Energy Loss Model

Jie Liu

10/08/2014

Last time Review

Energy loss step by step

Incoming beam energy loss
due to ionization, external Bremesstrahlung

↓

Internal Bremesstrahlung

↓

Electron scattering

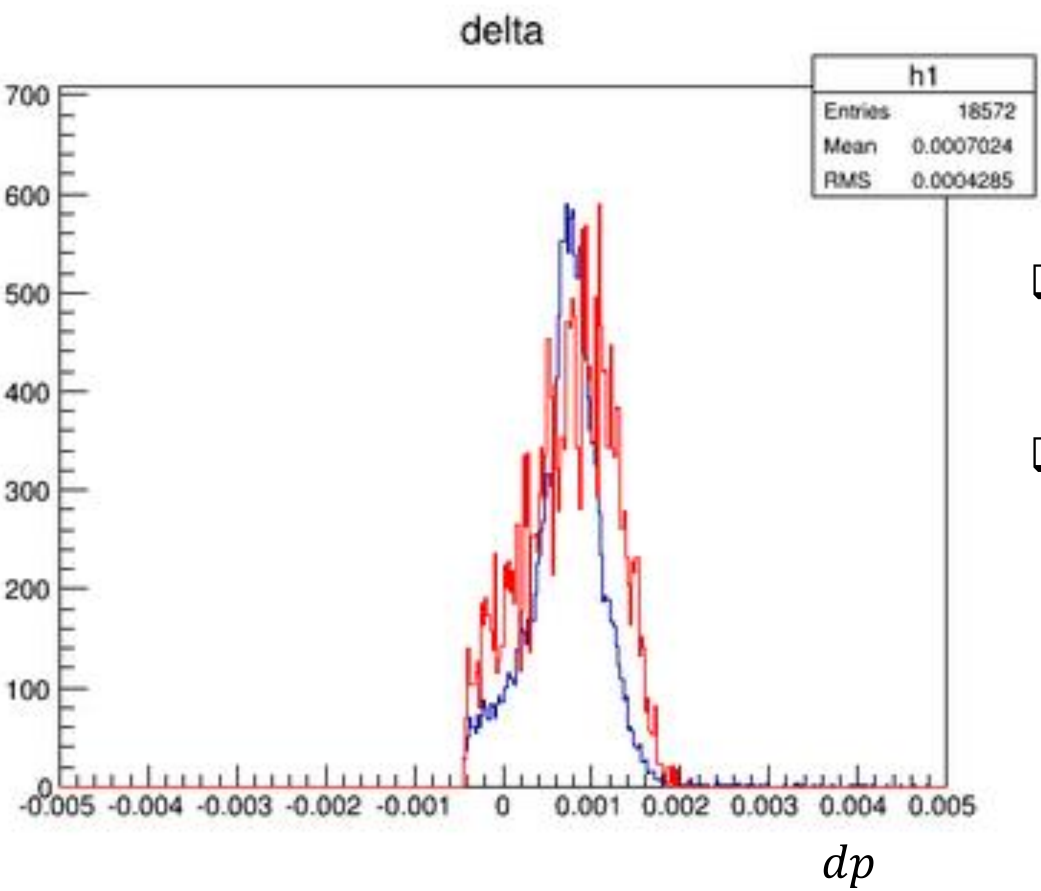
↓

Internal Bremesstrahlung

↓

Outgoing beam energy loss
due to ionization, external Bremesstrahlung

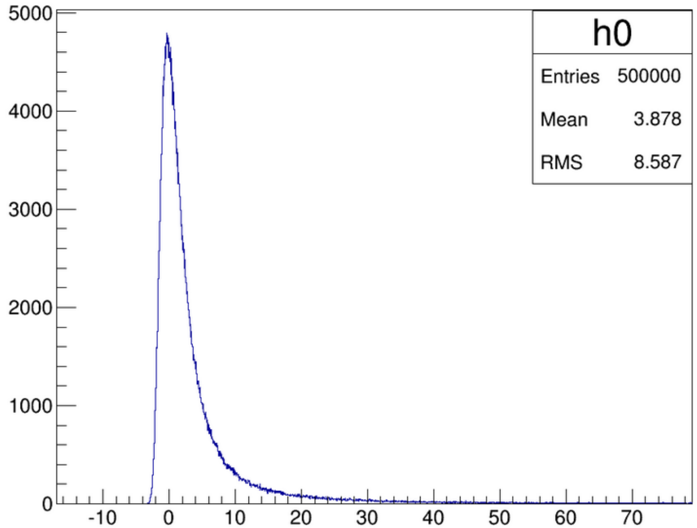
Last time Review



- Blue: from data, C w/o He optics
- Red: from simulation, energy loss only by ionization, the model is "landau" distribution (from SAMC)

Only Ionization contribution ("Landau distribution") already bring larger width than data) ?

Landau Distribution



Landau (0, 1) distribution

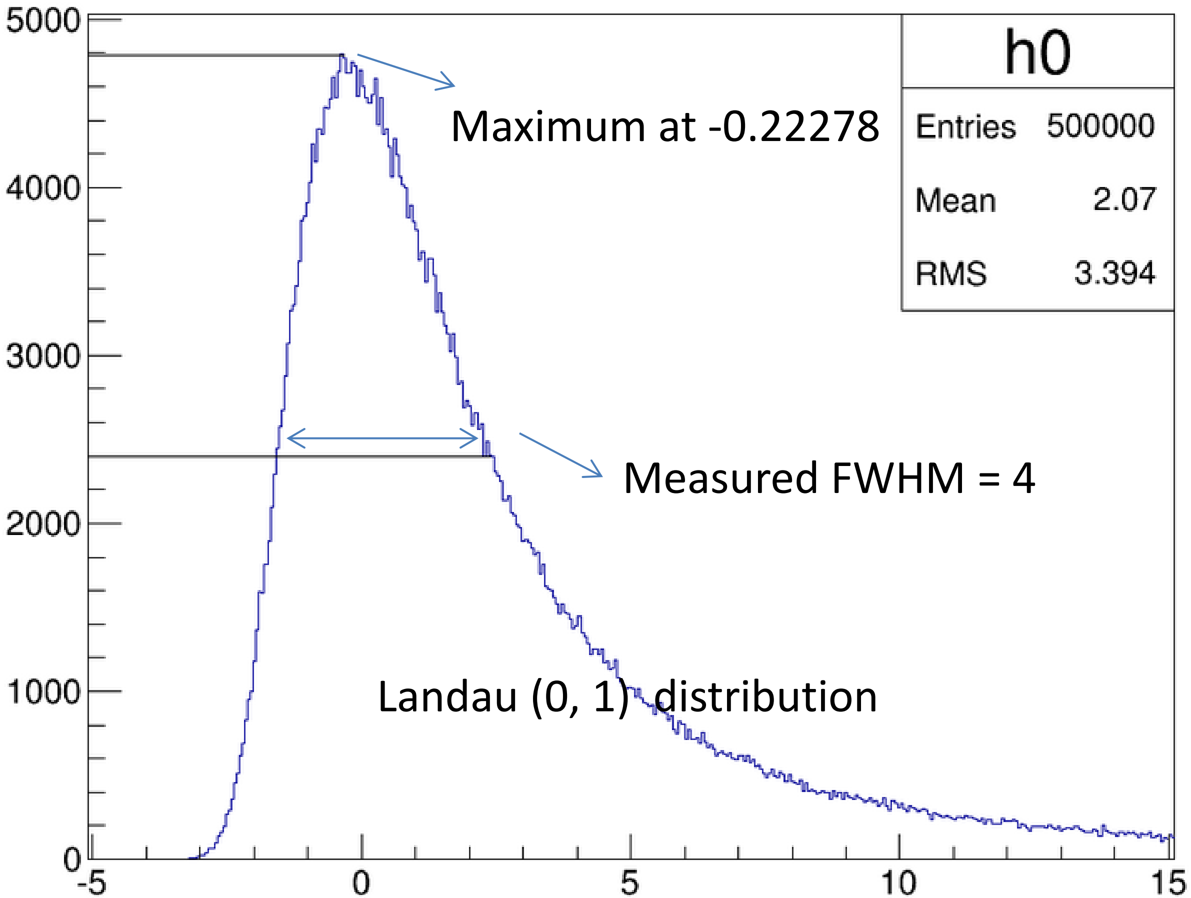
Double_t **Landau** (Double_t mean = 0, Double_t sigma = 1)

```
Generate a random number following a Landau distribution
with location parameter mu and scale parameter sigma:
     Landau( (x-mu)/sigma )
Note that mu is not the mpv(most probable value) of the Landa distribution
and sigma is not the standard deviation of the distribution which is not defined.
For mu  =0 and sigma=1, the mpv = -0.22278

The Landau random number generation is implemented using the
function landau_quantile(x,sigma), which provides
the inverse of the landau cumulative distribution.
landau_quantile has been converted from CERNLIB ranlan(G110).
```

Document in Root

Landau Distribution



From PDG book
The ionization landau distribution
Have a FWHM=4ε

$$\xi = (K/2) \langle Z/A \rangle (x/\beta^2) \text{ MeV}$$

Should use Landau (x, ε)

Instead of Landau (x, 4ε) (SAMC)

Also Need consider peak shift

Model comparison

- **New Landau Function Distribution**
  (most probable value, sigma)

- **Fluctuation distribution** (mean energy fluctuate)

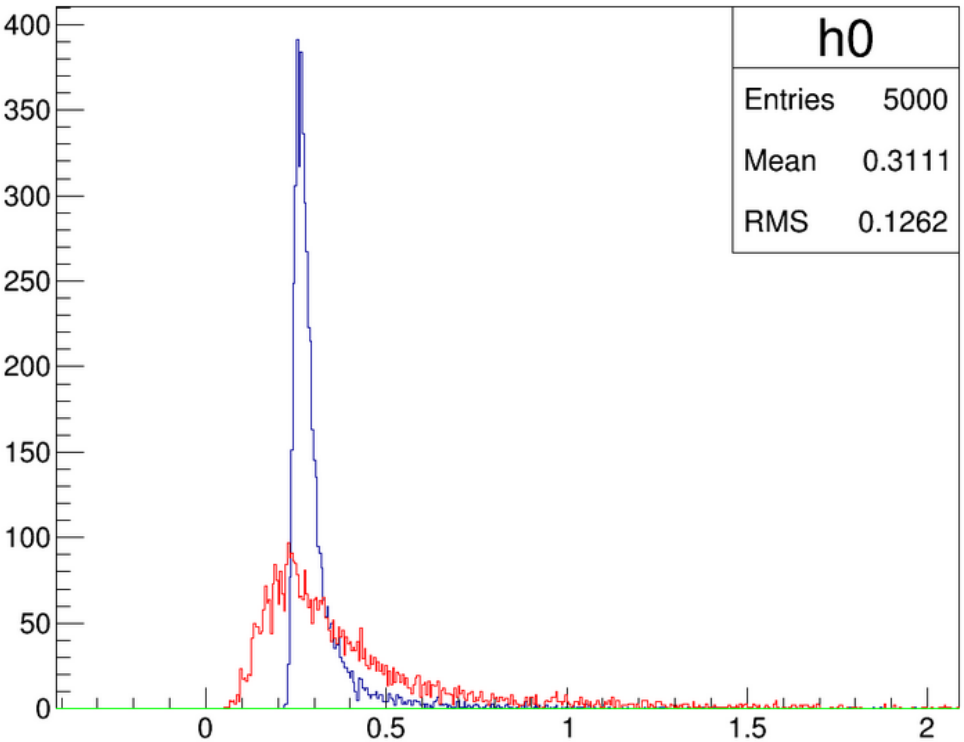
- General Idea:

- Atoms have only two energy levels with binding energy E1 and E2
- particle–atom interaction will then be an excitation with energy loss E1 or E2
- Or an ionization with an energy loss distributed according to a function E^{-2}

- Comments

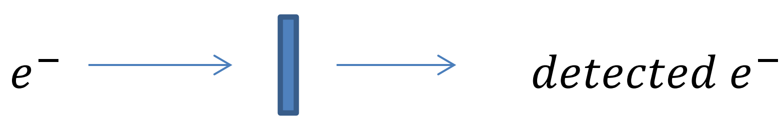
- Can be used for any thickness of a medium.
- Approaching the limit of the validity of Landau's theory, the loss distribution approaches smoothly the Landau

Model comparison



Energy loss/ MeV

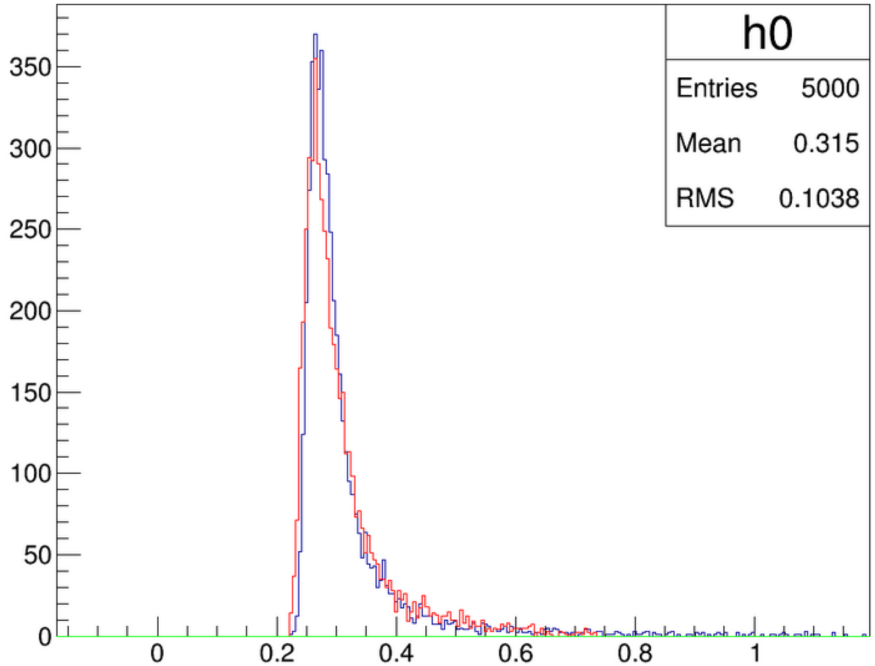
Setup: Fixed pass distance 0.1016cm for each event



- ❑ Look at the energy loss distribution for electron pass through carbon at fixed length 0.1016cm

- ❑ Blue is from fluctuation model
- ❑ Red is from old Landau function Landau (x, 4ε)

Model comparison

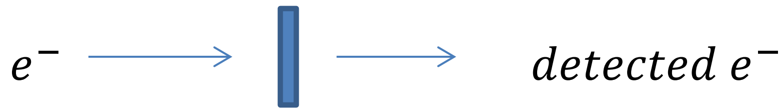


Energy loss/ MeV

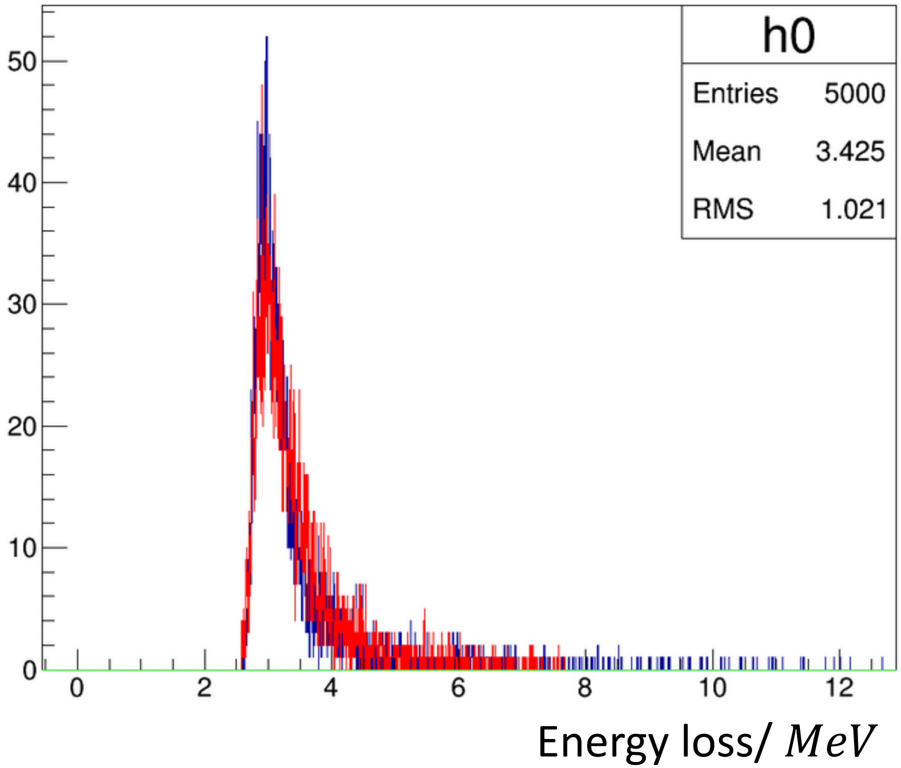
- ❑ Look at the energy loss distribution for electron pass through carbon at fixed length 0.1016cm

- ❑ Blue is from fluctuation model
- ❑ Red is from New Landau function Landau (x, ε)

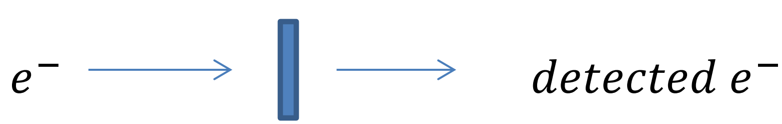
Fixed pass distance 0.1016cm for each event



Model comparison

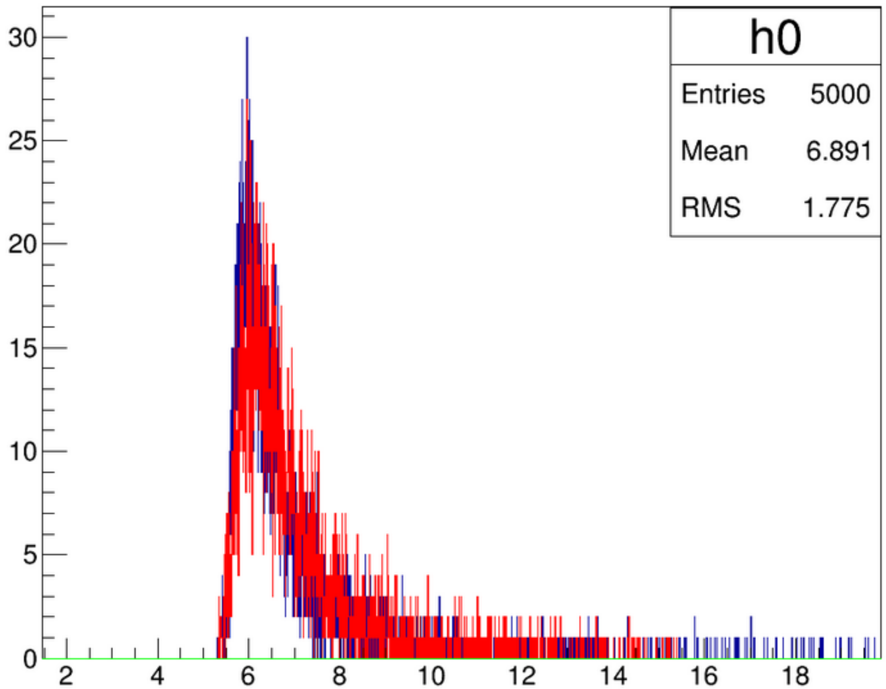


Fixed pass distance 1.016cm for each event



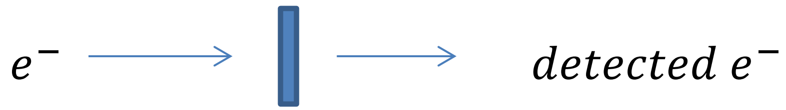
- ❑ Look at the energy loss distribution for electron pass through carbon at fixed length 1.016cm
- ❑ Blue is from fluctuation model
- ❑ Red is from New Landau function Landau (x, ε)

Model comparison



Energy loss/ MeV

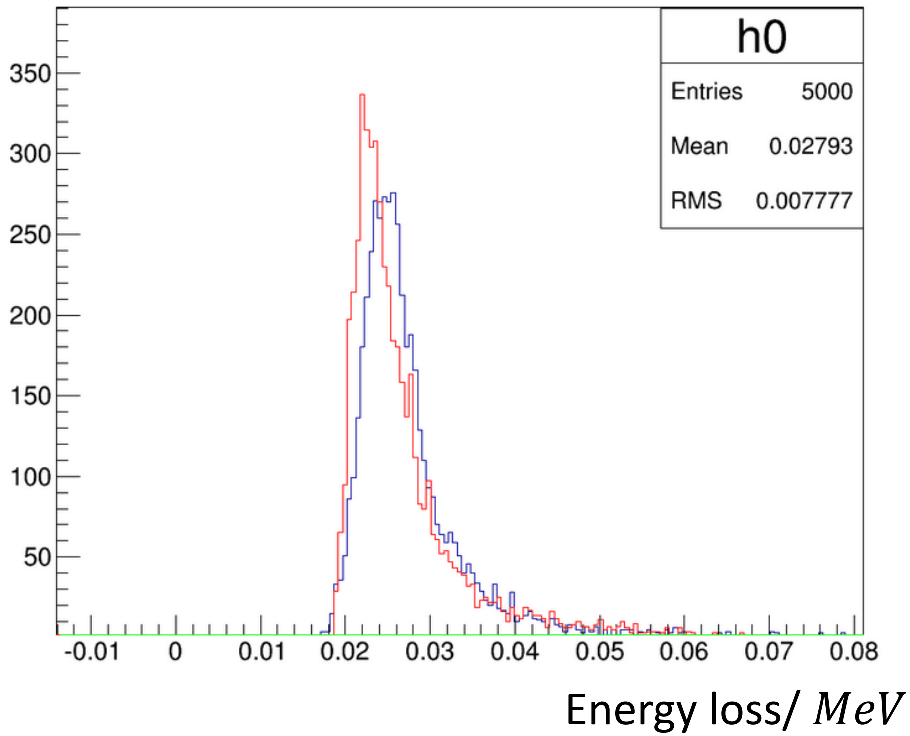
Fixed pass distance 2.016cm for each event



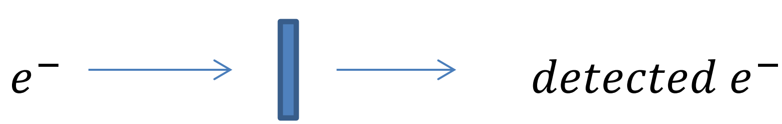
- Look at the energy loss distribution for electron pass through carbon at fixed length 2.016cm

- Blue is from fluctuation model
- Red is from New Landau function Landau (x, ε)

Model comparison



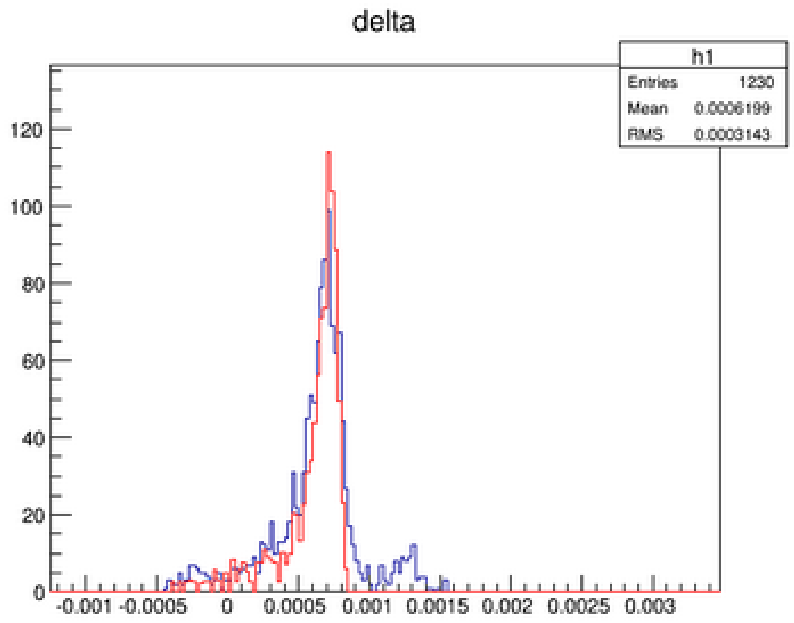
Fixed pass distance 0.01016cm for each event



- ❑ Look at the energy loss distribution for electron pass through carbon at fixed length 0.01016cm

- ❑ Blue is from fluctuation model
- ❑ Red is from New Landau function Landau (x, ε)

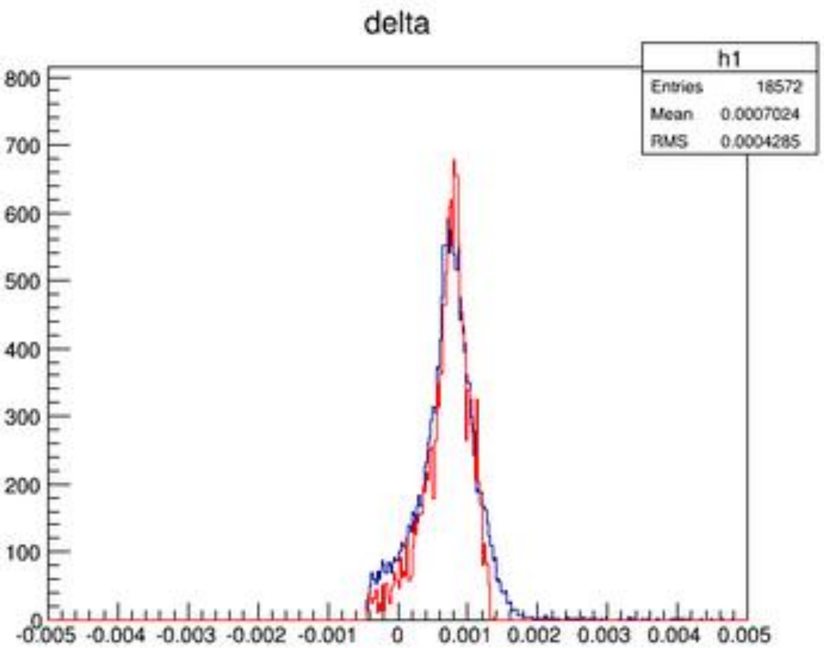
Model vs Data



- Blue: from data, *C* w/o He optics
- Red: is from ioni fluctuation + internal+external brem.
- center sieve hole

dp

Model vs Data



dp

- Blue: from data, C w/o He optics
- Red: is from ioni fluctuation + internal+external brem.
- Total sieve holes

Todo

- Check it in other type target
- Any suggestions?