INTT Seeding Tracking Performance Study

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Aim of this study

Improve electron tracking using INTT by adding calorimeters

There is possibility TPC detector do not work well.

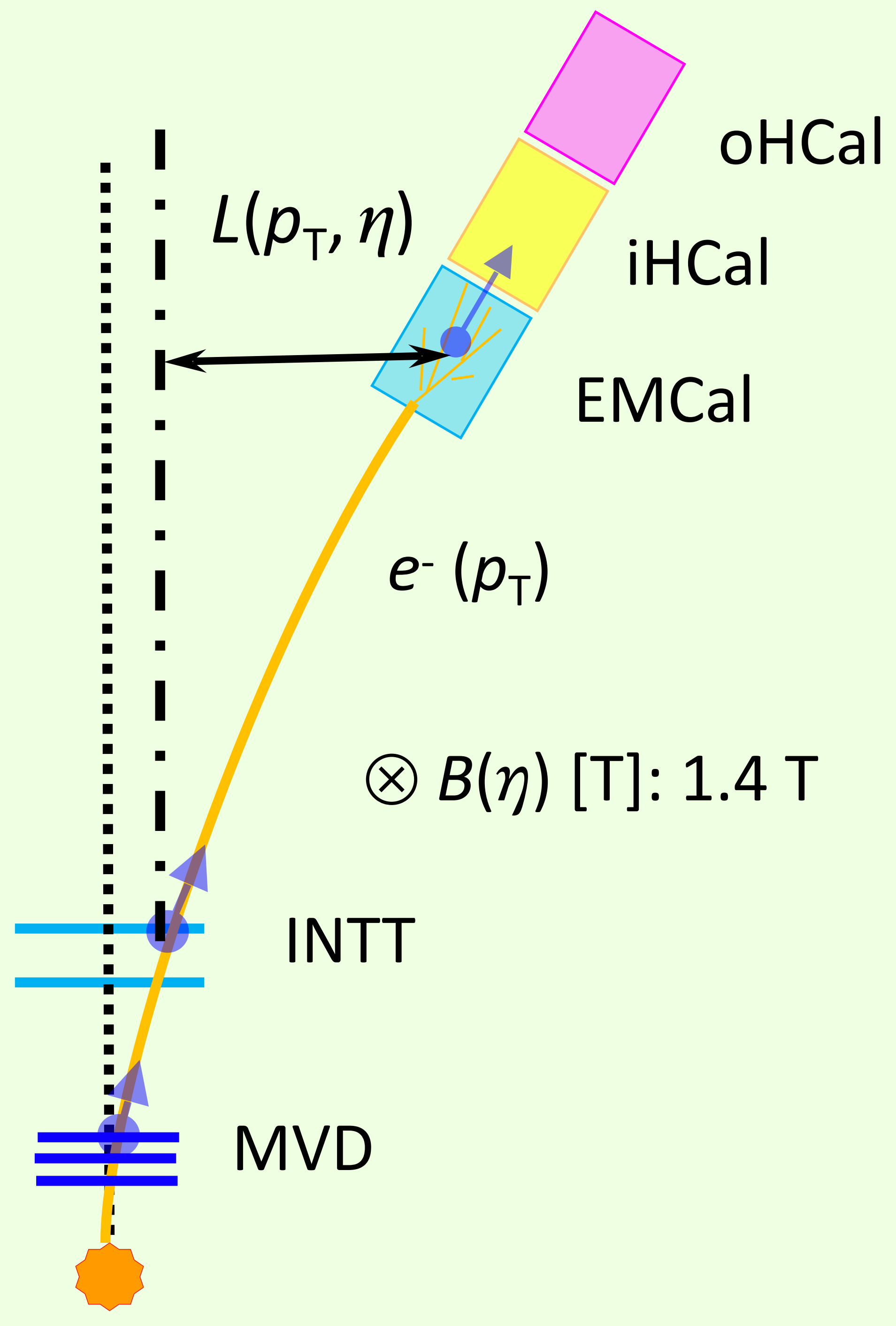
→ By adding calorimeter hit point, the tracking quality is expected to improve.

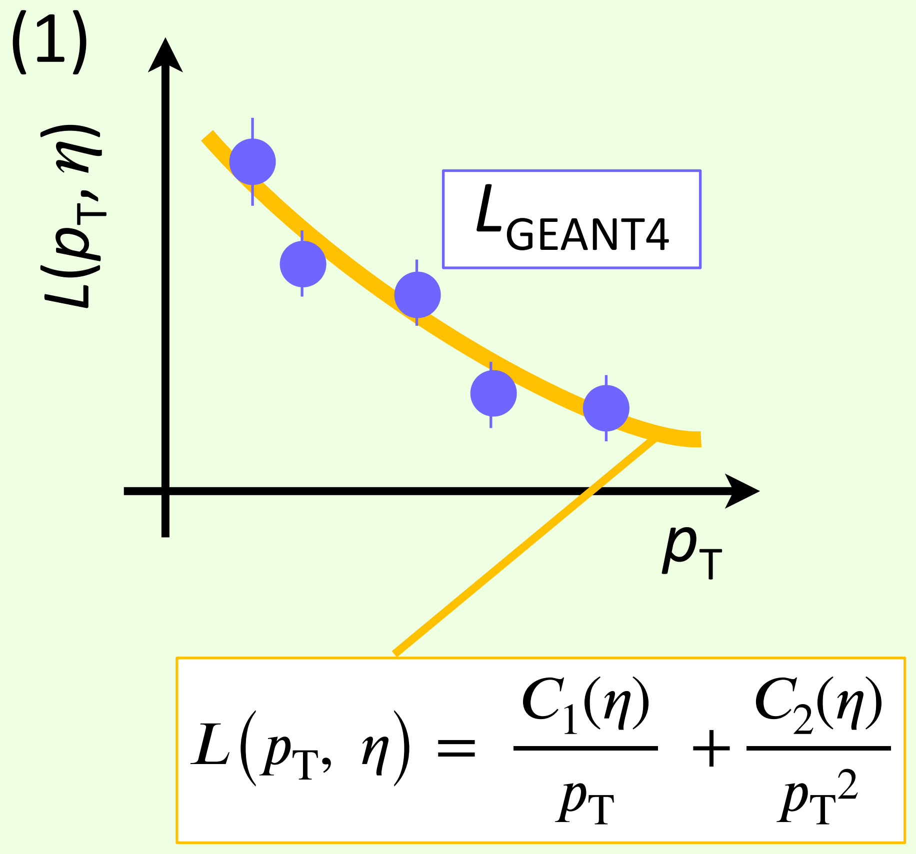
<Final goal> Improve the E/p and reconstruct J/ψ

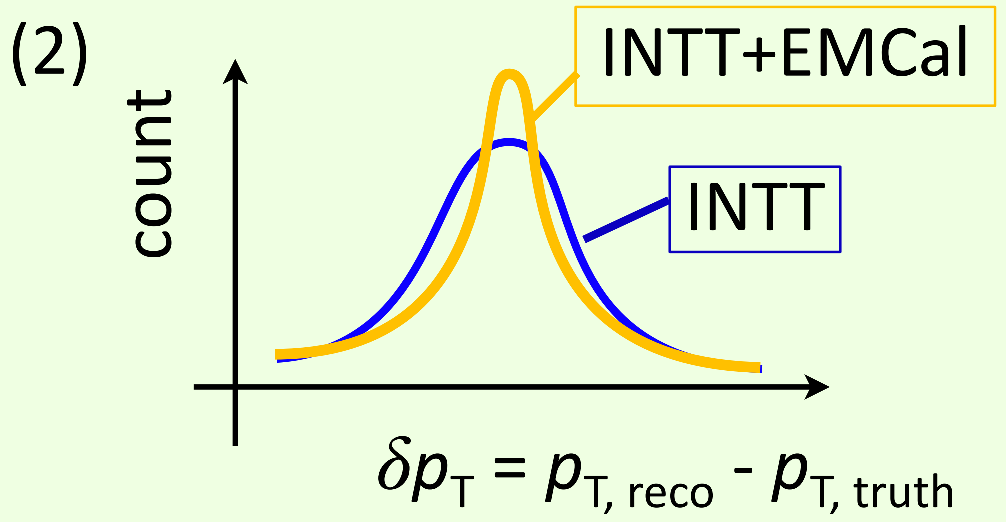
<Short term goal>

(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
($\delta p_T = p_{T,\,reco} - p_{T,\,truth}$)







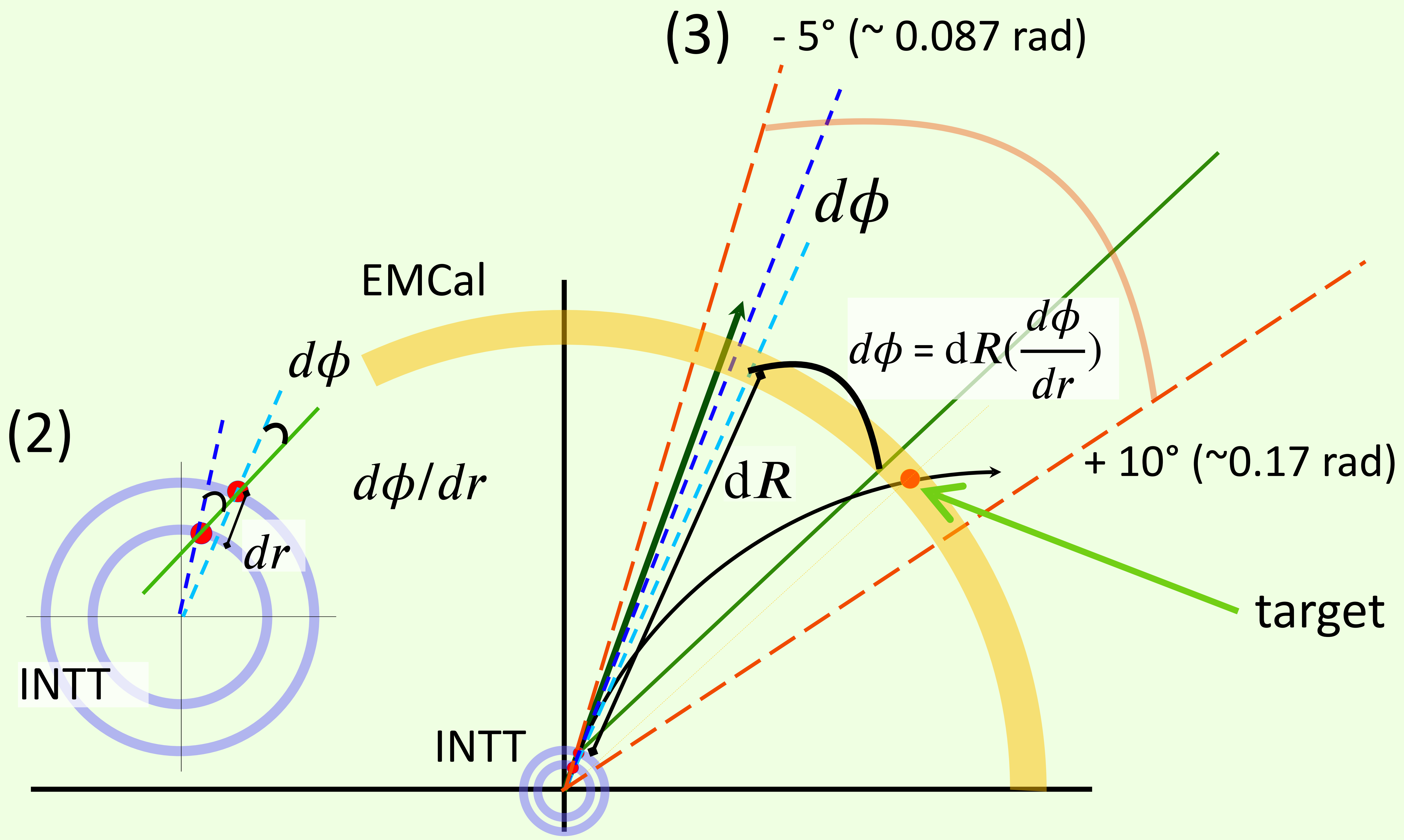
INTT + EMcal Hit Matching Algorithm

(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 (> 0.1 MeV) having the highest energy in the ϕ_{Cal} range ϕ_{INTT} - 5° < ϕ_{Cal} < ϕ_{INTT} + $d\phi_{\text{Cal}}$ + 10°

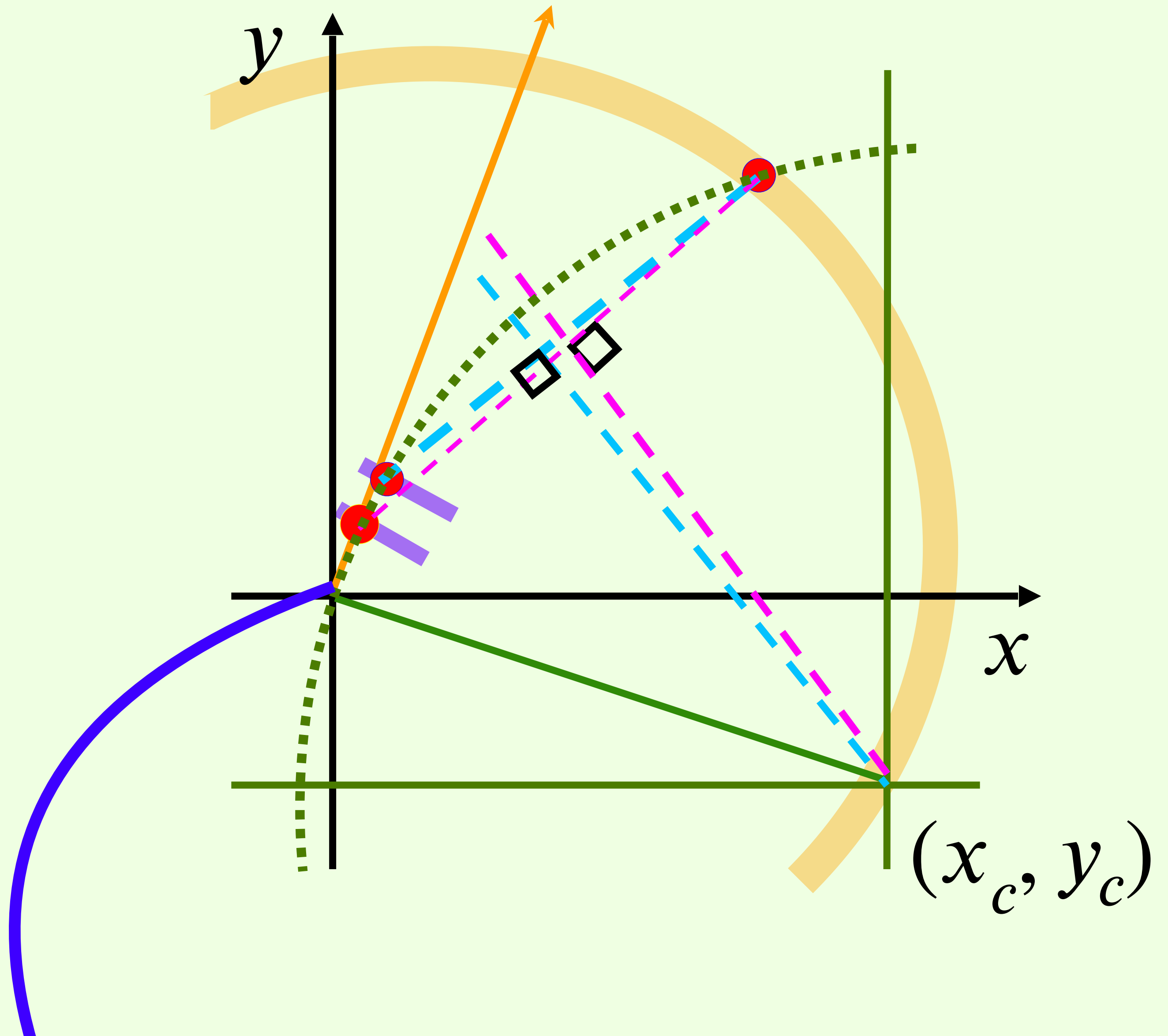
$$d\phi_{\text{Cal}} = d\phi/dr * (R_{\text{EMCal}} - R_{\text{INTT}})$$



MVTX Hit Matching Algorithm

(1) Draw a circle using three hit points (iINTT + oINTT + EMcal)

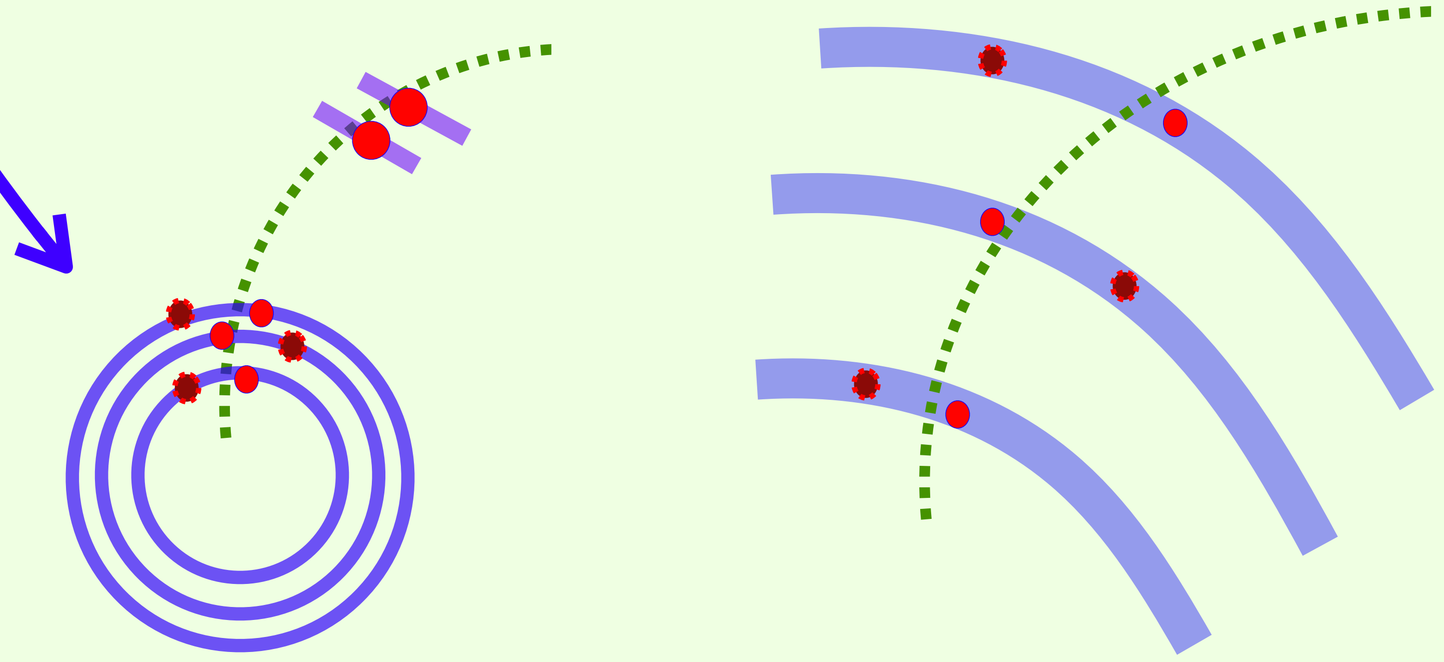
(a) No fit approach (The last page result)



(b) Use ROOT fit

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

(2) Select Closest Points of MVTX



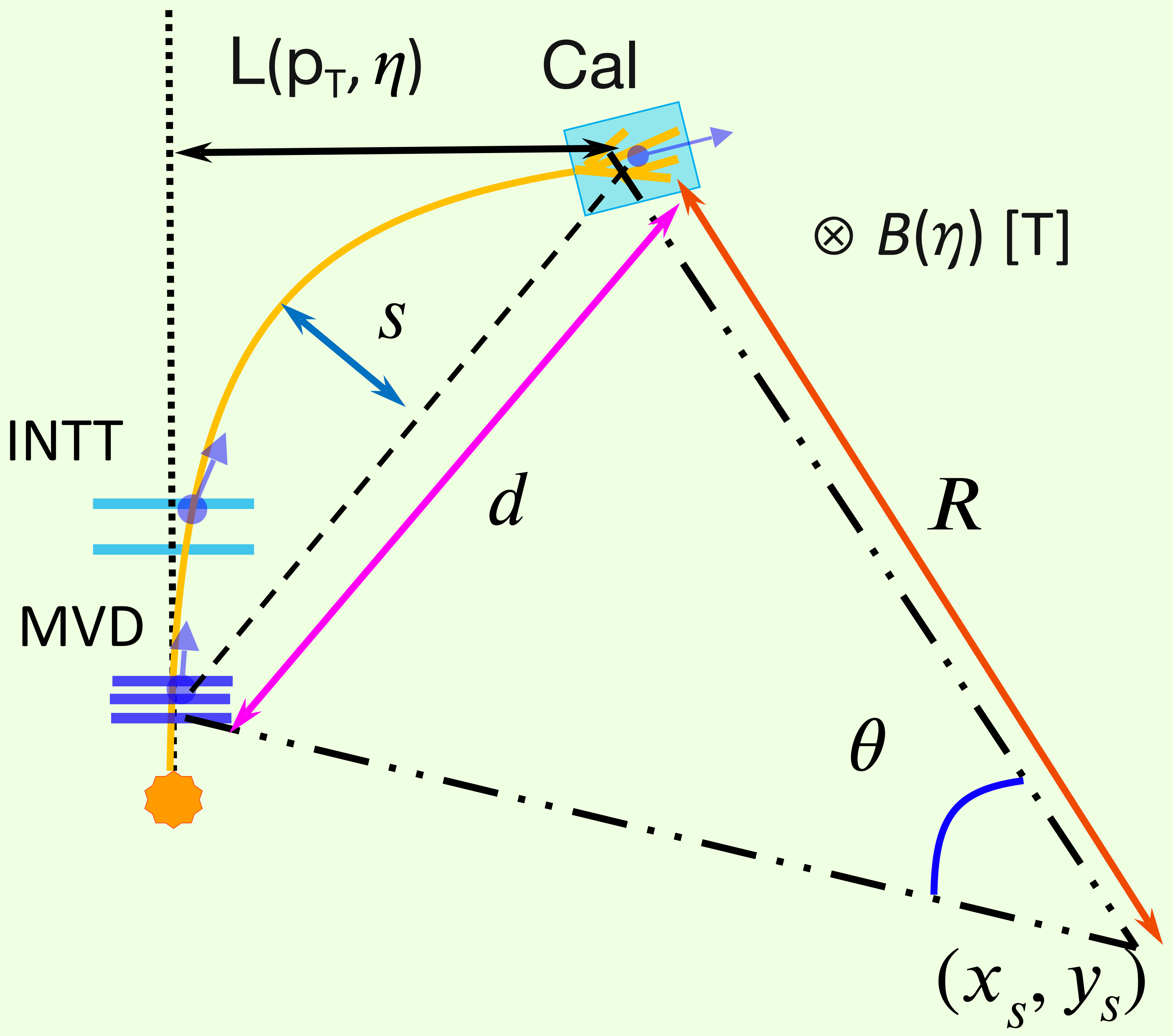
p_T calculation way1

Sagitta p_T equation

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

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.



sPHENIX Magnetic Field

Document Location

https://indico.bnl.gov/event/7081/attachments/25527/38284/sphenix_tdr_20190513.pdf

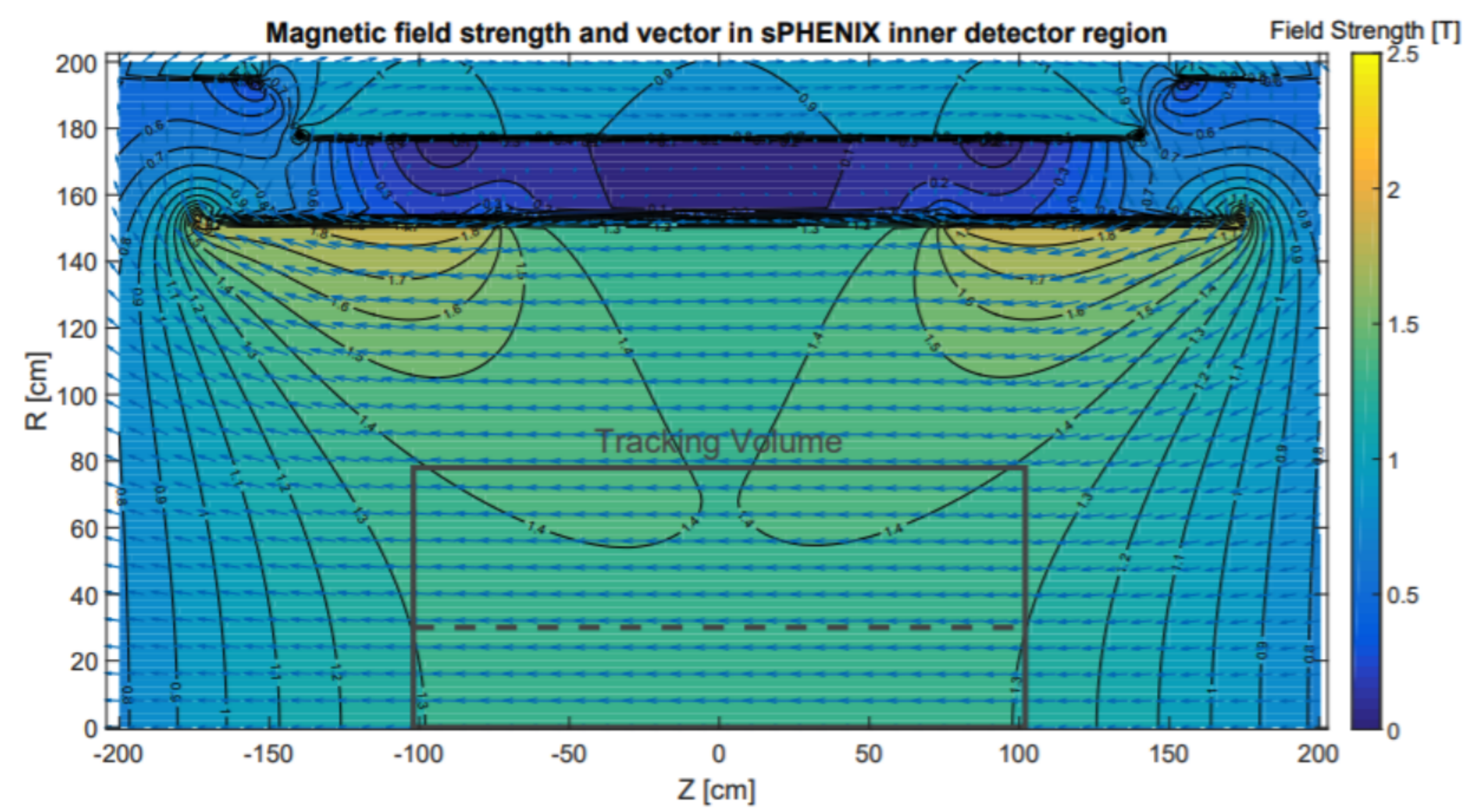
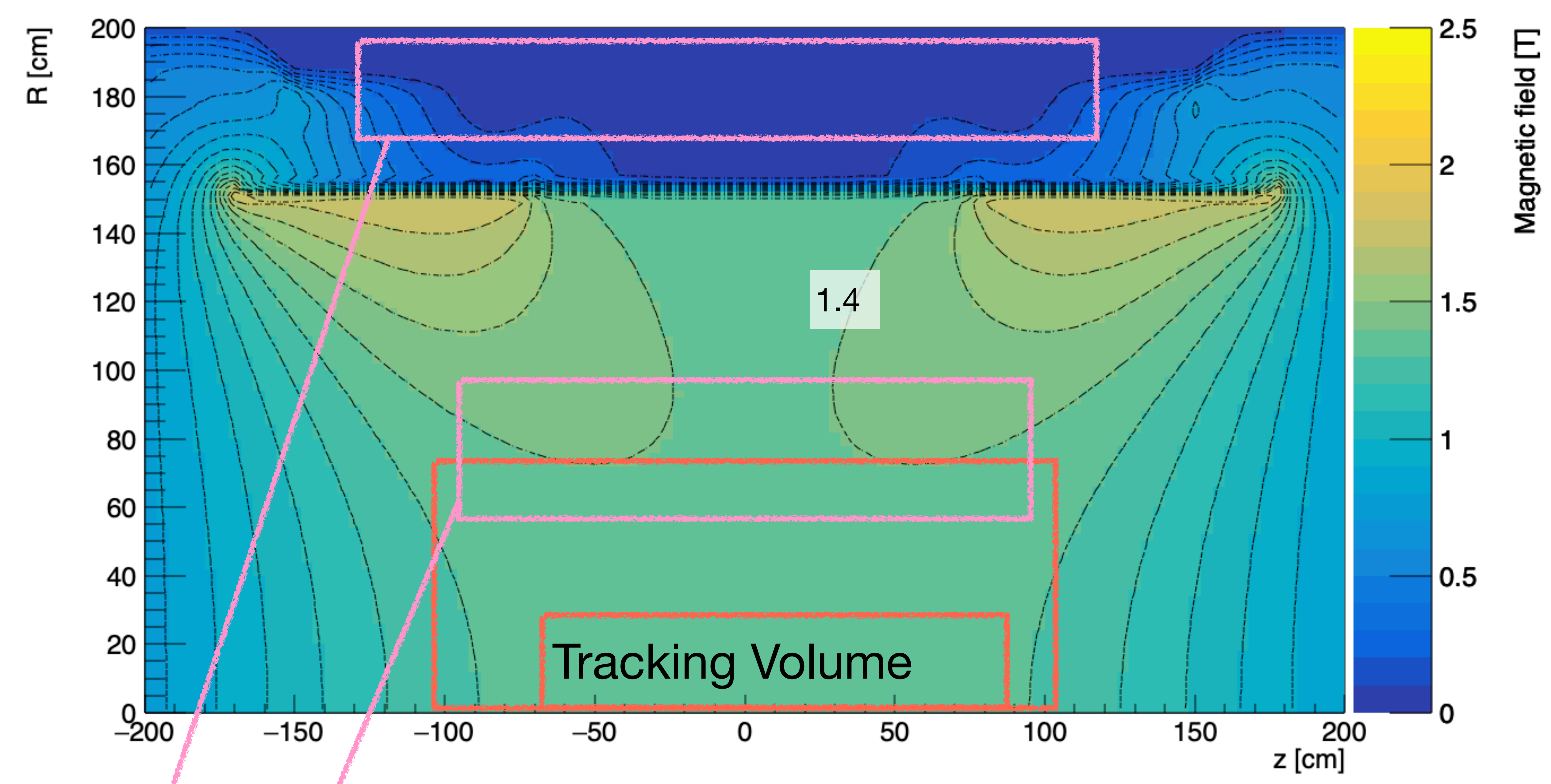


Figure 12. Field Map of the sPHENIX Solenoid

ROOT file Location

/cvmfs/sphenix.sdcc.bnl.gov/calibrations/sphnxpro/cdb/FIELDMAP_GAP/65/a9/65a930ed6de9c0e049cd0f3ef226e6b4_sphenix3dbigmapxyz_gap_rebuild_v2.root



Different behavior:
However, I do not know what is this magnetic field.

Input Event File

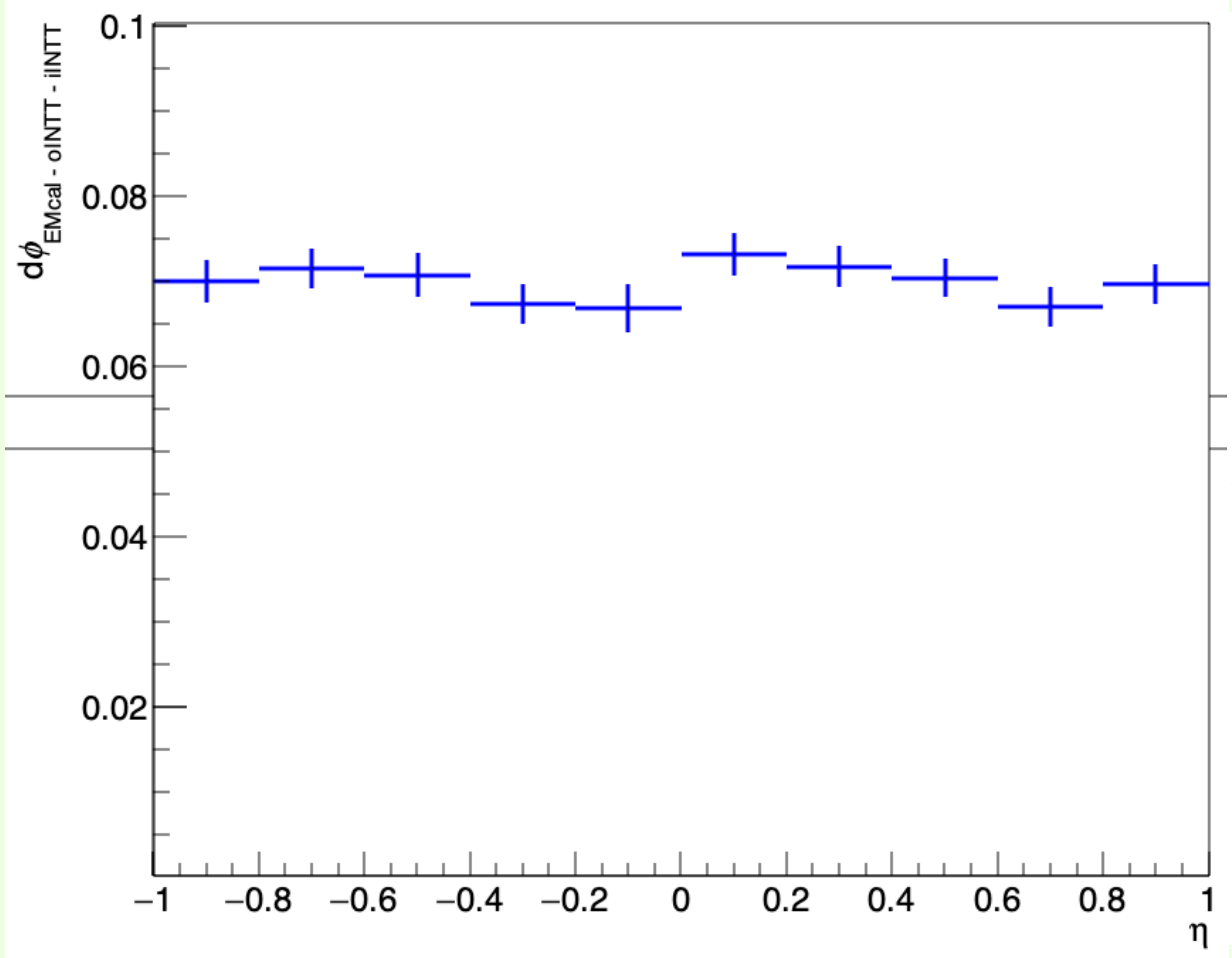
Simulation: Single particle gun + GEANT4
→ output: DST file format

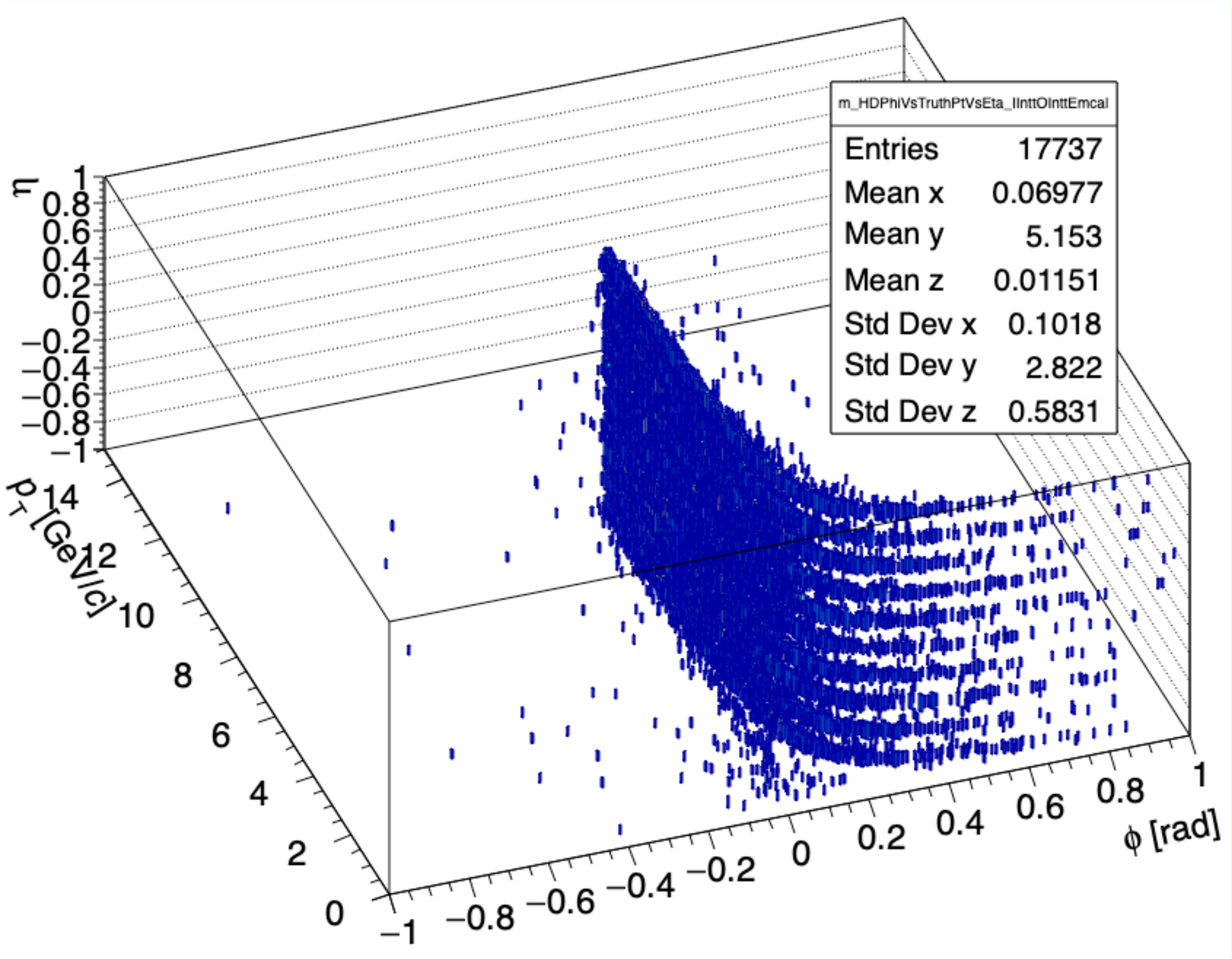
Inject electron p_T : 0.5, 1, 2, 5, 8, 10 GeV/c (This talk is only 1 GeV/c)

Inject range: ϕ: $-\pi$ to π, η: -1 to 1

GEANT4 Setting: Magnet 1.4 T
Detector: MVTX, INTT, TPC, EMCal, iHCal, oHCal

η dependency

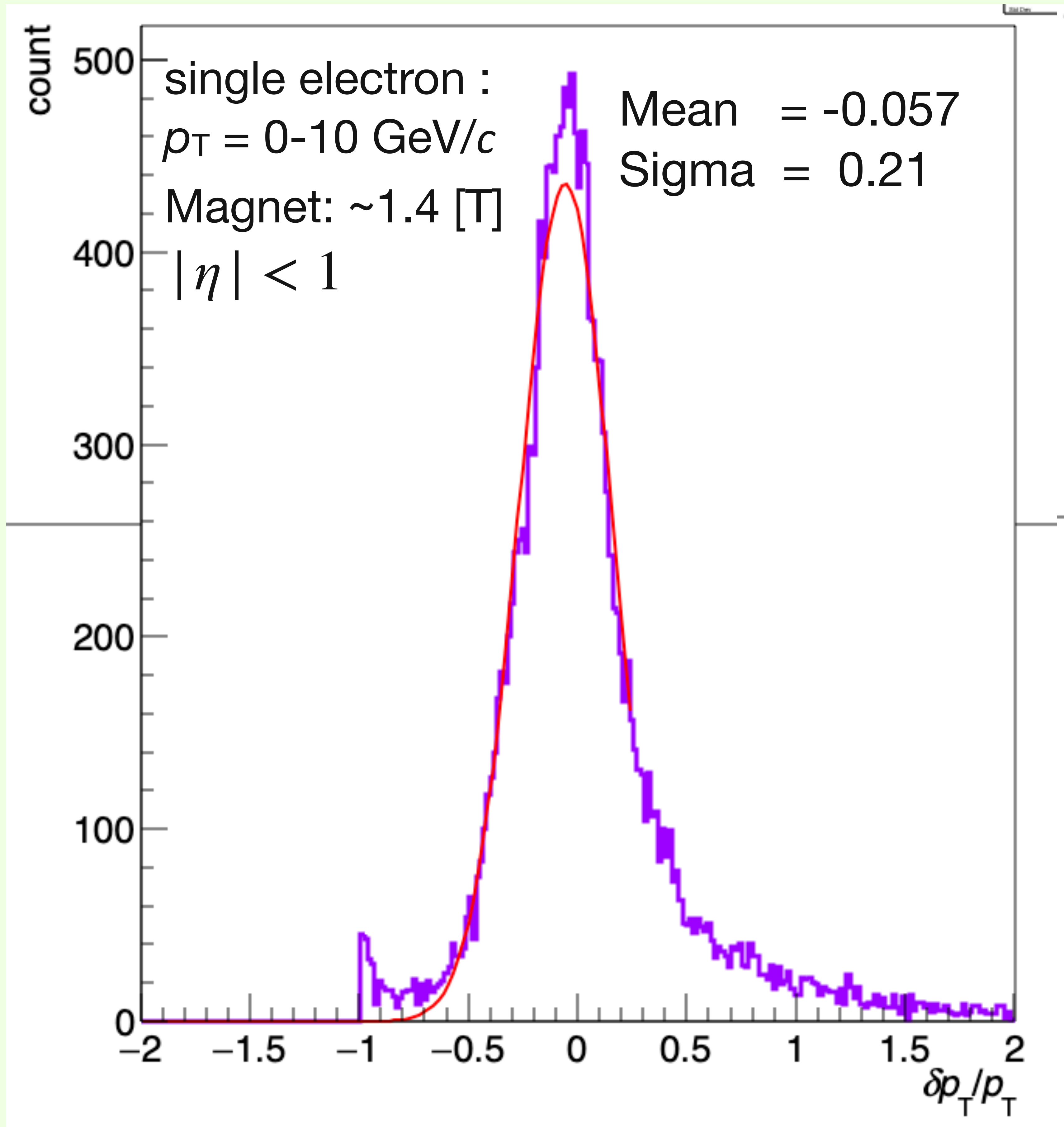




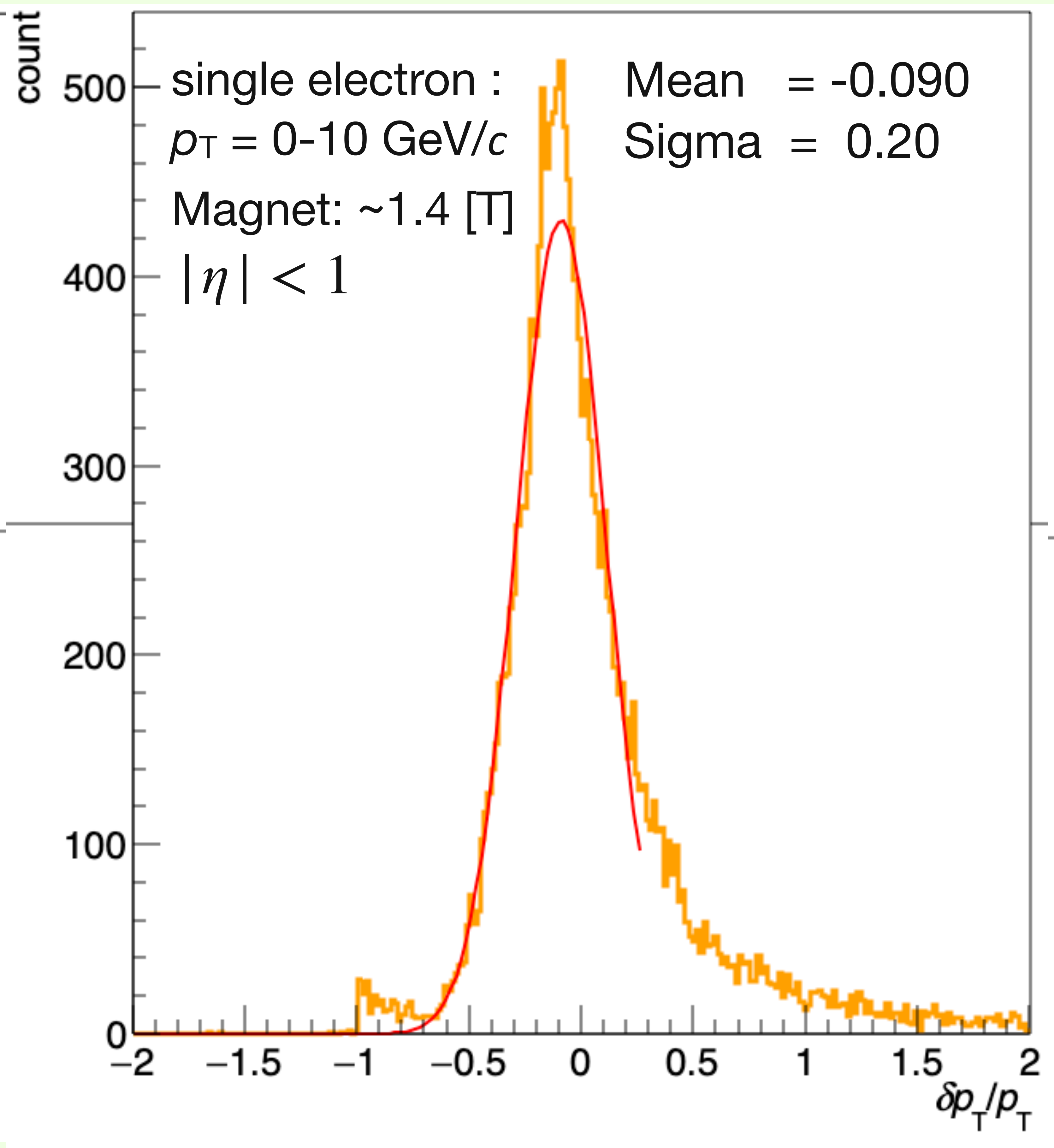
pT resolution

(reco - truth)/truth

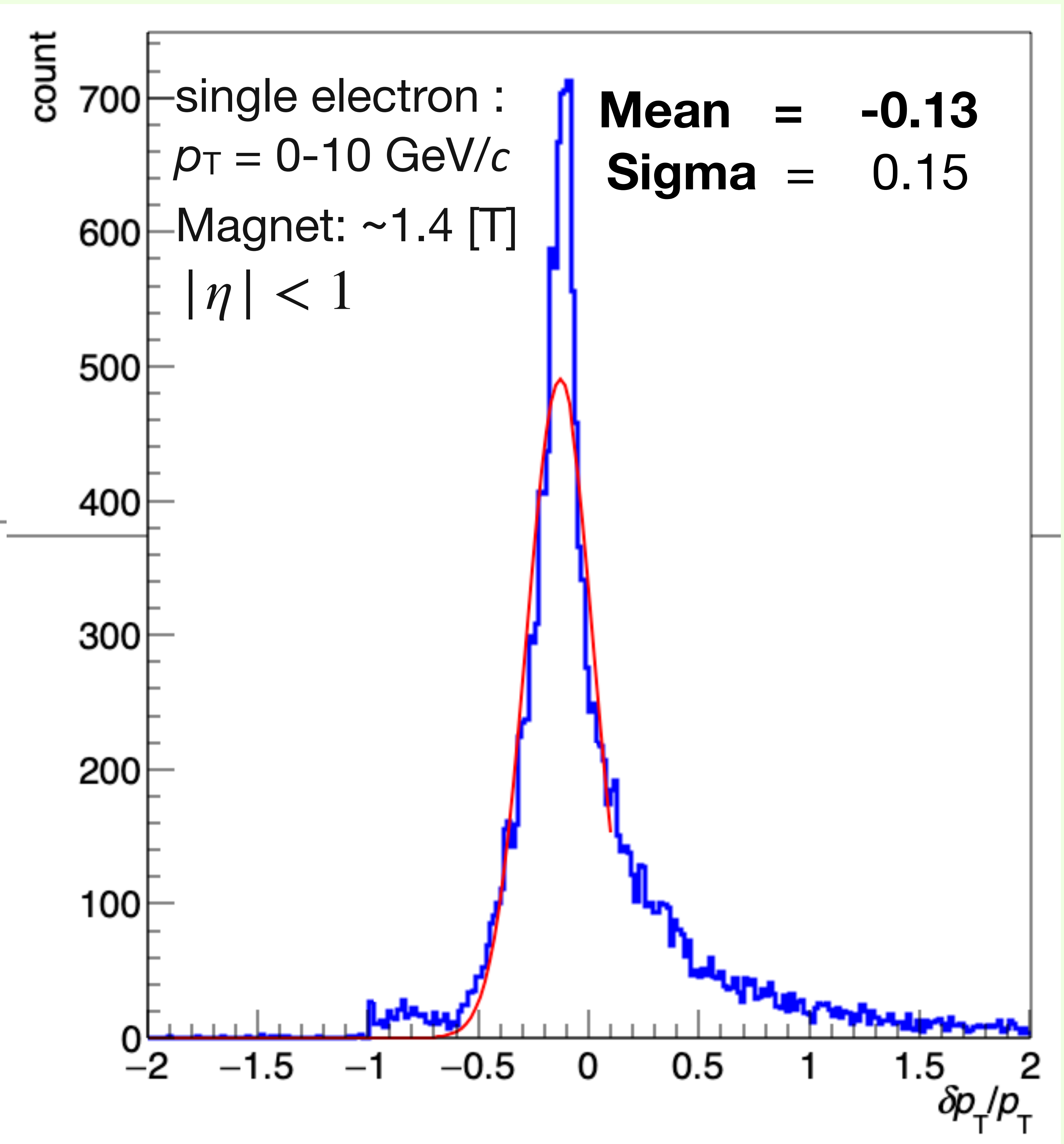
iINTT+oINTT+EMCal



Vertex+iINTT+oINTT+EMCal

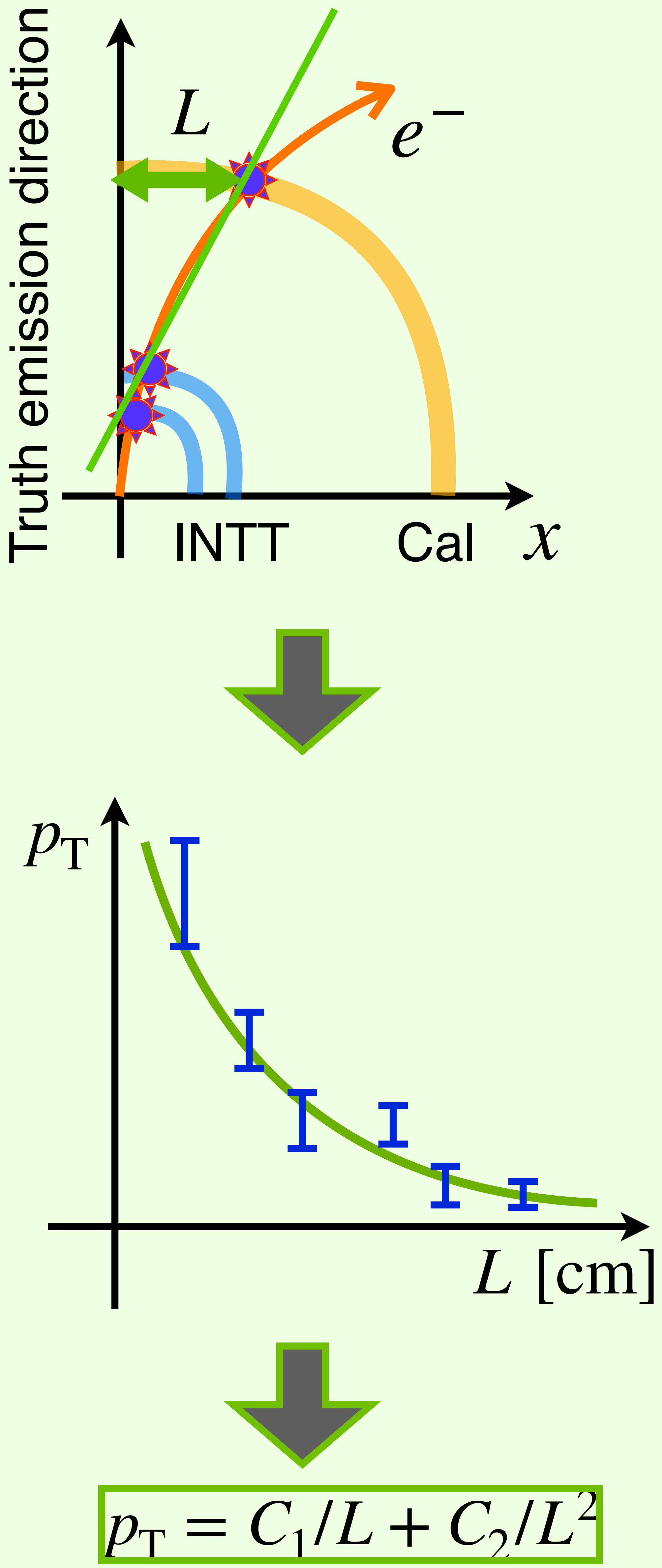


MVTX+iINTT+oINTT+EMCal



Acculate p_T Estimation Idea

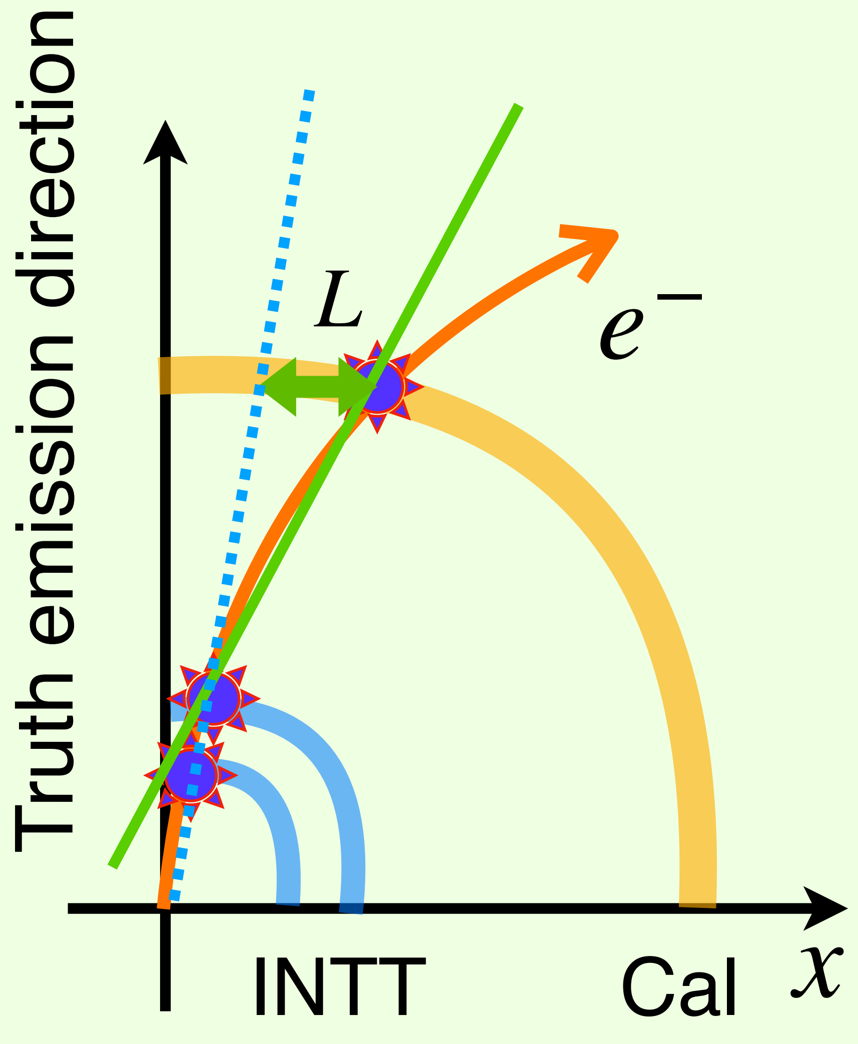
We expect the p_T can be described by a magnetic shift length (L) equation.



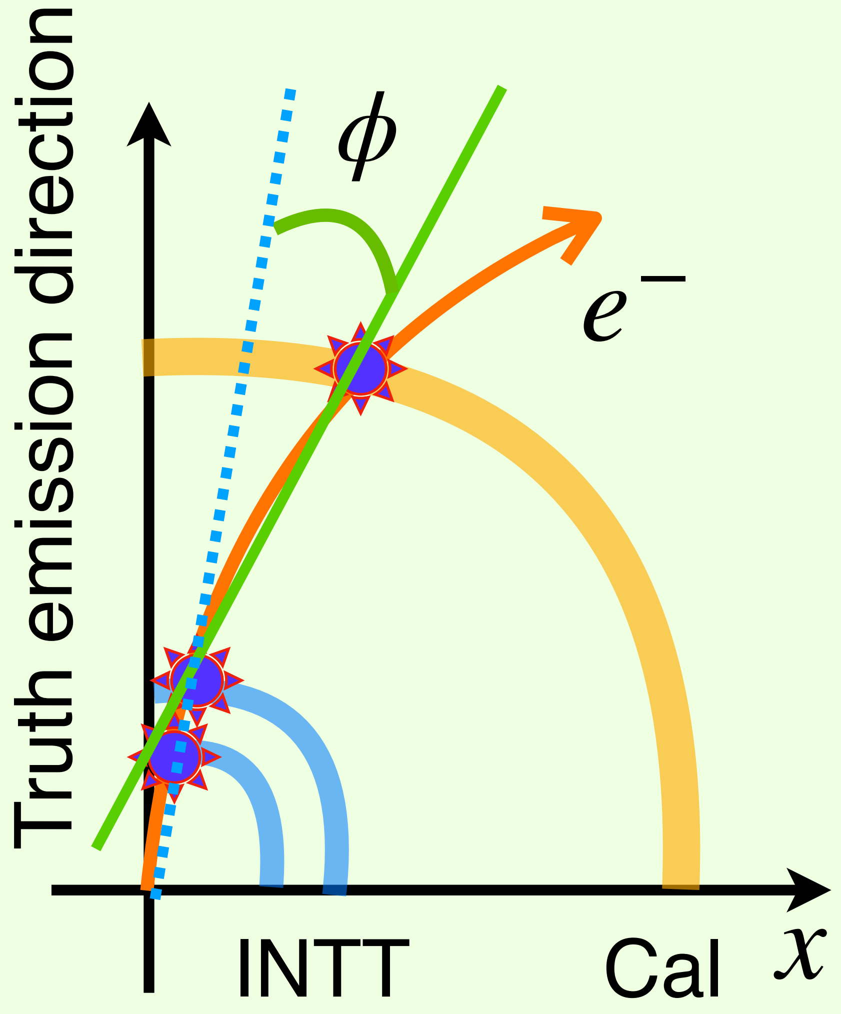
Now, I am estimating the coefficients (C_1 and C_2) using single electron simulation.
→ I need to estimate the function performance.

$$\sigma p_T = \frac{p_{T,\text{reco}} - p_{T,\text{truth}}}{p_{T,\text{reco}}}$$

We do not know the truth emission direction.



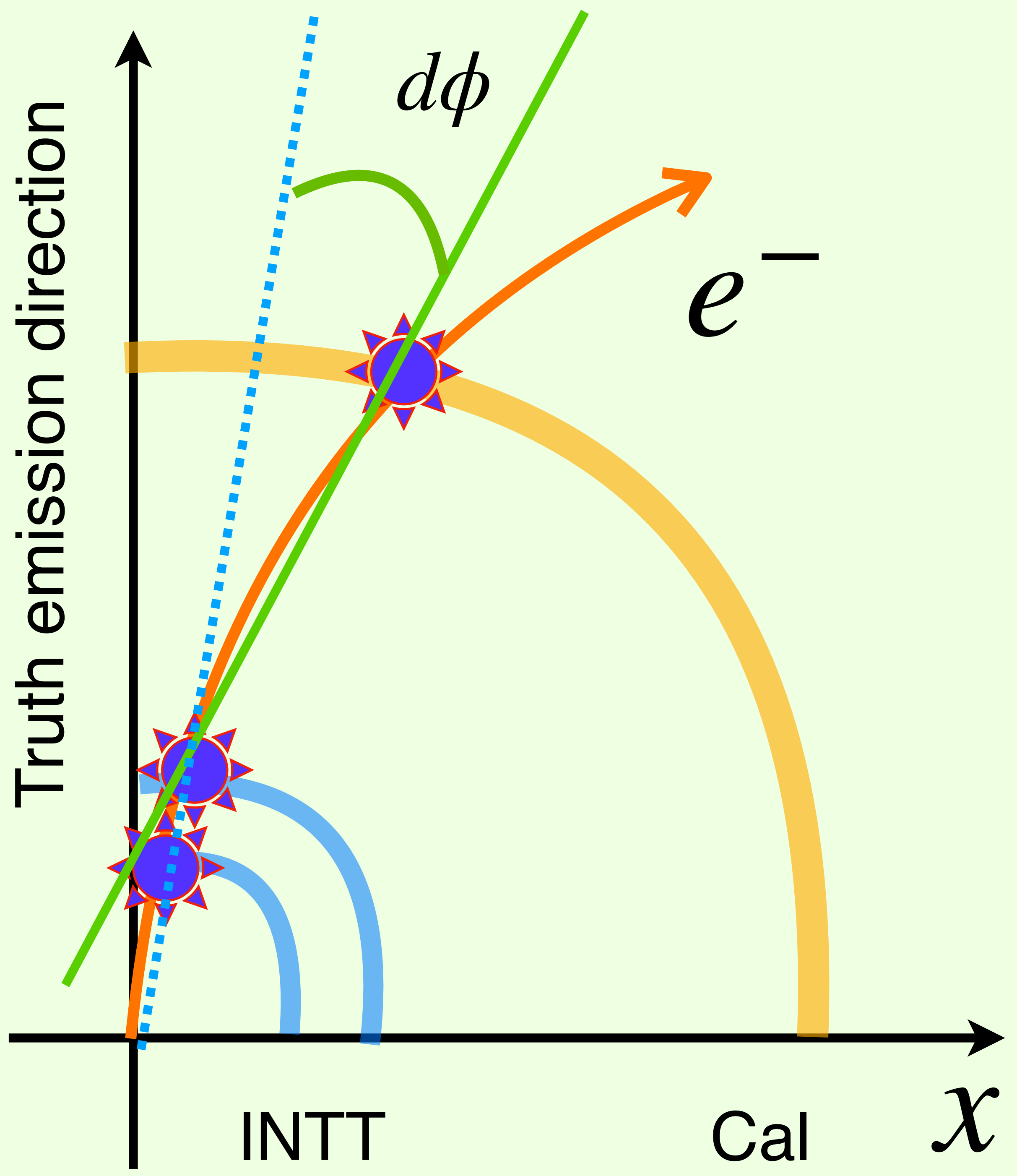
or

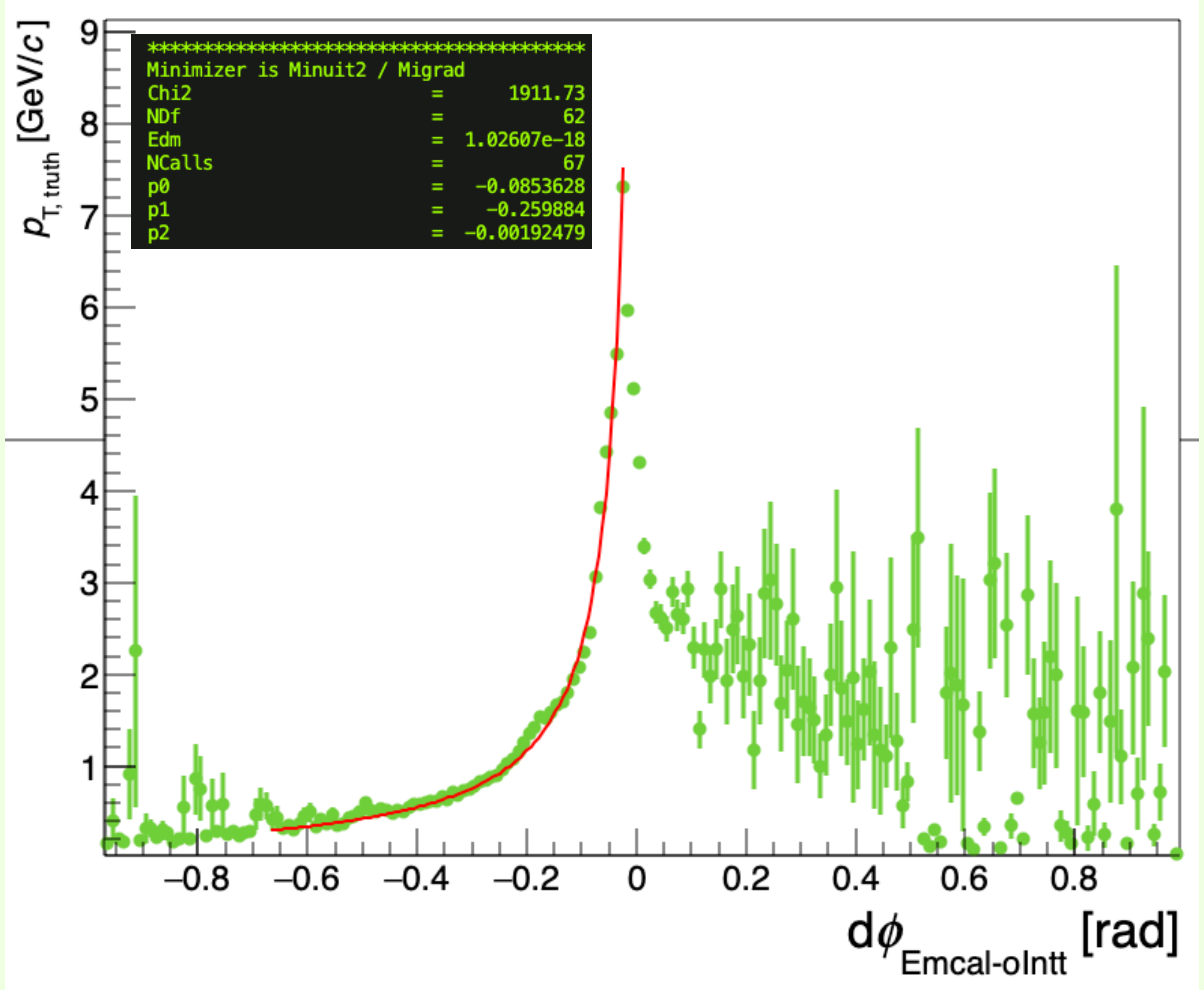


d$\phi_{\mathrm{Emcal-oIntt-iIntt}}$ – $p_{\mathrm{T,truth}}$ fitting

Use fitting function

$$p_{\mathrm{T}} = \mathrm{p0} + \frac{\mathrm{p1}}{d\phi} + \frac{\mathrm{p2}}{d\phi^2}$$



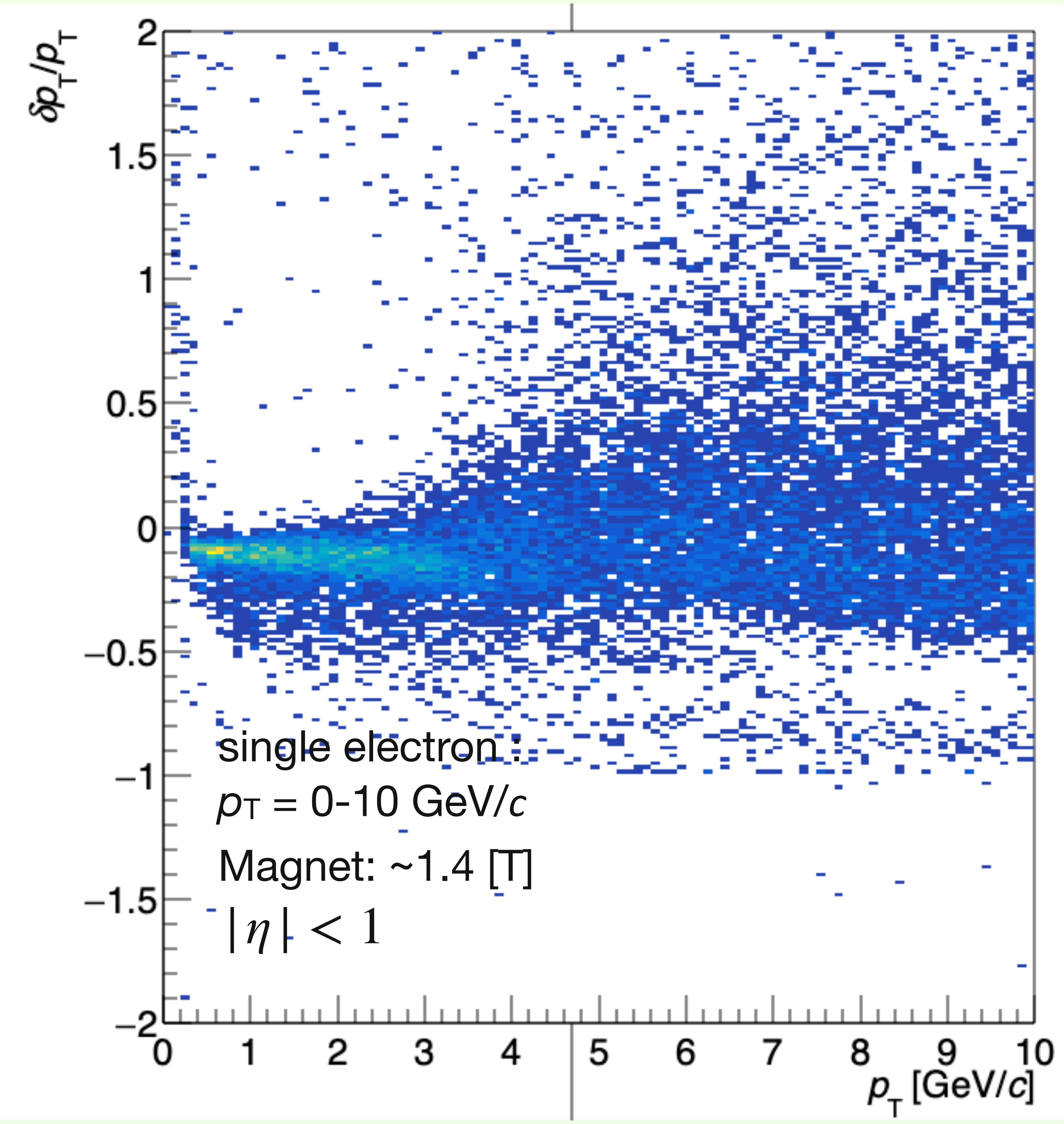


$$p_{\mathrm{T}} = \mathrm{p0} + \frac{\mathrm{p1}}{x} + \frac{\mathrm{p2}}{x^2} = -0.085 - 0.26/x - 0.0019/x^2$$

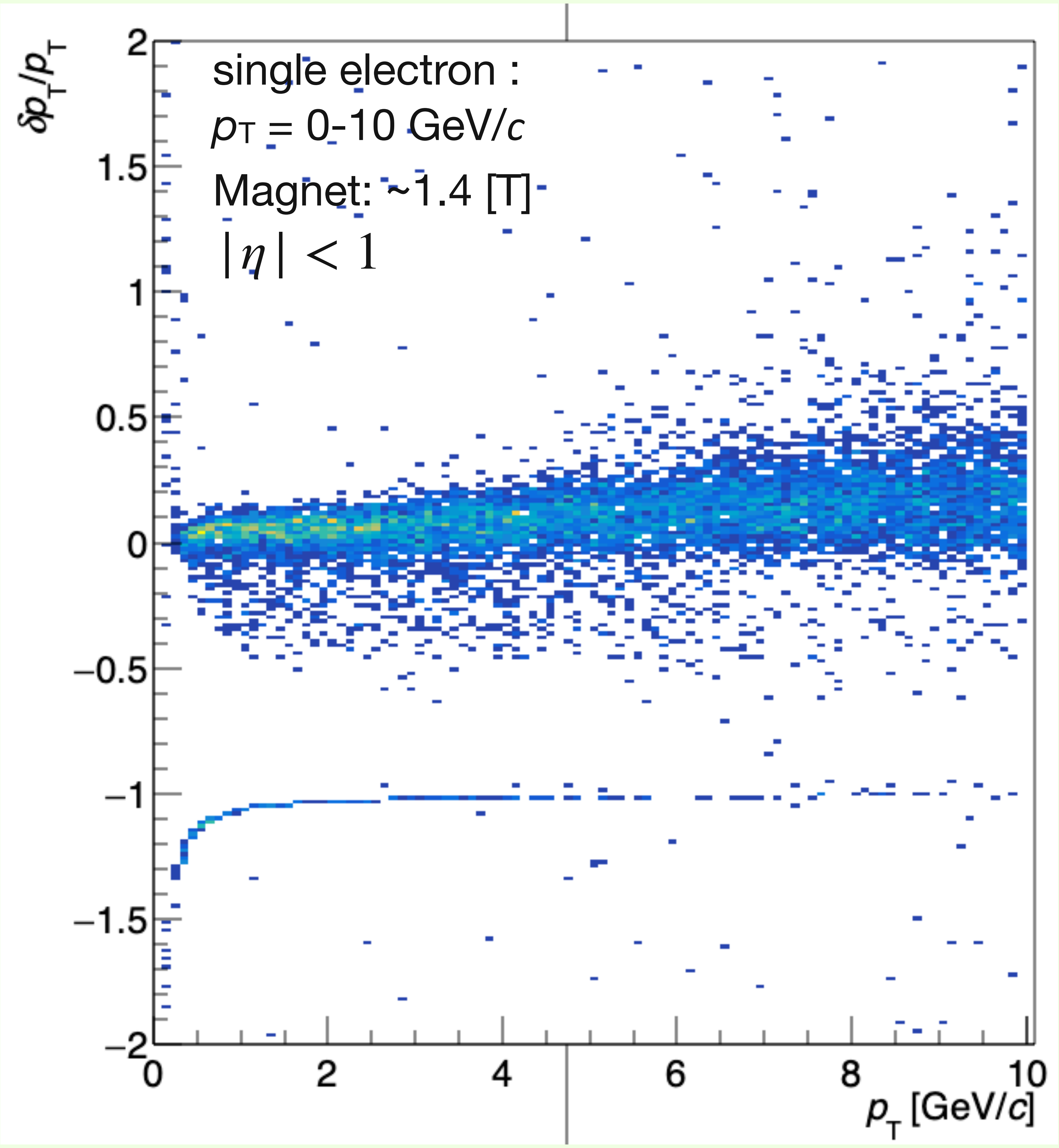
pT resolution vs pT

MVTX+iINTT+oINTT+EMCal

$$p_{\mathrm{T}}[\mathrm{GeV}] = qBR$$



$$p_{\mathrm{T}} = \mathrm{p0} + \frac{\mathrm{p1}}{d\phi} + \frac{\mathrm{p2}}{d\phi^2}$$

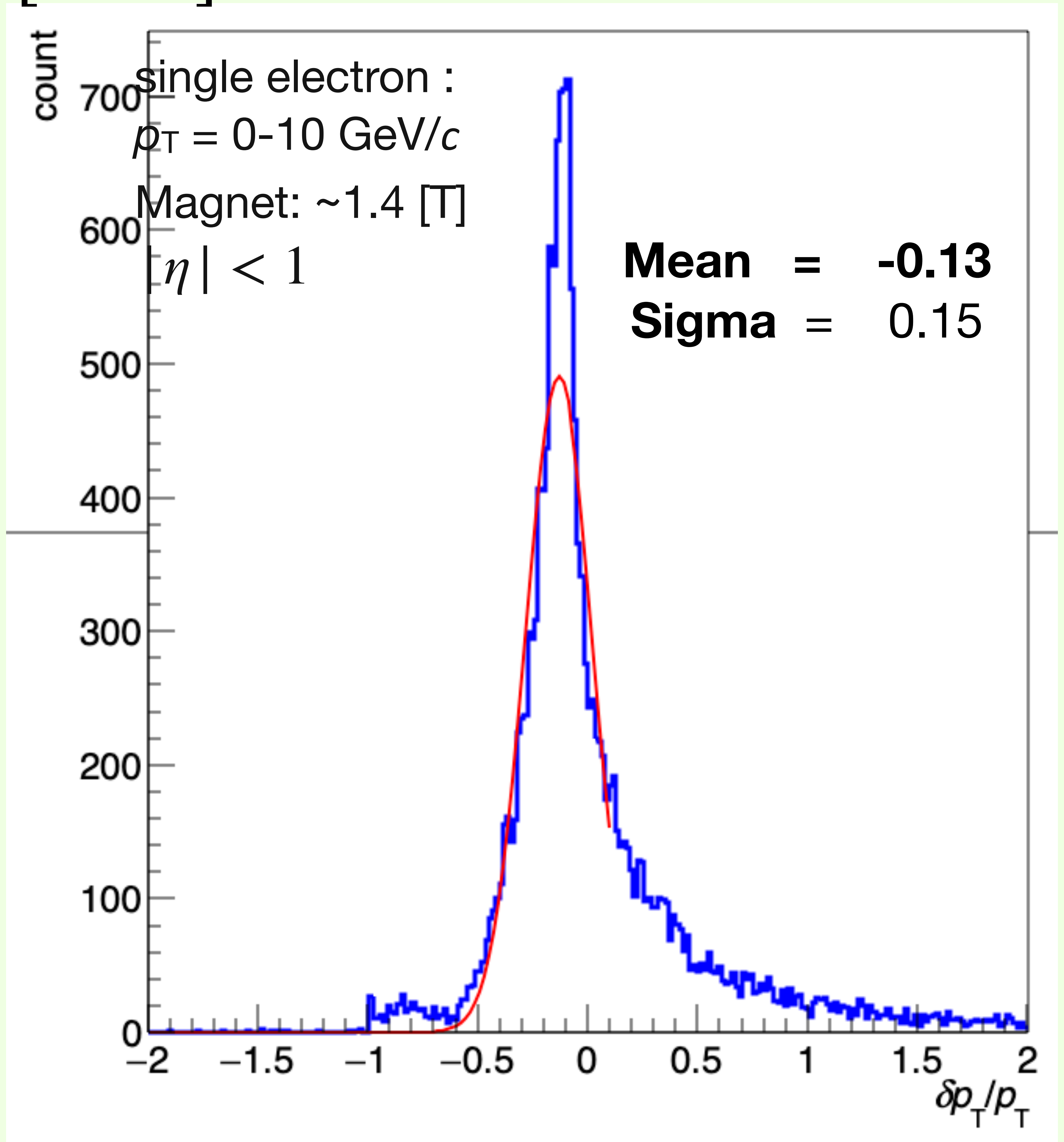


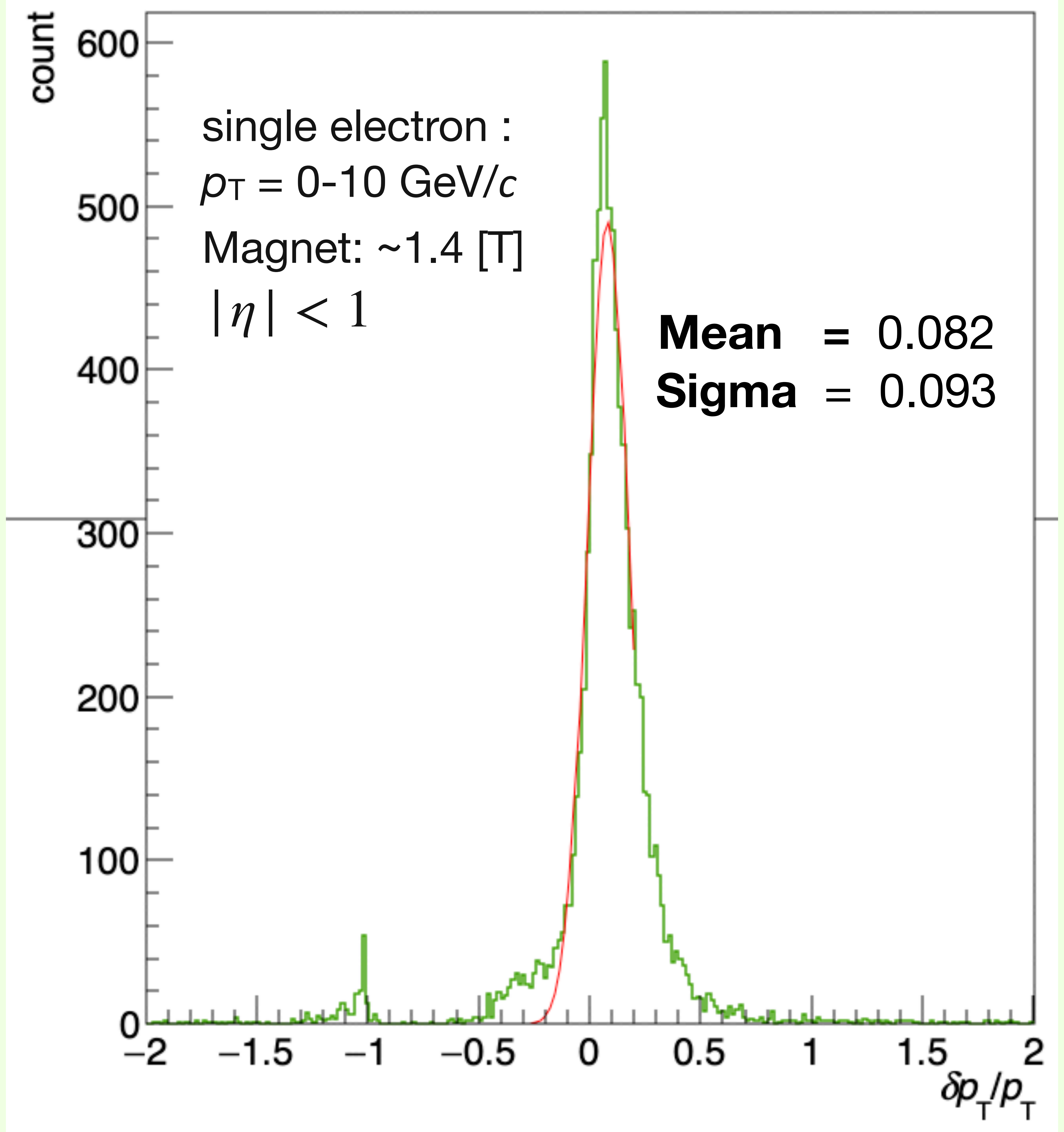
pT resolution with fitting function

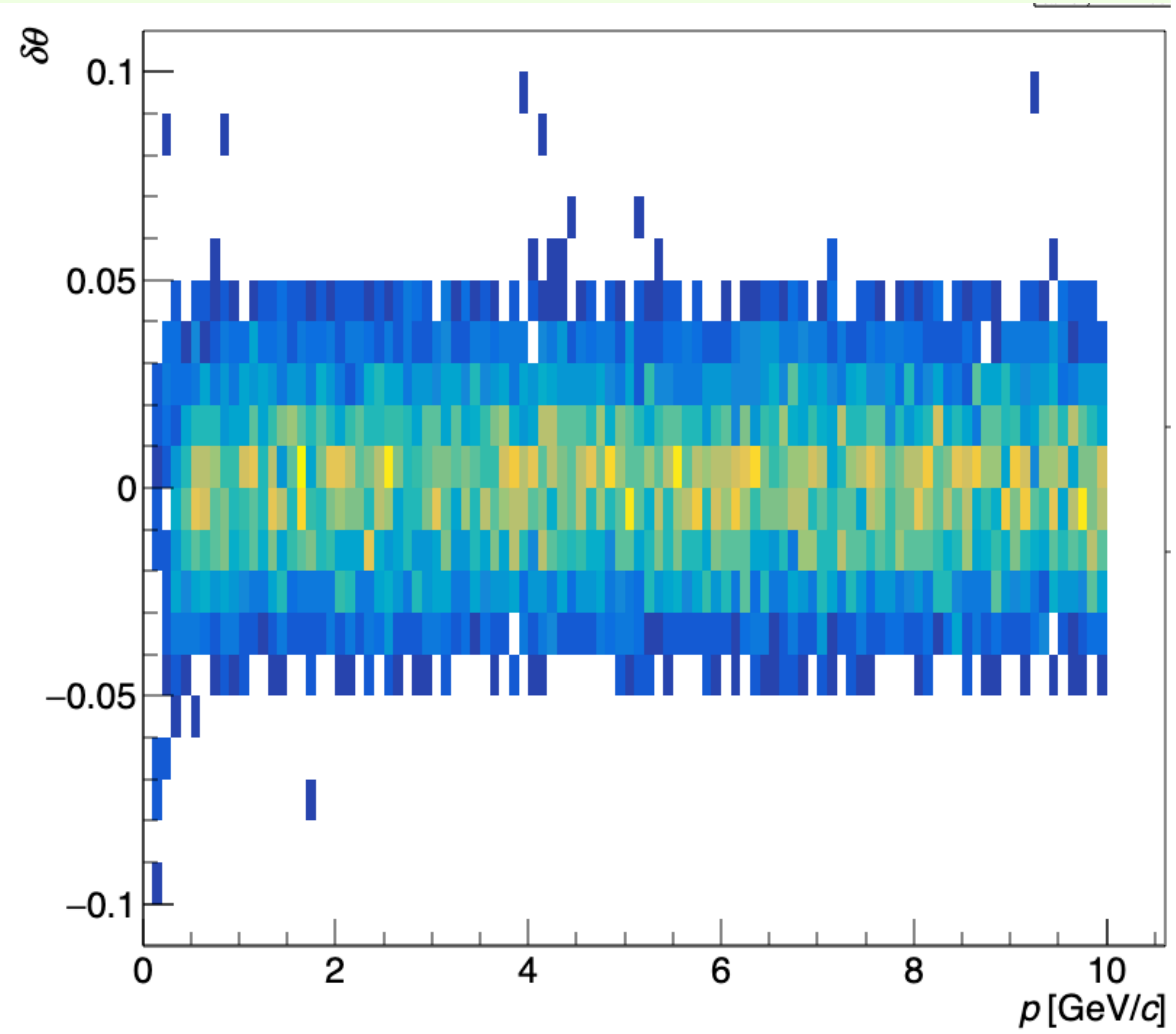
MVTX+iINTT+oINTT+EMCal

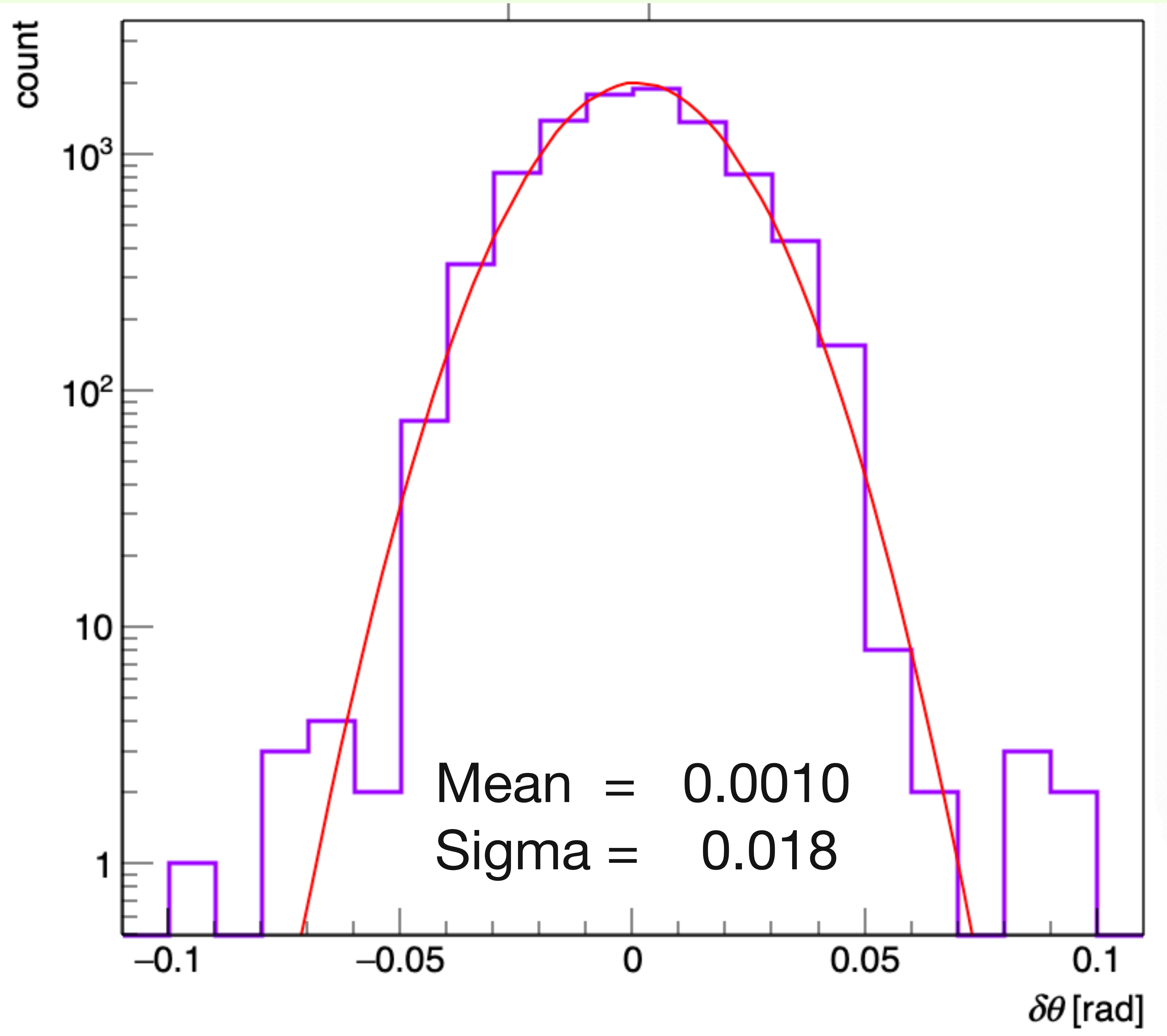
$$p_{\mathrm{T}}[\mathrm{GeV}] = qBR$$

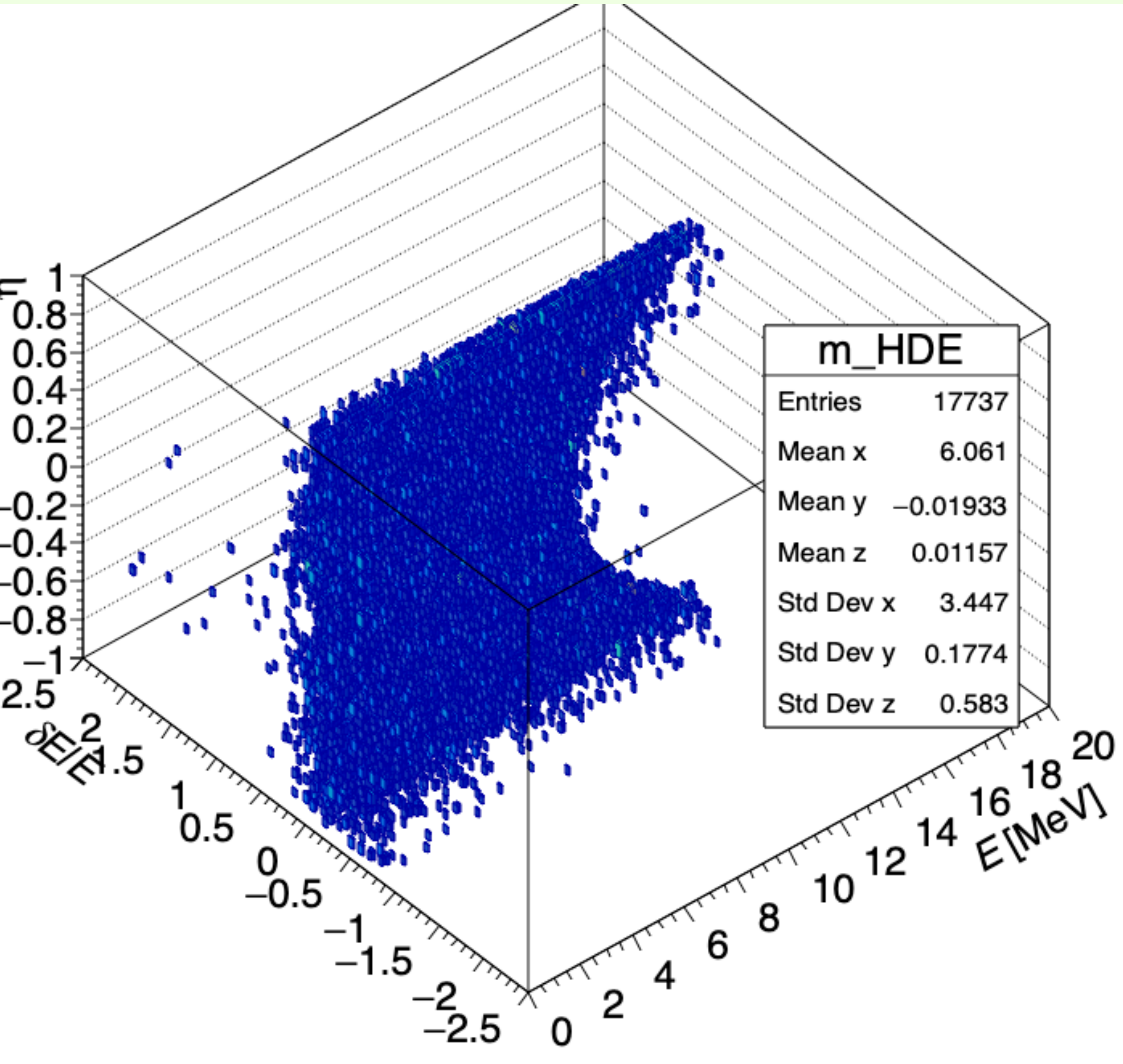
$$p_{\mathrm{T}} = \mathrm{p0} + \frac{\mathrm{p1}}{d\phi} + \frac{\mathrm{p2}}{d\phi^2}$$

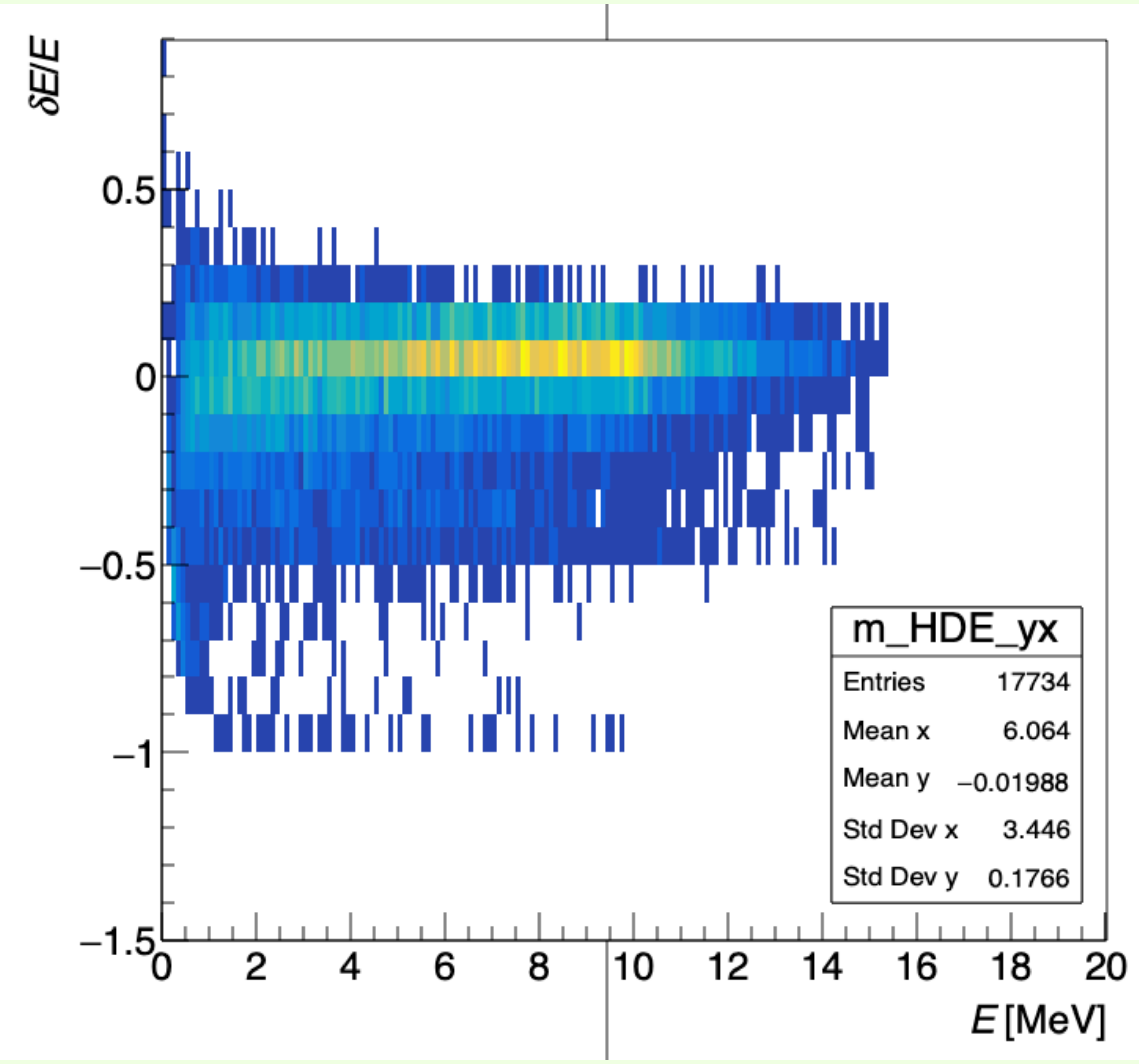


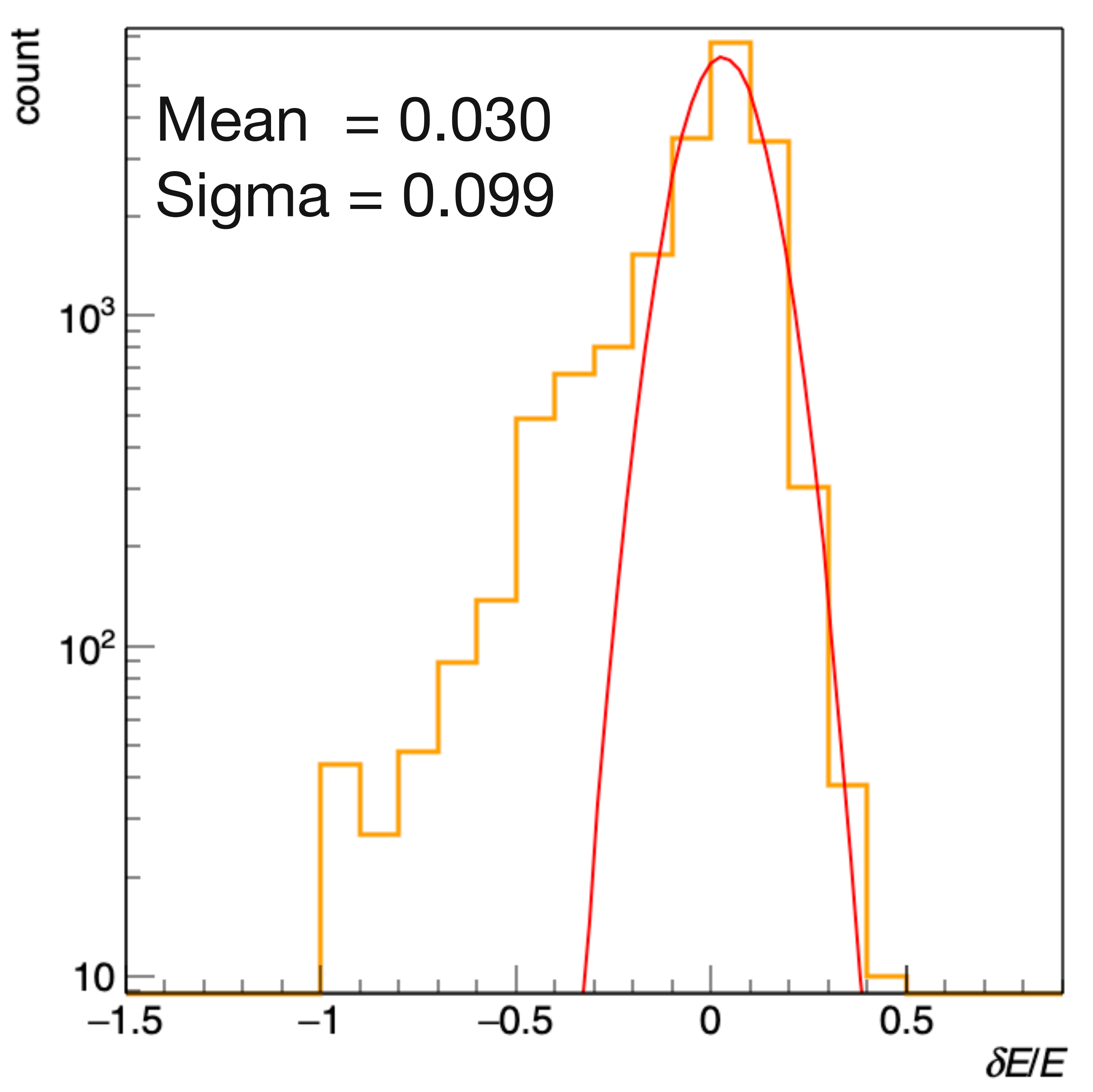



δθ
0.1
0.05
0
−0.05
−0.1
0
2
4
6
8
10
p [GeV/c]


count
10³
10²
10
1
−0.1
−0.05
0
0.05
0.1
δθ [rad]
Mean = 0.0010
Sigma = 0.018

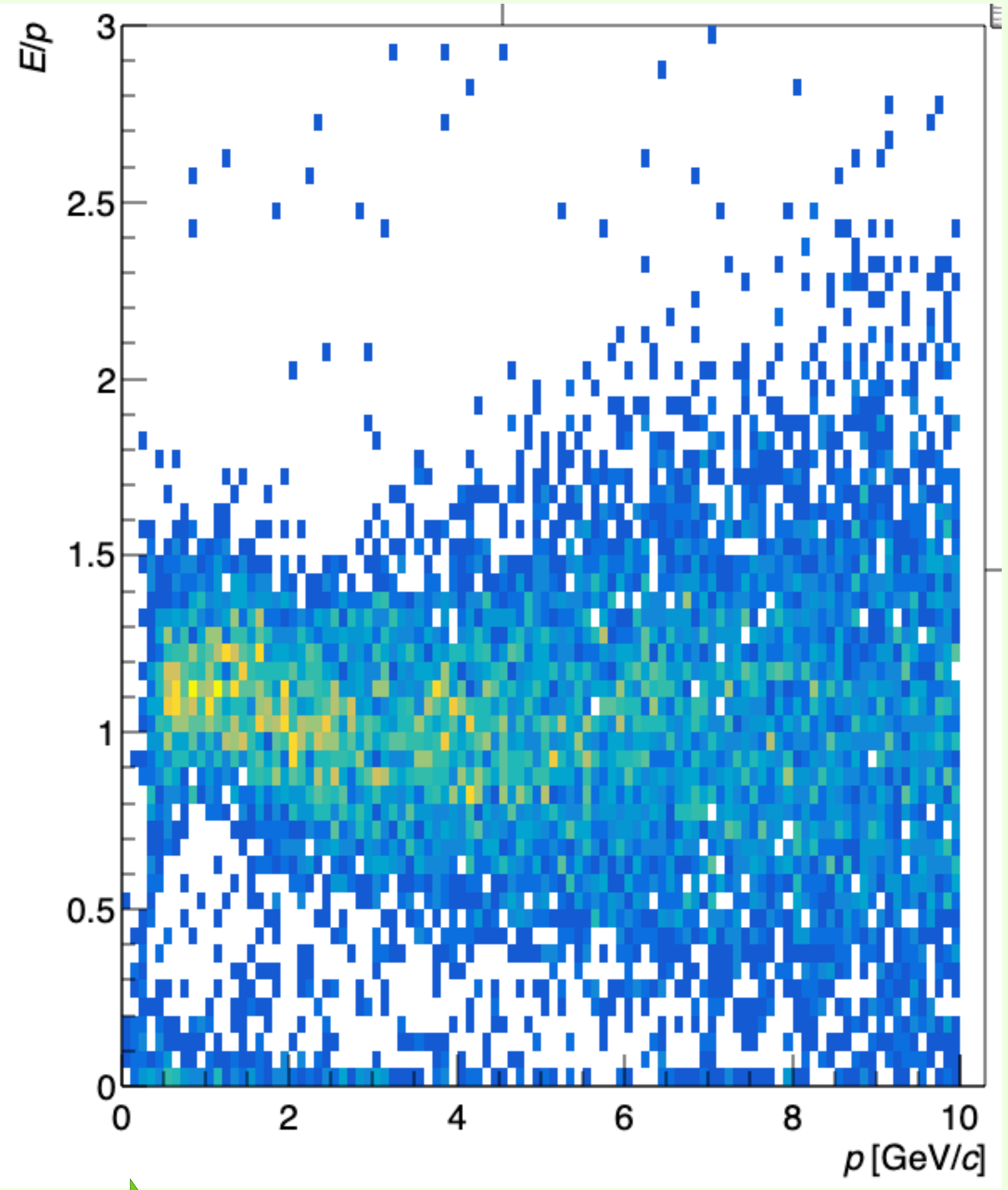

m_HDE
Entries 17737
Mean x 6.061
Mean y −0.01933
Mean z 0.01157
Std Dev x 3.447
Std Dev y 0.1774
Std Dev z 0.583
E [MeV]
δE/E


δE/E
E [MeV]
m_HDE_yx
Entries 17734
Mean x 6.064
Mean y −0.01988
Std Dev x 3.446
Std Dev y 0.1766

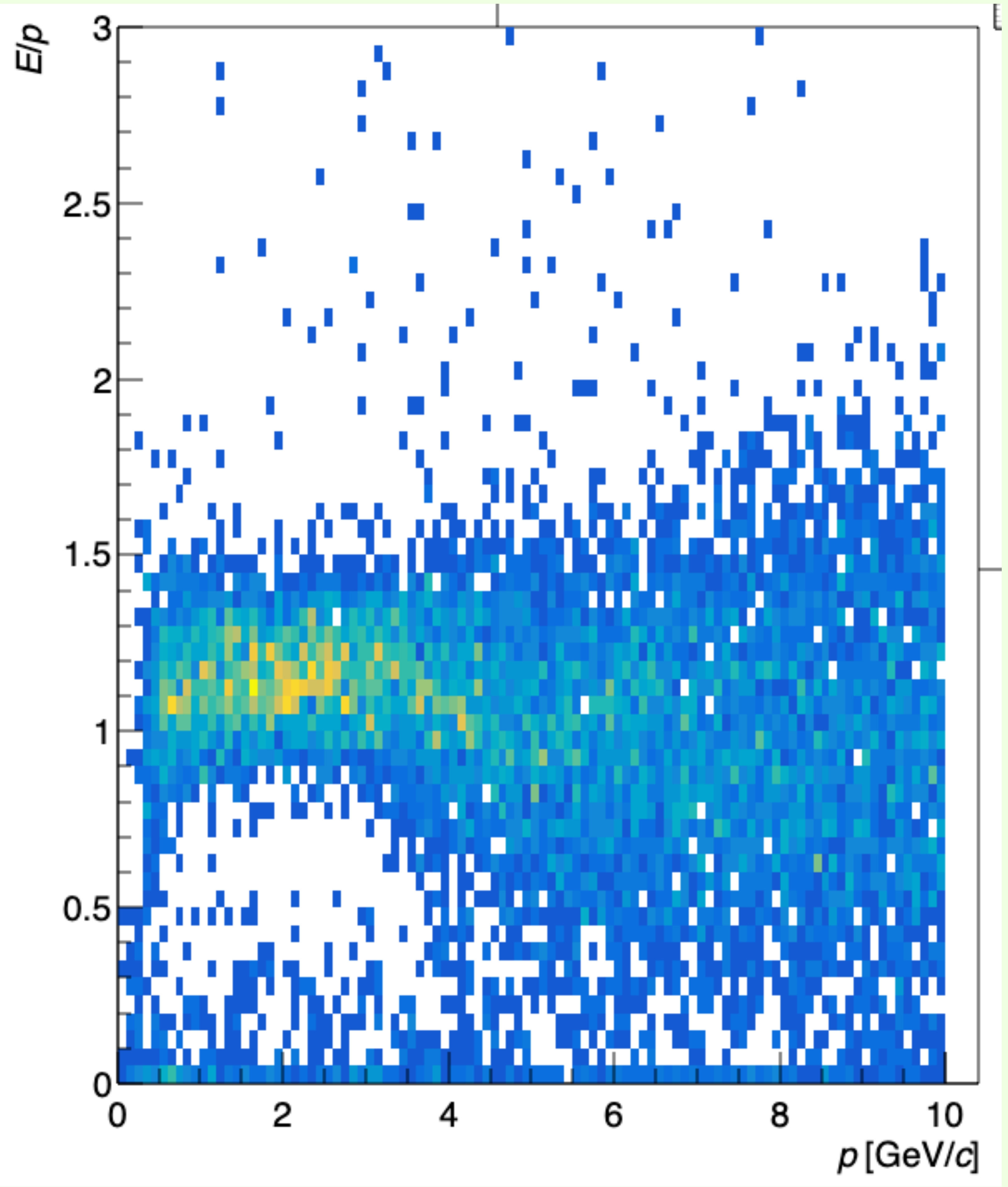

count
Mean = 0.030
Sigma = 0.099
δE/E

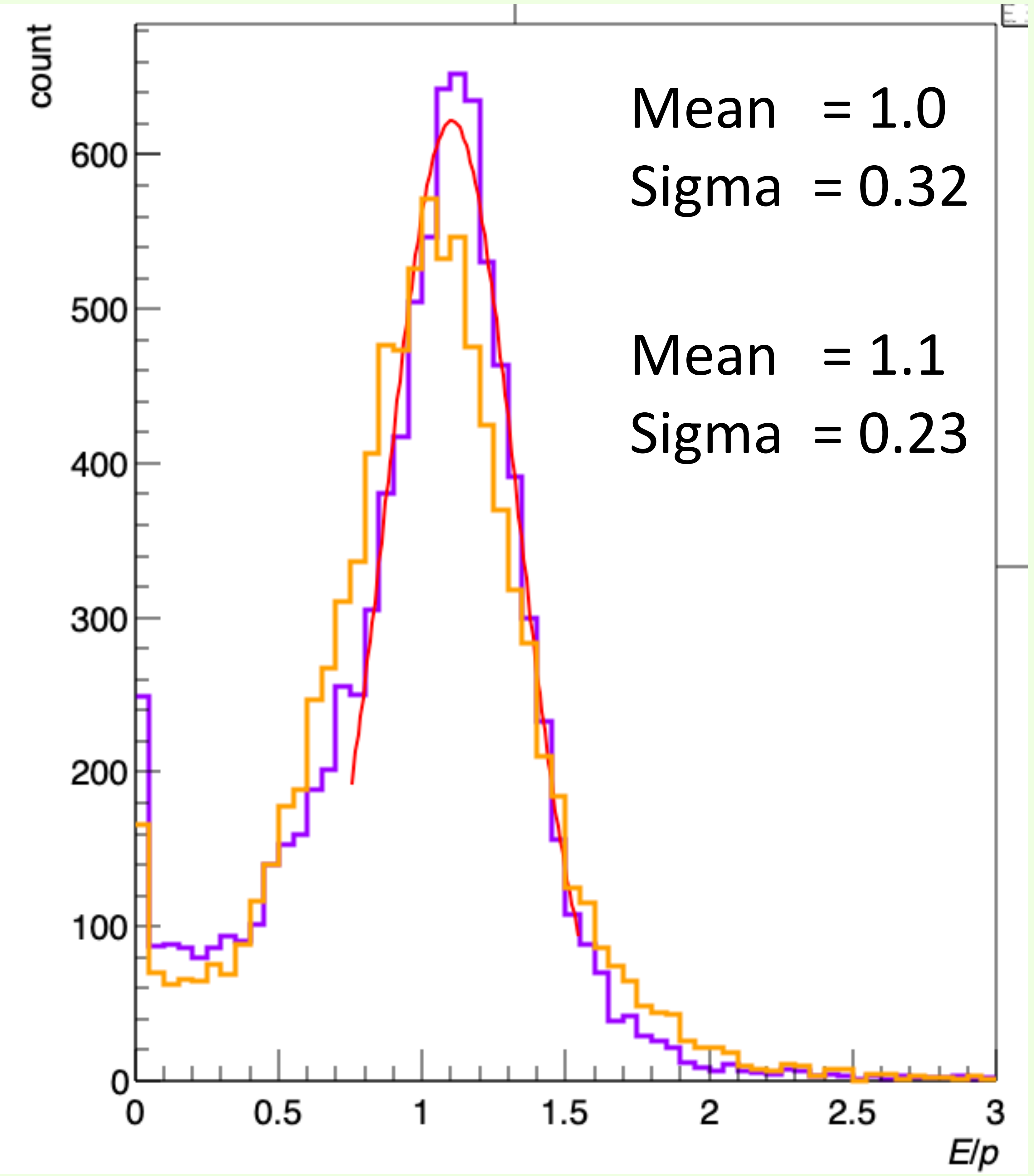
E/p

iINTT+oINTT+EMCal



MVTX+iINTT+oINTT+EMCal





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.