Obtaining the Dual Readout Correction

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- Calculate k_s, k_c
- Obtain the dual readout correction function $f_{corr}(C/S)$
- Obtain energy response and energy resolution for single particles
- Where to find and how to run the scripts

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Definitions

- E_{in}: energy of incident particle.
- E_{dep}: represents measurement of deposited Energy in Calorimeter (by ionizing particles) e.g. represented by
  - deposited energy as reported by Geant 4.
  - number of scintillation photons.

Assuming electrons deposit all energy in the calorimeter:

$$E_{in}(e) = k_s \times E_{dep}(e) = S$$

- E_{Ceren}: represents measurement of Energy deposited in form of Cerenkov radiation e.g. represented by number of Cerenkov photons. For electrons E_{ceren} is assumed (we check it) to be directly proportional to E_{dep} and E_{in} :

$$E_{in}(e) = k_C \times E_{Ceren}(e) = C$$

- For electrons:

$$C/S = 1$$

- Dual read out correction: $E_{in} = S / f_{corr}(C/S)$

Motivation

- Corrections k_s, k_c, f_{corr}(C/S) depend on:
  - physics list
  - Detector configuration
  - Selections cuts (e.g. timing, threshold, clustering, etc.....)
  - What quantity we are measuring
  - .....
- Therefore k_s, k_c, f_{corr}(C/S) need to be estimated for each configuration --> need to automate the procedure (especially with the Grid spitting out results fast :(
- Automation is fine but keep the raw distributions:
  - Leakage --> leads to over corrctions (not handled yet)
  - Effects like non-continous physics list can have strange effects (QGSP_BERT is a good example)

Steps involved

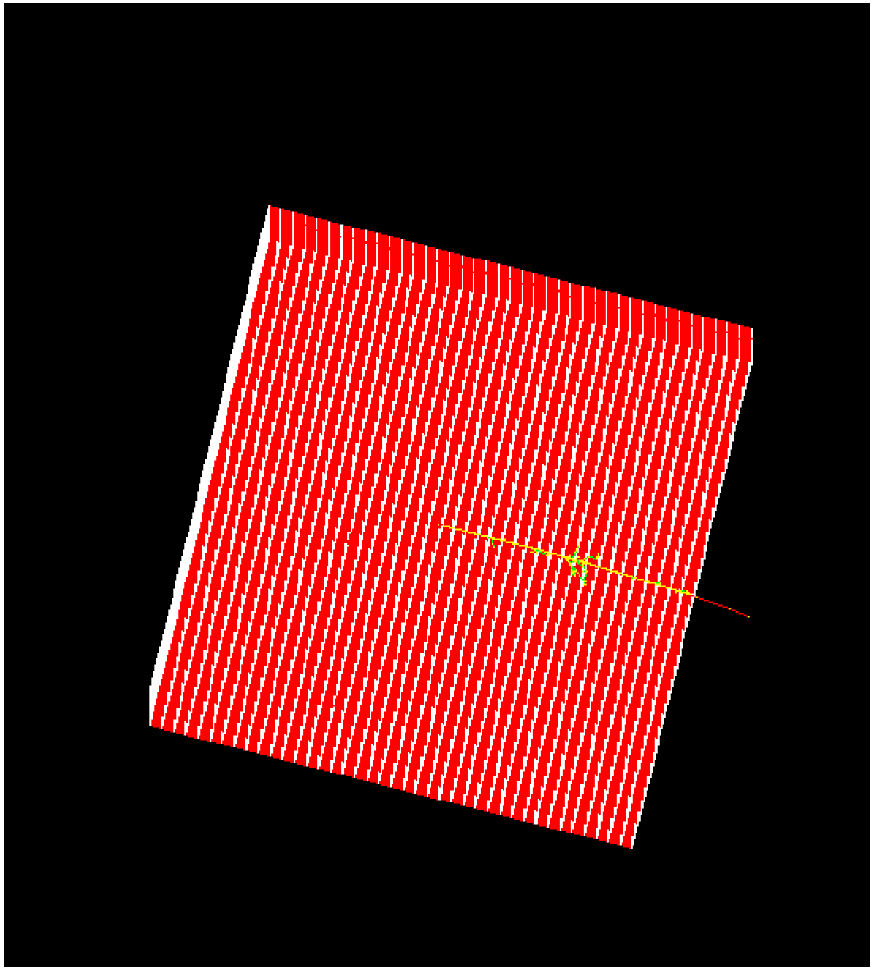
- Use mono-energetic electrons of various energies to determine k_s, k_c
- Use mono energetic pions (and electrons) to obtain f_{corr}(C/S).
- Use mono energetic pions to check the result.
    - Apply Dual readout correction
    - Check energy response and energy resolution.

DRCal detector used in this exercise

Crystal size in x,y,y: 5 cm
Nr. of cells in x,y,z: 40
Crystal Material : G4_BGO
Crystal Density : 7.13 [g/cm3]
Crystal interaction length: 22.6937 [cm]
Crystal radiation length: 1.11801 [cm]
Crystal total length (z,y,z): 200 [cm]
interaction length (x,y,z): 8.81301

(ignore material of silicon photo dets.
total # of IA length: 0.0524555)

Physics list: (the infamous) QGSP_BERT
No thresholds, no clustering



Electron energy response

Scintillation:

$E_{in}(e) = k_s \times E_{dep}(e)$

$= 1.0068 \times E_{dep}(e)$

$= S$

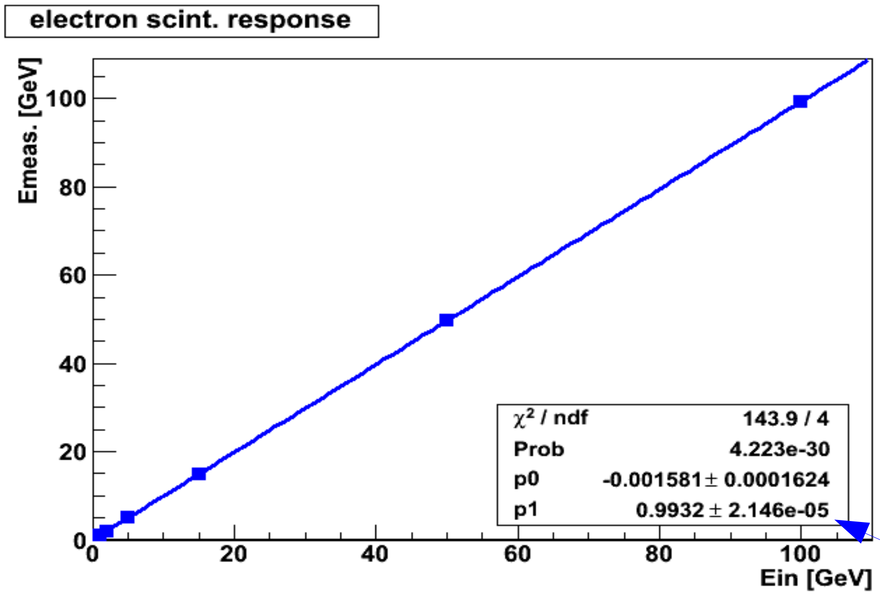
Cerenkov:

$E_{in}(e) = k_C \times E_{ceren}(e)$

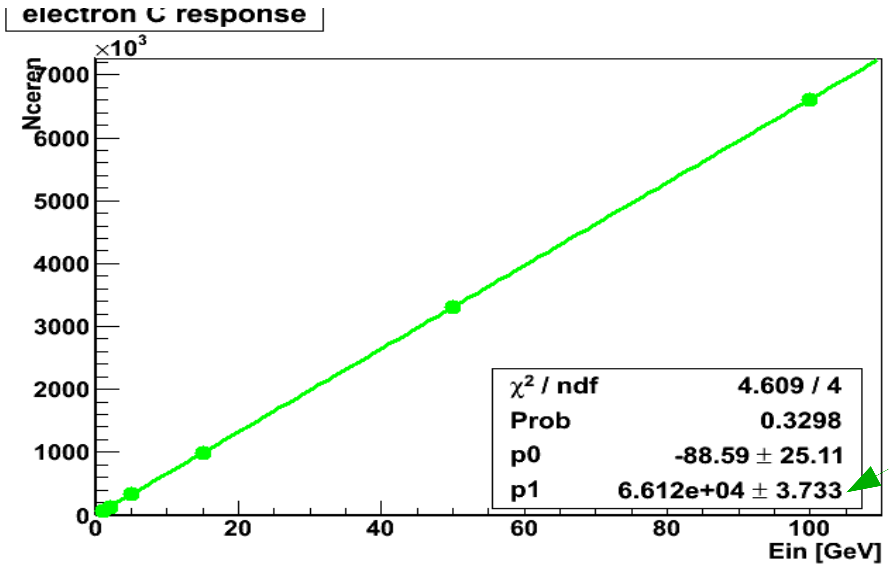
$= 0.000015 \times E_{ceren}(e)$

$= C$

Using multiple energies to verify
Linear response



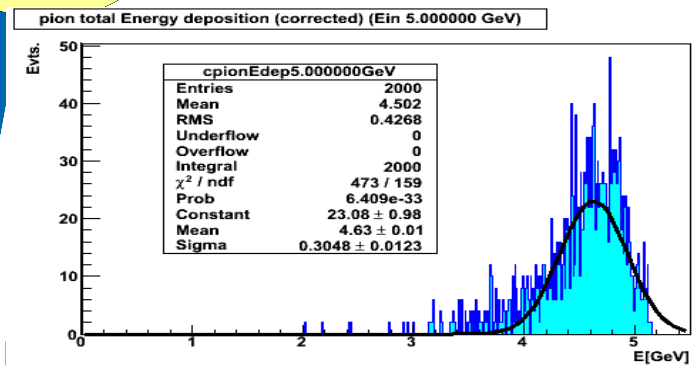
$1/k_s$

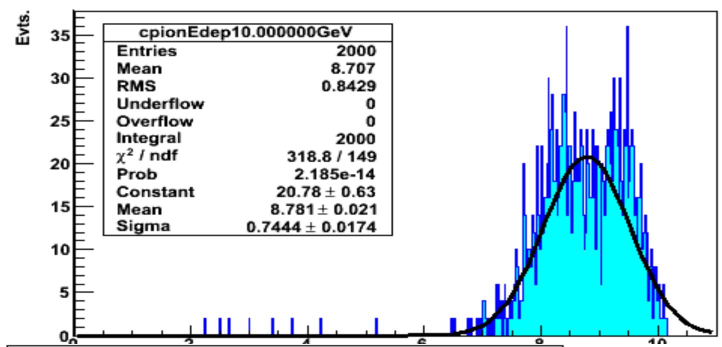


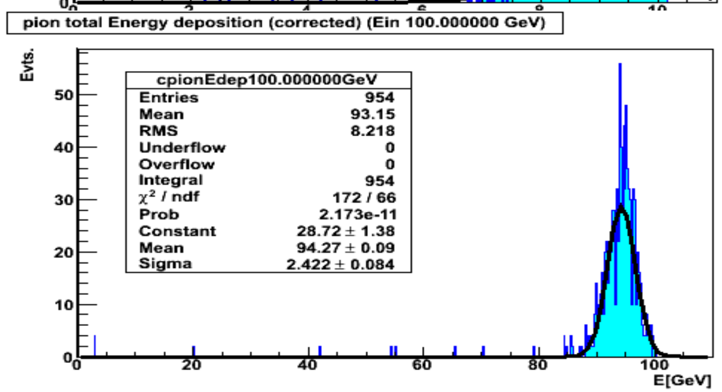
$1/k_C$

Calibrated Energy response for single pions

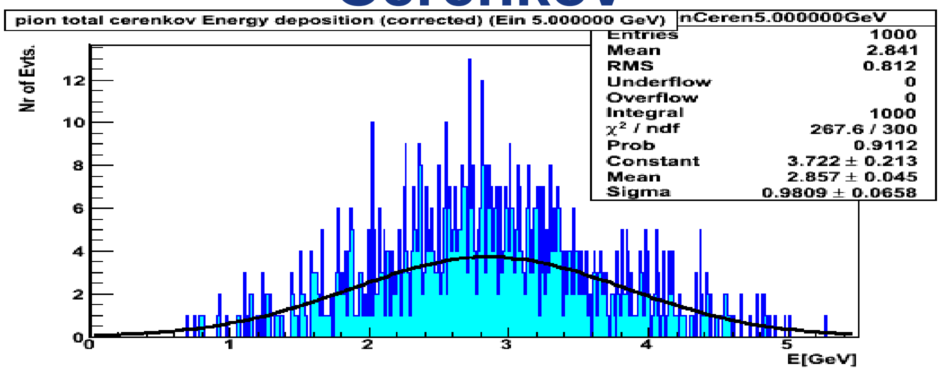
S

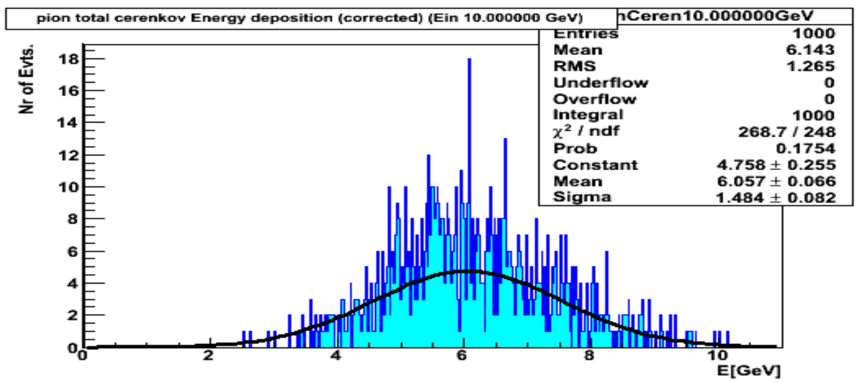


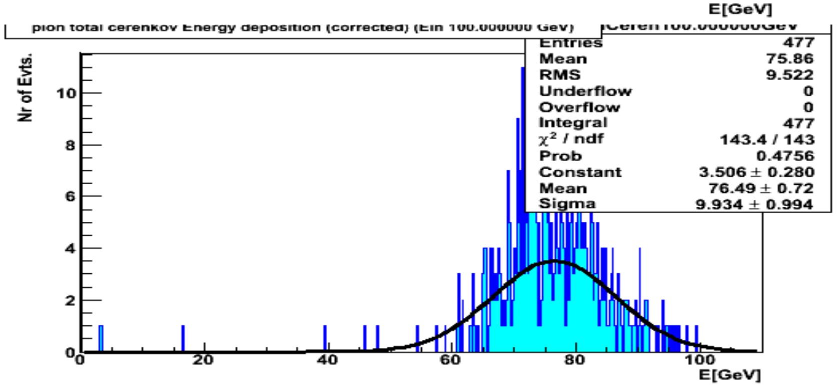




Cerenkov



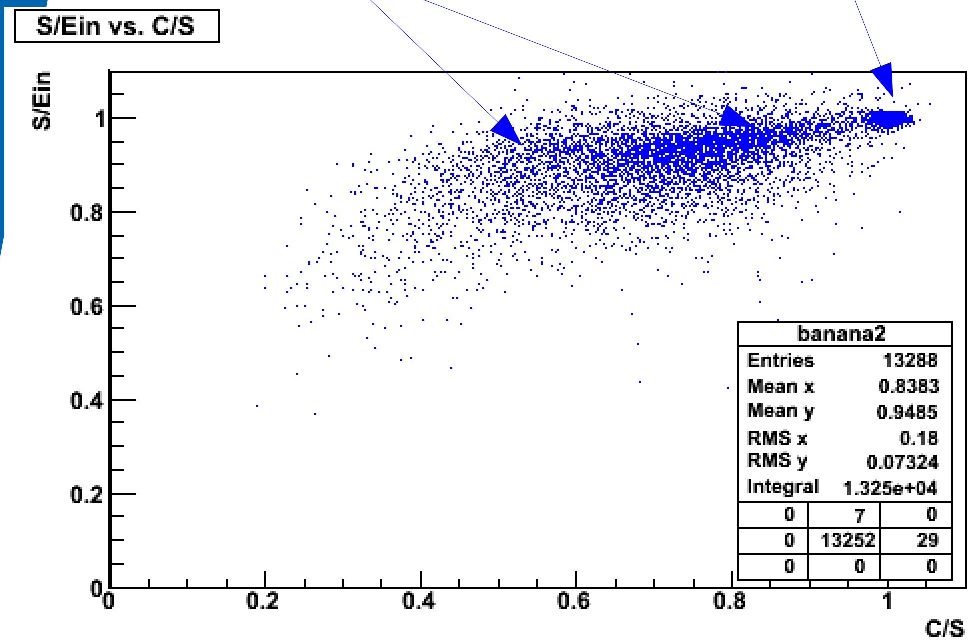


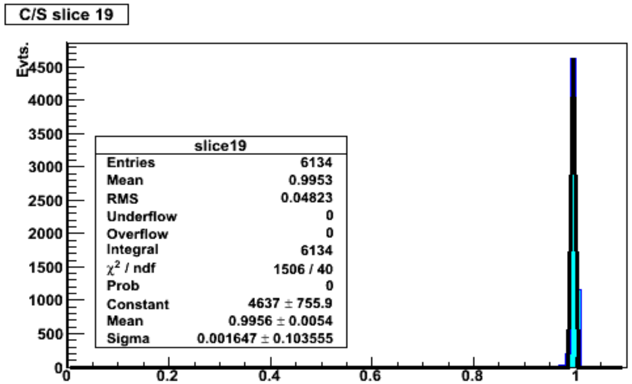


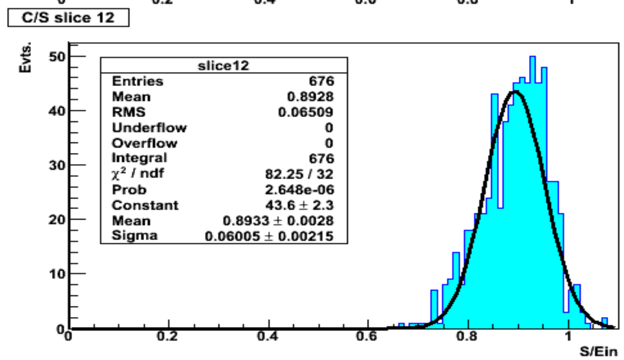
Obtaining the dual readout correction function

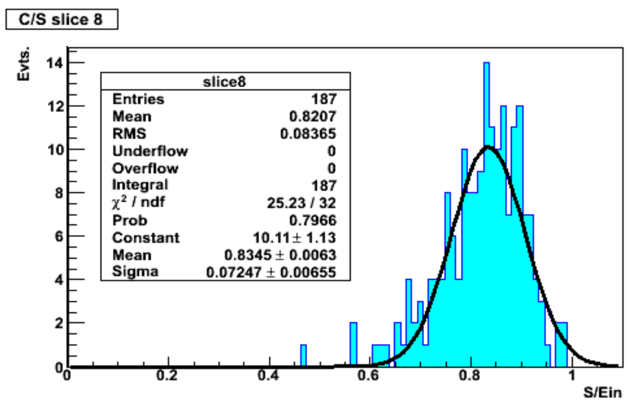
Pions

electrons



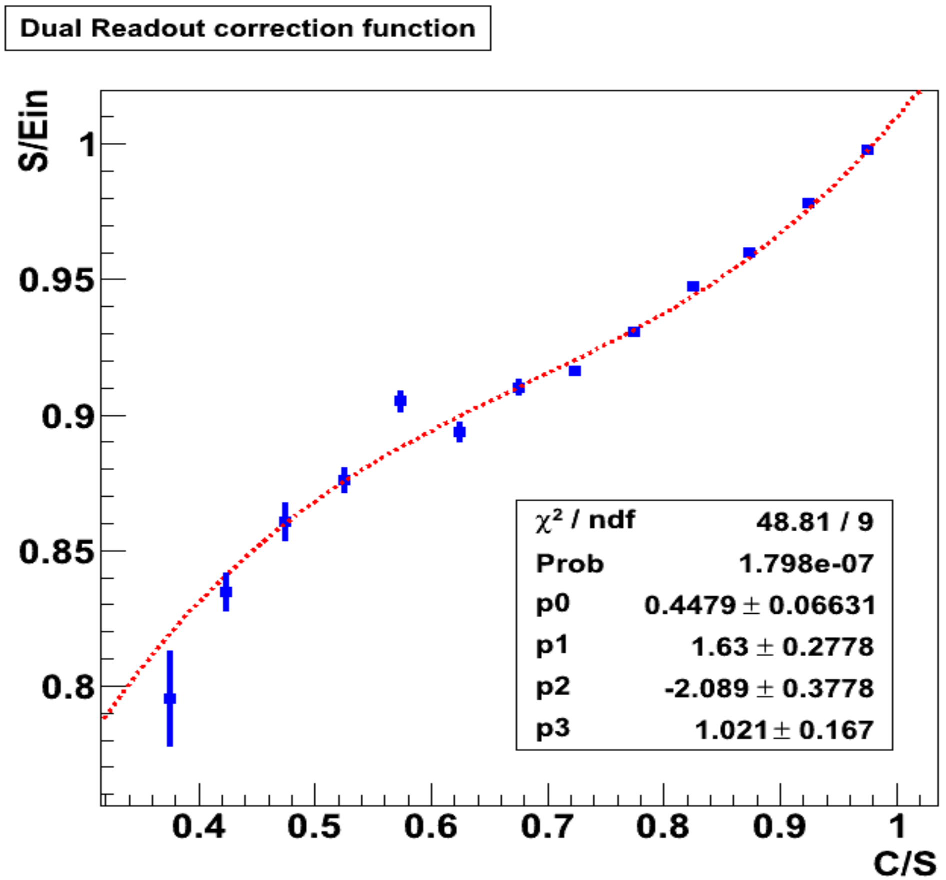






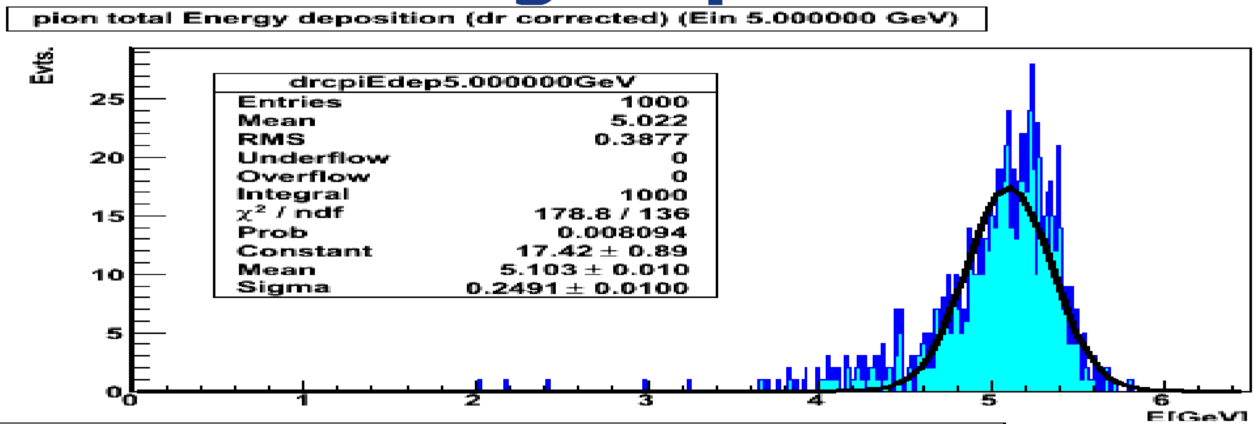
Make slices in C/S
fit gaussian to S/Ein distribution

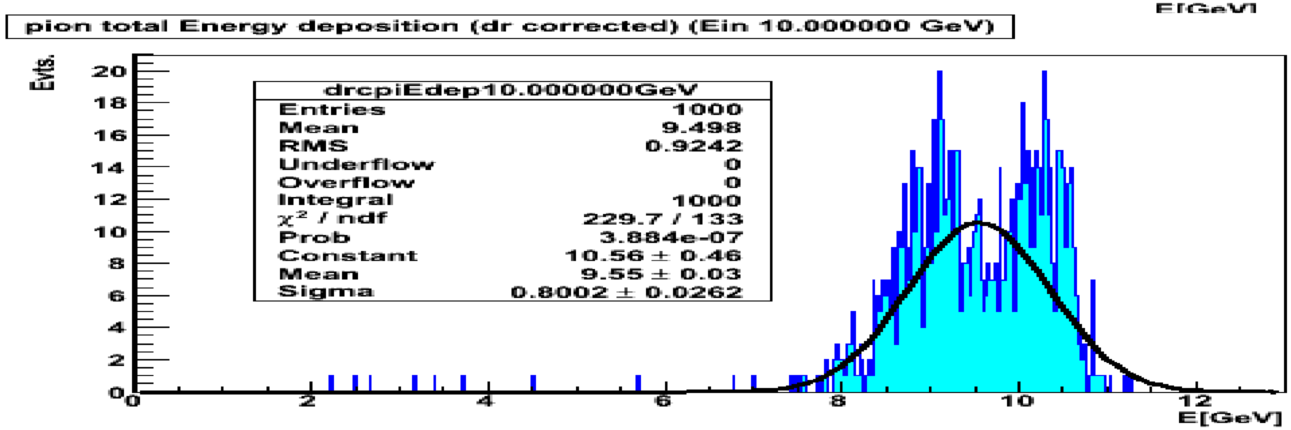
Dual Readout Correction function

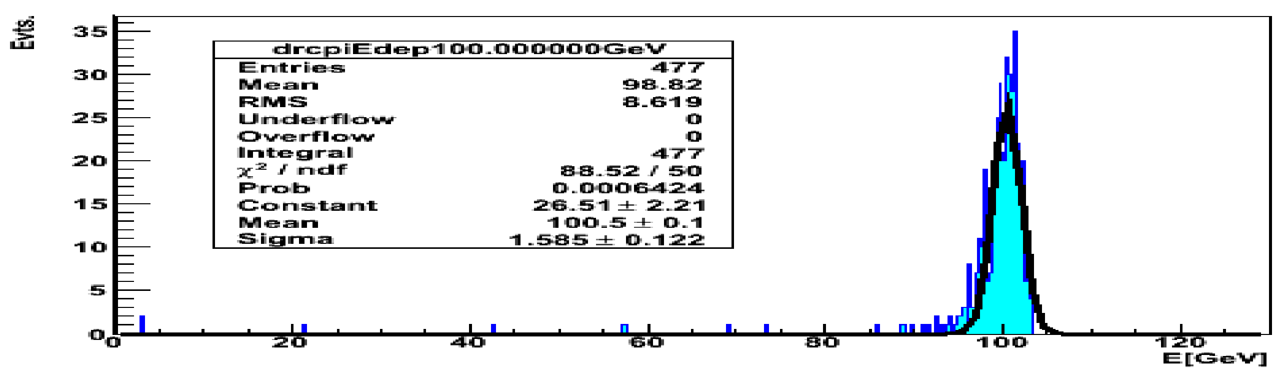


$$E_{in} = S / f_{corr}(C/S)$$

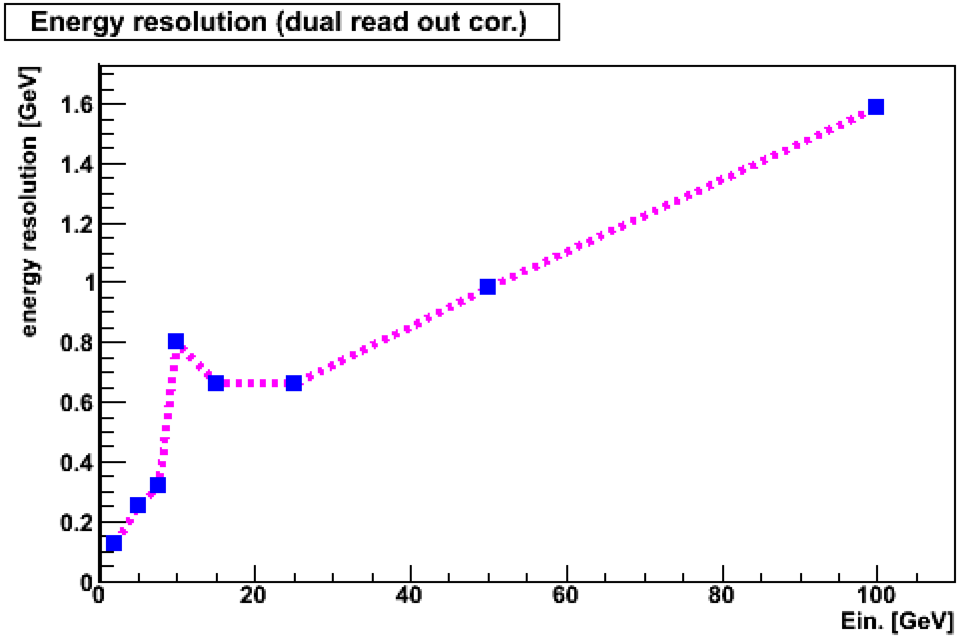
Dr corrected energy response for single pions.







DR corrected energy resolution



Where to find and how to run the scripts

Everything is in CVS (Work in Progress)

DRCalRoot/Event/Calibration.C

To run it in ROOT type:

```
.L libEvent.so
.L Calibration.C
init("infiles.txt");
CalE();
Tbrowser b;
```