Hadronic Calibration of BCAL

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Motivation

1. BCAL response (as one piece) to pions, protons …
2. Monitoring of cell gains (probably)
3. Absolute energy-to-signal calibration of cells (less probably)
4. Relative cell-to-cell gain alignment (much less probably but worth to try)

Method

1. Simulate energy deposited in the fibers of BCAL readout segments (cells) as a function of charged particle type, momentum, azimuthal and polar angles (available from CDC) .

2. Compare the simulated mean energy depositions (or energy deposition spectra using fitting procedure?) with the measured signals in the same PID/momentum/angles bins.

3. Observe the discrepancy in between the simulation and measurement (“cell-wise” or “layer-wise” fit) AND/OR the fluctuations of the fractional energy depositions in time.

Question #1

Q: We are talking hadron calorimetry, and everybody knows that hadron calorimeter is very non-accurate device (invisible energy, leaks etc.) How can we hope to have an accurate estimator for deposited energy?

A: It's important to understand that there is nothing "mystically unbeatable" about invisible energy and other effects of hadron calorimetry; all these effects/fluctuations just make the energy distribution wider. If we perform one single measurement of hadron energy, the result will be non-accurate indeed (and will correspond to the distribution RMS). But if we make a lot of measurements in the same conditions, we can have much more accurate estimator (mean value, for example).

Question #2

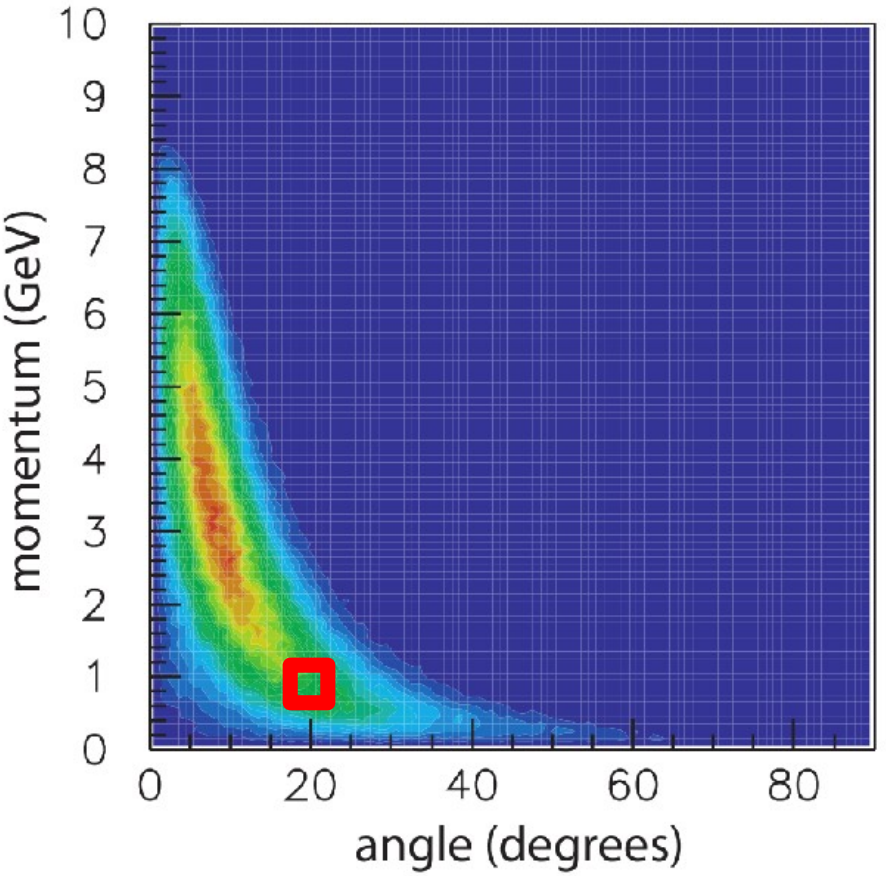
Q: Can we have "a lot" of suitable statistics?

We might...

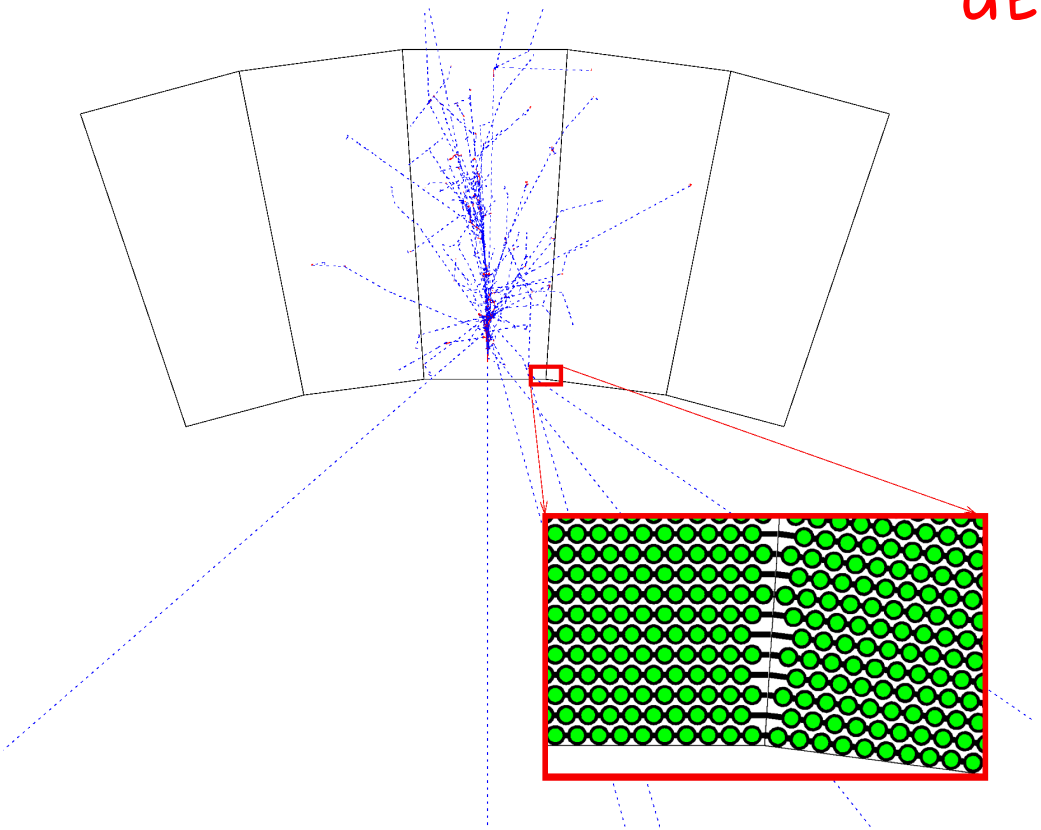
For example,

3-pi production

from GlueX-doc-1006



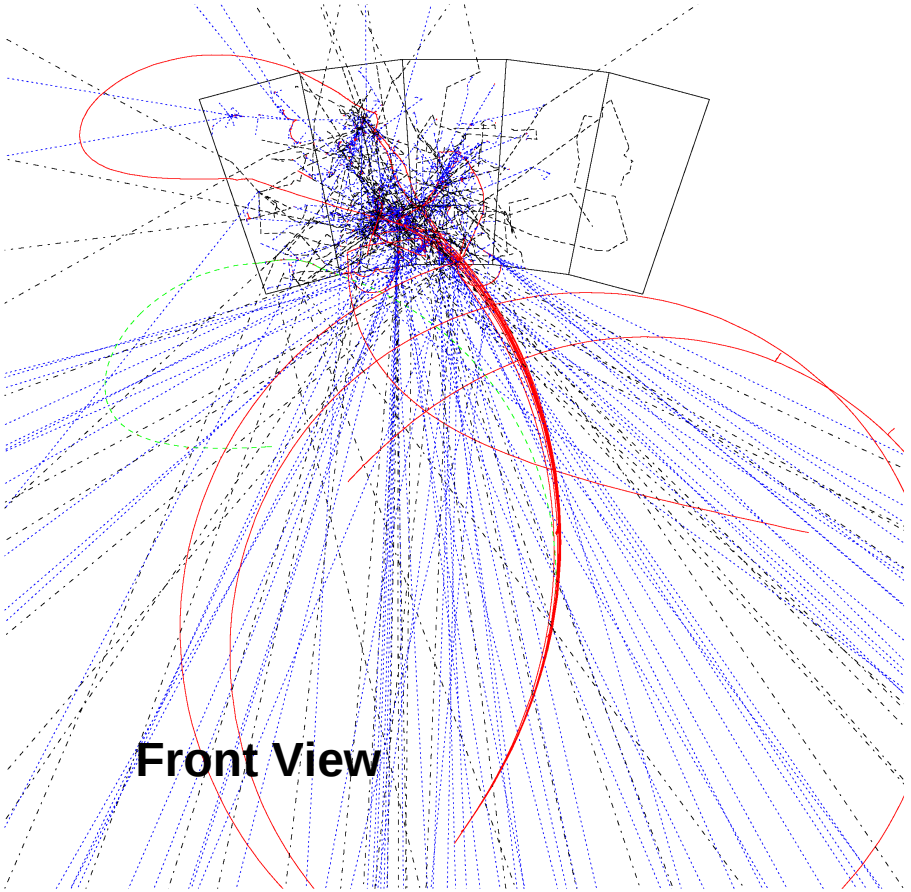
Geometry for Simulation

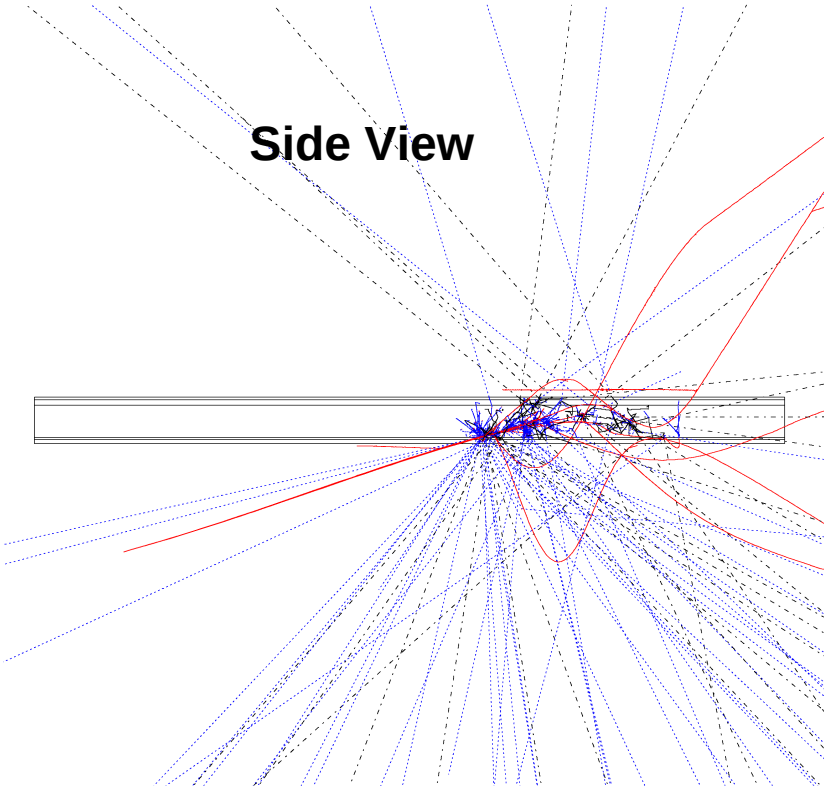


GEANT 3.21 + GFLUKA

Realistic map of
Magnetic field

π^+ ; P=1.0 GeV/c; θ=20°





Good kinematics: Energy enough to reach the modules as well the polar angle is small enough

Question #3

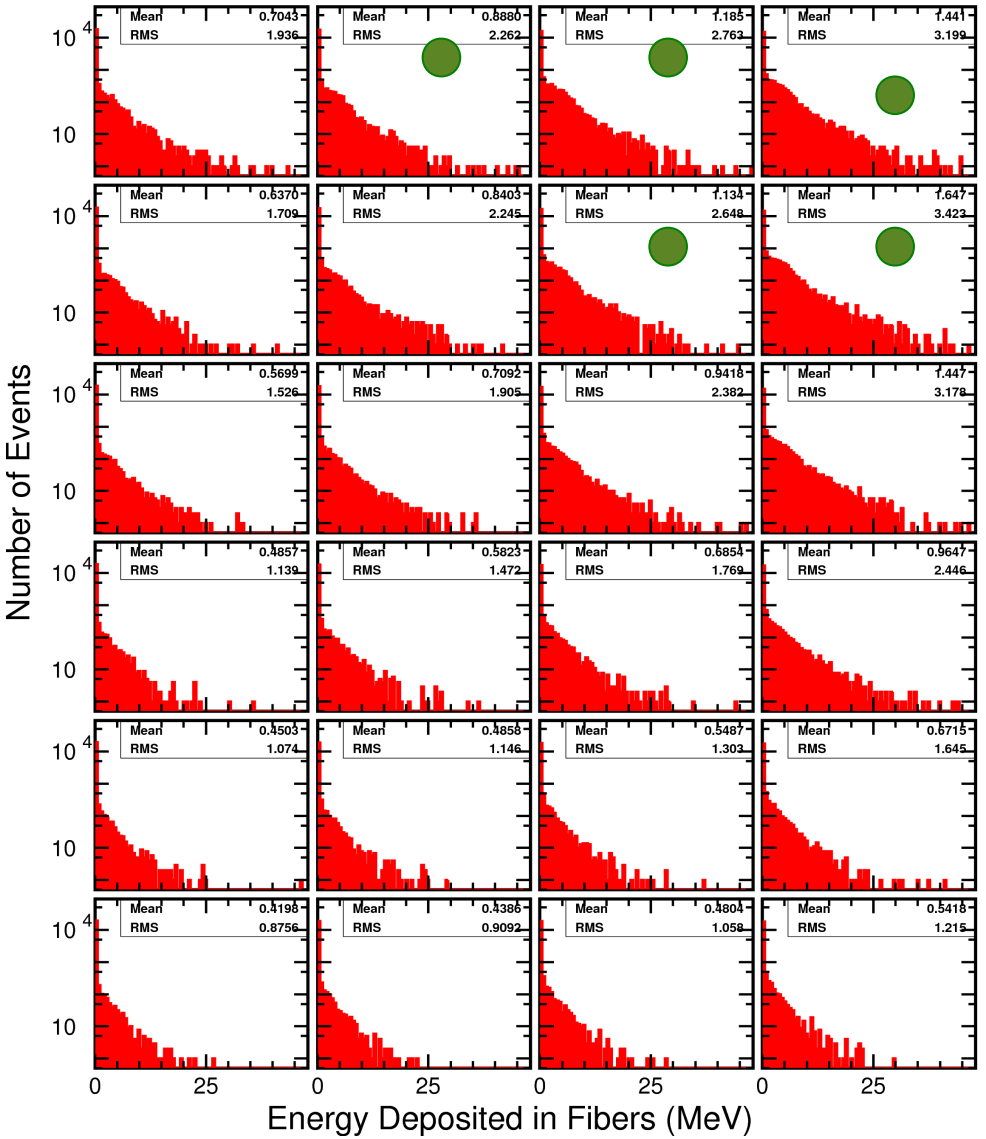
Q: Do we have the deposited energy distribution reasonably compact? Another words, this is EM calorimeter and it might be not thick enough...

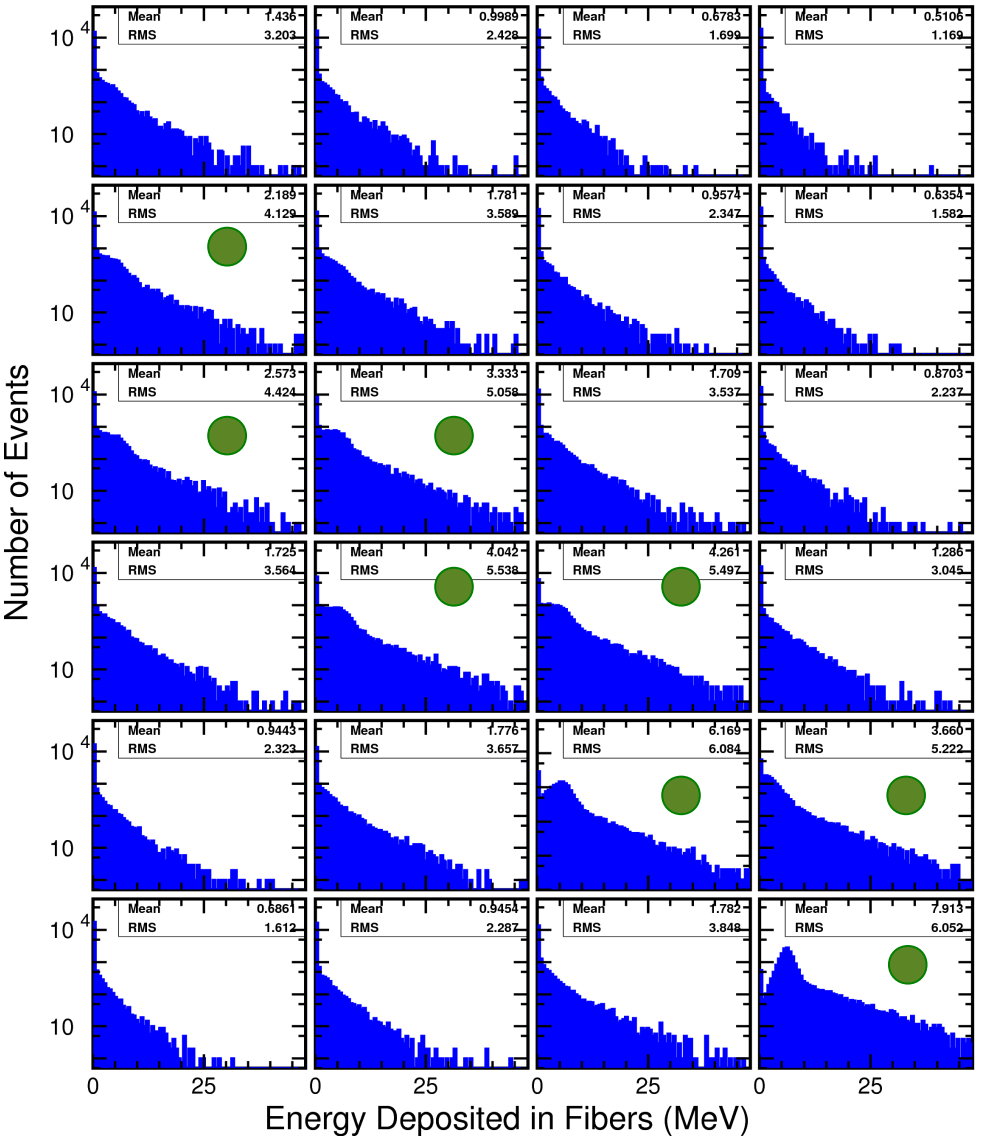
A: At certain kinematics, the calorimeter is not very bad... For the polar angle of 20 deg., the calorimeter thickness is more than 2 nucl. inter. lengths + high fibers/lead granularity + possibility to pick up the side energy leak from neighbour modules.

PID/momentum/angles binning => repeating kinematics

Might think about additional variable - depth of the shower start...

Energy Deposited in the Fibers by Pions





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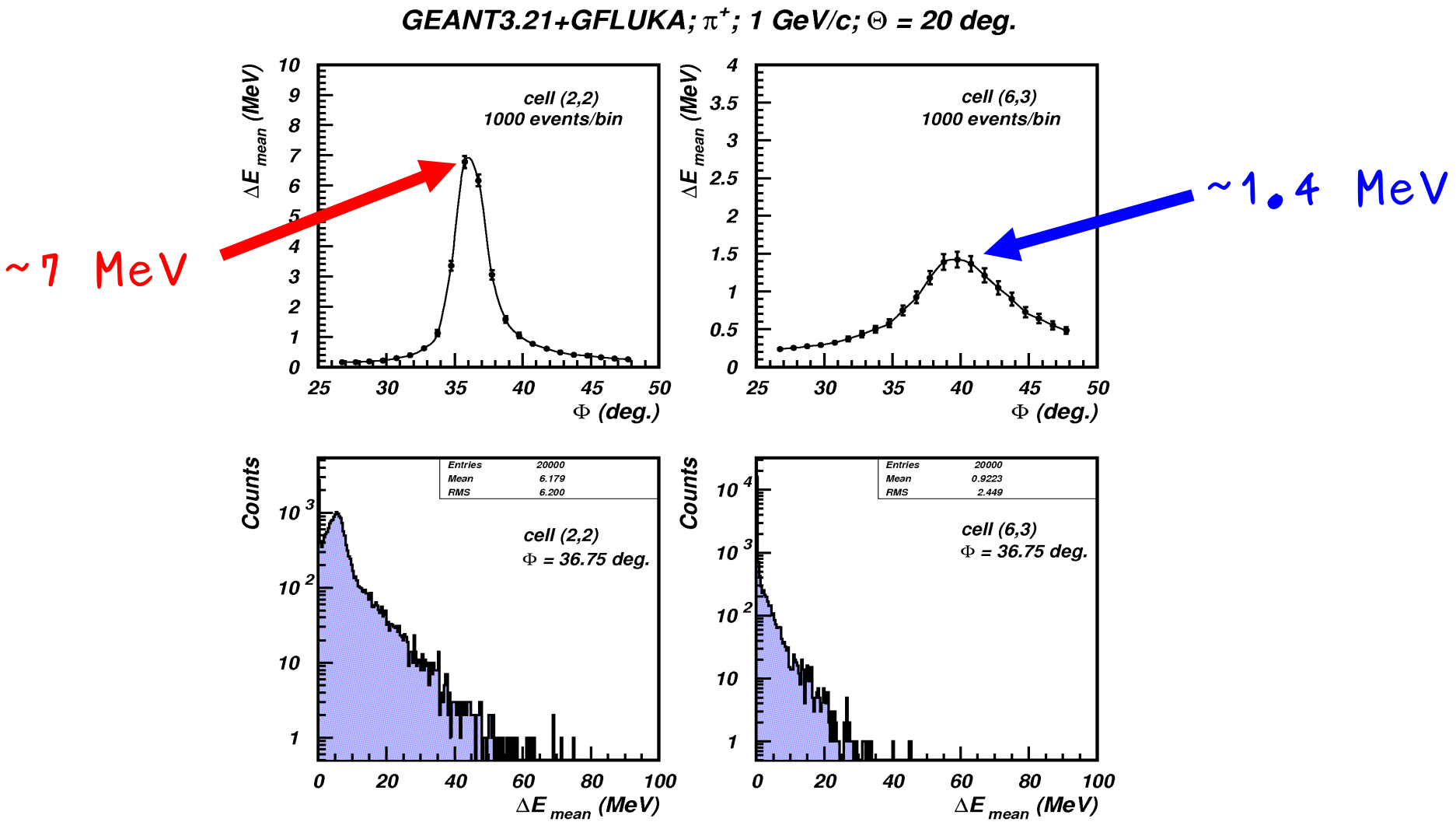
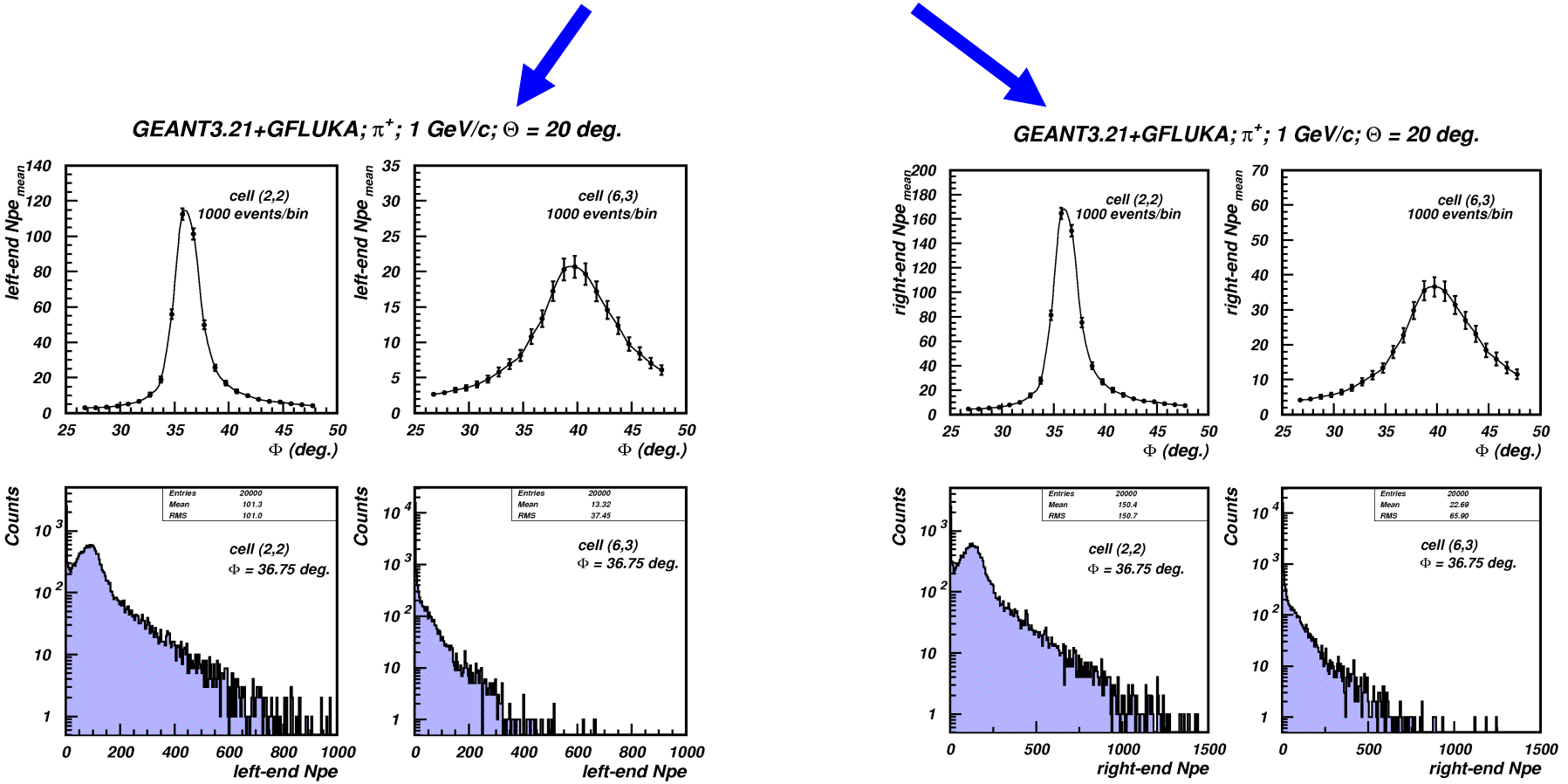


Signals (Npe) from Left and Right Ends of the Module



Deposited energy is "attenuated" to the module ends and convoluted with Poisson statistics

Signals are comparable with MIP

Question #4

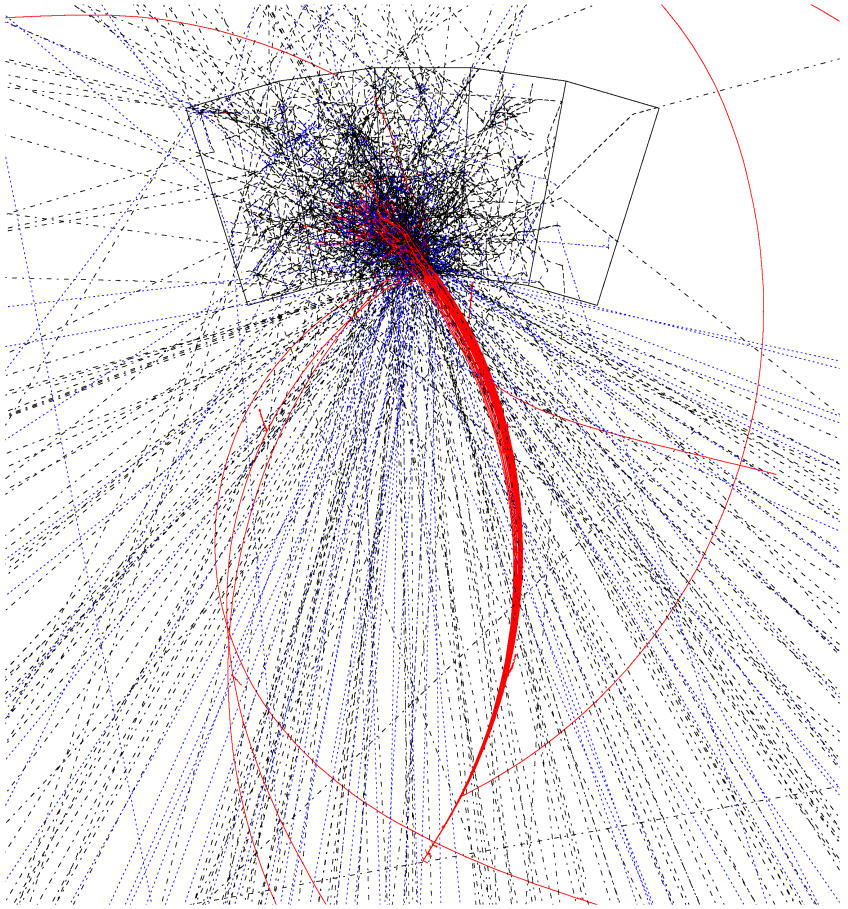
Q: What's about PID?

A: For negative charges, we have electrons and pions. Longitudinal profiles should work (most probably).

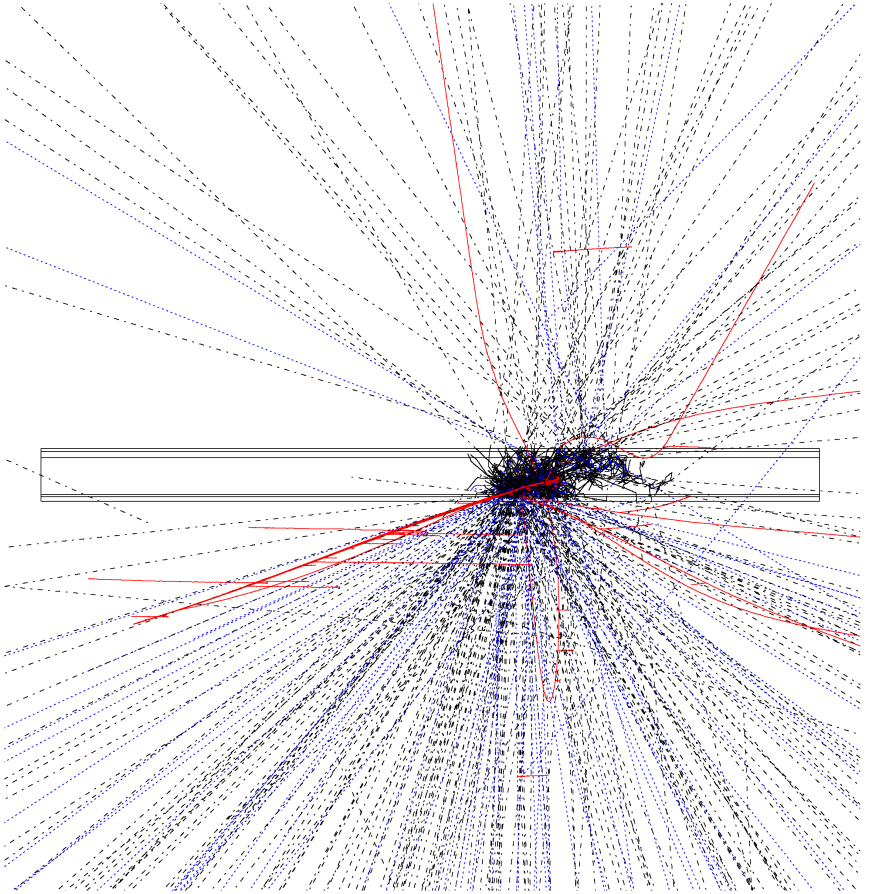
For positive charges, we have pions and significant fraction of protons. Though the deposited energy distributions for protons in some layers might be close to the pion ones, the longitudinal profile will be different (but not different enough to make event-by-event separation) => we need to know PID. Can CDC help?

Protons: P=1.0 GeV/c; θ=20°

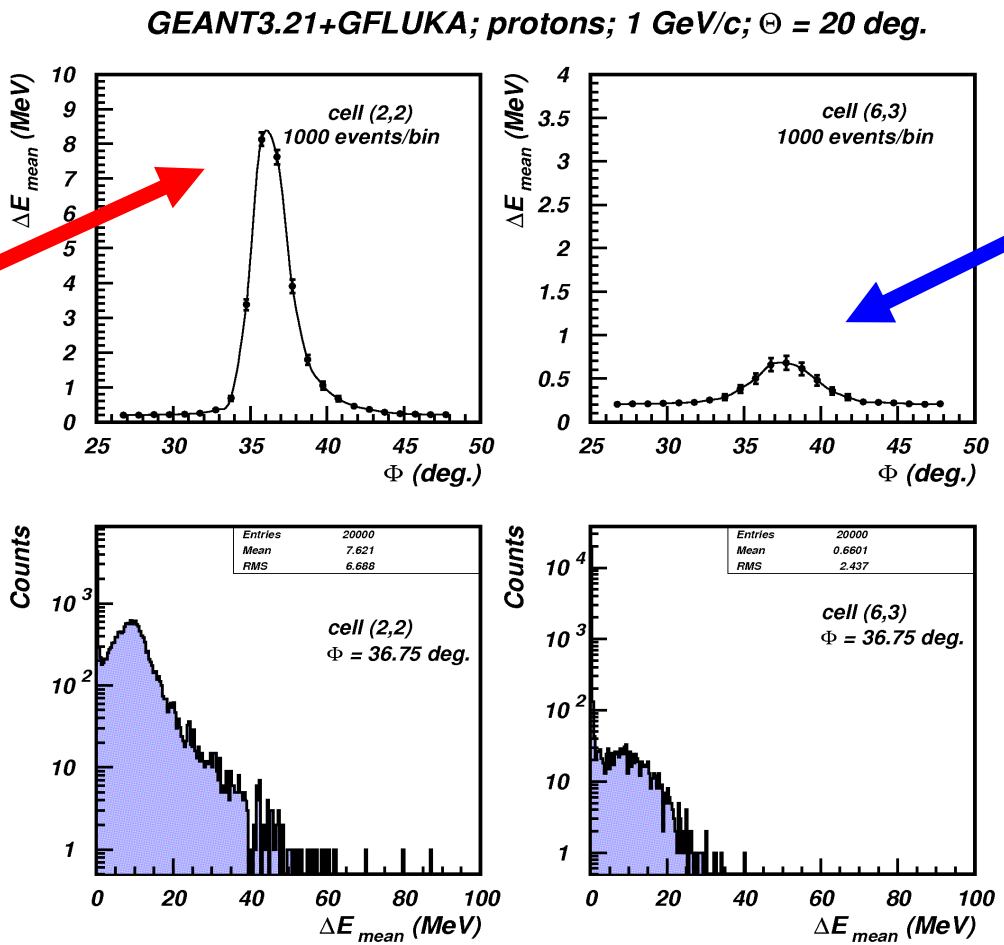
Front View



Side View



Energy Deposited in the Fibers by Protons



~8.2 MeV

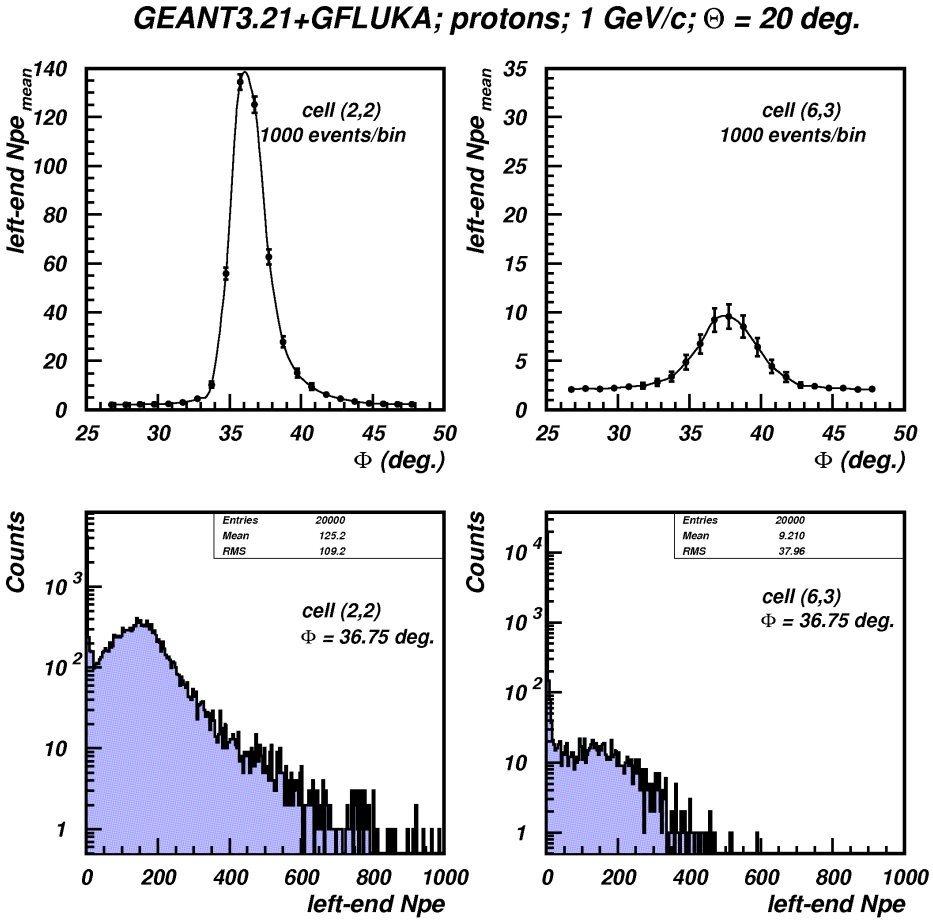
Not very far away from the value with pions

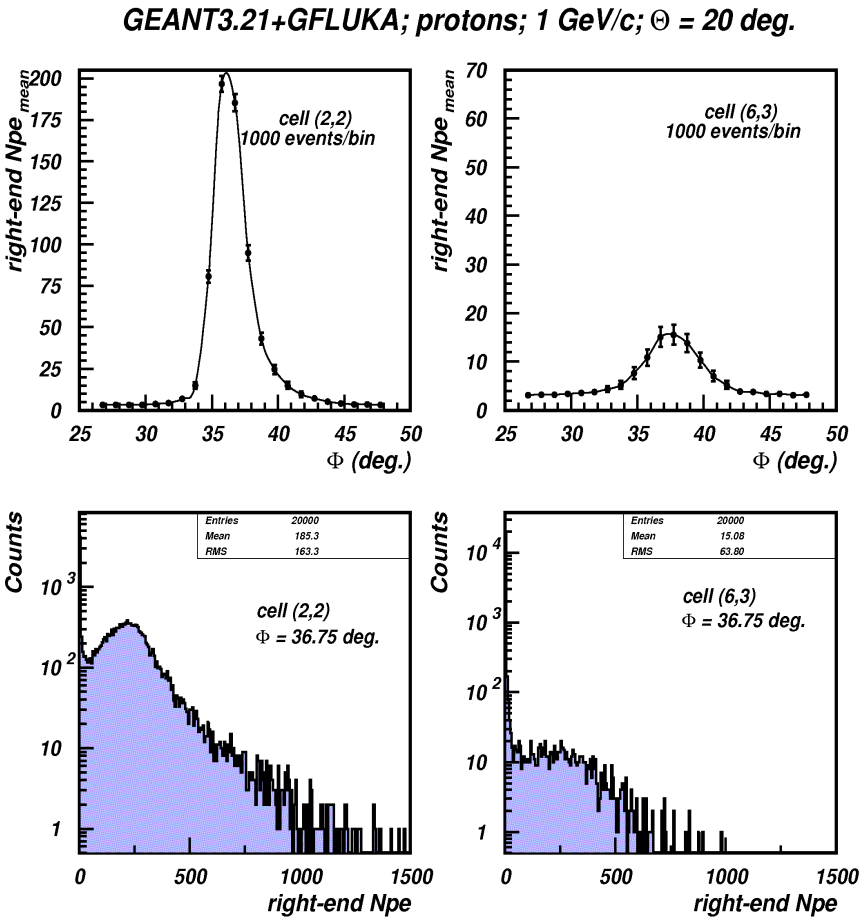
~0.8 MeV

Almost twice smaller...

Calibration of inner segments of BCAL is less sensitive to pion/proton ratio

Signals (Npe) from Left and Right Ends of the Module





Question #5

Q: How we know that our distributions from simulation are correct?

A: We don't. A priori, we can just try to estimate the systematics comparing the results from different generators. When we have real data, we will compare the shape of distributions.

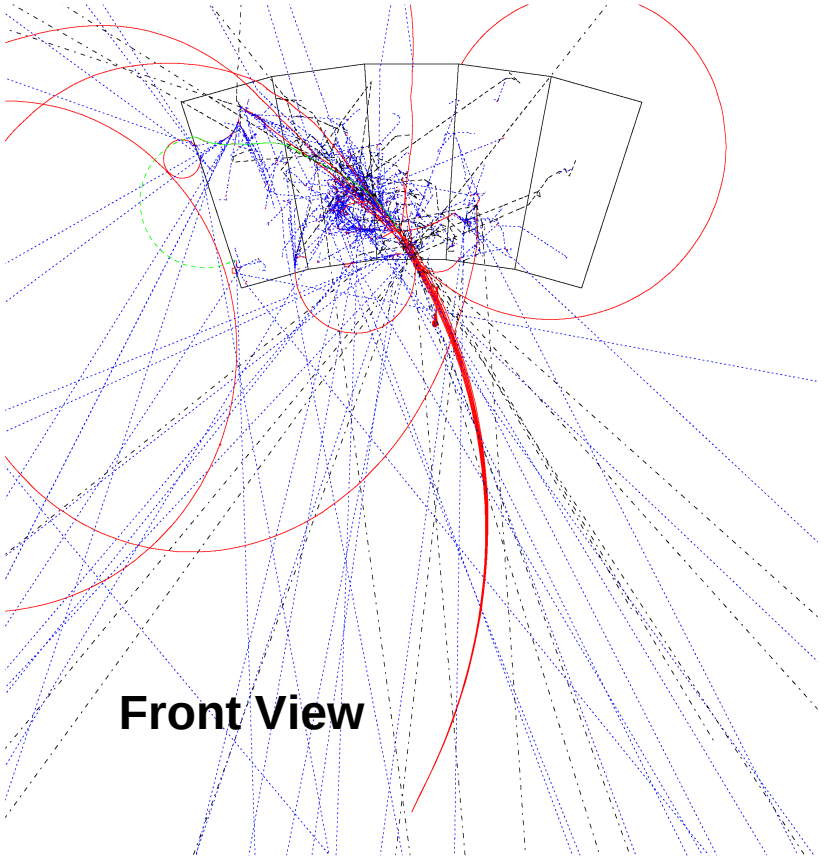
But we have a hope that new generation of programs (viz., GEANT4 or new "stand-alone" FLUKA) might work.
Reason for the hope: (for example) successful weighting algorithm of H1 collaboration for pions of 2-20 GeV/c with GEANT4.

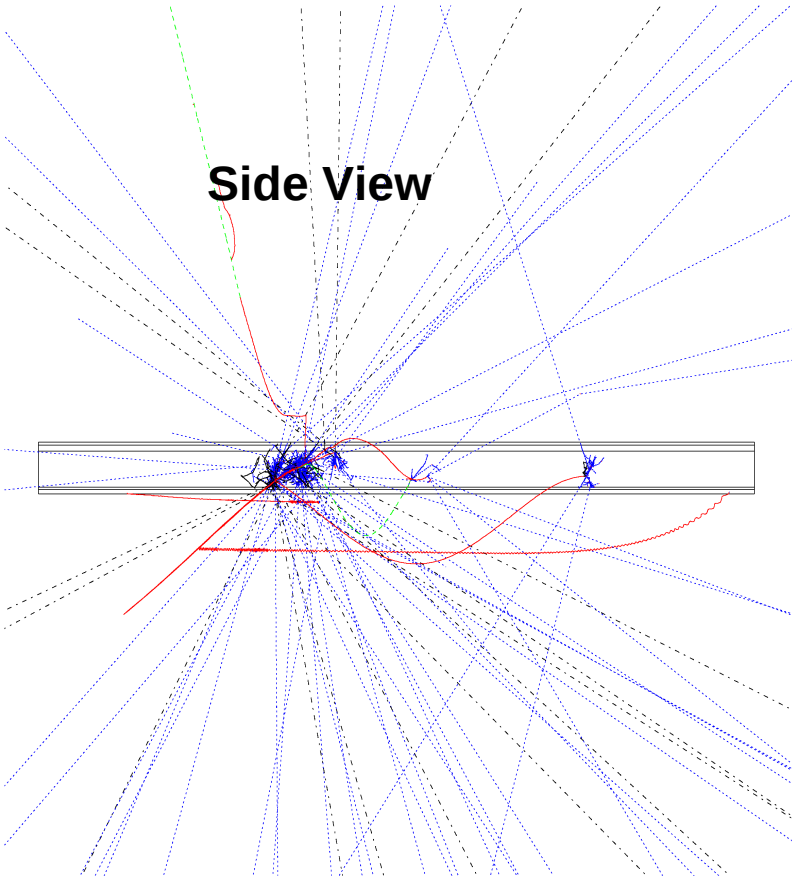
Question #6

Q: What's about another kinematics?

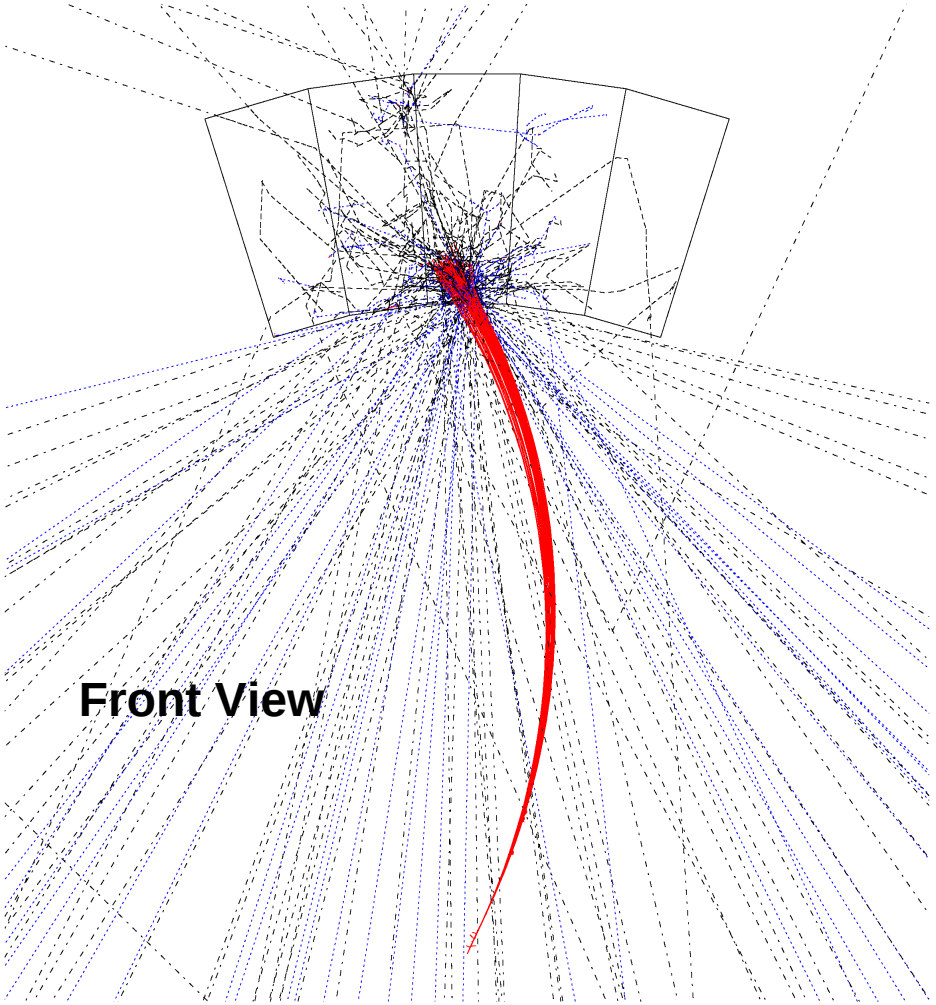
A: Bigger polar angles (and smaller momenta) are less favourable for the calibration purposes. But if we establish procedures and an agreement between the simulation and the experimental data for small polar angles, we might try to simulate big angles too...

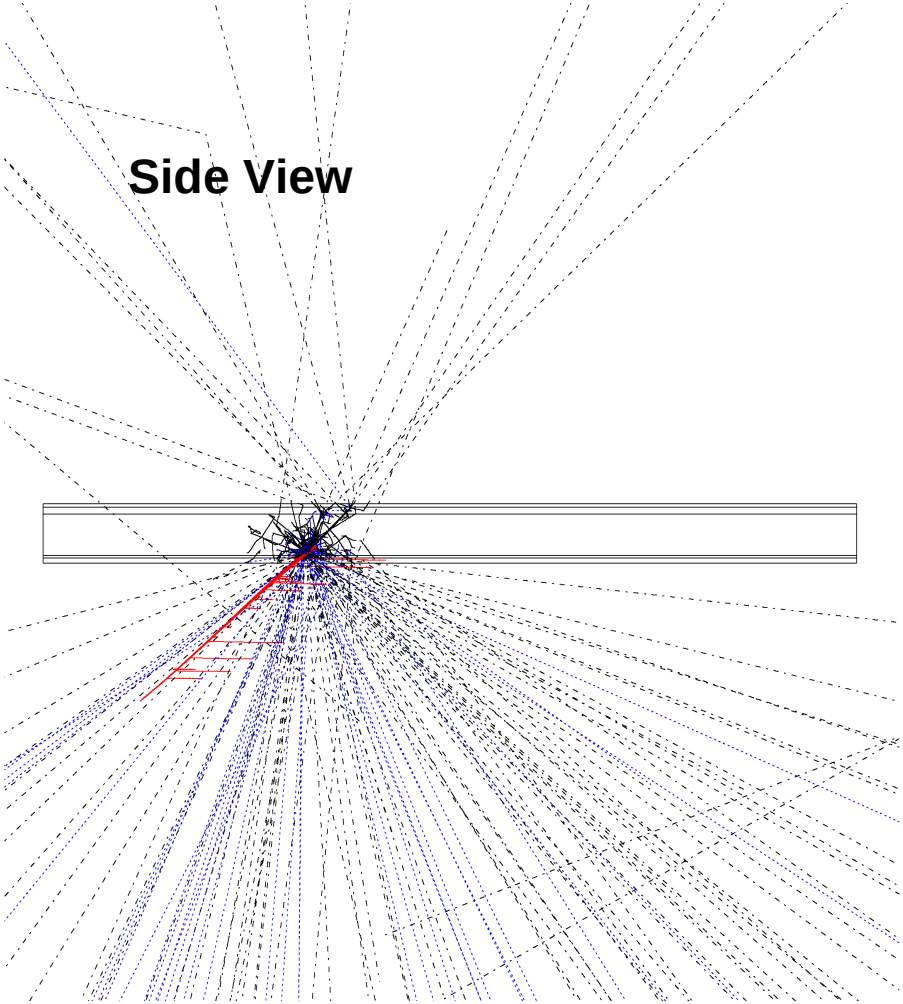
π^+ ; P=0.6 GeV/c; θ=40°





Protons: P=0.6 GeV/c; θ=40°





Last comments

- Why don't try?

- Did you see the back-splash of photons and neutrons?