ECAL Energy Resolution Updates

$$\frac{\sigma E}{E} = \frac{p0}{\sqrt{E}} \oplus p1 \oplus \frac{p2}{E}$$

PDG: 34.8.1

- Check the energy resolution for 1GeV electron to see the dependence of angle, Al, and filed.
- Use the same energy fitting points from Rakitha's results (PcDR) to compare the energy resolution got from GEMC with that got from Remoll for the PVDIS configuration.
- Why p2 is so large ?

Simulation Configurations

1. 7 -module configuration: based on the PVDIS configuration

a) preshower: only keep 2-cm scintillator, and remove the 1.12-cm lead (in order to test low momentum (100MeV/c and 200 MeV/c) e^+, and π^+ shower behavior with the SOLID shashalik design)

b) shower: 194 layers of lead (0.05 cm), scintillator (0.15 cm) and Mylar (0.024 cm) alternation configuration.

c) support: Al (2 cm)

2. 1748-module configuration: the same as 7-module structure

3. PVDIS configuration

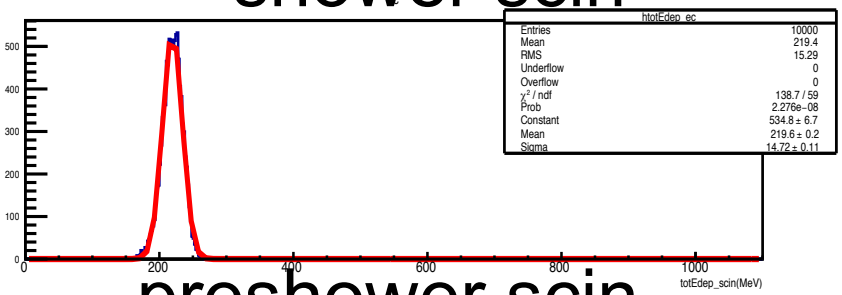
All results belongs to the ECAL stand alone simulation

1GeV e^- Energy Resolution Dependence Study

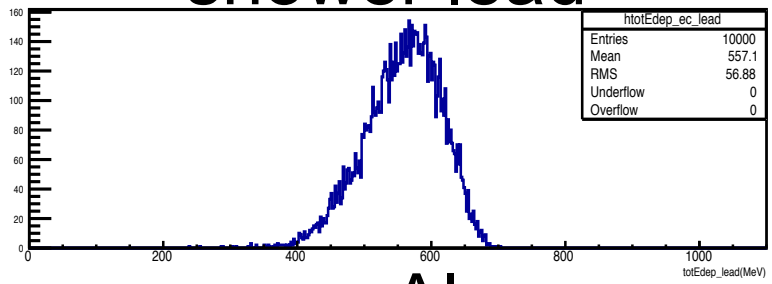
1GeV e^-		σ	μ MeV	σE/E (σ/μ) %
No field	7 modules θ= 0°	9.343±0.022	222.662±0.029	4.20±0.010
	1748 modules θ= 0°	9.536±0.068	239.263±0.096	3.98±0.028
	1748 modules θ= 25°	9.581±0.072	241.083±0.097	3.97±0.030
	1748 modules θ= 25° no Al	9.769±0.074	243.921±0.098	4.00±0.030
	1748 modules θ= 35° no Al	9.804±0.072	242.641±0.099	4.04±0.030
Field	1748 modules θ= 25°	9.706±0.071	240.944±0.098	4.03±0.029
	1748 modules θ= 25° no Al	9.640±0.071	244.35±0.097	3.95±0.029
	1748 modules θ= 25° prelead (PVDIS)	14.721±0.11	219.647±0.153	6.70±0.05
	1748 modules θ= 25° prelead, (PVDIS noAl)	14.829±0.15	237.115±0.150	6.25±0.05

1 GeV e^- PVDIS configuration

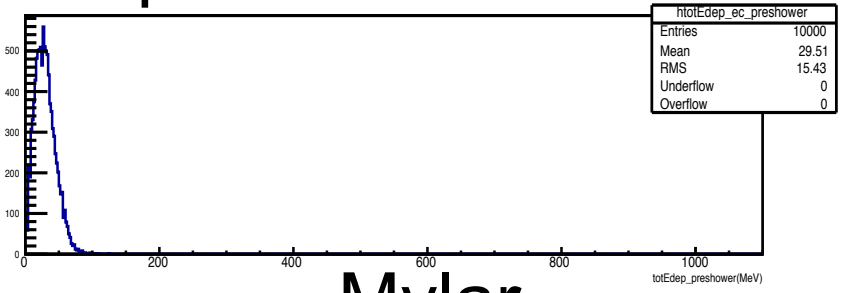
shower scin



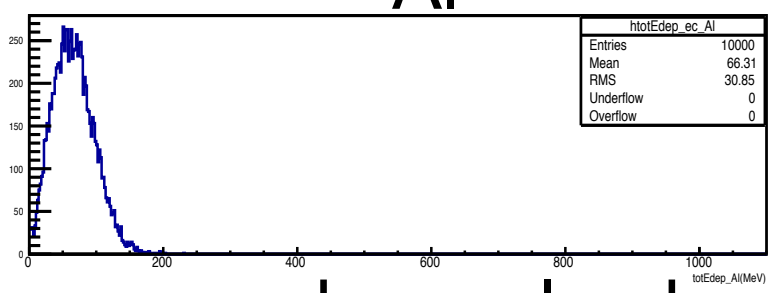
shower lead



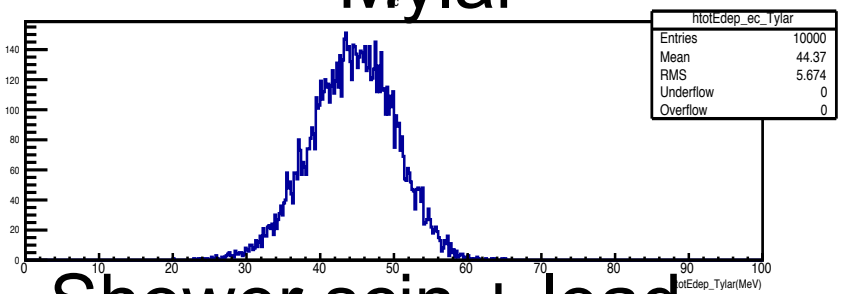
preshower scin



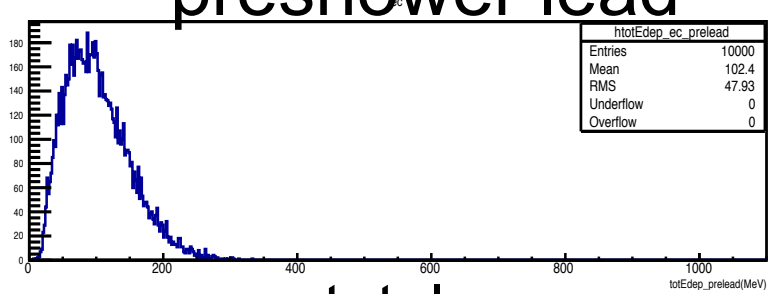
Al



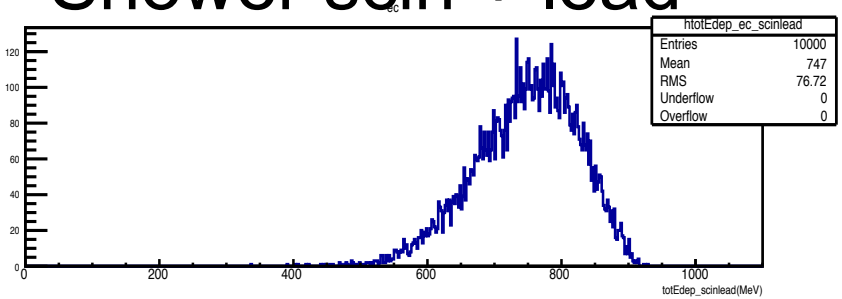
Mylar



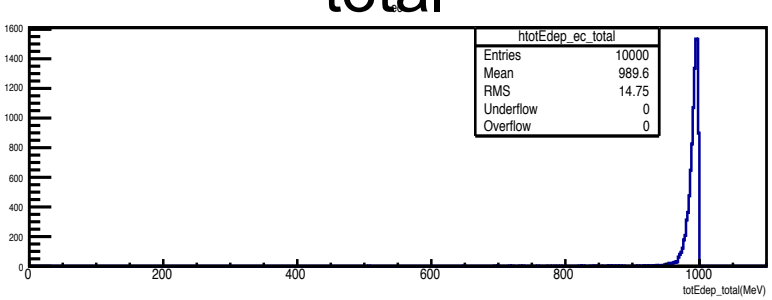
preshower lead



Shower scin + lead

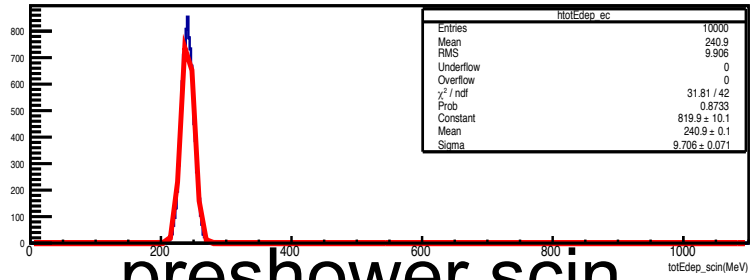


total

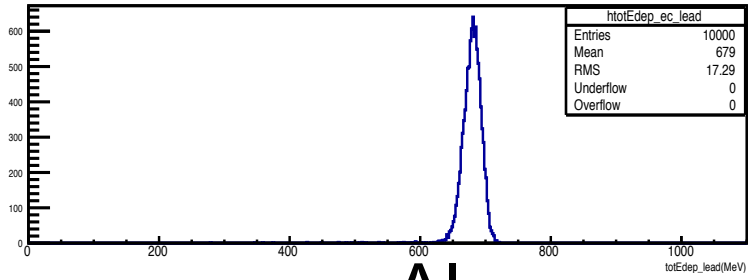


1 GeV e^- PVDIS configuration without Pre-lead

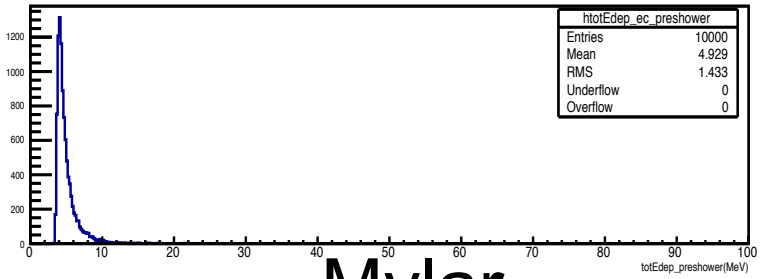
ec shower scin



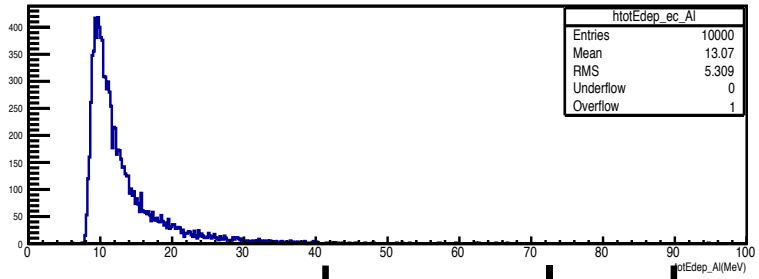
ec shower lead



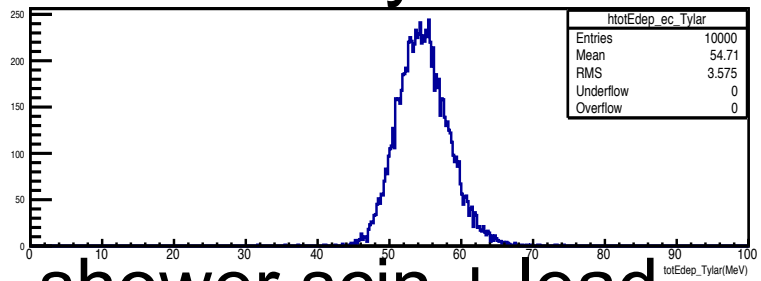
ec preshower scin



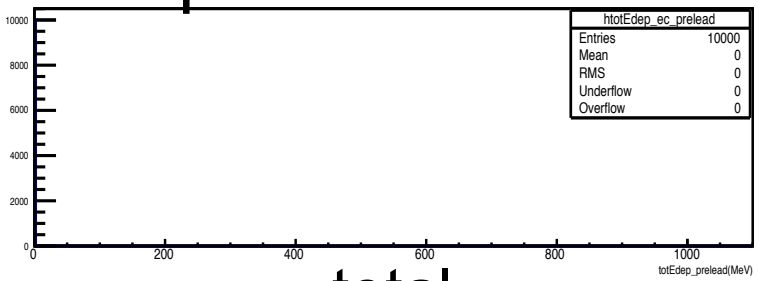
ec Al



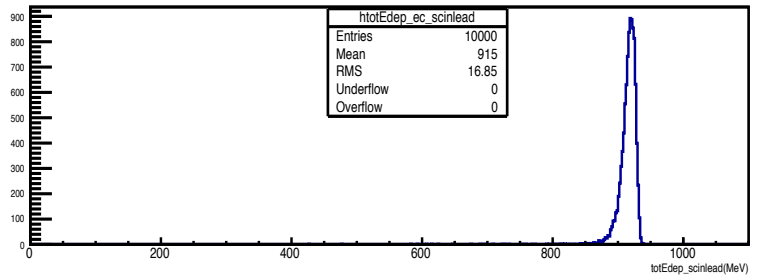
ec Mylar



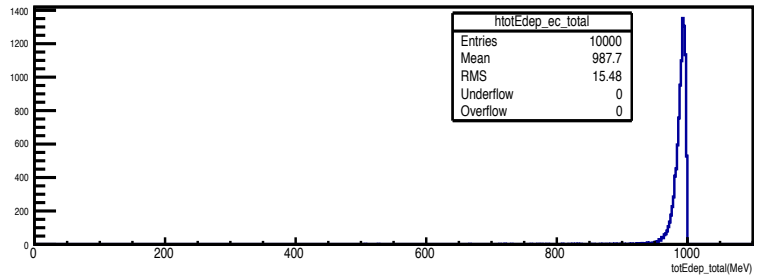
ec preshower lead



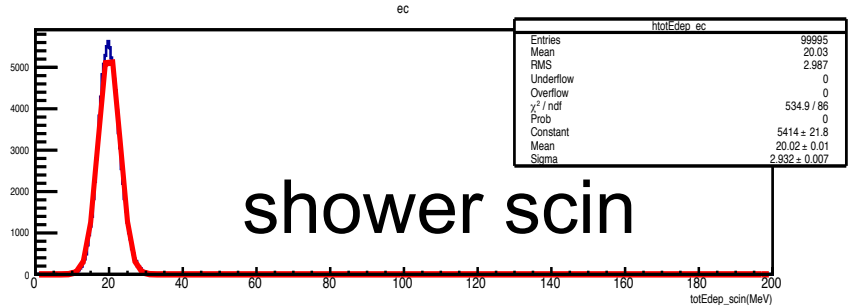
ec shower scin + lead

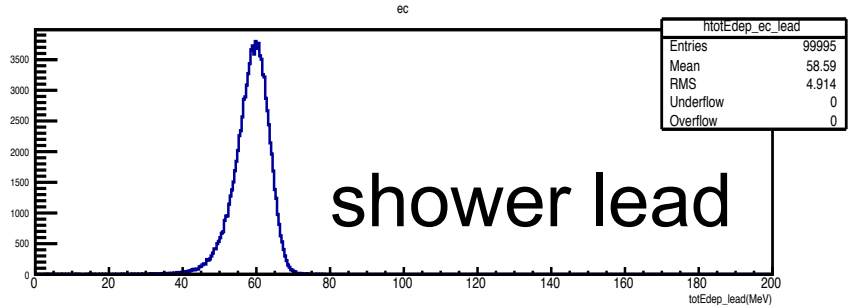


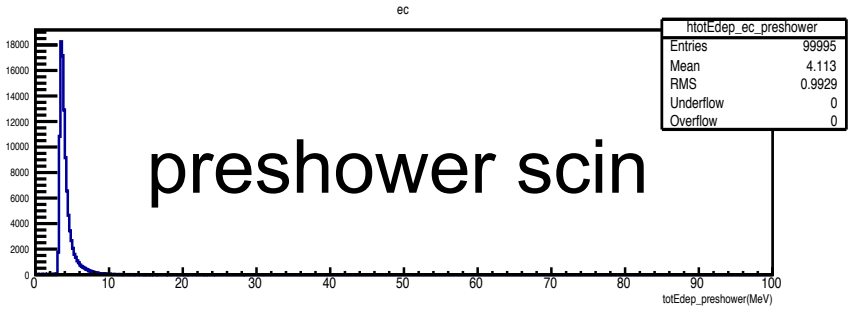
ec total

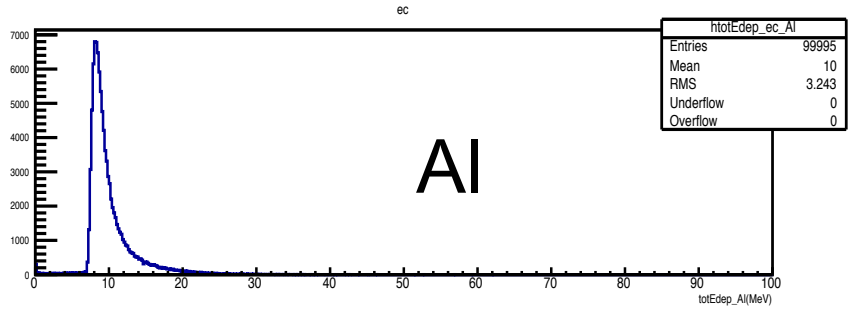


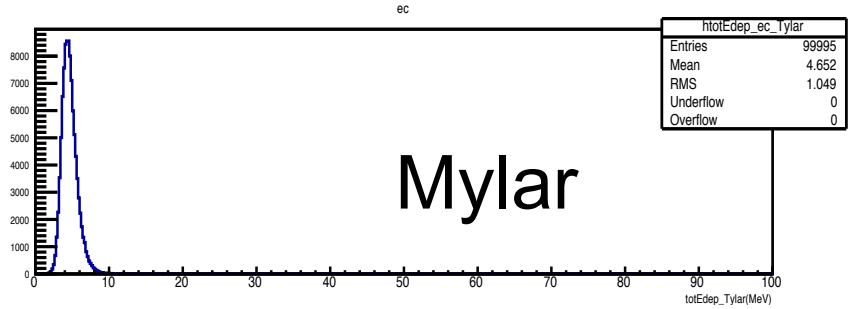
100 MeV/c, e+ 7modules configuration (old)

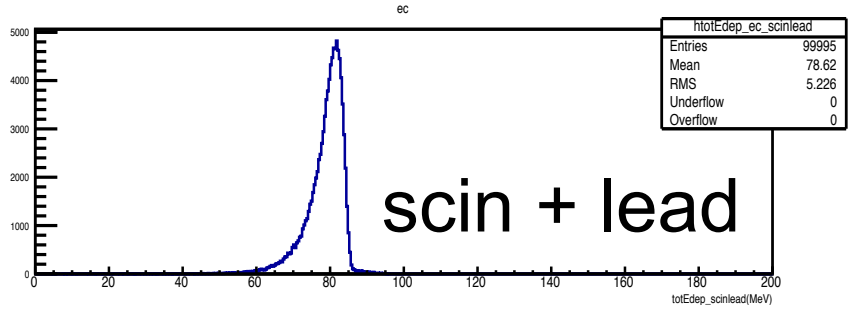


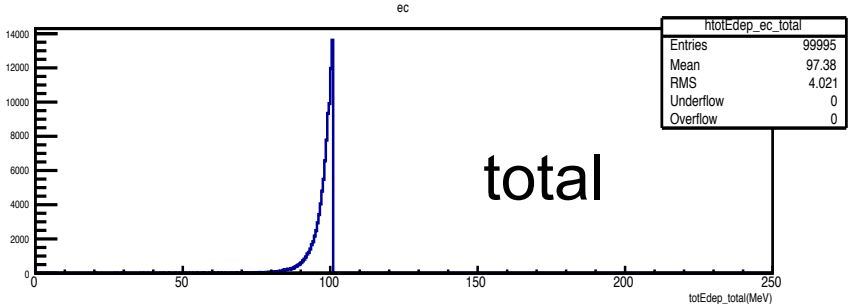




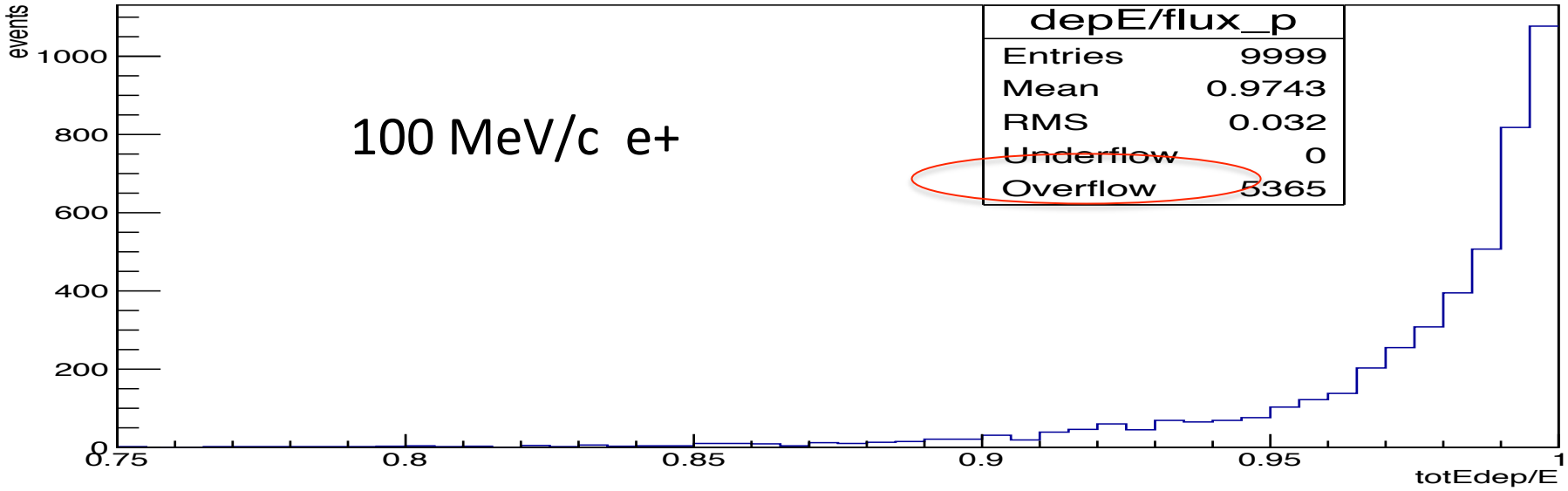


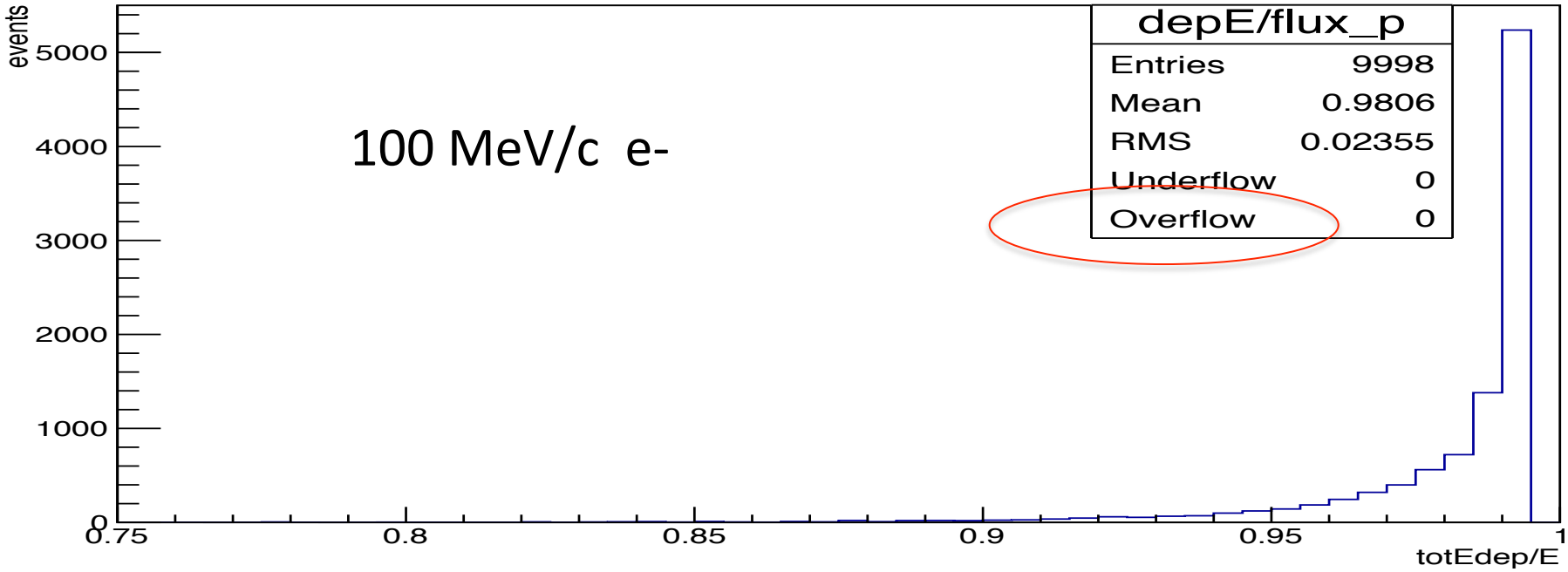


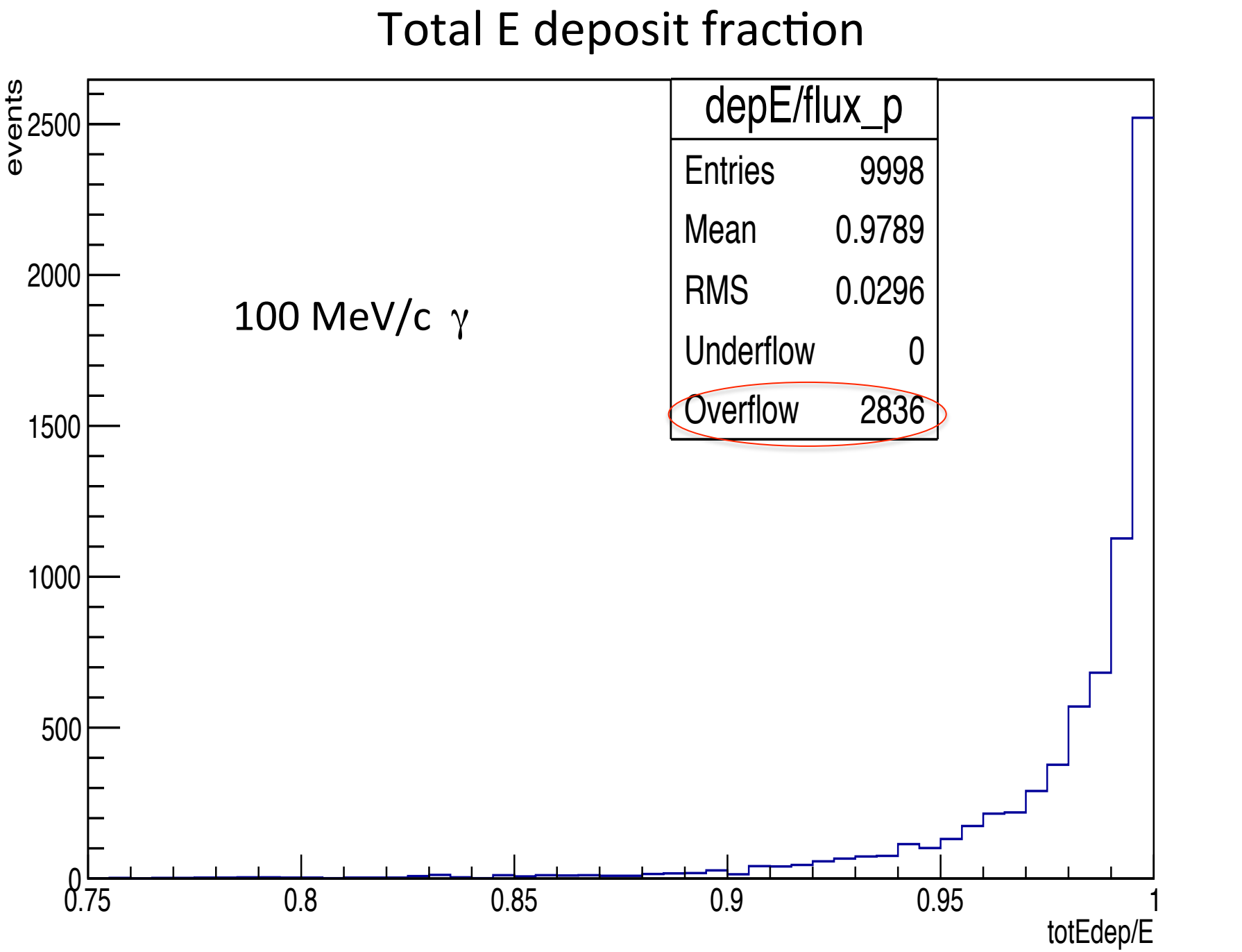




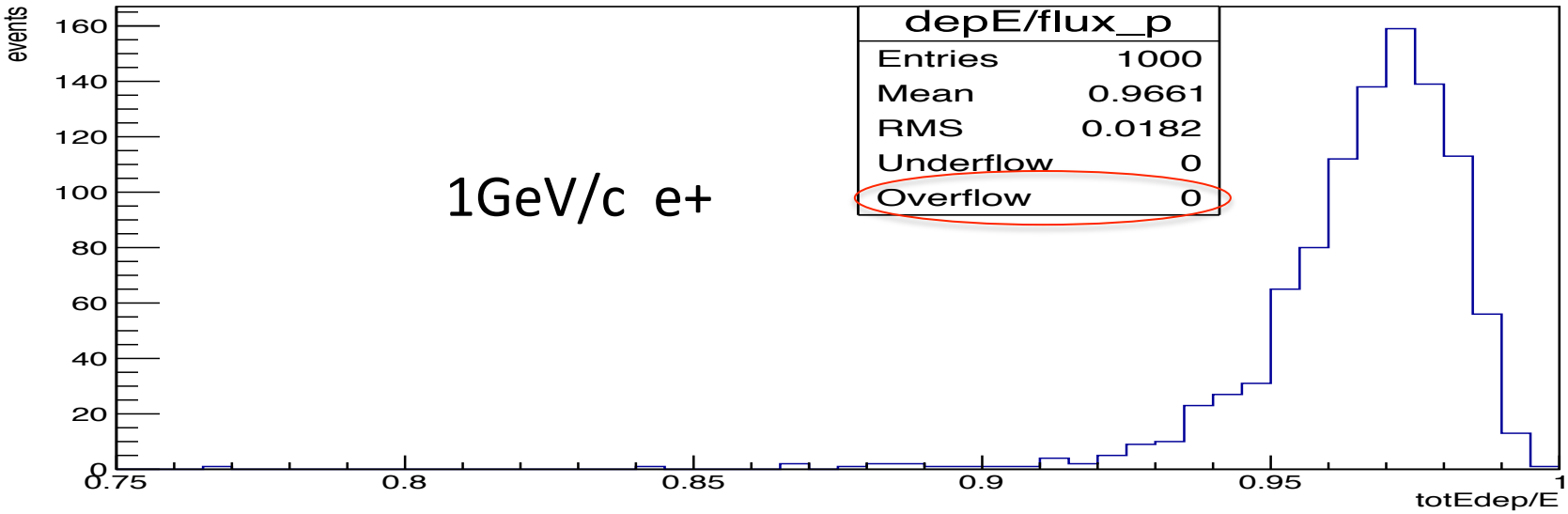
Total E deposit fraction

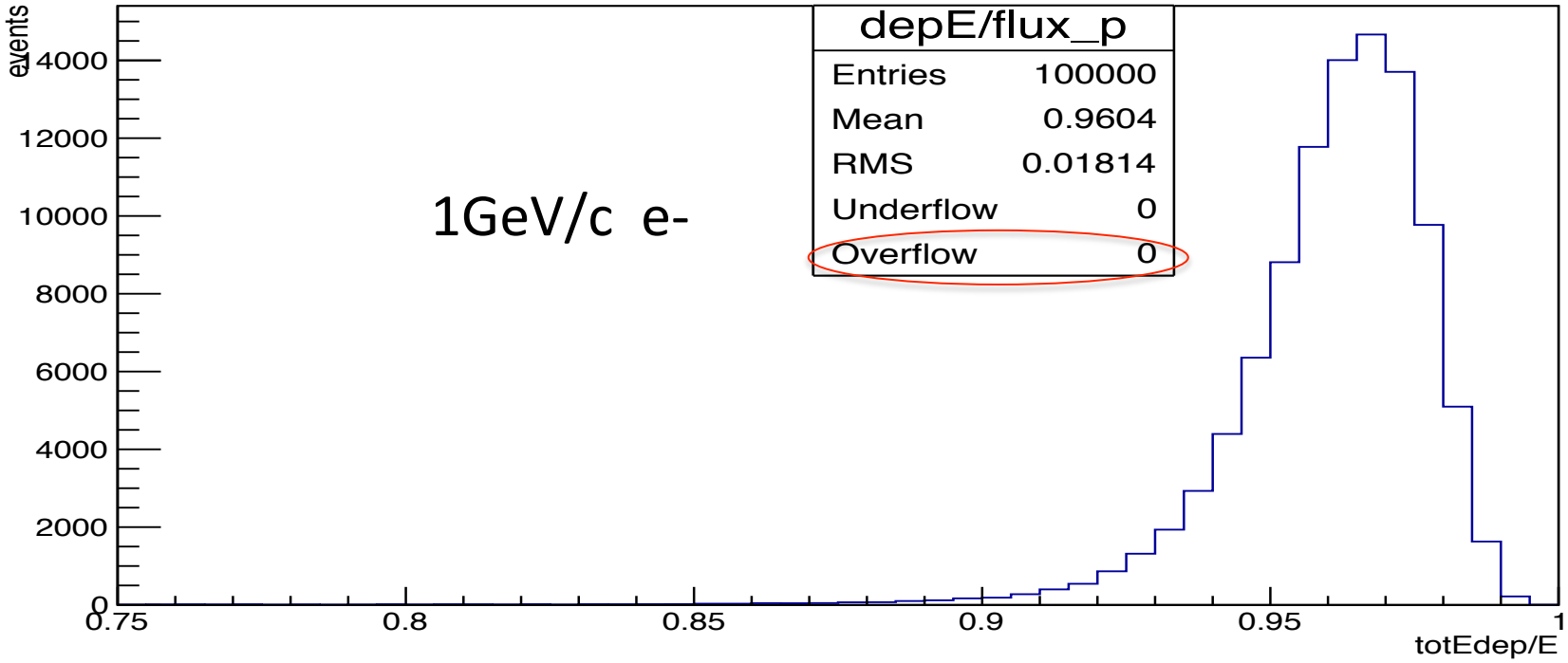





Total E deposit fraction
events
2500
2000
1500
1000
500
0
100 MeV/c γ
depE/flux_p
Entries 9998
Mean 0.9789
RMS 0.0296
Underflow 0
Overflow 2836
0.75
0.8
0.85
0.9
0.95
1
totEdep/E

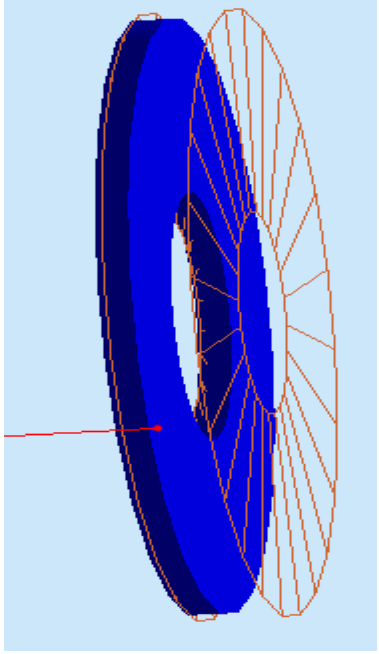
Total E deposit fraction





For the energy over counting issue:

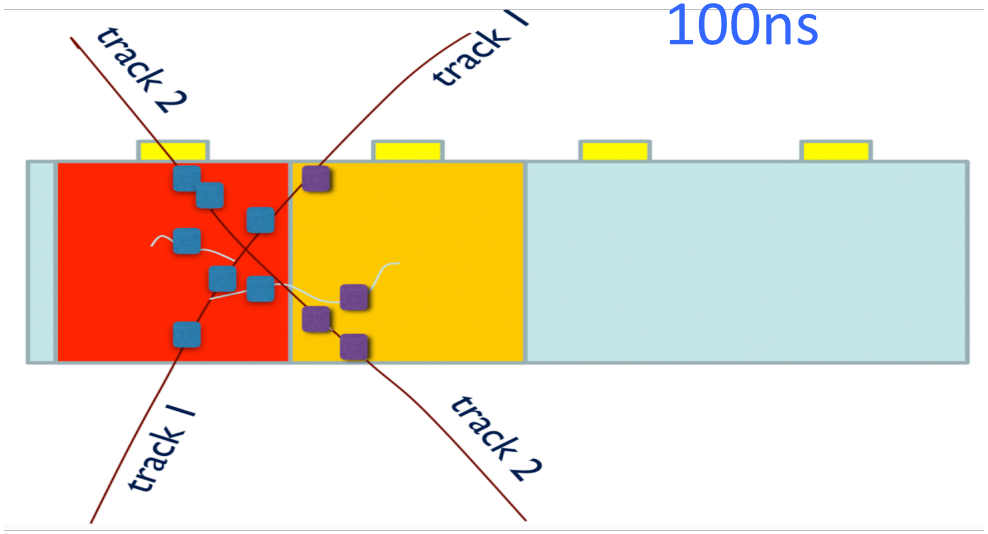
- Not happen for neither low and high energy electron
- Happen for low energy position (photon).



To explore this problem:

- ✓ Simulate low energy (100 MeV) positron to hit on a whole piece of lead ($20X_0$), in order to separate the physics process issue and the structure issue

TW window:
100ns



1, 10 , and 1000ns

The same conclusion as 100 ns TW window

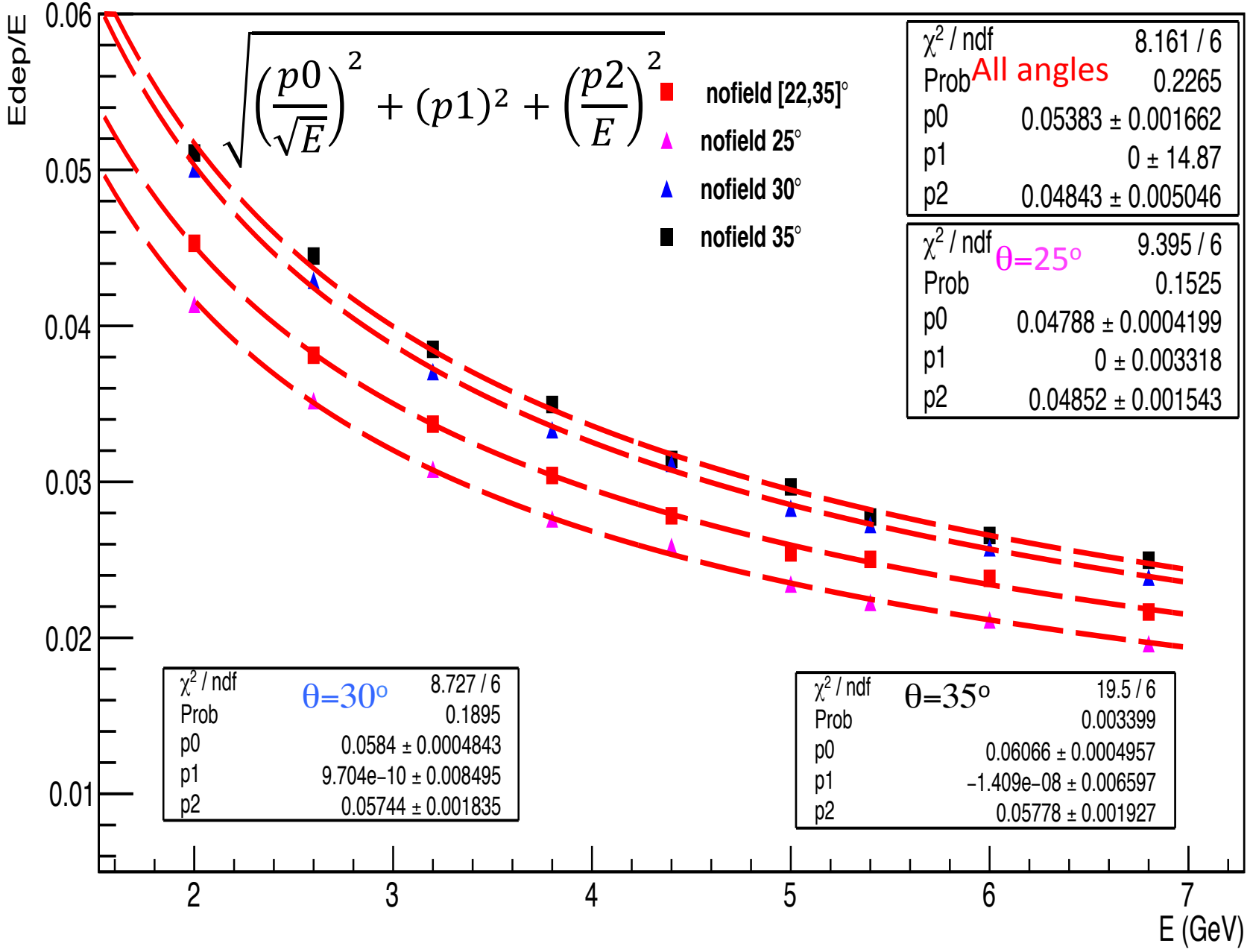
PVDIS Energy Resolution Study

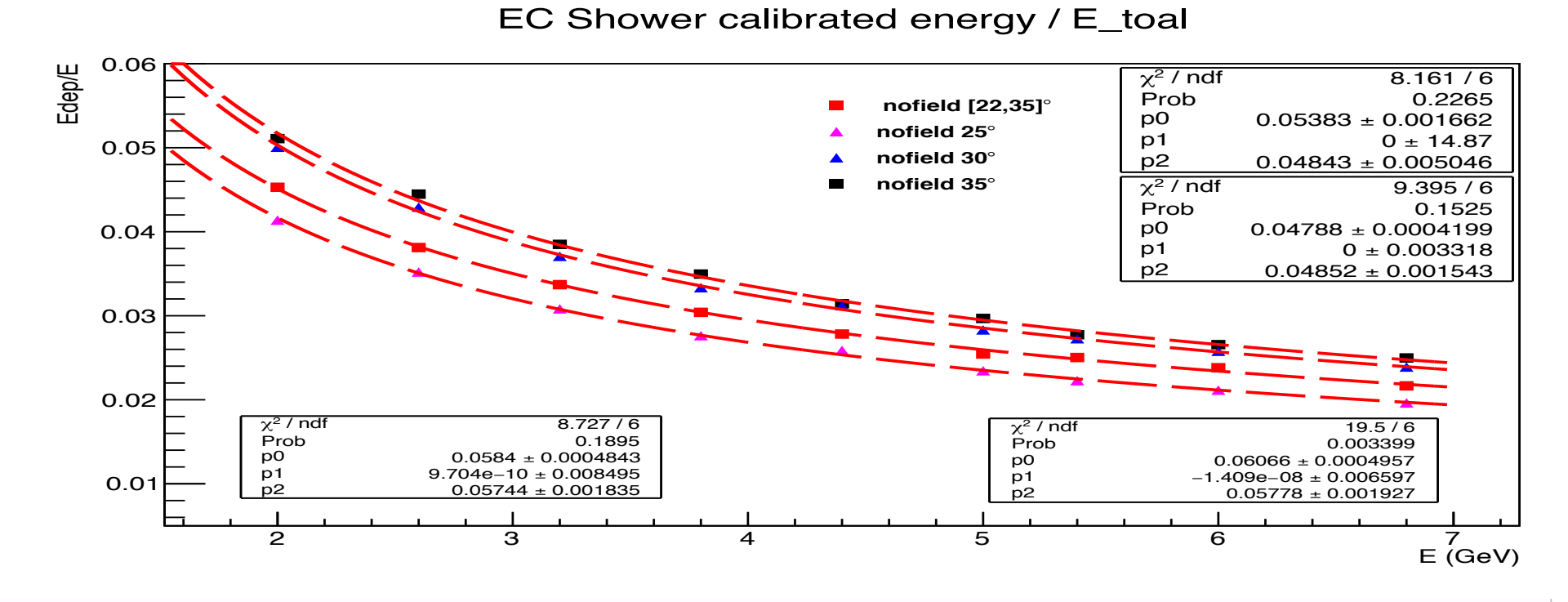
No field e^- beam:

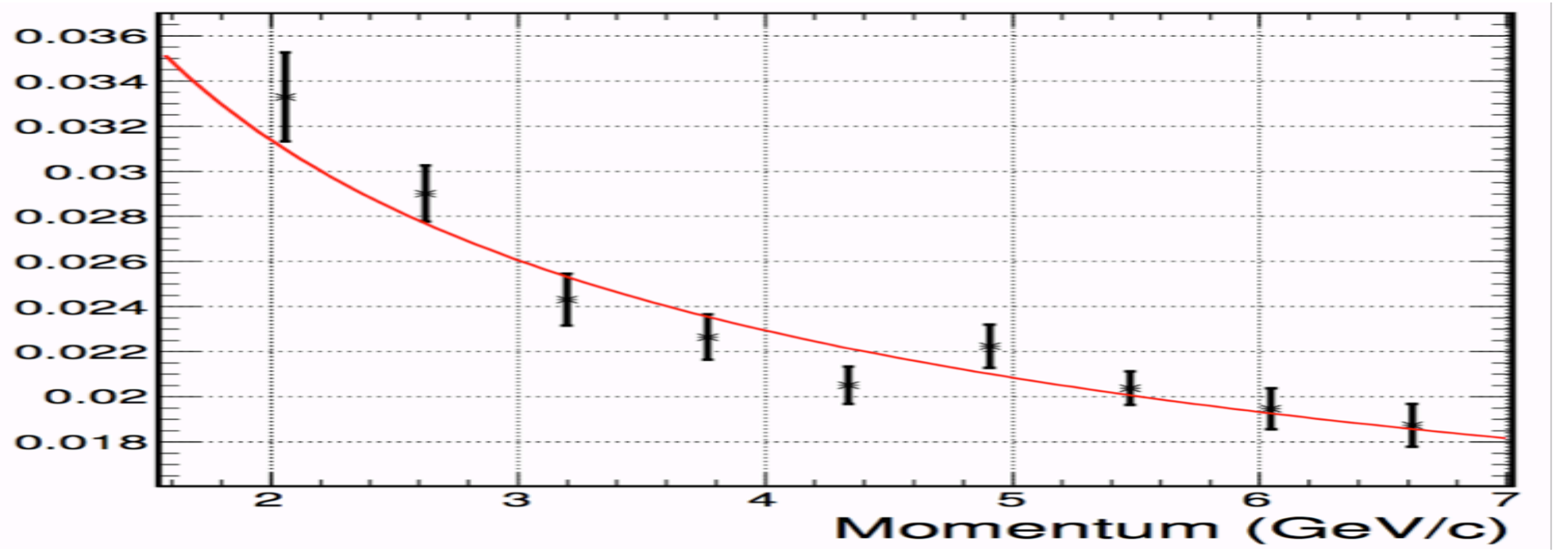
1. θ_e = 25°, 30°, 35° and ϕ=0°
   vertex=(0,0,10 cm)

1. all angles: θ_e= [22°,35°], and ϕ= $[-180^o, 180^o]$
   vertex=(0,0,10 cm) vertex_spread=(0.21,20)

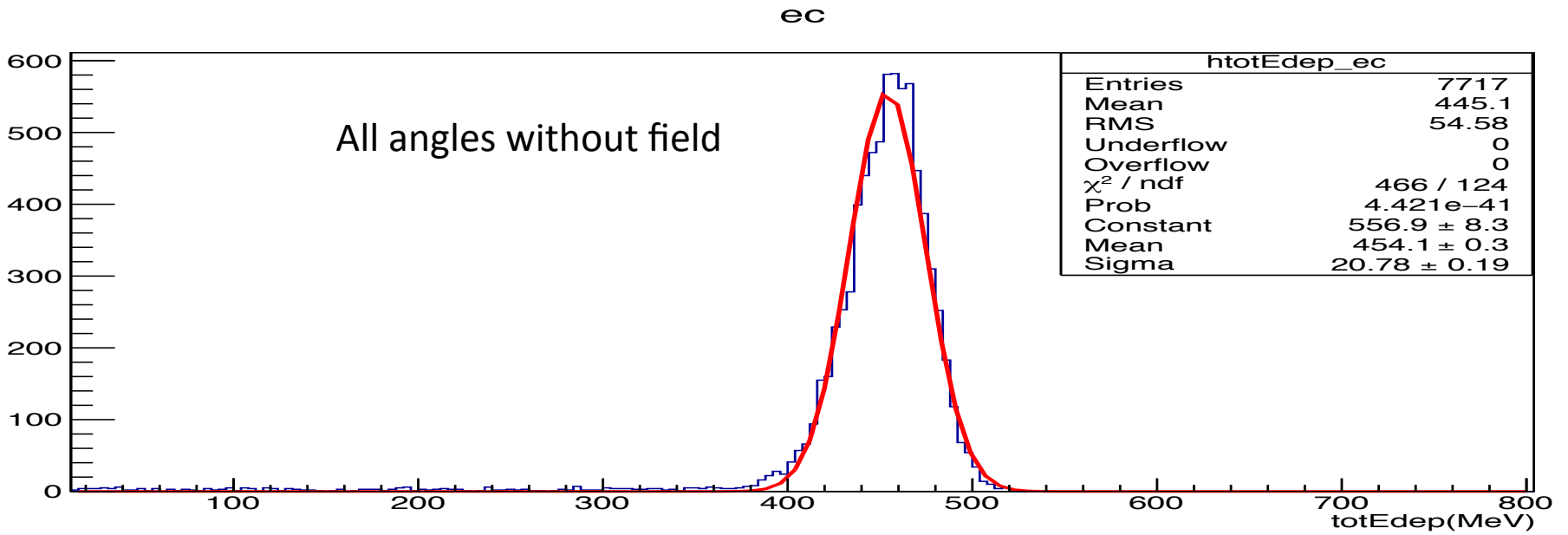
EC Shower calibrated energy / E_toal

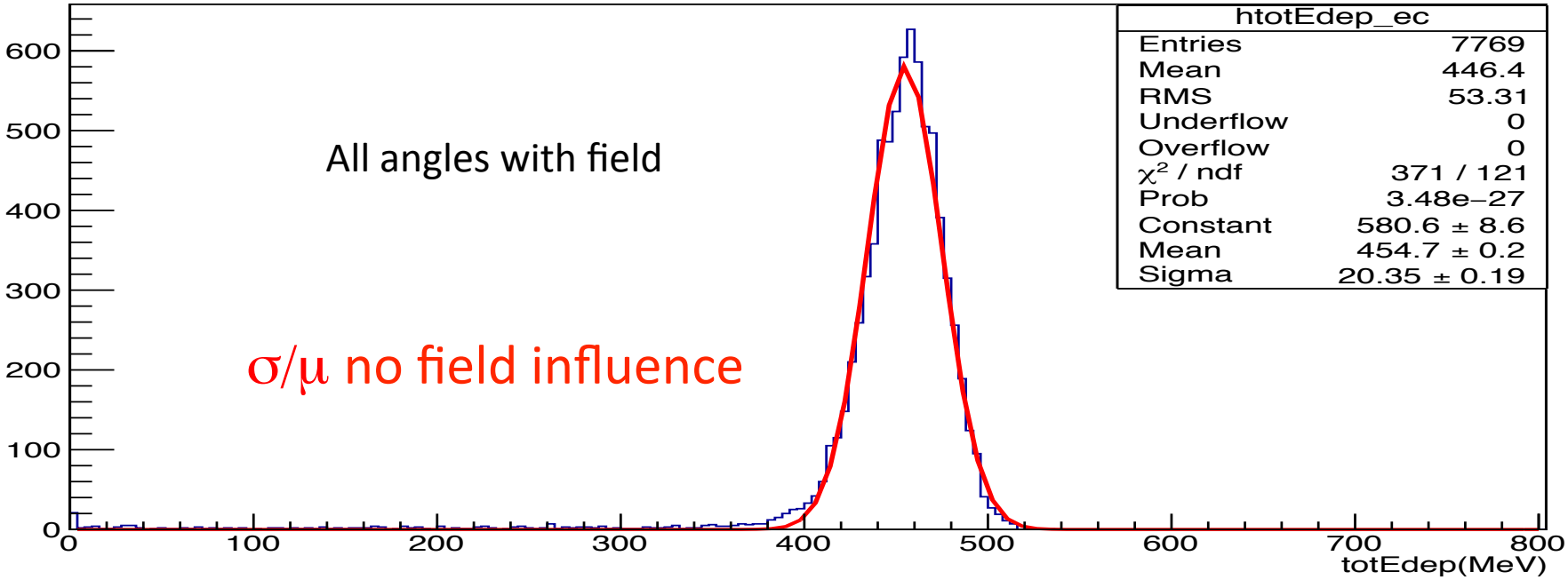



EC Shower calibrated energy / E_toal
Edep/E
E (GeV)
nofield [22,35]°
nofield 25°
nofield 30°
nofield 35°
χ² / ndf 8.161 / 6
Prob 0.2265
p0 0.05383 ± 0.001662
p1 0 ± 14.87
p2 0.04843 ± 0.005046
χ² / ndf 9.395 / 6
Prob 0.1525
p0 0.04788 ± 0.0004199
p1 0 ± 0.003318
p2 0.04852 ± 0.001543
χ² / ndf 8.727 / 6
Prob 0.1895
p0 0.0584 ± 0.0004843
p1 9.704e−10 ± 0.008495
p2 0.05744 ± 0.001835
χ² / ndf 19.5 / 6
Prob 0.003399
p0 0.06066 ± 0.0004957
p1 −1.409e−08 ± 0.006597
p2 0.05778 ± 0.001927


Momentum (GeV/c)

2 GeV e⁻ ECAL energy deposit distribution

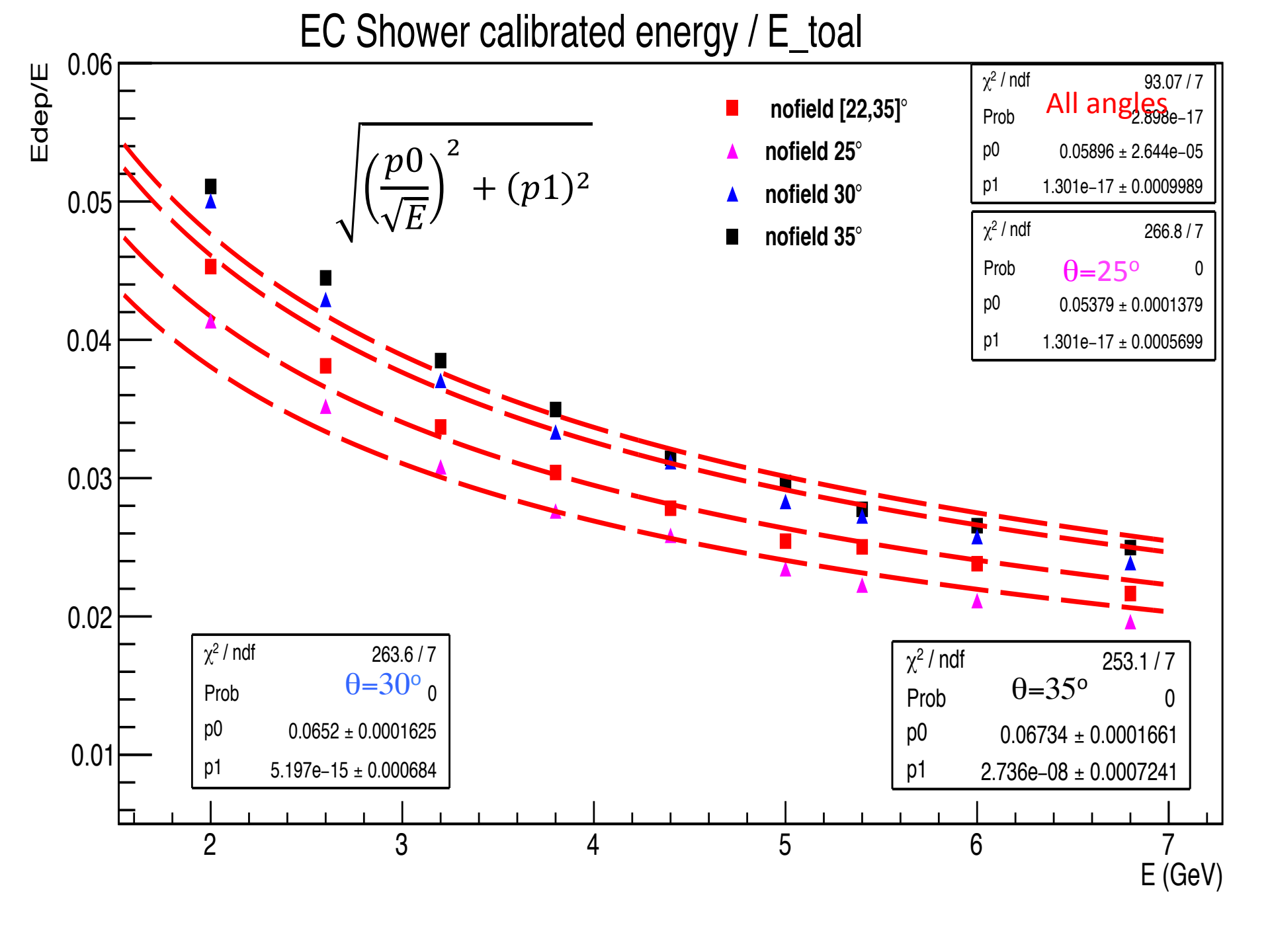




Why P2 is large for the simulation result ?

- In order to check this issue, the experimental test result is needed.

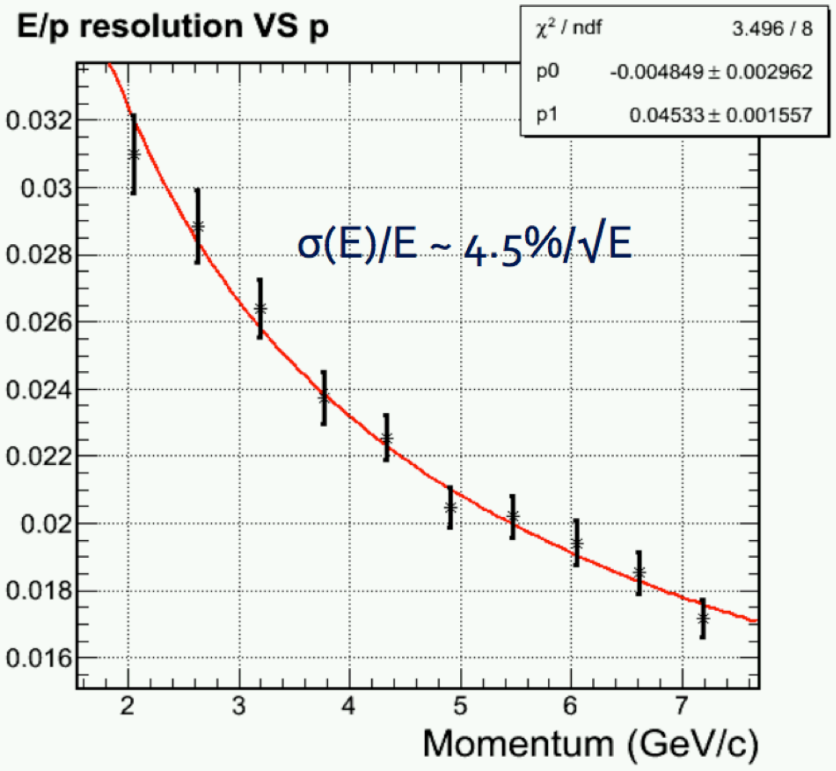
- Fit the plot by ignoring the p2 term.

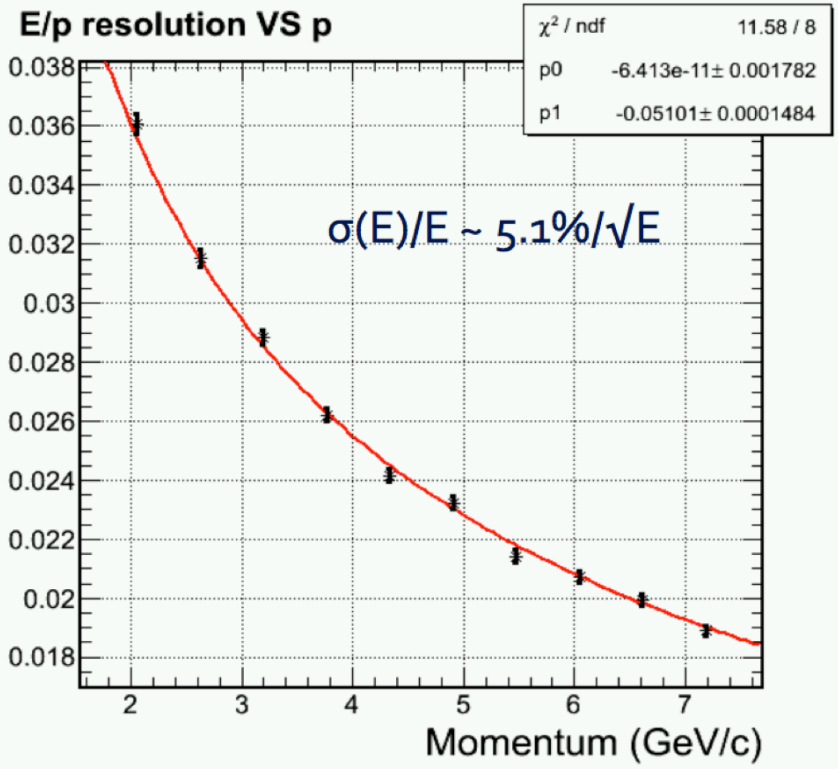

EC Shower calibrated energy / E_toal
Edep/E
E (GeV)
$\sqrt{\left(\frac{p0}{\sqrt{E}}\right)^2 + (p1)^2}$
nofield [22,35]°
nofield 25°
nofield 30°
nofield 35°
All angles
χ² / ndf 93.07 / 7
Prob 2.898e−17
p0 0.05896 ± 2.644e−05
p1 1.301e−17 ± 0.0009989
θ=25°
χ² / ndf 266.8 / 7
Prob 0
p0 0.05379 ± 0.0001379
p1 1.301e−17 ± 0.0005699
θ=30°
χ² / ndf 263.6 / 7
Prob 0
p0 0.0652 ± 0.0001625
p1 5.197e−15 ± 0.000684
θ=35°
χ² / ndf 253.1 / 7
Prob 0
p0 0.06734 ± 0.0001661
p1 2.736e−08 ± 0.0007241

The influence of support structure (2cm Al) on ECAL energy resolution from SOLID GEMC simulation

Change in energy resolution

Use preshower reading to recover missing energy in Al support structure

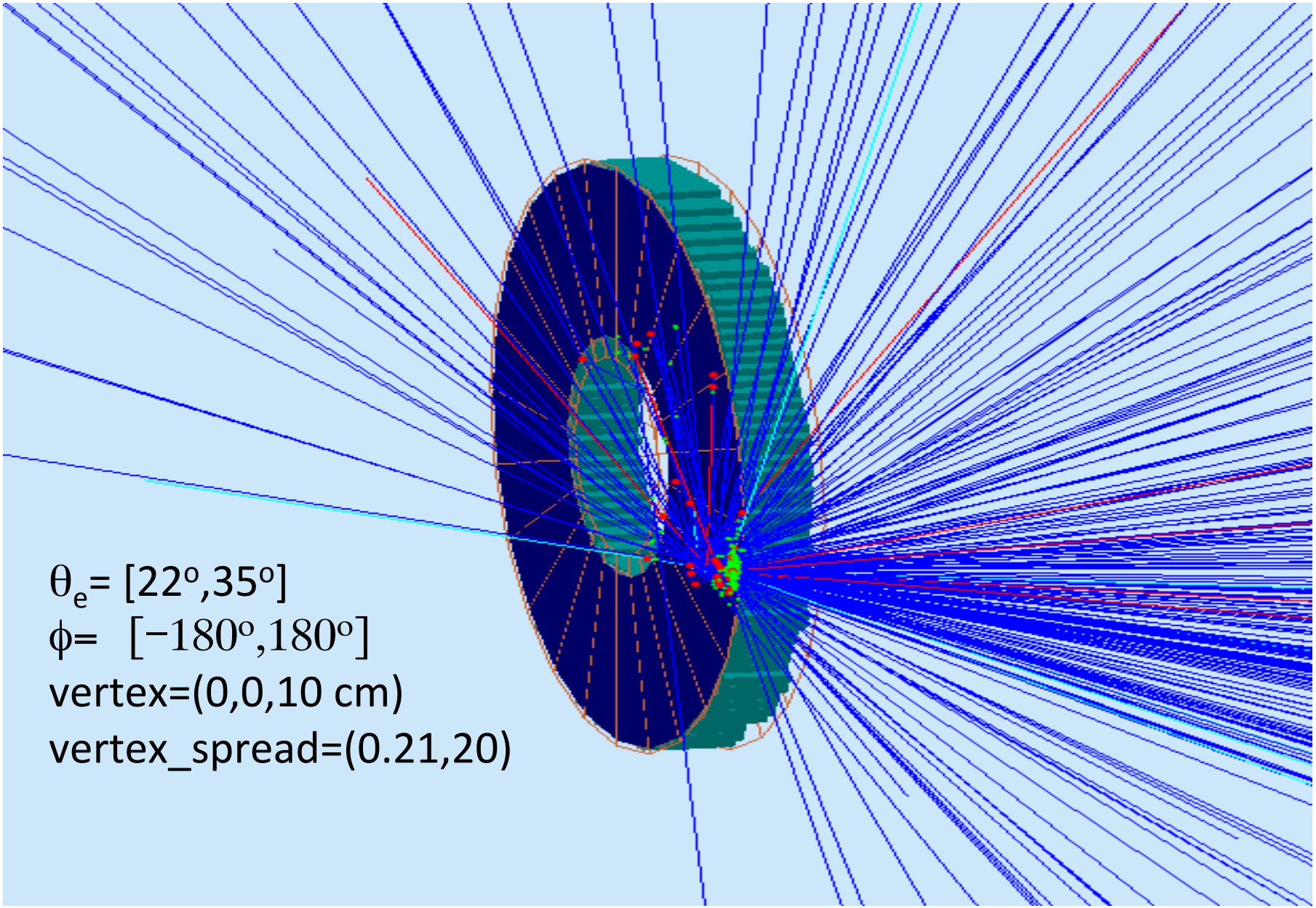


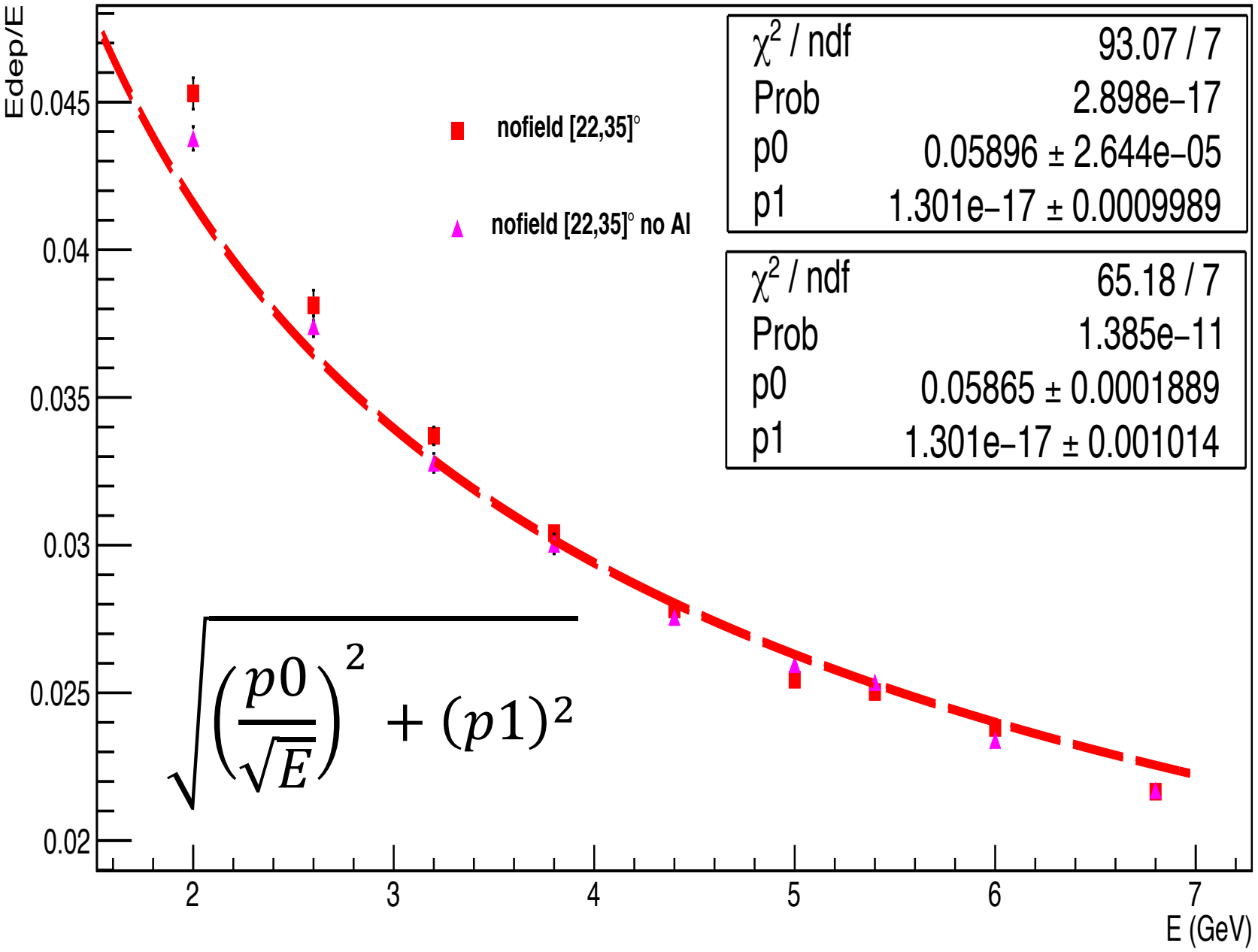


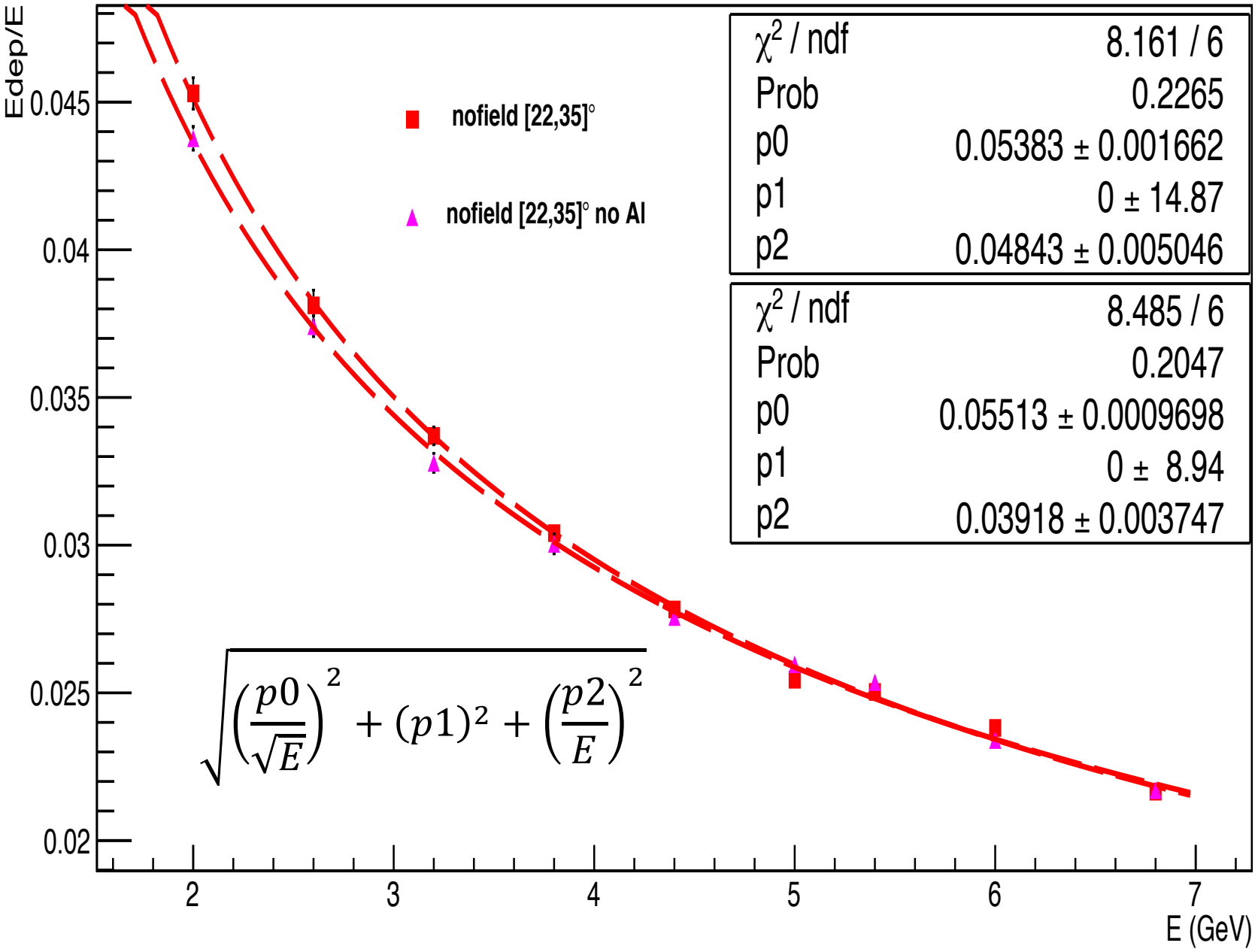
Without Al support plate

With Al support plate

SOLID ECAL Stand Alone Simulation




EC Shower calibrated energy / E_toal
Edep/E
0.045
0.04
0.035
0.03
0.025
0.02
2
3
4
5
6
7
E (GeV)
nofield [22,35]°
nofield [22,35]° no Al
χ² / ndf 93.07 / 7
Prob 2.898e−17
p0 0.05896 ± 2.644e−05
p1 1.301e−17 ± 0.0009989
χ² / ndf 65.18 / 7
Prob 1.385e−11
p0 0.05865 ± 0.0001889
p1 1.301e−17 ± 0.001014
$\sqrt{\left(\frac{p0}{\sqrt{E}}\right)^2 + (p1)^2}$


EC Shower calibrated energy / E_toal
Edep/E
0.045
0.04
0.035
0.03
0.025
0.02
2
3
4
5
6
7
E (GeV)
nofield [22,35]°
nofield [22,35]° no Al
χ² / ndf 8.161 / 6
Prob 0.2265
p0 0.05383 ± 0.001662
p1 0 ± 14.87
p2 0.04843 ± 0.005046
χ² / ndf 8.485 / 6
Prob 0.2047
p0 0.05513 ± 0.0009698
p1 0 ± 8.94
p2 0.03918 ± 0.003747
$\sqrt{\left(\frac{p0}{\sqrt{E}}\right)^2 + (p1)^2 + \left(\frac{p2}{E}\right)^2}$

Summary

- ✧ For SoLID PVDIS configuration: the ECAL energy resolution become worse by increasing the polar angle of electron beam.
- ✧ The full polar angle coverage [22^o, 35^o] energy resolution from GEMC simulation is larger than the PcDR results
- ✧ From 1 GeV electron beam $\sigma E/E$ comparison, the preshower lead influence the ECAL energy resolution rather than support structure and field.

Any comments and suggestions ?