Laboratoire d'Annecy-le-Vieux
de Physique des Particules

Study of the DHCAL semi-digital readout (first look)

Jan BLAHA

Micromegas Physics Meeting, 6 Avril 2010, LAPP

UNIVERSITE CHAMBERY SAVOIE

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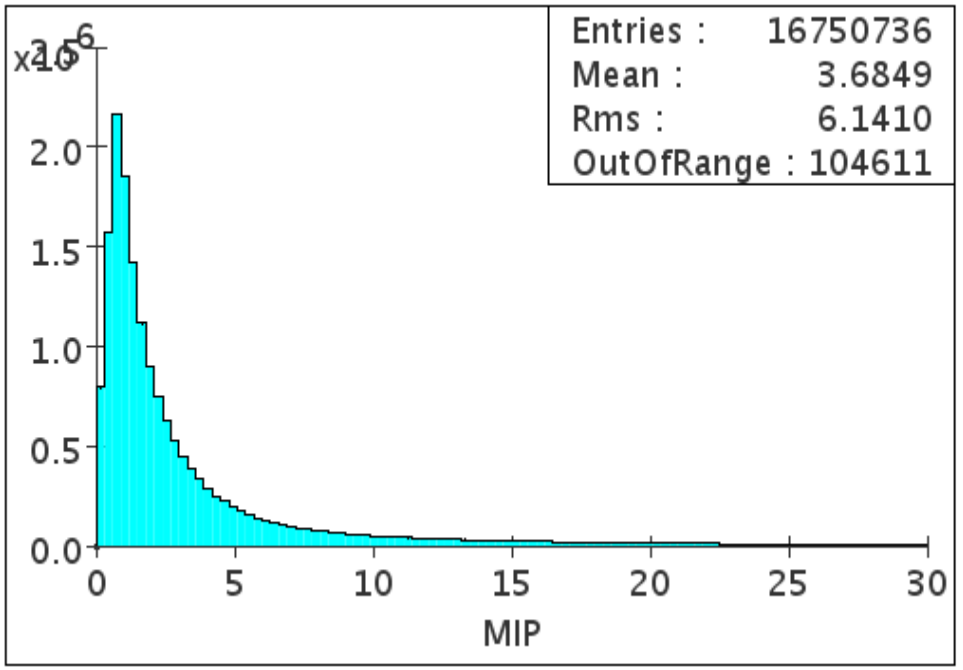
In2p

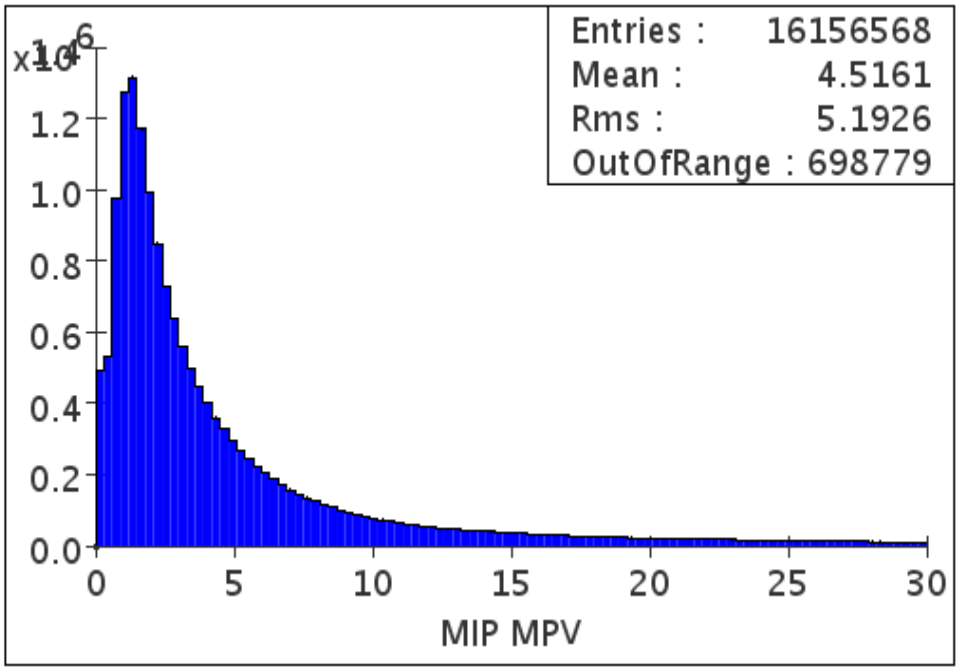
Objective

To find the optimal parameters for DHCAL semi-digital readout that will improve energy resolution for higher energies

Study of properties of semi-digital readout and find a way how to get the best performance

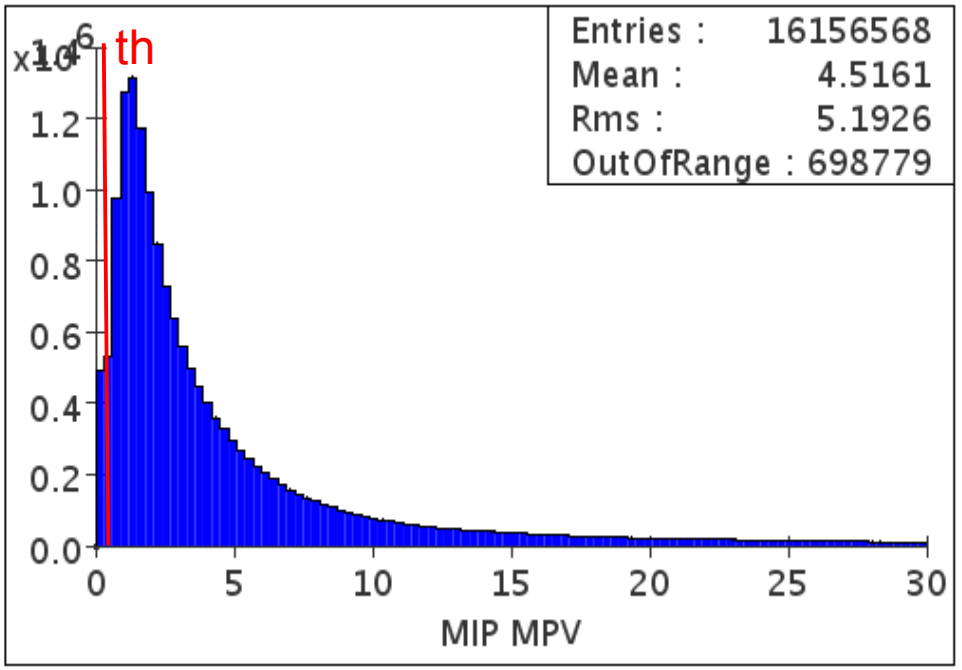
Energy deposited in one cell





MIP: 0.71E-6 GeV
MIP MPV: 0.43E-6 GeV
Values are determined for 450 GeV muons and used here as MIP and MIP MPV units, respectively

Digital readout

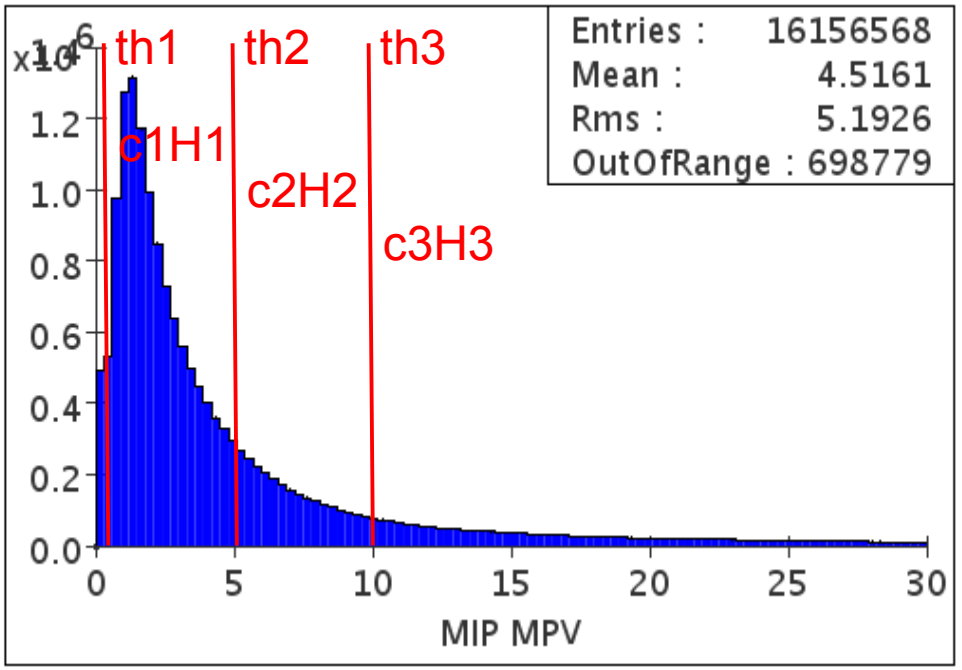


Energy in calorimeter:

$$E_{rec} = c\,H$$

$$H = \sum_i h_i, \quad for\ E_{dep} > th$$

Semi-digital readout

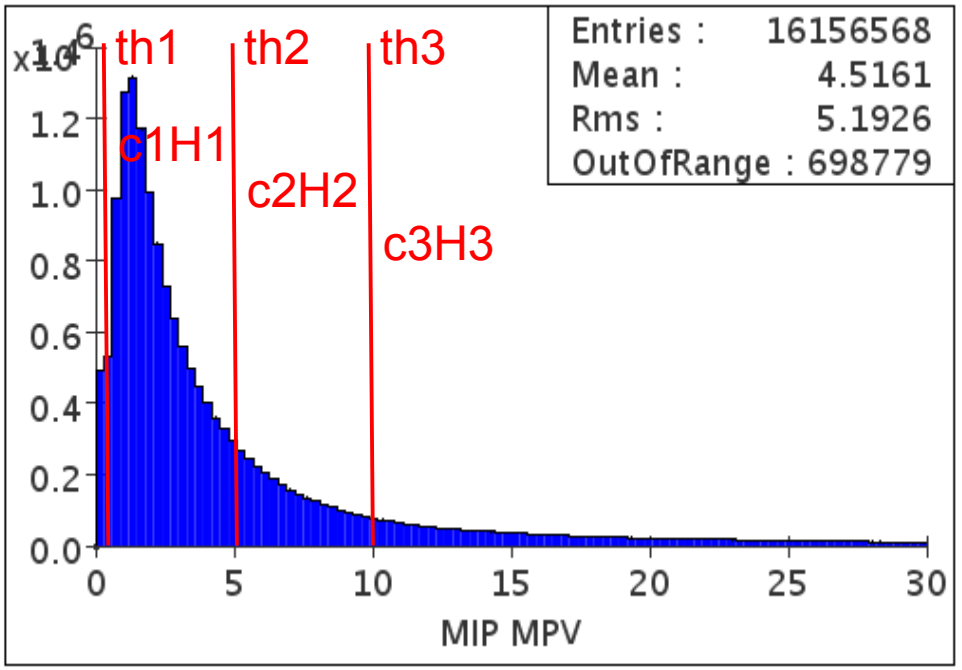


Energy in calorimeter:

$$E_{rec} = \sum_i c_i H_i \qquad H_i = \sum_j h_j, \quad for \quad \begin{array}{ll} i=1 & th_1 < E_{dep} \le th_2 \\ i=2 & th_2 < E_{dep} \le th_3 \\ i=3 & th_3 < E_{dep} \end{array}$$

What is the optimal values of thresholds and corresponding weights?

Semi-digital readout



Simplified case with fixed thresholds (MIP MPV):
th1 = 0.5, th2 = 5, th3 = 10

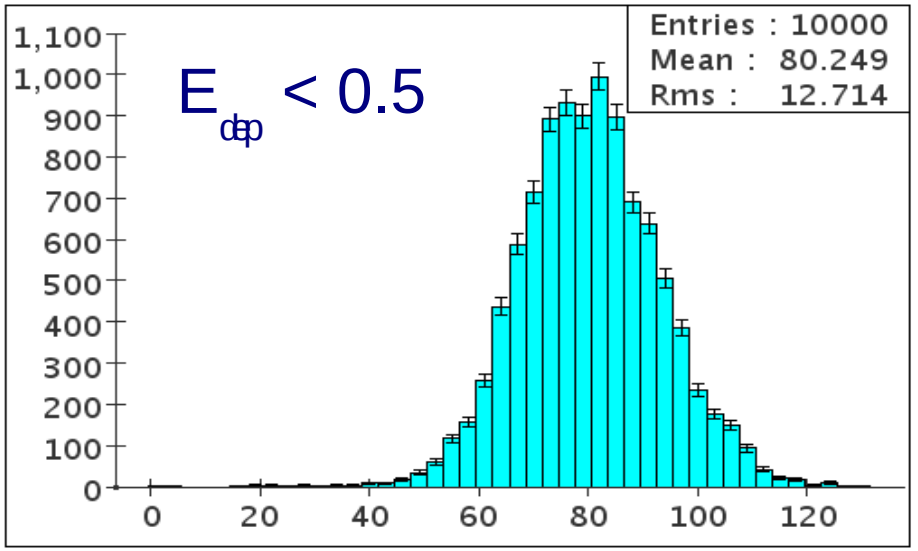
Optimal weighs → ch2 min.:

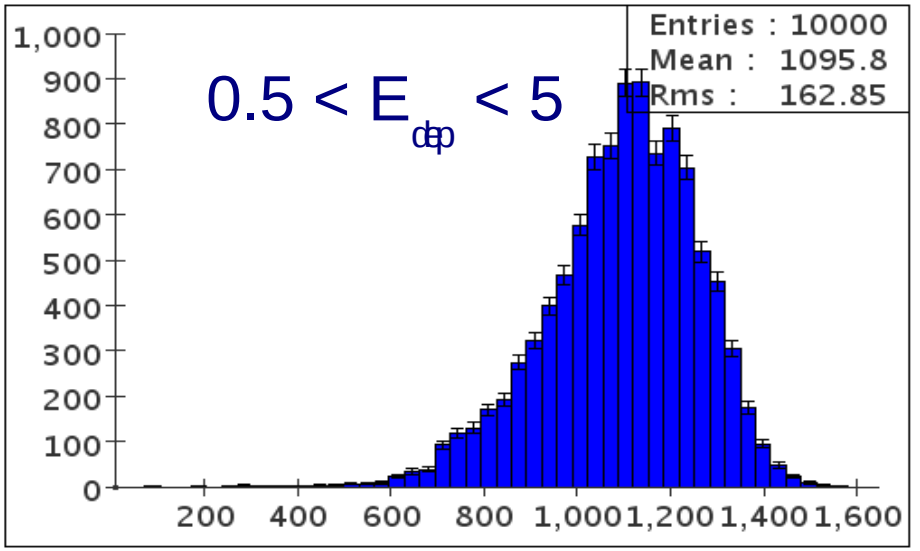
$$E_{rec} = \sum_{j}^{3} c_j H_j, \quad \sigma \approx \frac{1}{\sqrt{E_{true}}}$$

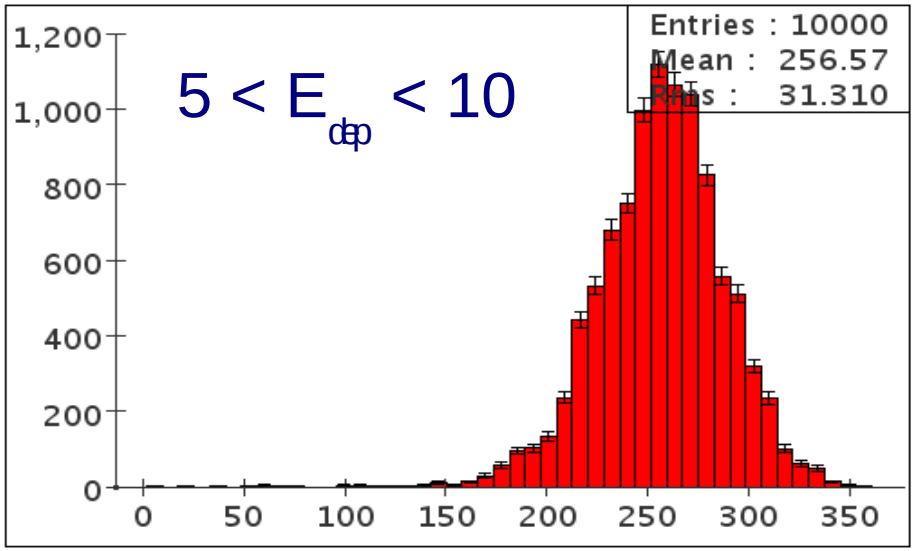
$$\chi^2 = \frac{1}{N} \sum_{i=1}^{N} \frac{\left[\sum_{j}^{3} c_j H_j - E_{true} \right]^2}{\sigma^2}$$

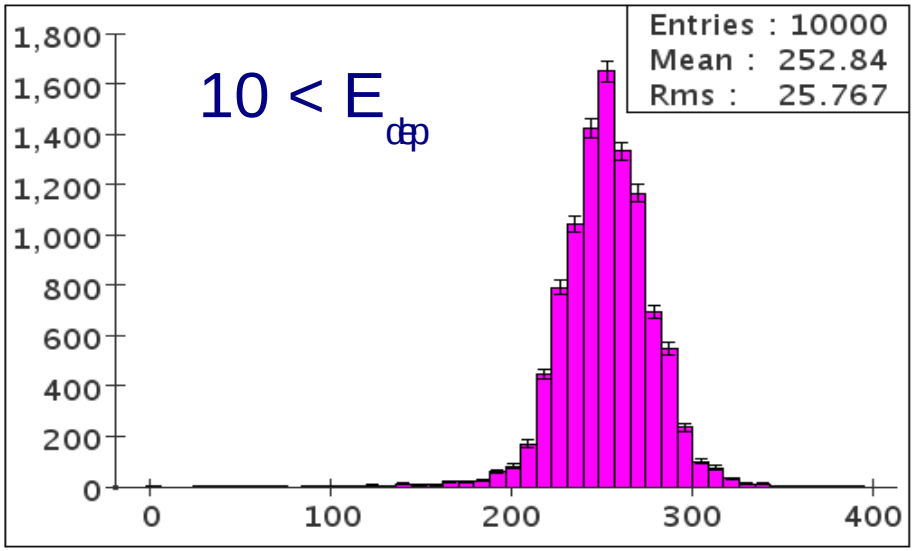
Nb of hits for different th. regions

200 GeV pions, thresholds: th1 = 0.5, th2 = 5, th3 = 10



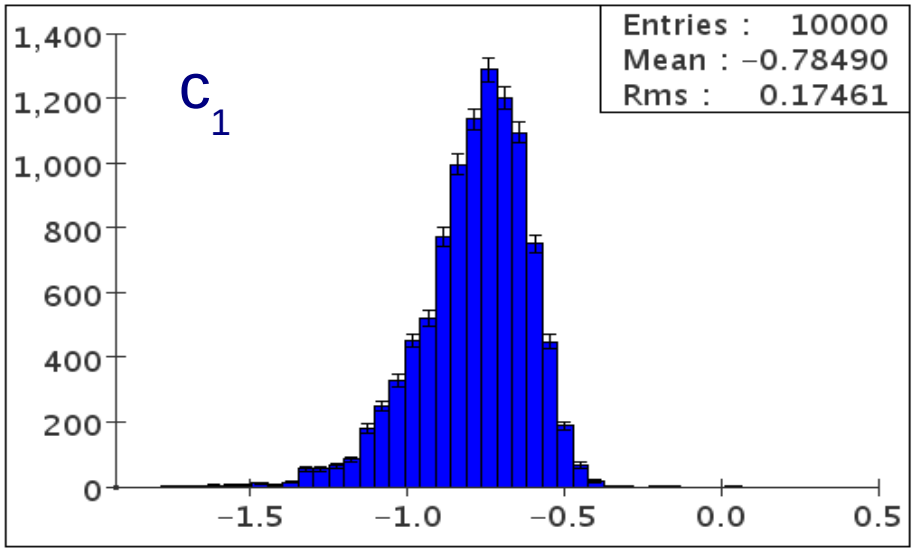


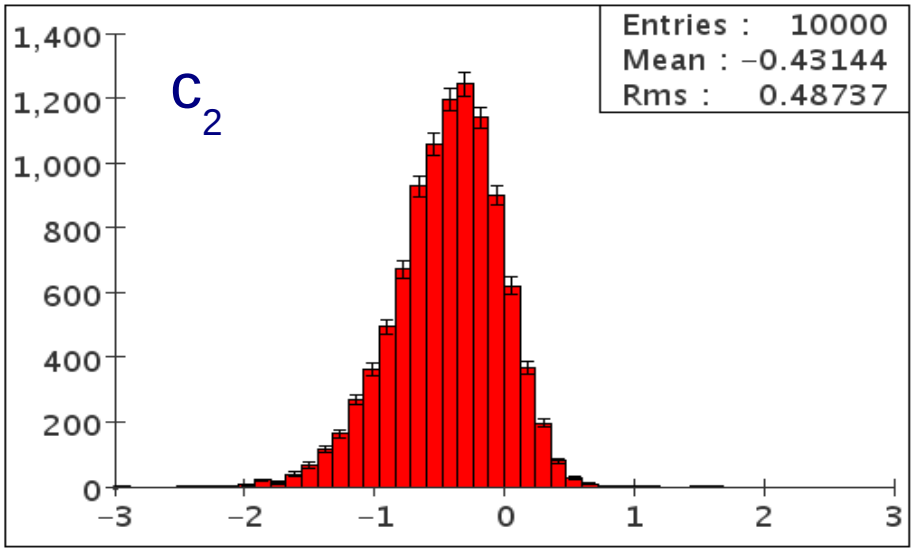


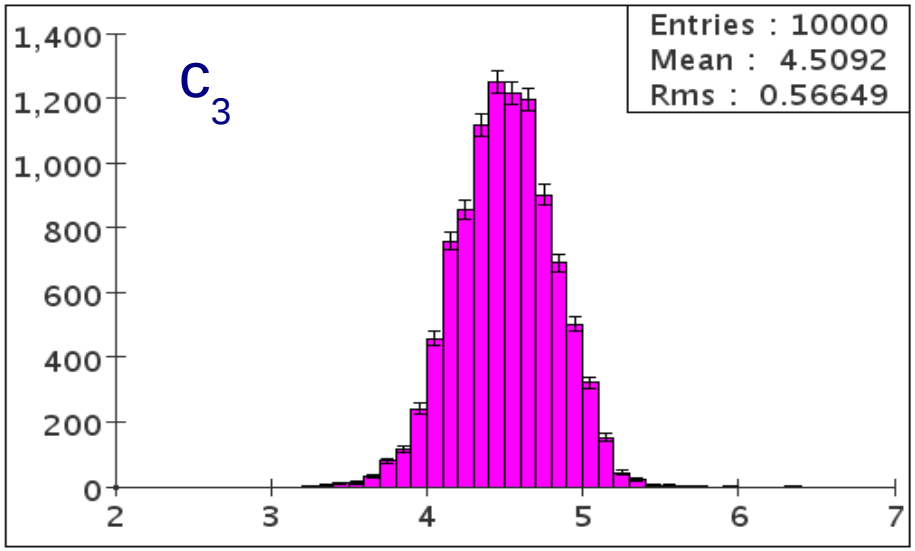


Optimal weights

200 GeV pions, thresholds: th1 = 0.5, th2 = 5, th3 = 10



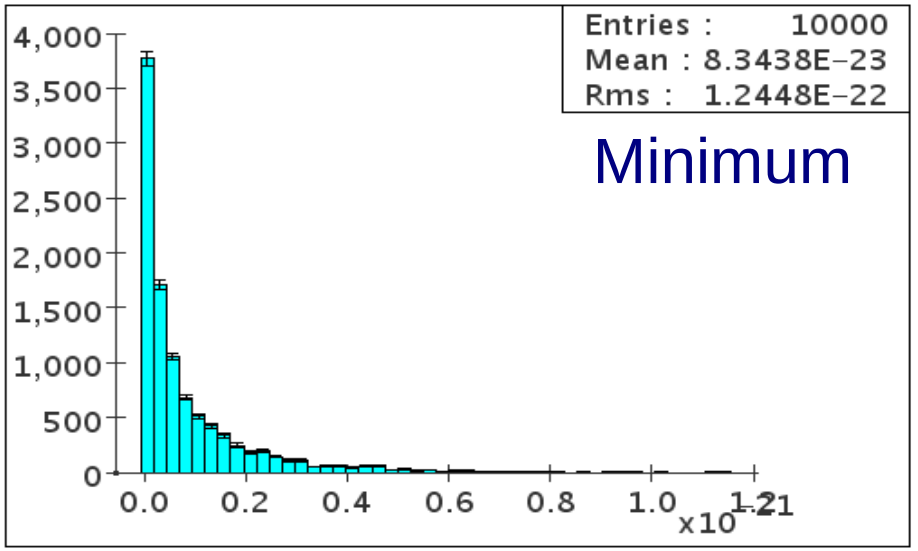


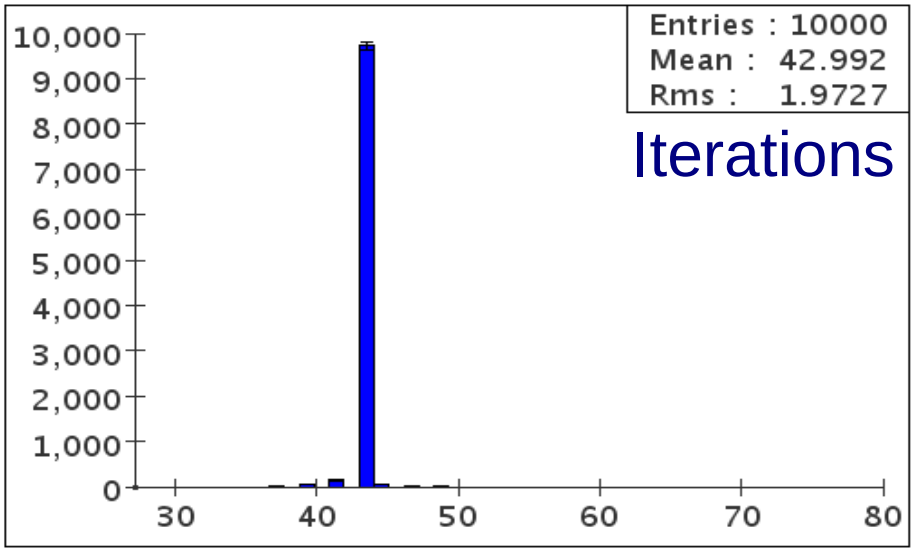


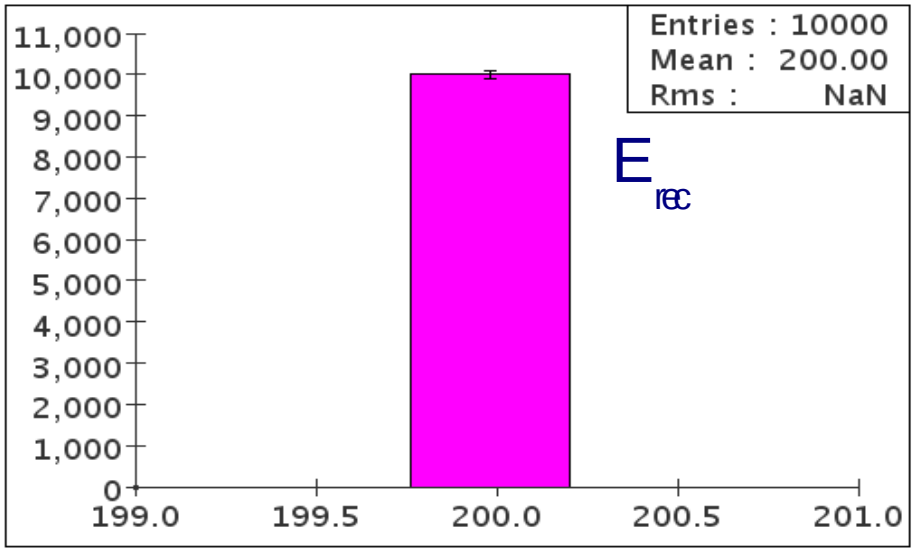
$$\chi^2_i = \frac{1}{\sigma^2}\left[\sum_{j=1}^{3} c_j H_j - E_{true}\right]^2$$

Properties of minimization

200 GeV pions, thresholds: th1 = 0.5, th2 = 5, th3 = 10







Reconstructed energy

200 GeV pions, thresholds: th1 = 0.5, th2 = 5, th3 = 10