Performance Study of the single electron tracking with INTT + EMCal

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Motivation

Improve electron tracking using INTT by adding calorimeters

There is possibility TPC detector do not work well.

→ By adding calorimeter hit point, the tracking quality is expected to improve.

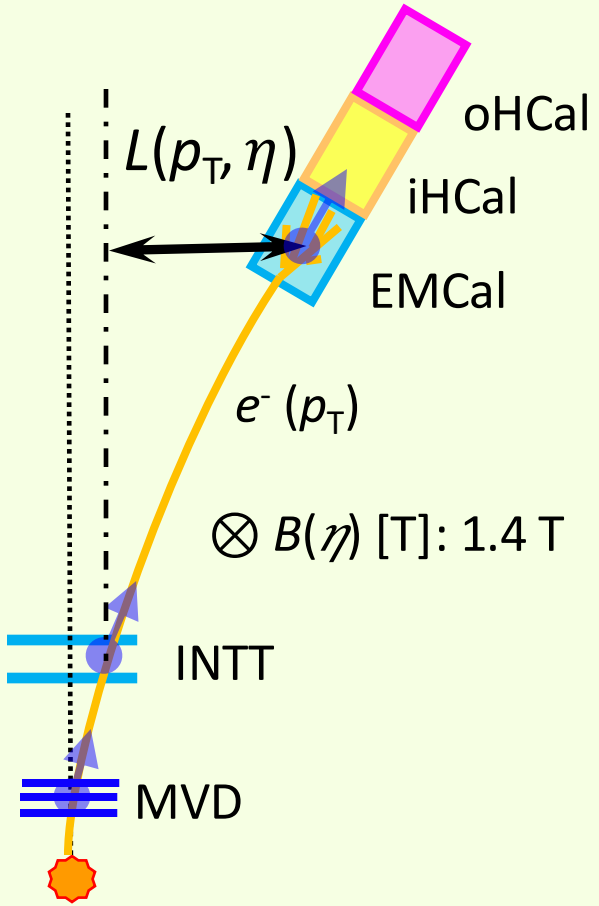
<Final goal>

Impove the E/p and reconstruct J/ψ

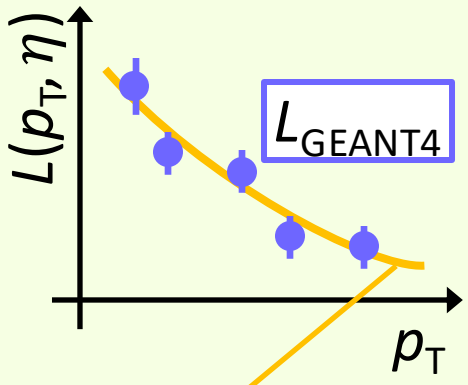
<Short term goal>

(1) Estimate the correlation $p_{T, e-}$ and how shift by magnetic field.

(2) Using the INTT and EMCal hit points, we estimate $p_{T, e-}$ and it's resolution ($\delta p_T = p_{T, reco} - p_{T, truth}$)

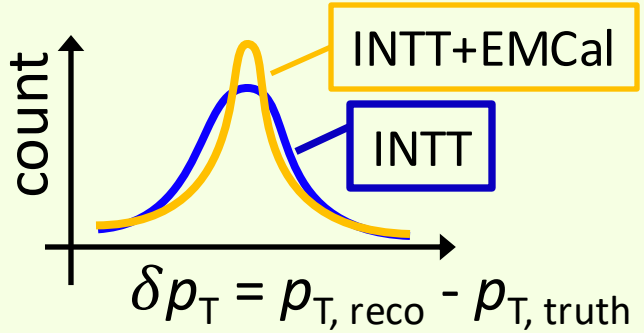


(1)



$$L(p_T, \eta) = \frac{C_1(\eta)}{p_T} + \frac{C_2(\eta)}{{p_T}^2}$$

(2)



Methods

Simulation: Single particle gun + GEANT4

Inject electron p_T : 0.5, 1, 2, 5, 8, 10 GeV/c (This talk is only 1 GeV/c)
Inject range: ϕ: $-\pi$ to π, η: -1 to 1
GEANT4 Setting: Magnet 1.4 T (not flat: However, I still do not check the detail)
Detector: MVTX, INTT, TPC, EMCal, iHCal, oHCal

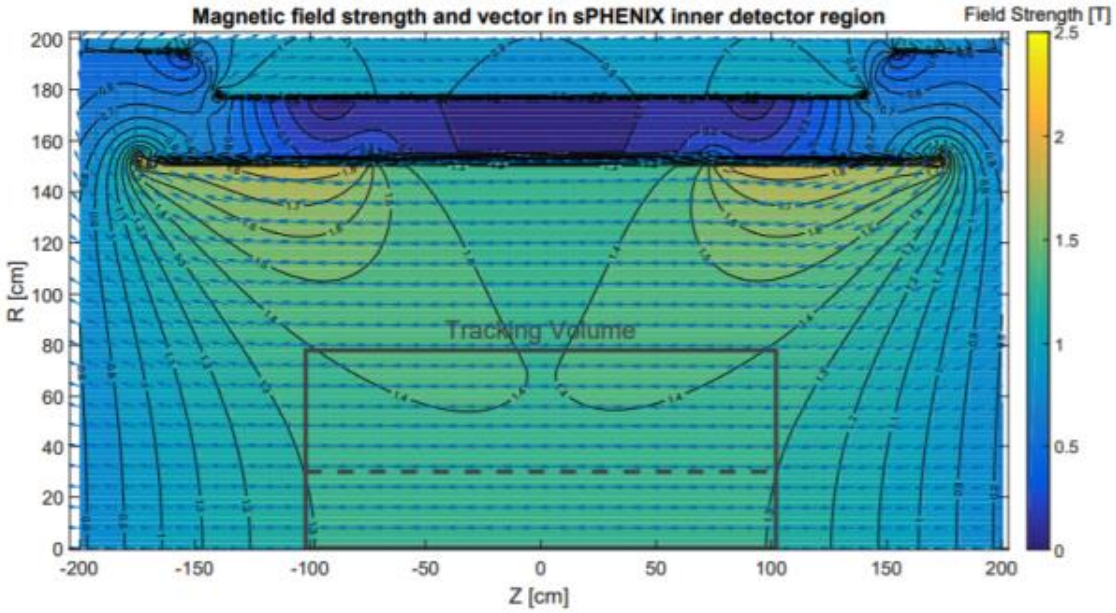


Figure 12. Field Map of the sPHENIX Solenoid

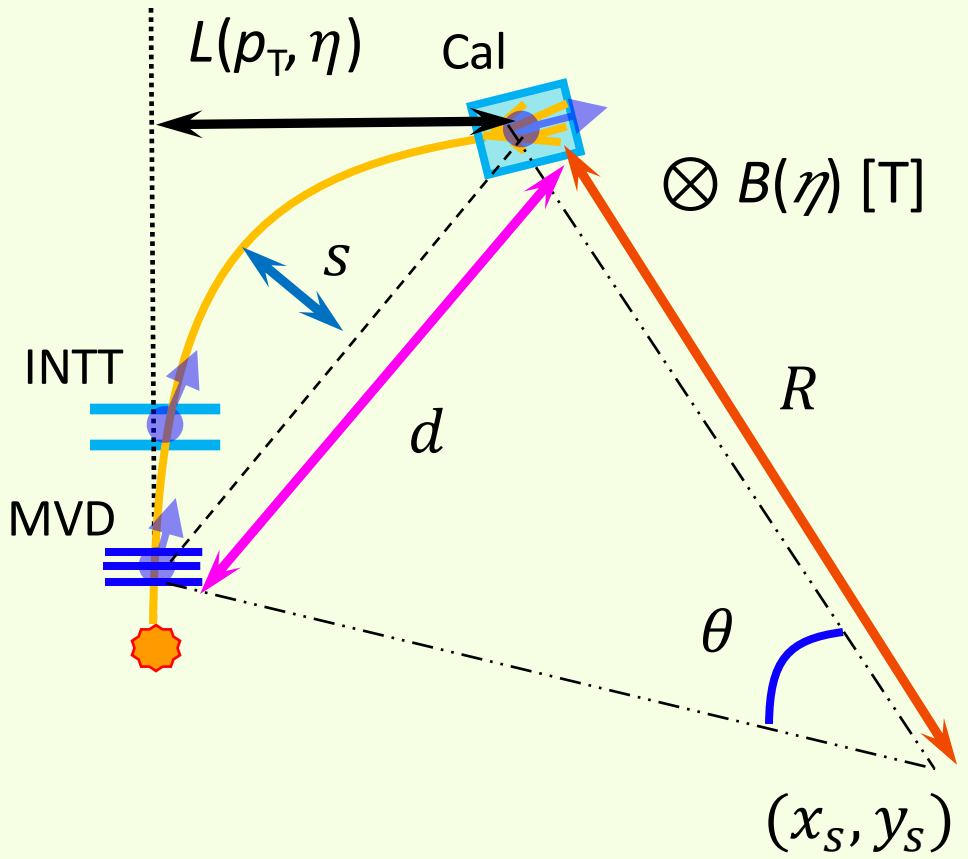
Estimate track p_T using the Sagitta equation

Sagitta p_T equation

$$p_T[\mathrm{GeV}] = qBR$$
$$= 0.3B[T]R[m]$$

Fitting the circle equation ($y = \sqrt{R^2 - (x - x_s)^2} + y_s{}^2$) for the three points (inner INTT, outer INTT, and EMCal) and estimate the *R*.

Using this *R*, the p_T can be calculated.



Hit Matching Algorithm

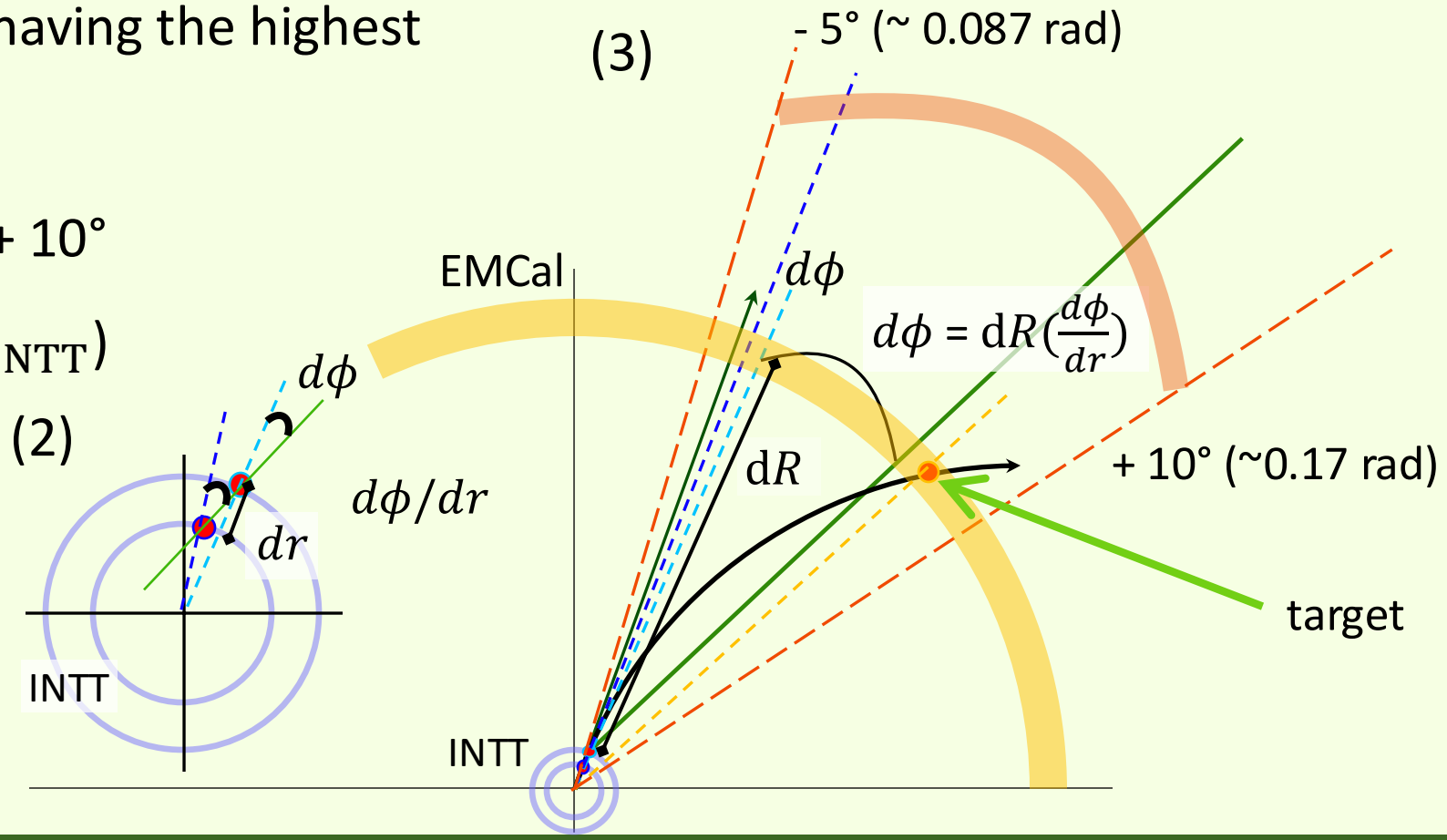
(1) Find a inner INTT cluster having the closest $\phi_{\text{outer INTT}}$

(2) Caclulate $d\phi/dr$ (outer INTT - inner INTT)

(3) Searching for an EMCal cluster having the highest energy in the ϕ_{Cal} range

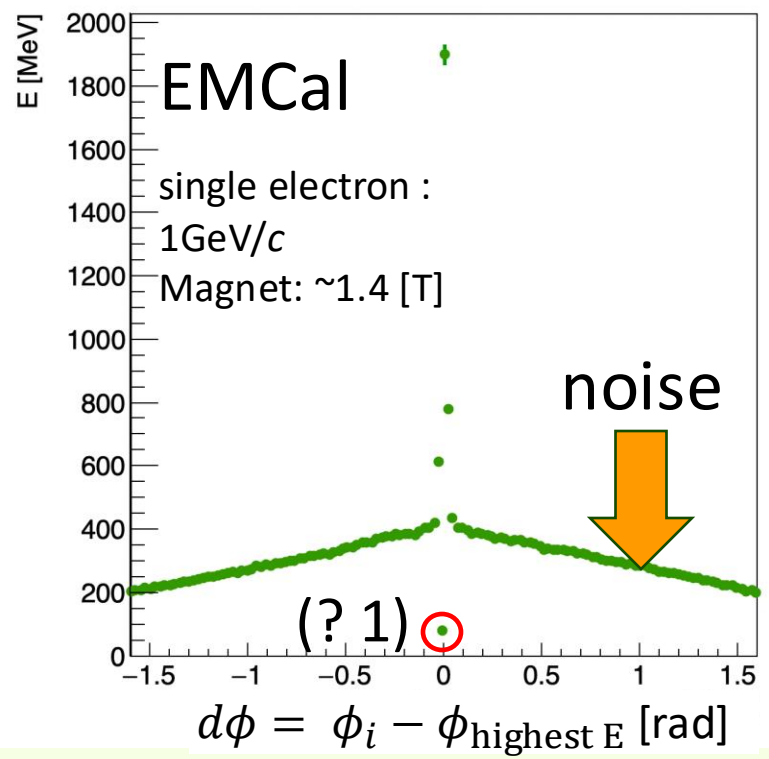
ϕ_{INTT} - 5° < ϕ_{Cal} < ϕ_{INTT} + $d\phi_{\text{Cal}}$ + 10°

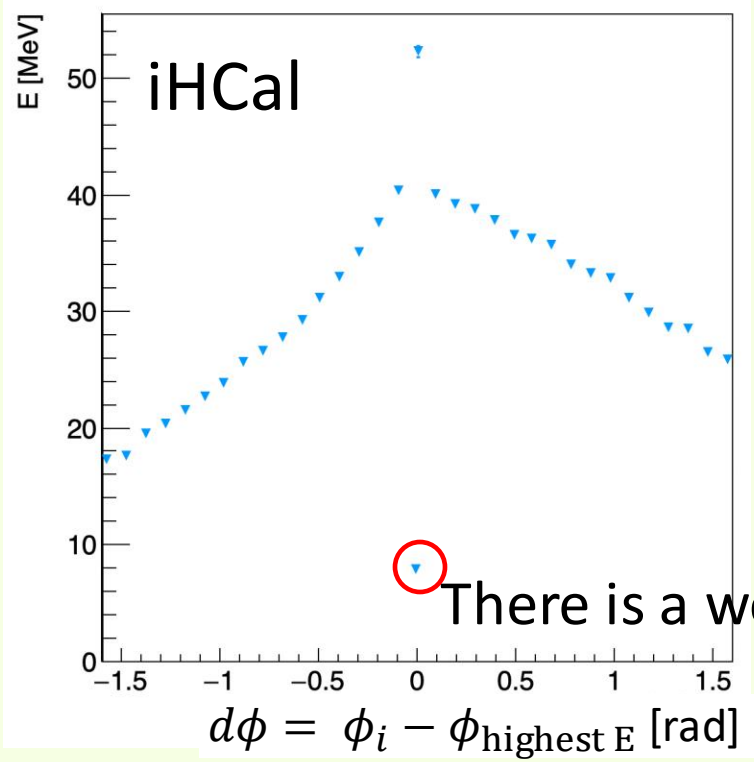
$$d\phi_{\text{Cal}} = d\phi/dr * (R_{\text{EMCal}} - R_{\text{INTT}})$$

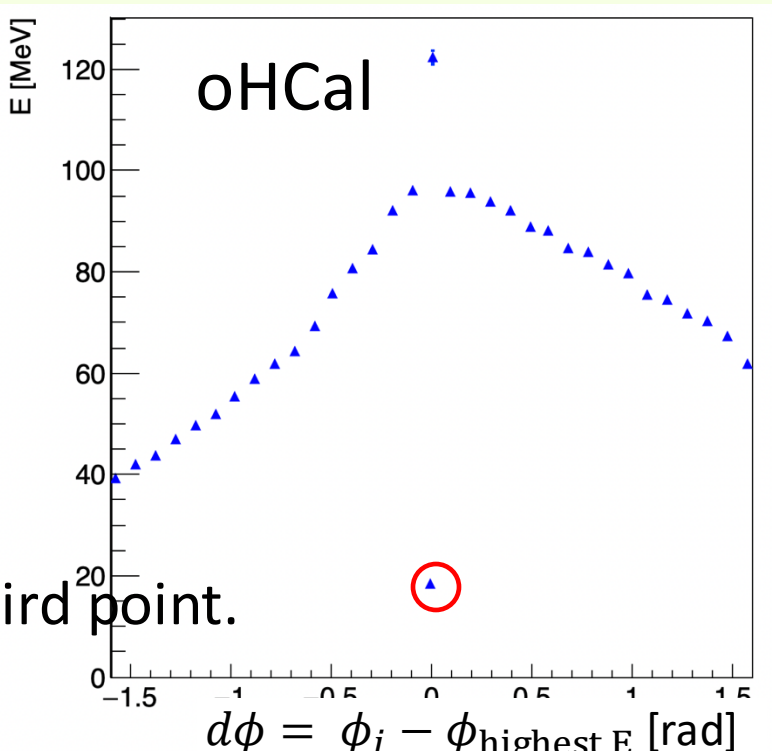


Calorimeter Deposit Energy Dispartion

Check the criteria to use a tower having the highest energy







- Electron deposits its most energy in a tower (not much dispersed).

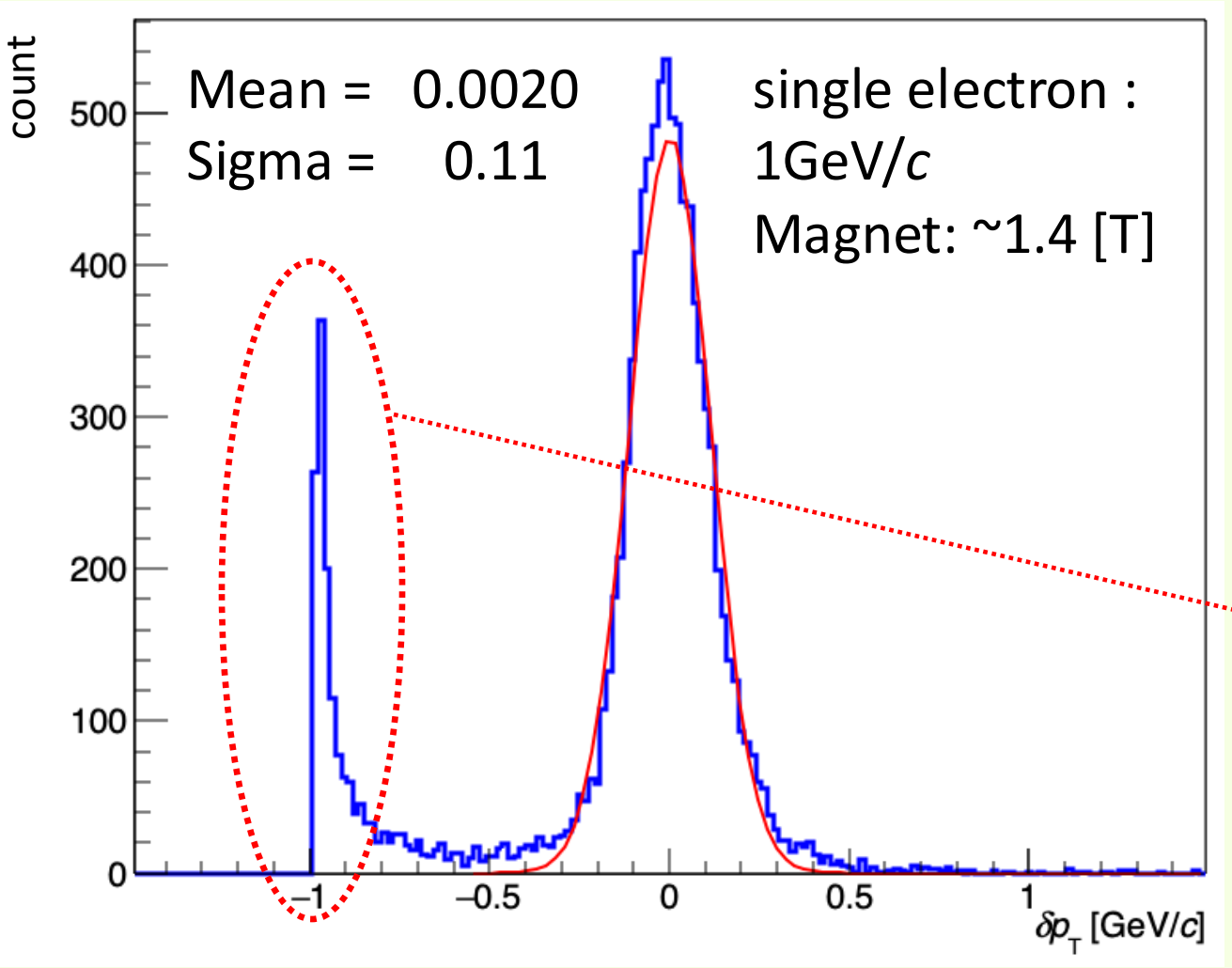
→ It seems well to use only the highest energy tower, temporally.

(1) Search for the wired point

(2) Make a map phi-eta (now project 2D map to phi direction)

Without EMCal Hit Tracking p_T resoltion

Vertex+iINTT+oINTT



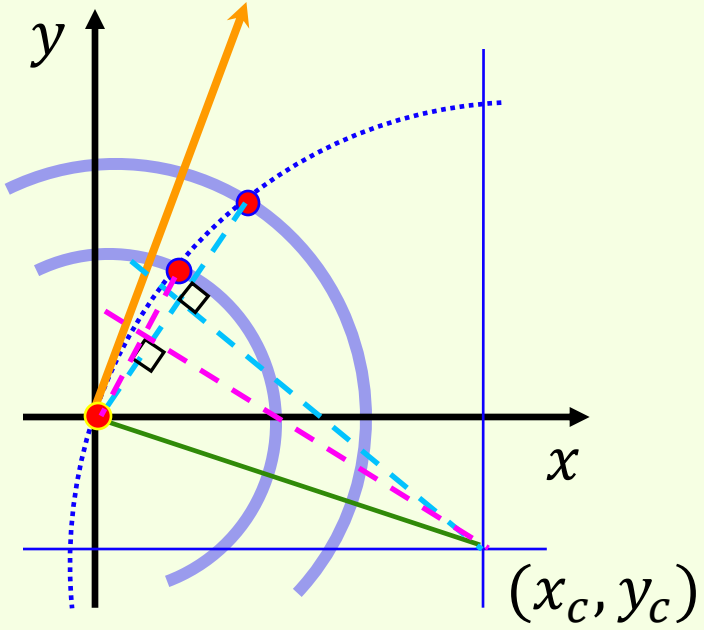
- the resolution is consistent with NWU's study (~10%)
 + Peak center close to 0

- Wird peak

reco - truth

Without EMCal Hit Tracking p_T resoltion

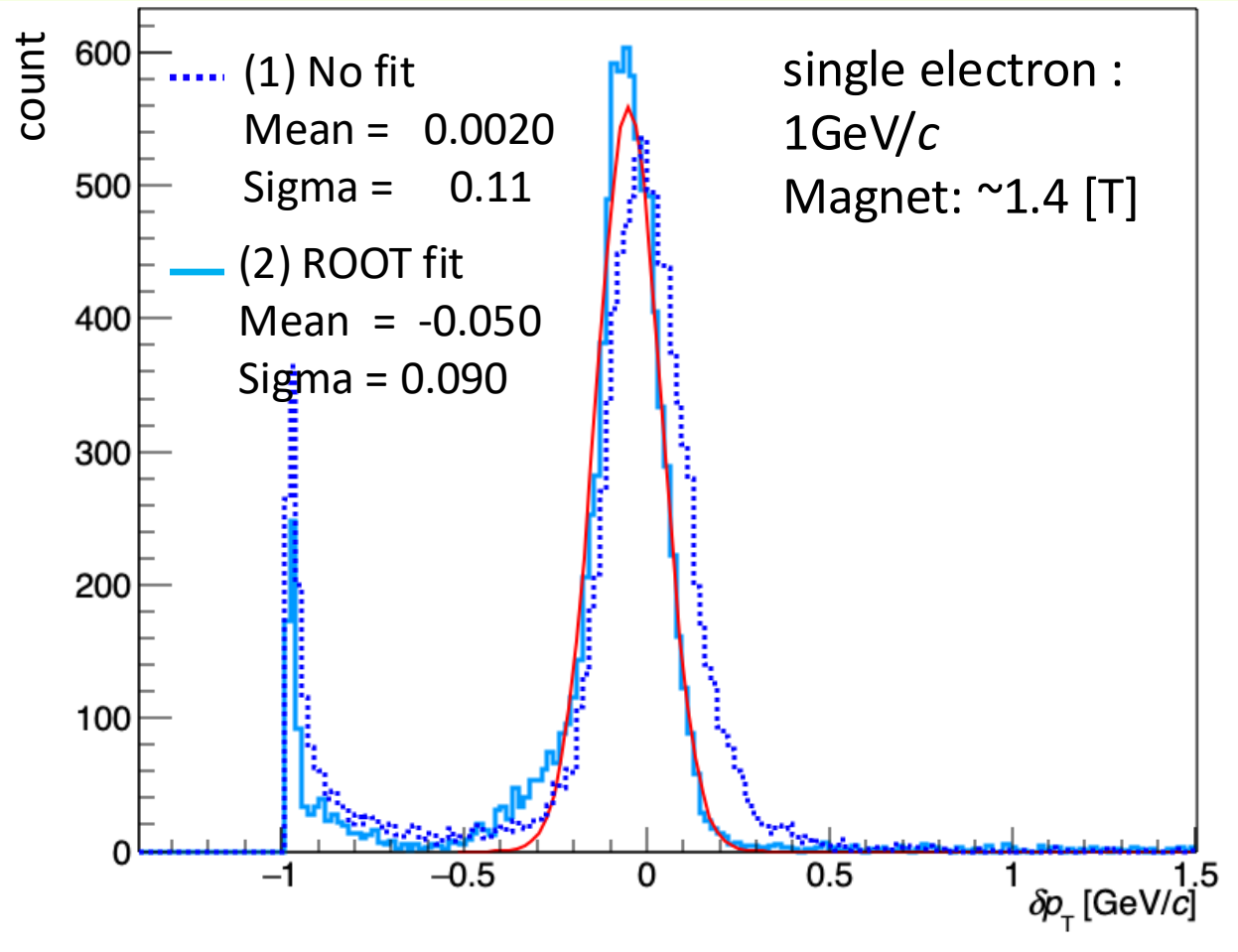
(1) No fit approach (The last page result)



(2) Use ROOT fit ($y = \sqrt{R^2 - (x - x_c)^2} - y_c$)

The fit result's width becomes narrow, but the peak shifts to negative.

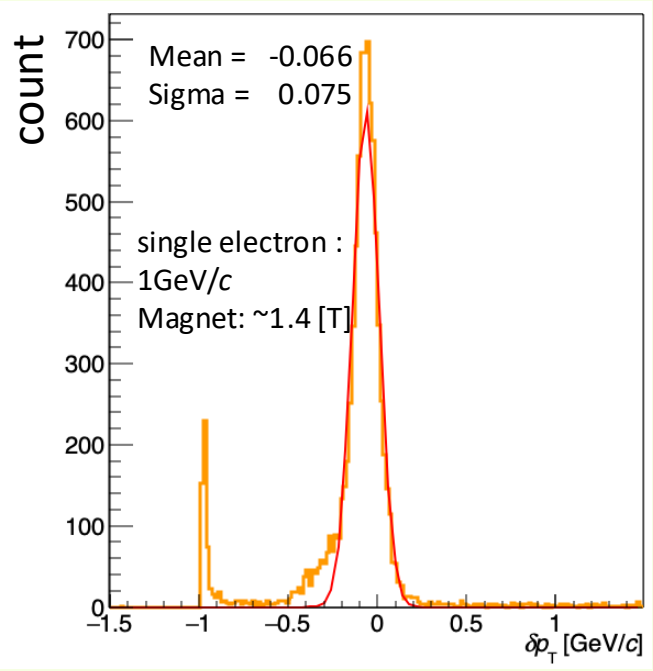
Vertex+iINTT+oINTT



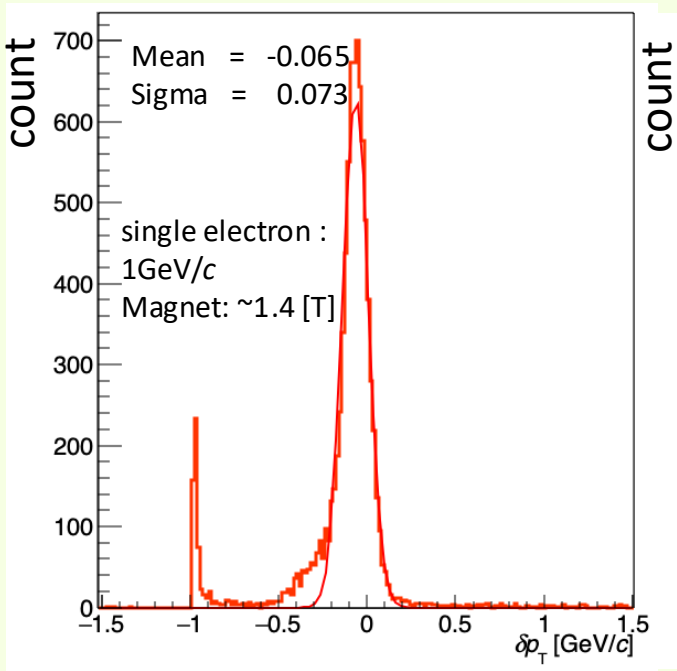
reco - truth

Use some detectors p_T resoltion

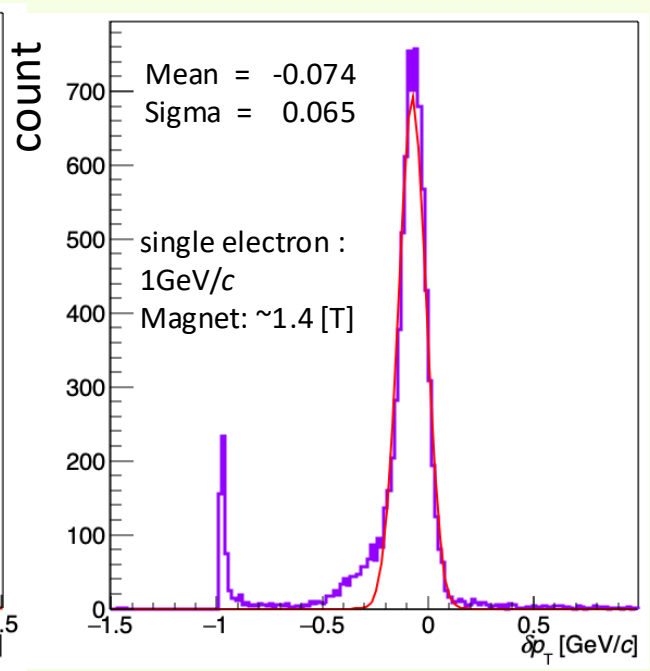
iINTT+oINTT+EMCal



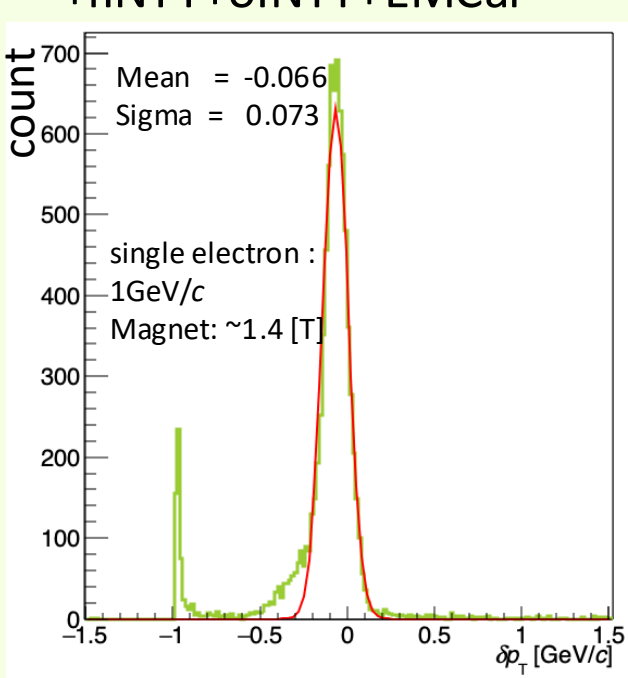
Vertex+iINTT+oINTT+EMCal



MVTX+iINTT+oINTT+EMCal



Vertex+MVTX
+iINTT+oINTT+EMCal

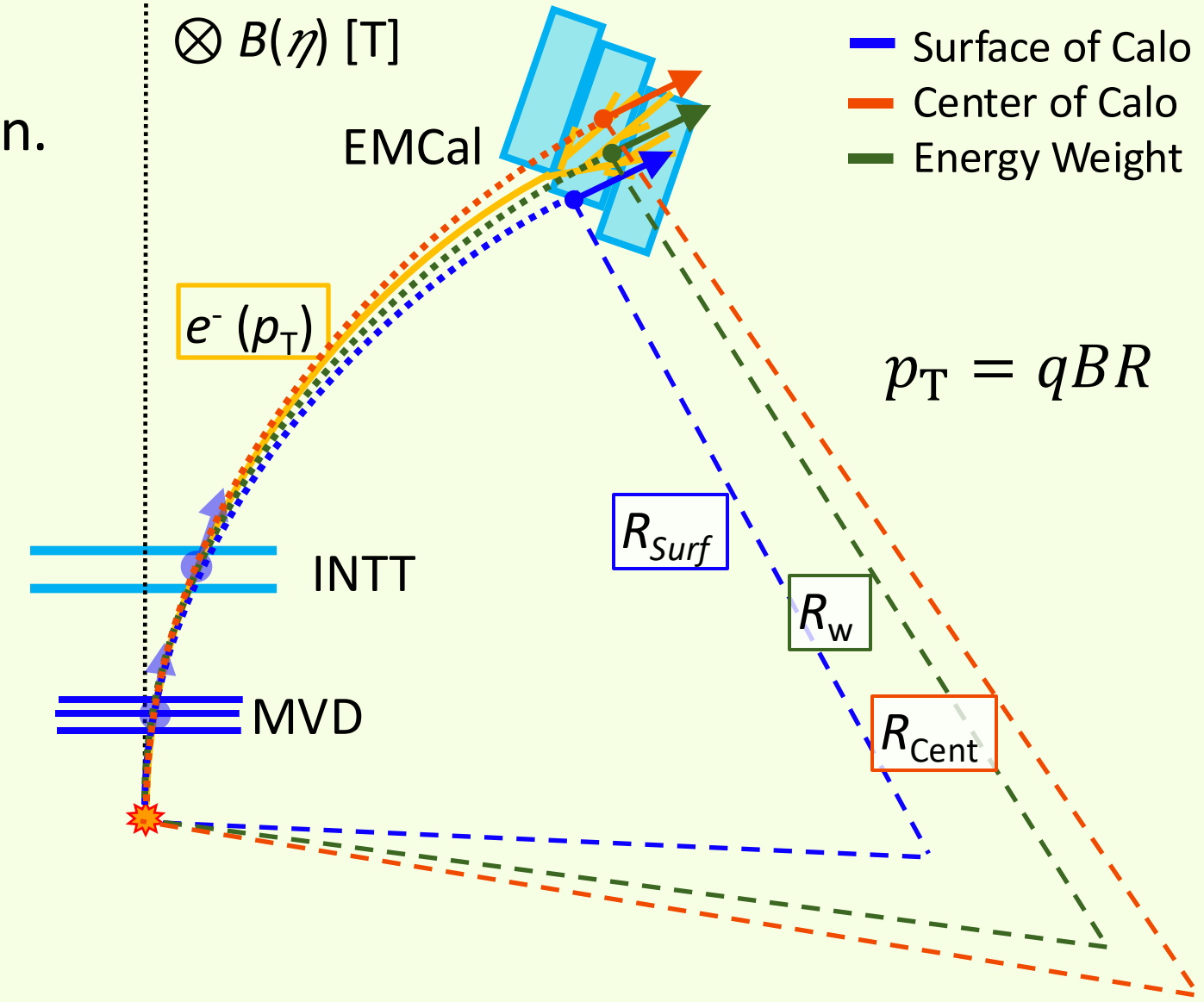


The resolution become better, but not so good even the best one.
And the peak is not zero...

Understand the Way to Make a Calorimeter's Tower/Cluster

Clastering way and the postion is very sensitive for the p_{T} estimation.

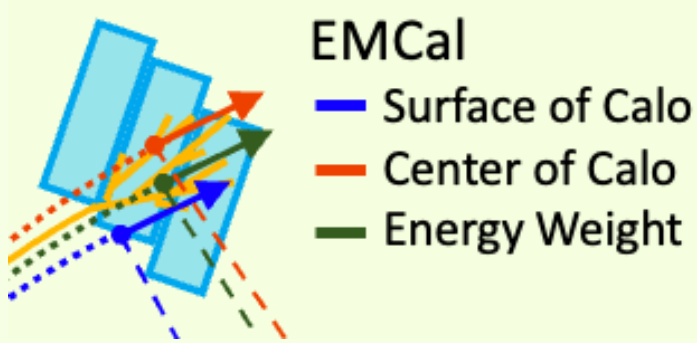
→ Need to modify clustering or shift position.



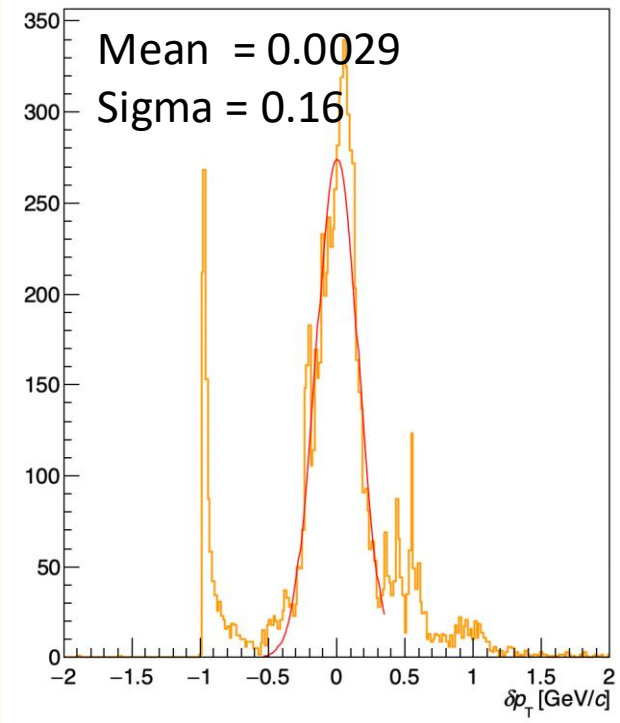
EMCal position shift p_T resoltion

I tried to move the Calorimeter geometry hit position from the surface to the center.

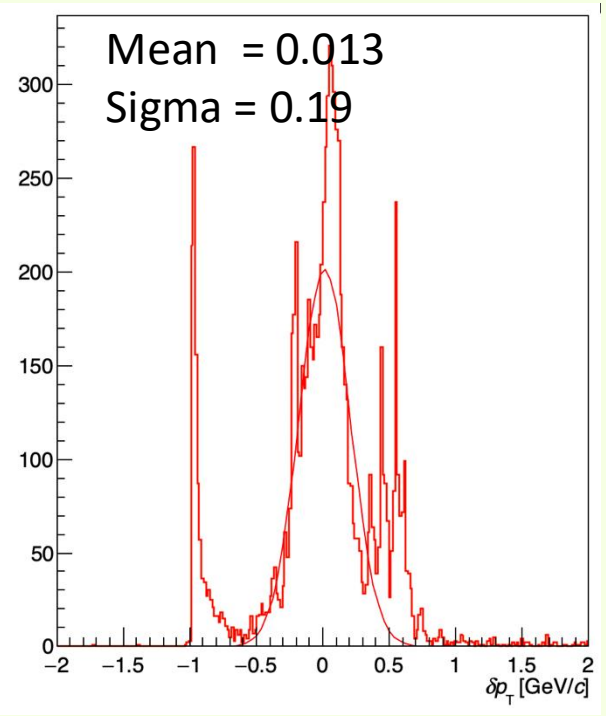
However, the result becomes worse and the peak is separated.



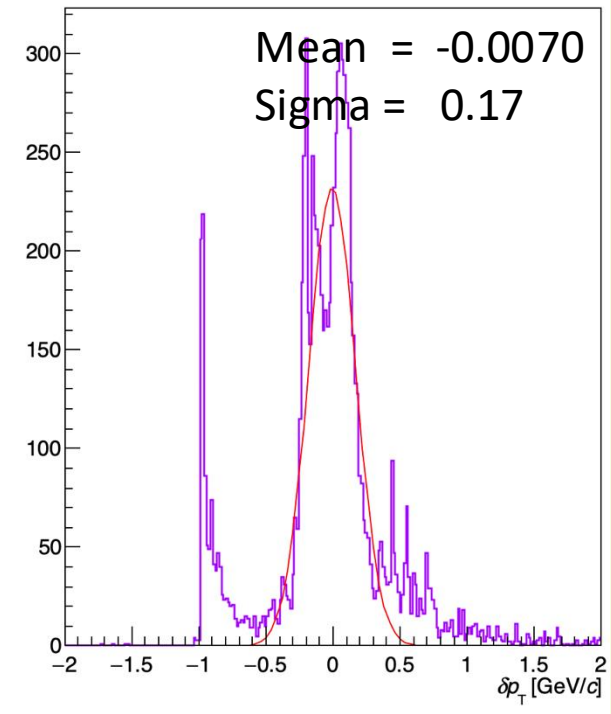
iINTT+oINTT+EMCal



Vertex+iINTT+oINTT+EMCal

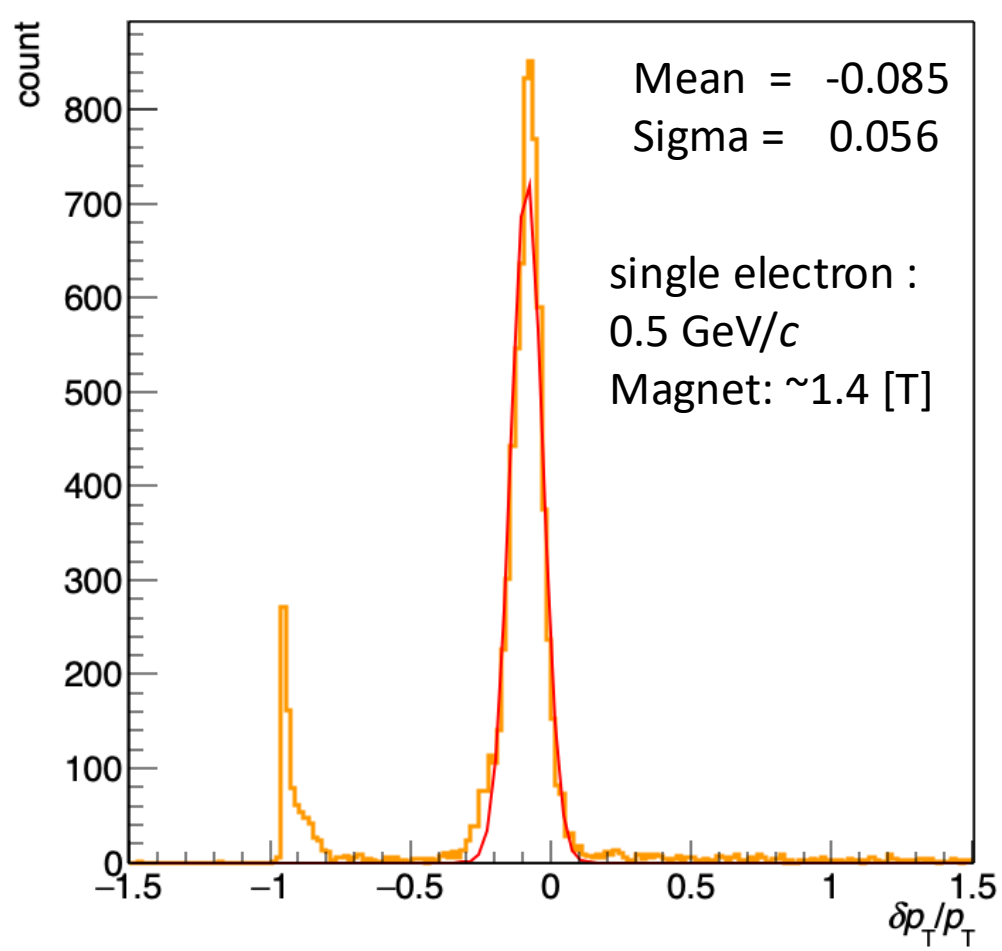


MVTX+iINTT+oINTT+EMCal

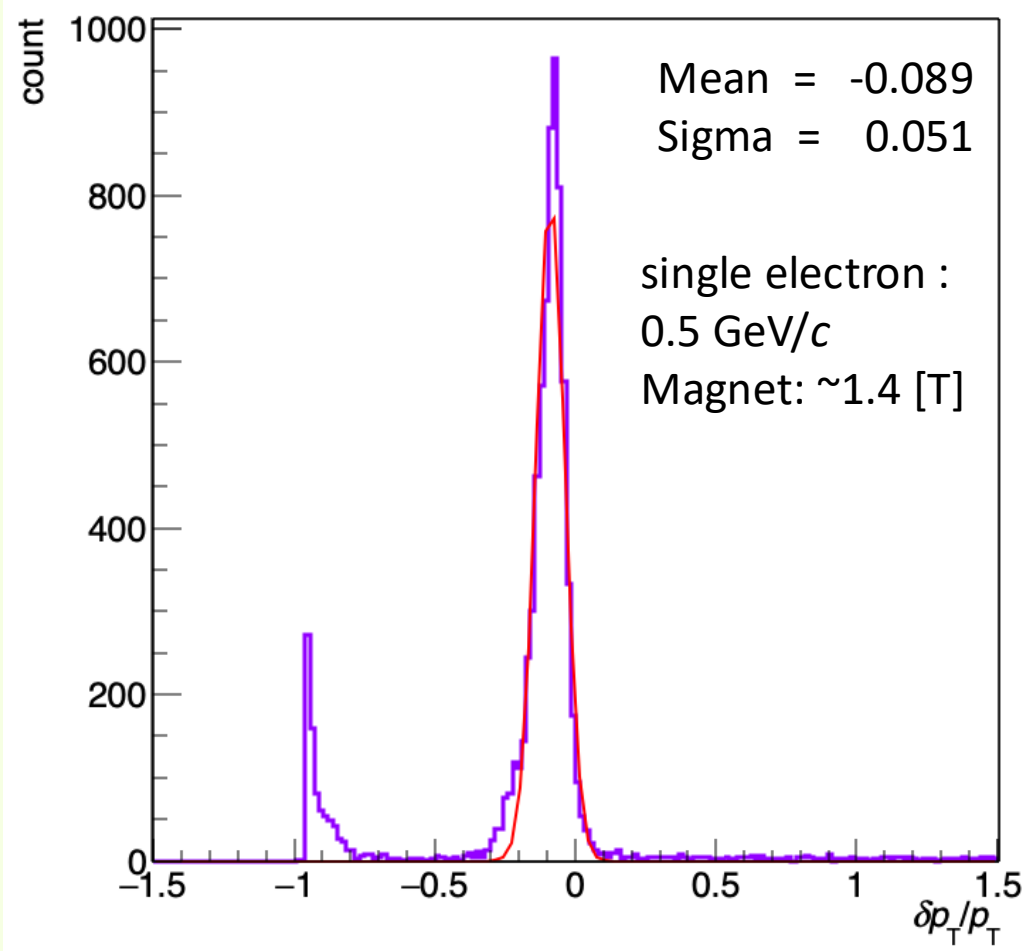


Use some detectors p_T resoltion (0.5 GeV/c)

iINTT+oINTT+EMCal

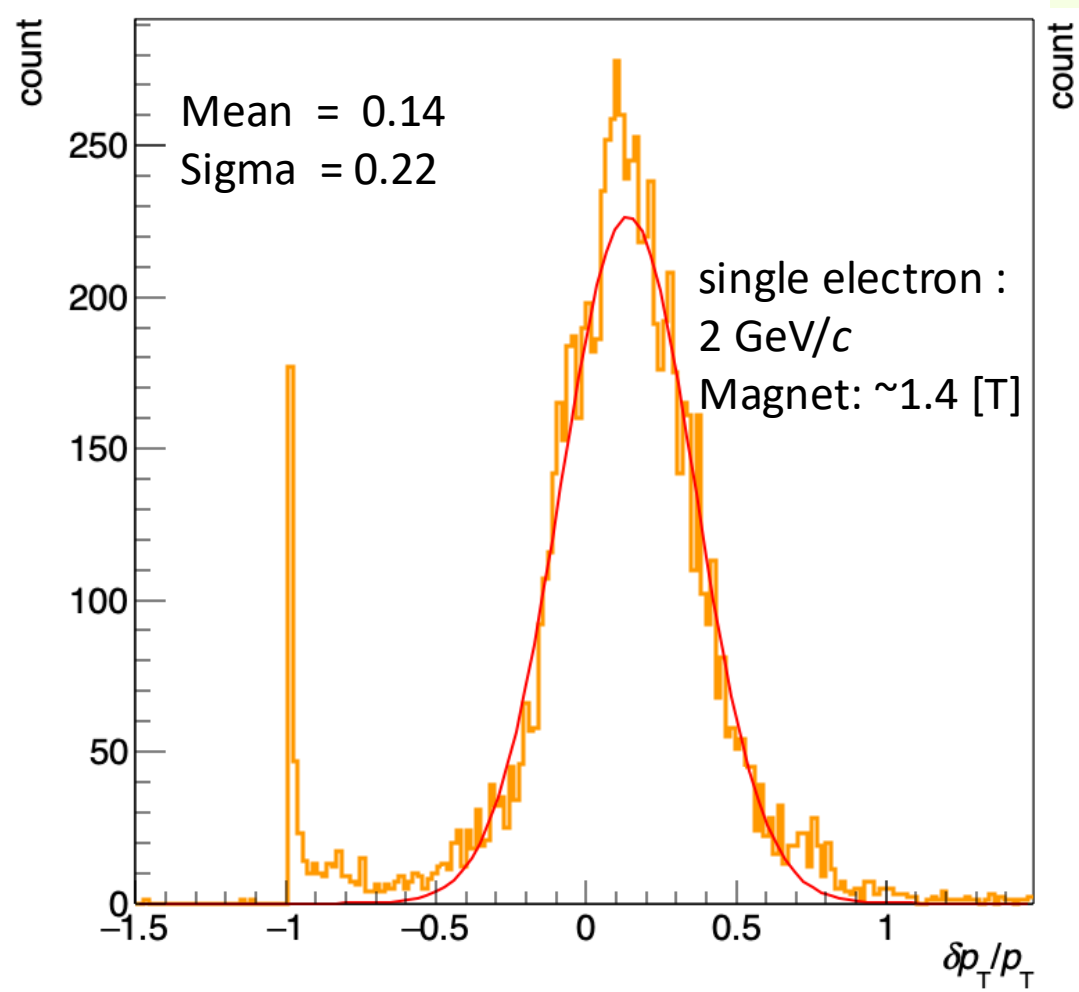


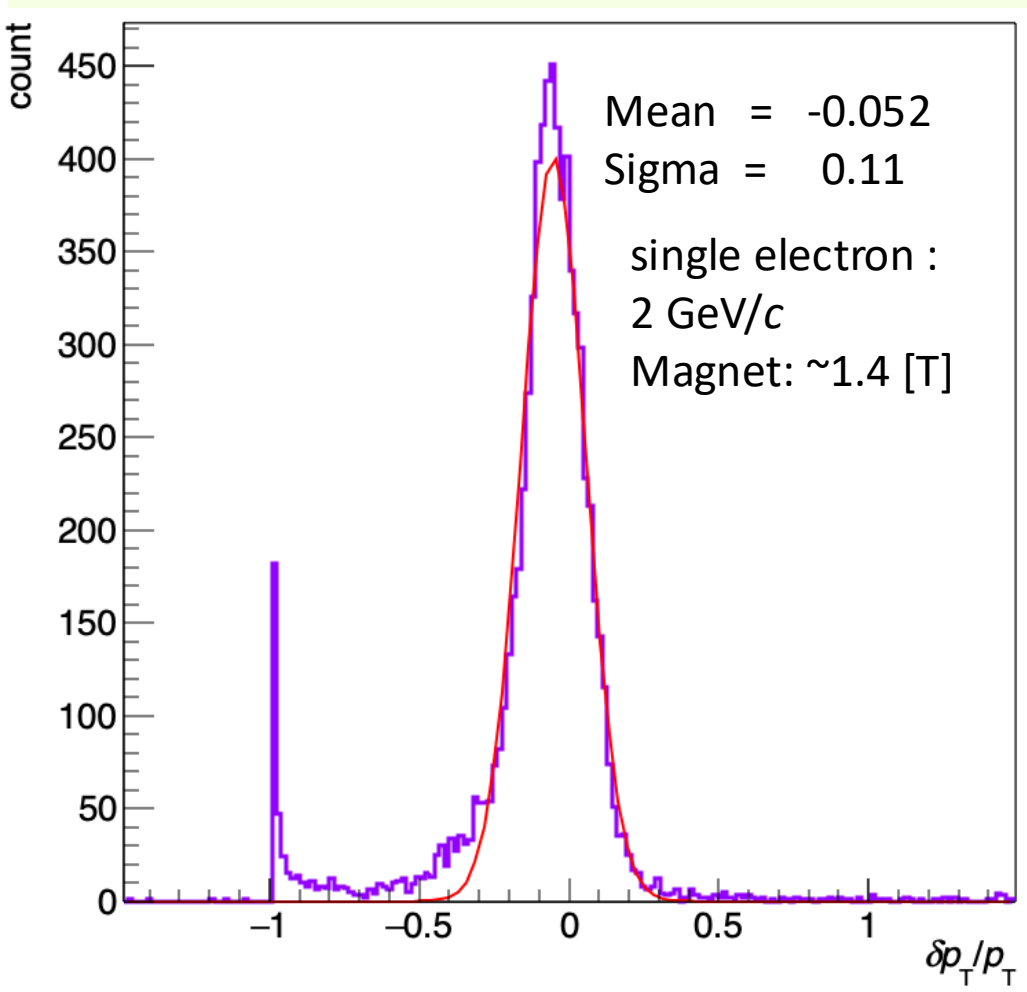
MVTX+iINTT+oINTT+EMCal



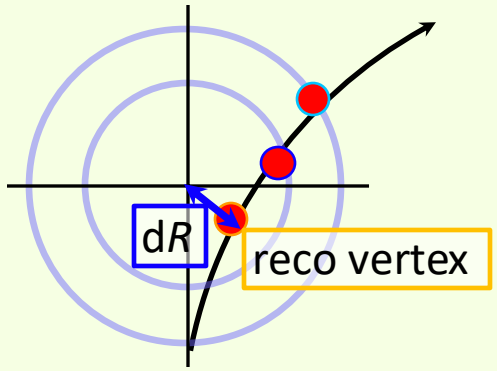
Use some detectors p_T resoltion (0.5 GeV/c)

iINTT+oINTT+EMCal

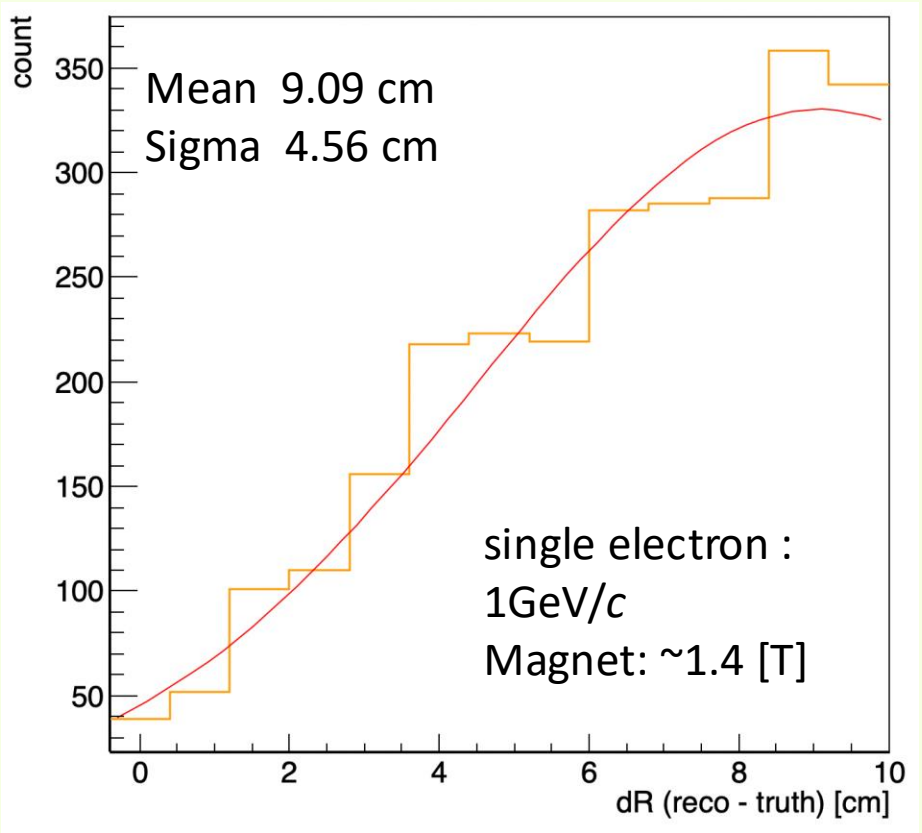




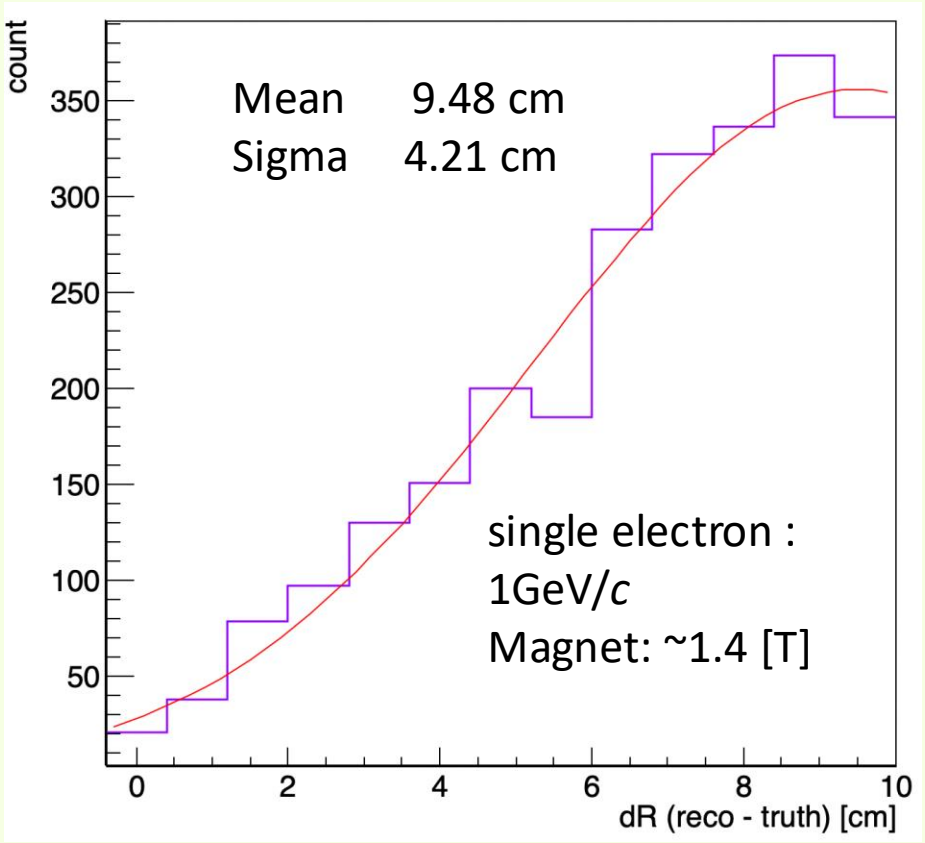
Vertex Estimation



iINTT+oINTT+EMCal



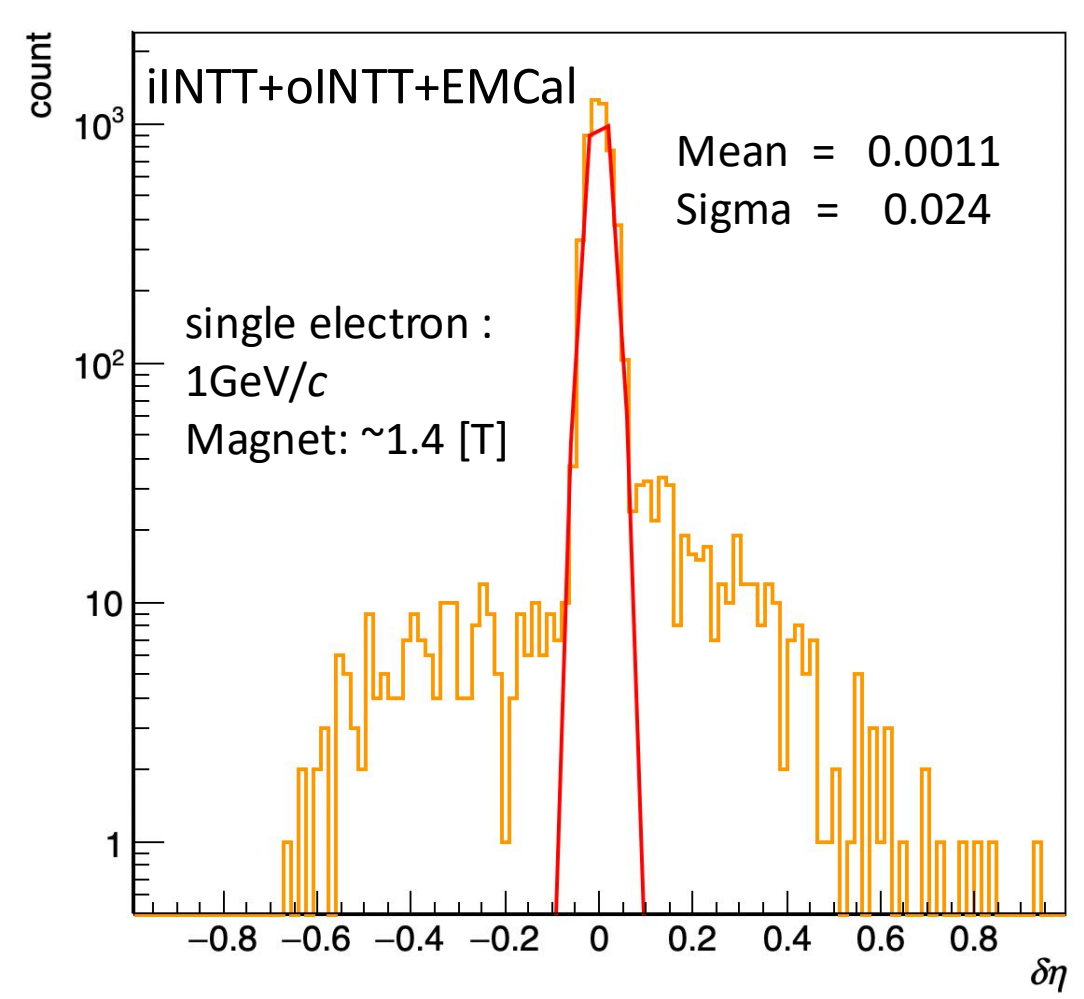
MVTX+iINTT+oINTT+EMCal

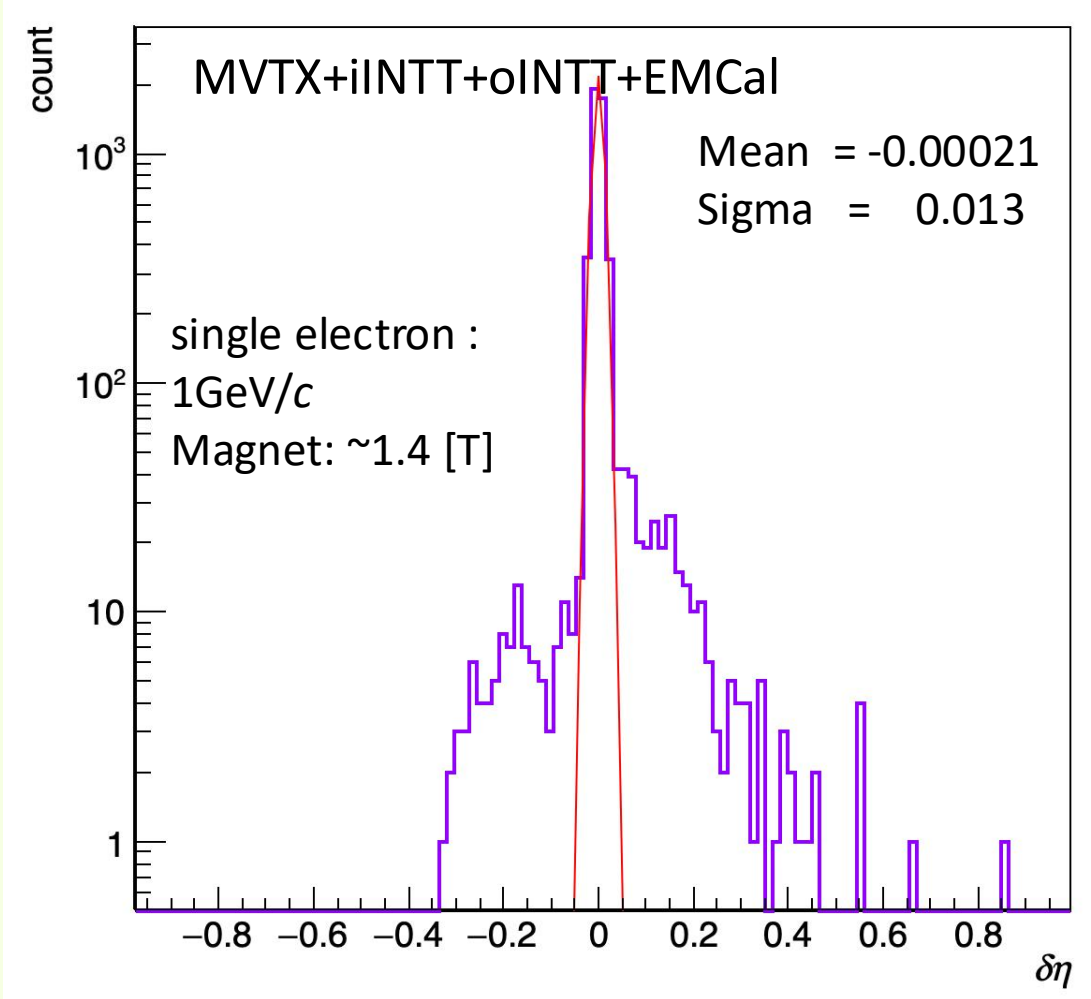


The distribution width is still so large. I have to improve it.

→ I expect that using some tracks (PYTHIA) can improve the vertex position.

eta resolution

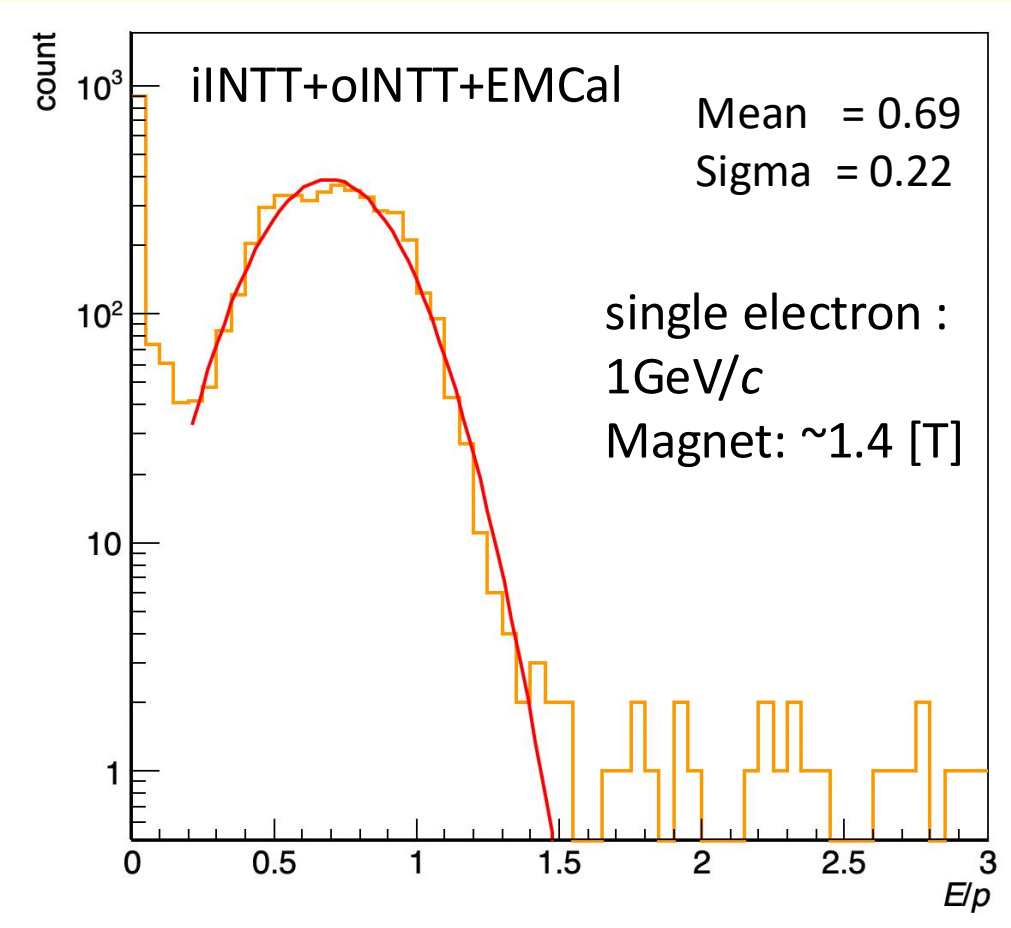


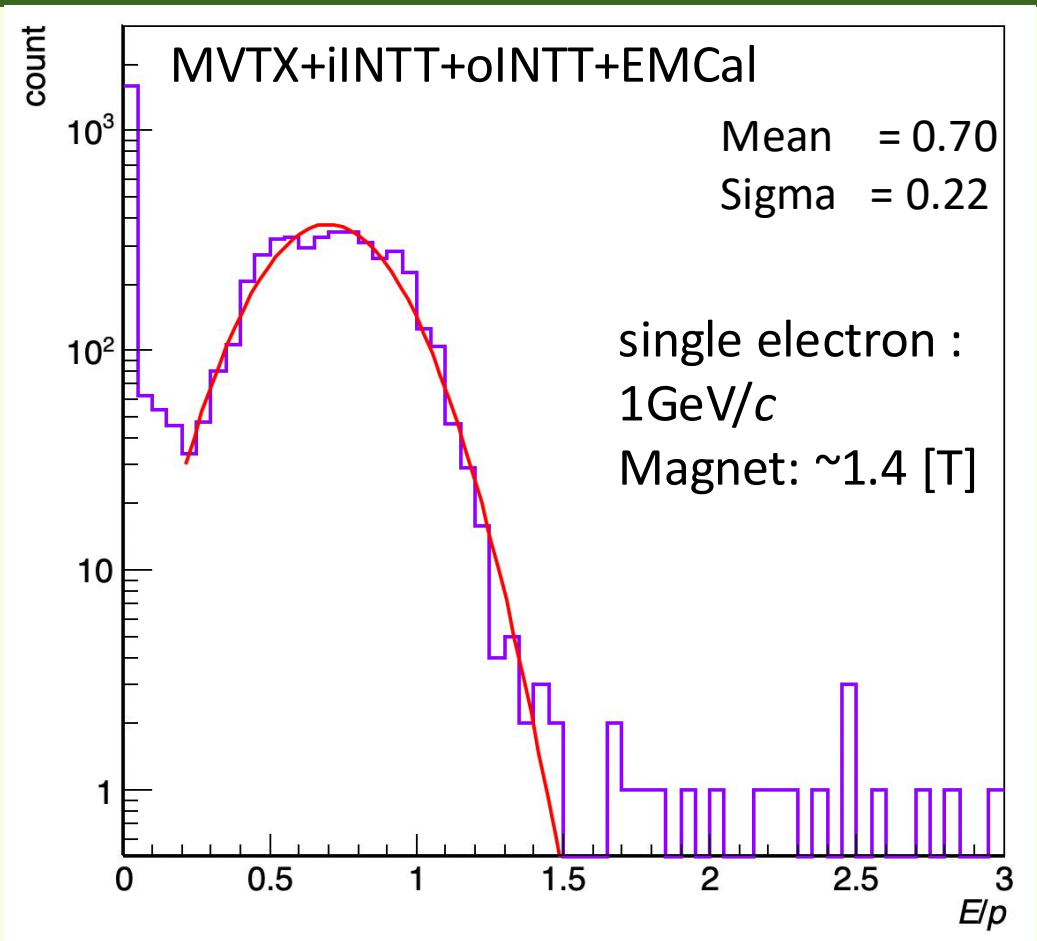


reco - truth

I should've estimated dθ....

E/p





The peak is expected around 1. ($E = \sqrt{m^2 + p^2}$, $m \ll p \rightarrow E = p$

However, the value is smallear than 1.

I should try to add iHCal and oHCal energy.

Outlook

1. Have to check some weird points of my results.
2. Increase p_T range of single electrons (p_T = 0.5, 1, 2, 5, 8, 10 GeV/c)

→ Thanks to Cheng-Wei, the single electron samples were already made.

3. Check and summarize what does the calorimeter tower making and clustering do
4. Check that it work in PYTHIA simulation (tracking efficiency, p_T resolution)
5. Make event displays

My schedule

- Dec 2nd week: Finish 2, 3.
- Dec 3rd week: I would like to take over this study for anyone.