DREAM calorimeter, after the correction given in Eq. 4 has been applied.

$$\left(\frac{S}{E}\right)_{\text{corr}} = \left(\frac{S}{E}\right)_{\text{meas}} + 0.453\left[1.9 - \frac{Q+S}{E}\right] \quad (4)$$

The rotation method is almost equivalent to the (Q+S)/E method where one makes use of the knowledge of the exact beam energy

Rotation method

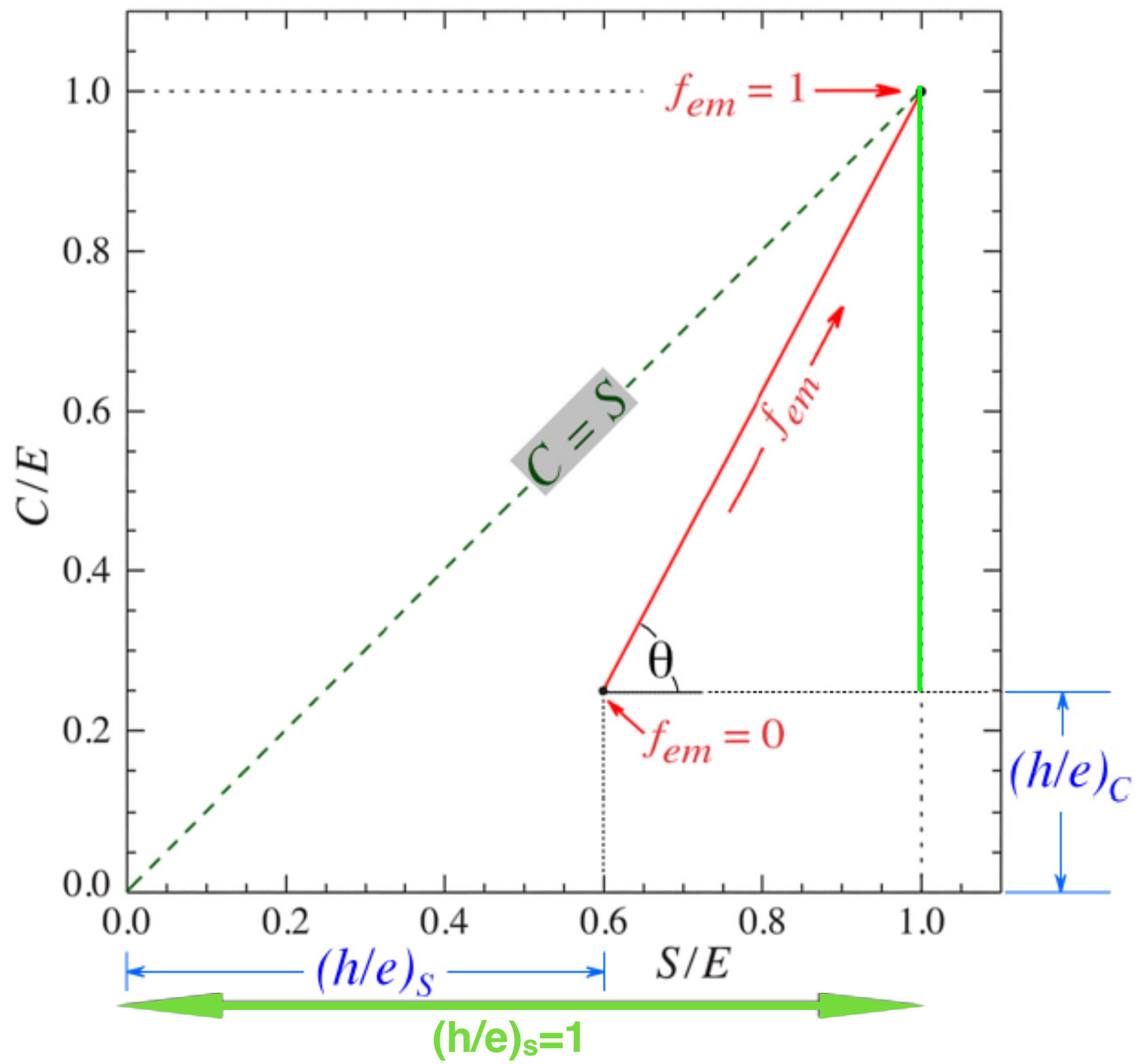

FIG. 7: Graphic representation of Equations 8. The data points for hadron showers detected with a dual-readout calorimeter are located on the straight red line in this diagram. The data points for em showers in this calorimeter are clustered around the point where this line intersects the $C = S$ line, *i.e.*, the point (1,1). See text for further details.

The rotation method is almost equivalent to having a S calorimeter compensating (e/h=1) which is in turn equivalent to get a good measurement of the particle energy by the S calorimeter

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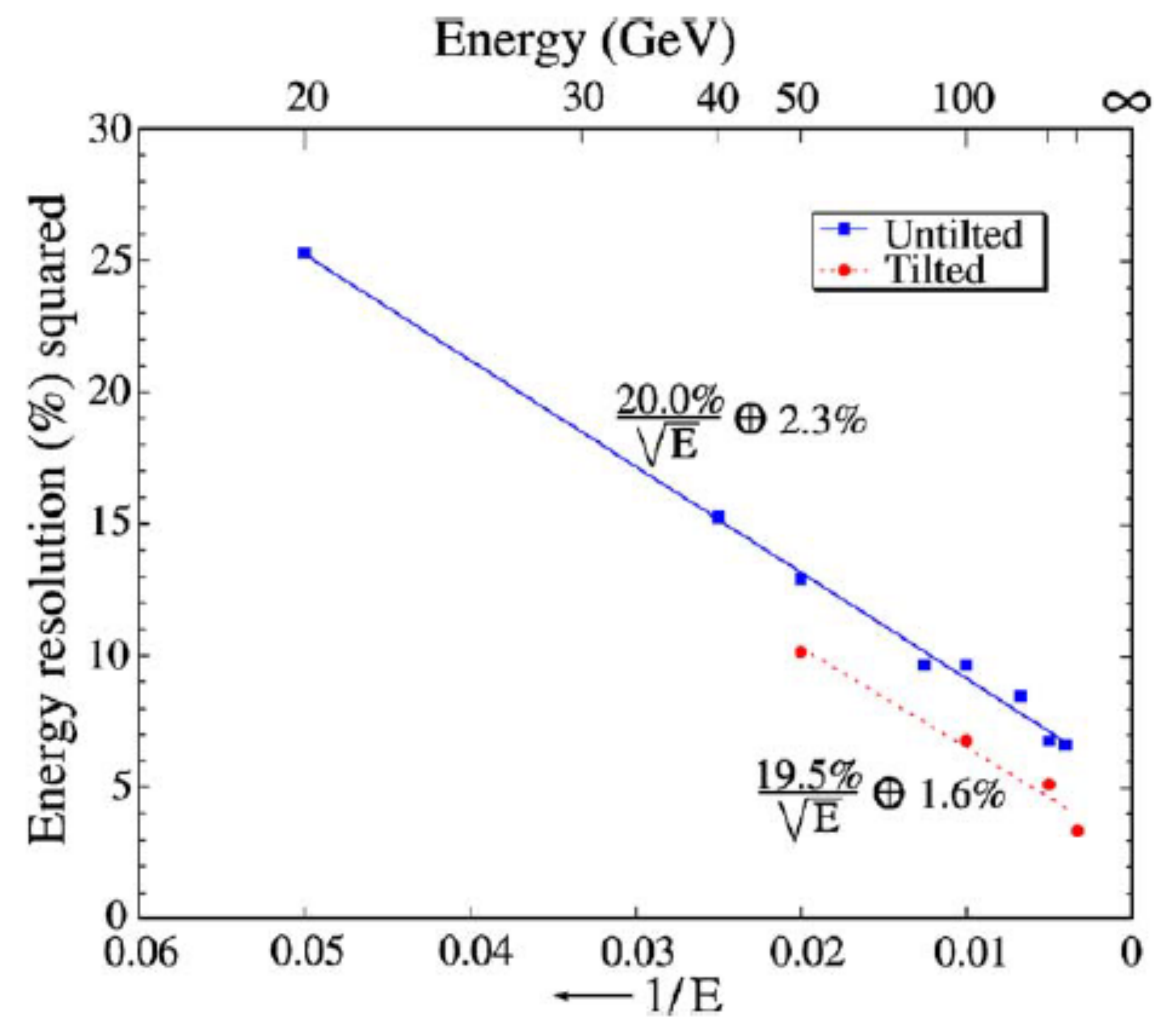

Fig. 17. The squared energy resolution $(\sigma/E)^2$ as a function of the pion energy, after the correction described in Eq. (4) was applied to the scintillator signals. Results are given for the DREAM calorimeter oriented in the "tilted" and "untilted" positions.

$$\left(\frac{S}{E}\right)_{\text{corr}} = \left(\frac{S}{E}\right)_{\text{meas}} + 0.453\left[1.9 - \frac{Q+S}{E}\right] \qquad (4)$$

The (Q+S)/E method brings the resolution of the "old" Cu DREAM calorimeter to 20%/√E

Rotation method

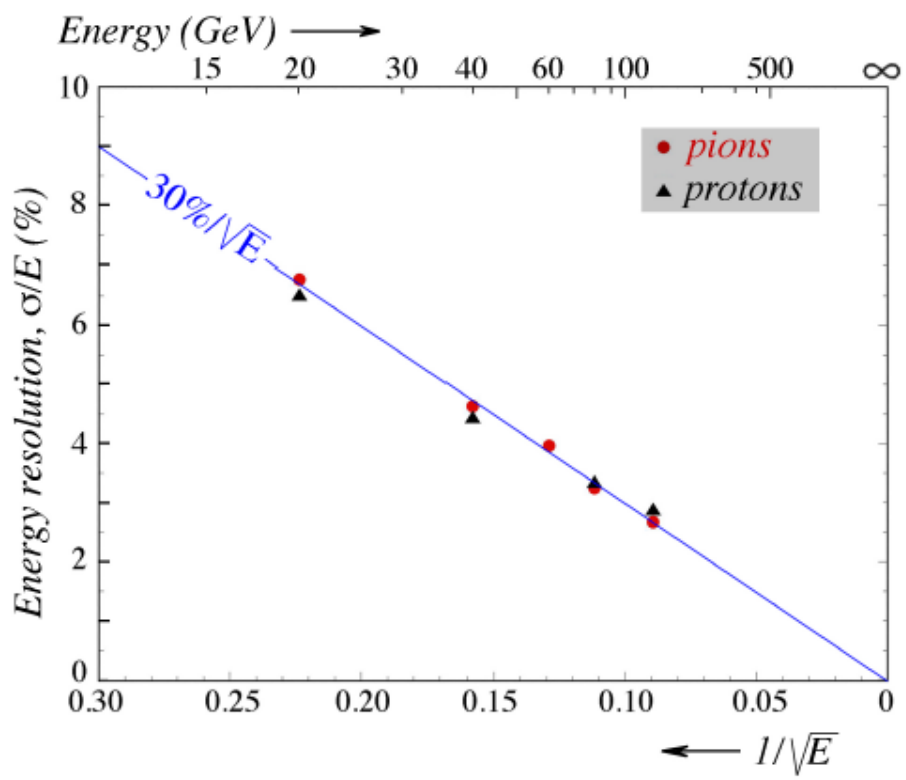

Fig. 18. The fractional width of the signal distribution, σ/E, as a function of energy, for pions and protons in the 20 - 125 GeV energy range. The line represents $\sigma/E = 30\%/\sqrt{E}$.

The resolution obtained by the rotation method with the Pb module is 30%/√E. This calorimeter has a higher sampling fraction and a better sampling frequency that the “old”, therefore one would expect a better resolution than the one obtained by the (Q+S)/E method

Rotation method

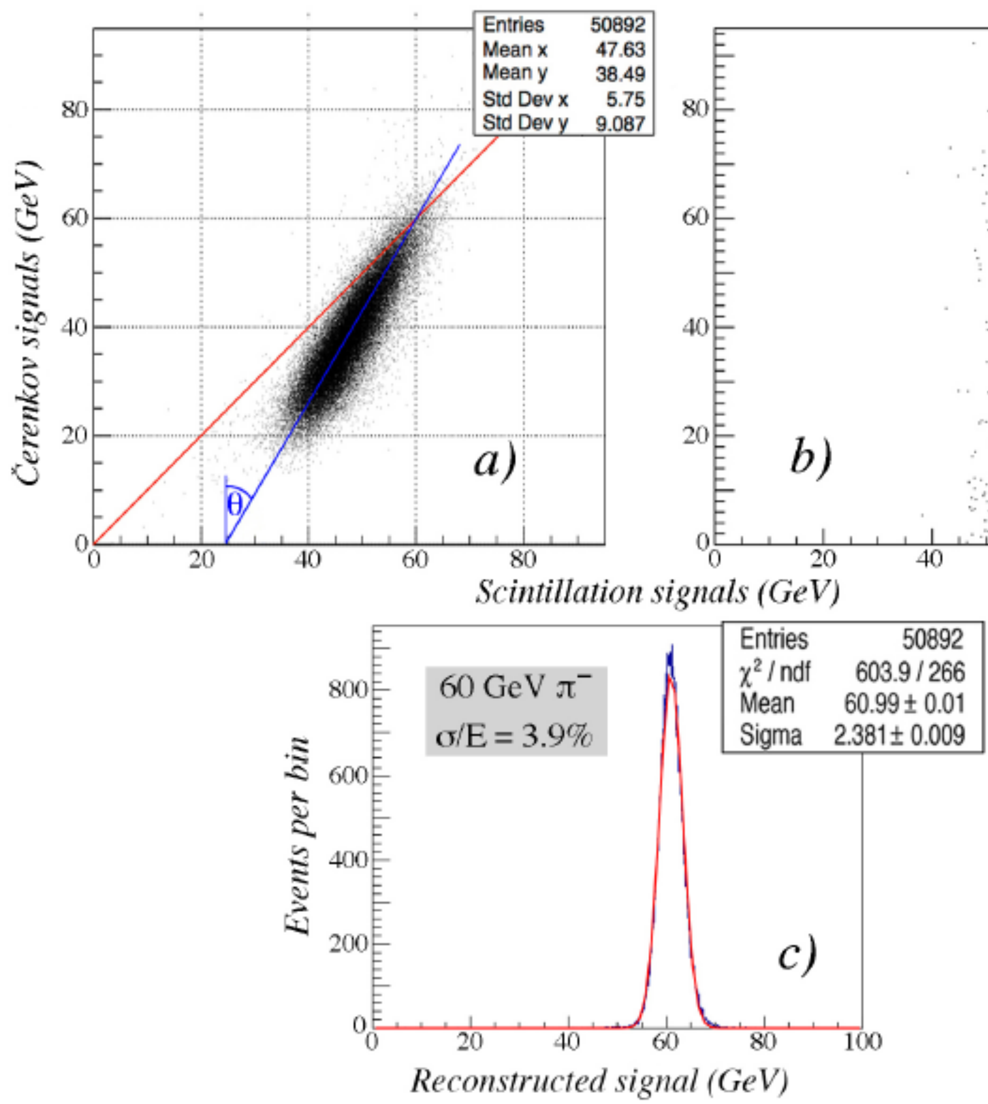

Fig. 14. Signal distributions of the RD52 Dual-Readout lead/fiber calorimeter for 60 GeV pions. Scatter plot of the two types of signals as recorded for these particles (a) and rotated over an angle $\theta = 30°$ around the point where the two lines from diagram a intersect (b). Projection of the latter scatter plot on the x-axis (c).

$$\begin{pmatrix} S' \\ C' \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} S \\ C \end{pmatrix}$$

But the rotation method is slightly different from the (Q+S)/E method because the latter uses the real beam energy to correct event by event, meaning that there is no experimental error in the correction factor.
In the rotation method the pivot point is determined by the data and therefore is affected by a measurement error. This, to my mind causes the difference in resolution

Some personal conclusions

- I am convinced that the use of the rotation method is correct. Again the knowledge the beam energy is not used.
- In a way it is a sort of “magic” that gets, at least partially, rid of the leakage fluctuations, improving the resolution.
- Very likely the use of a full containment calorimeter will reduce, if not cancel its beneficial effects
- I think we should look into this more carefully and see if it is worth to prepare a short letter to NIM on this topic.