# Charged pion analysis

*Single Spin Asymmetry*

- Pythia Simulation

Korea Univ.
Jaehee Yoo

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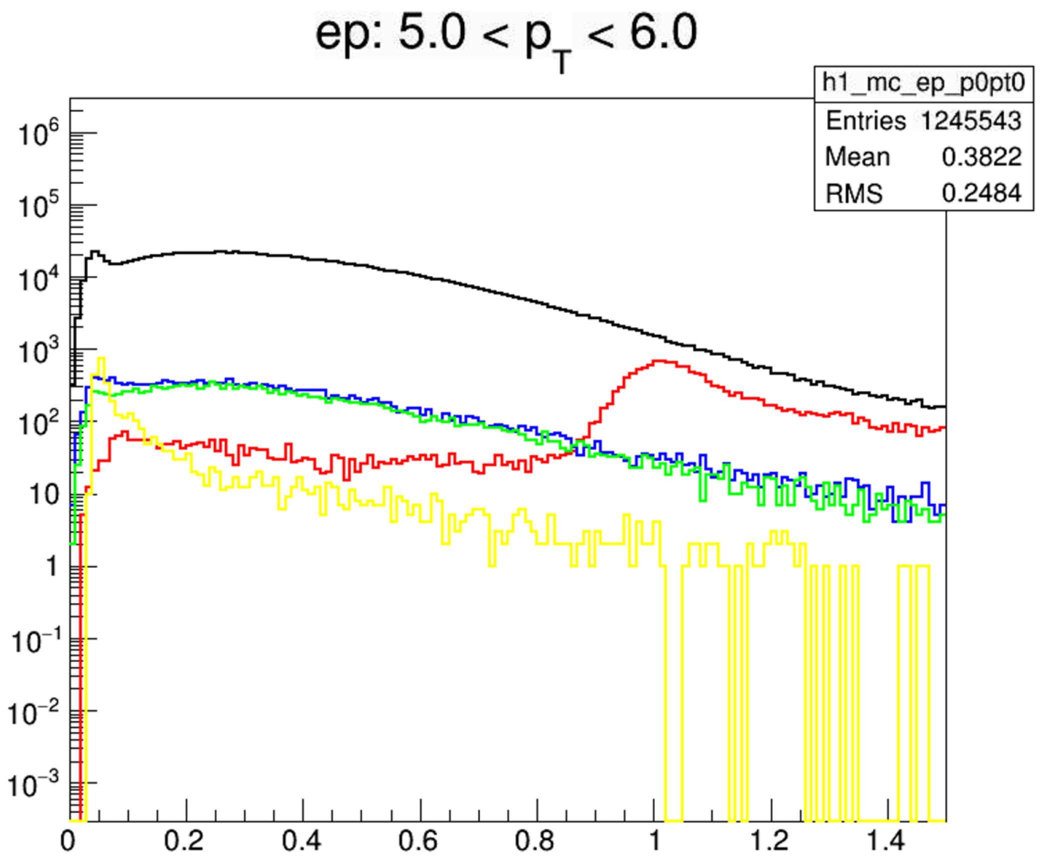
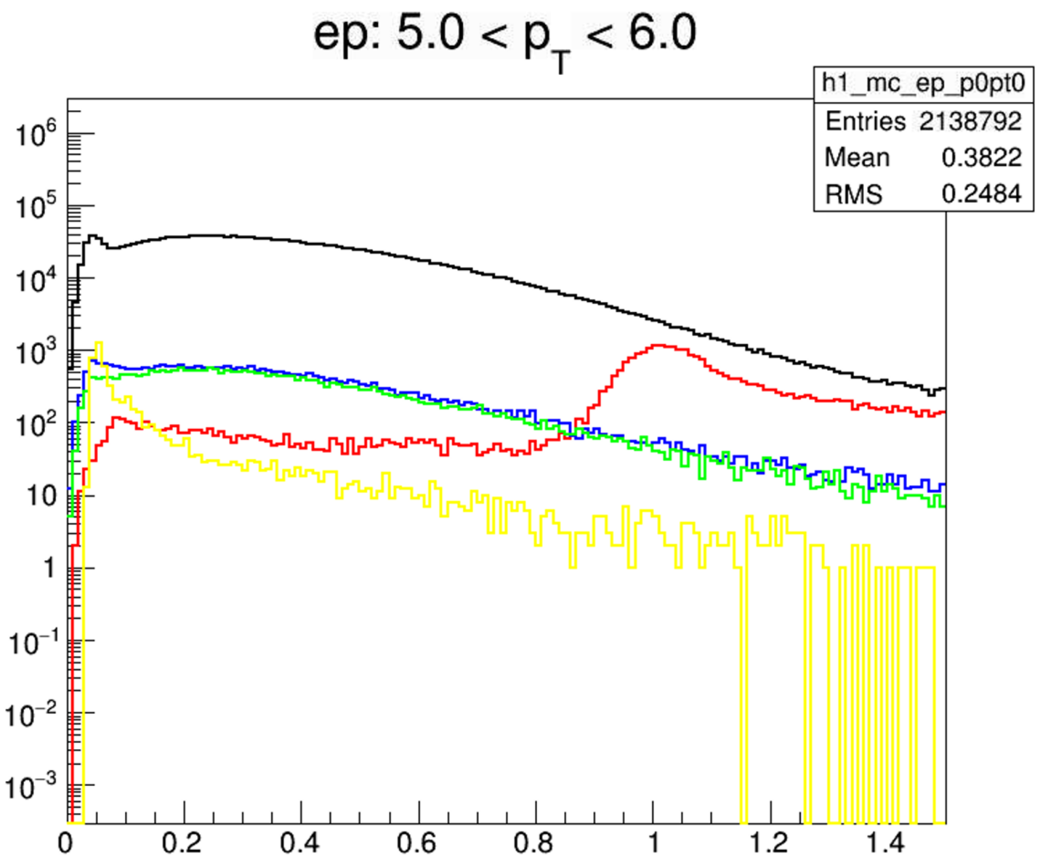
# Pythia simulation cut distribution(5~6 GeV)

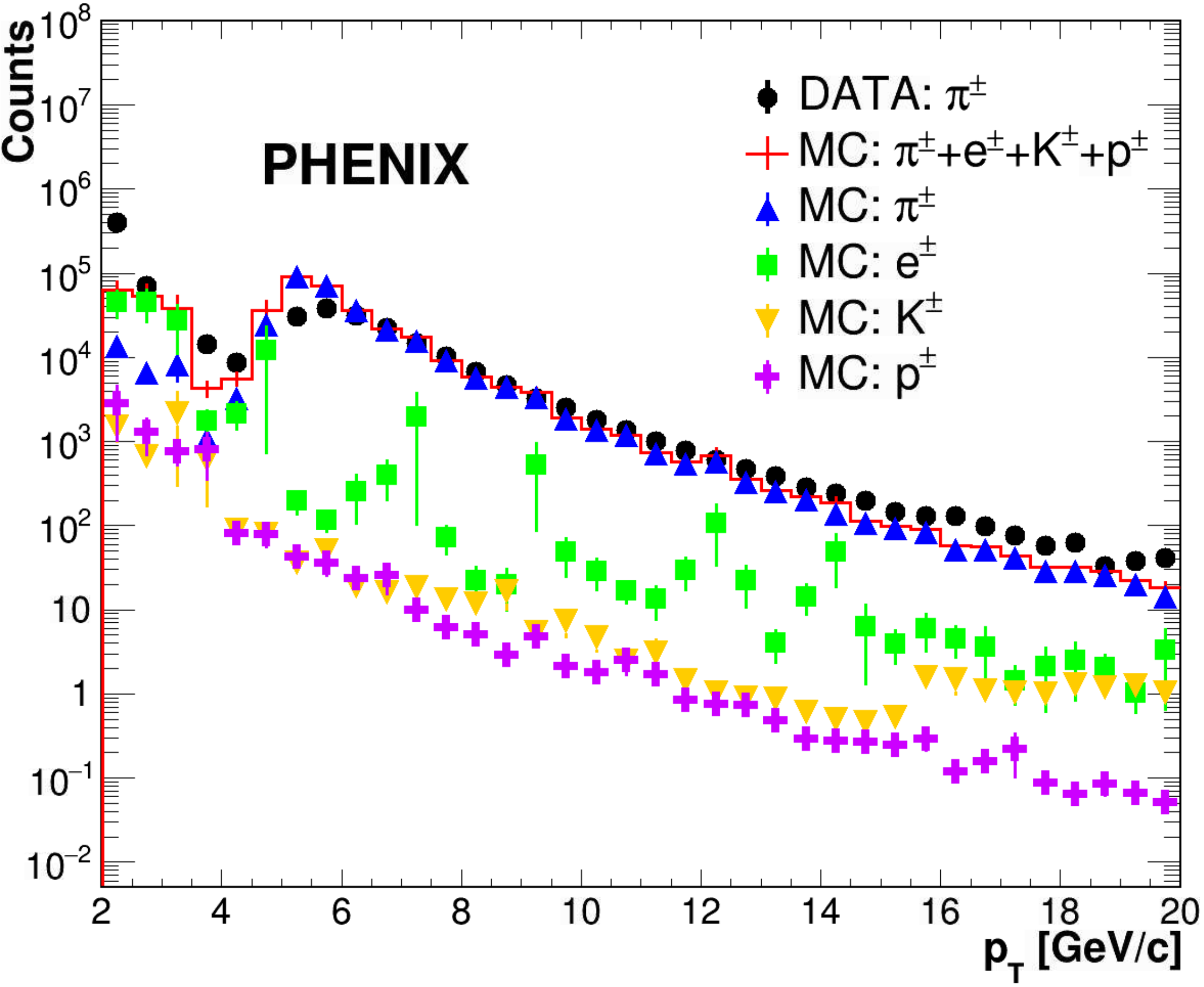
| before | after |
|---|---|

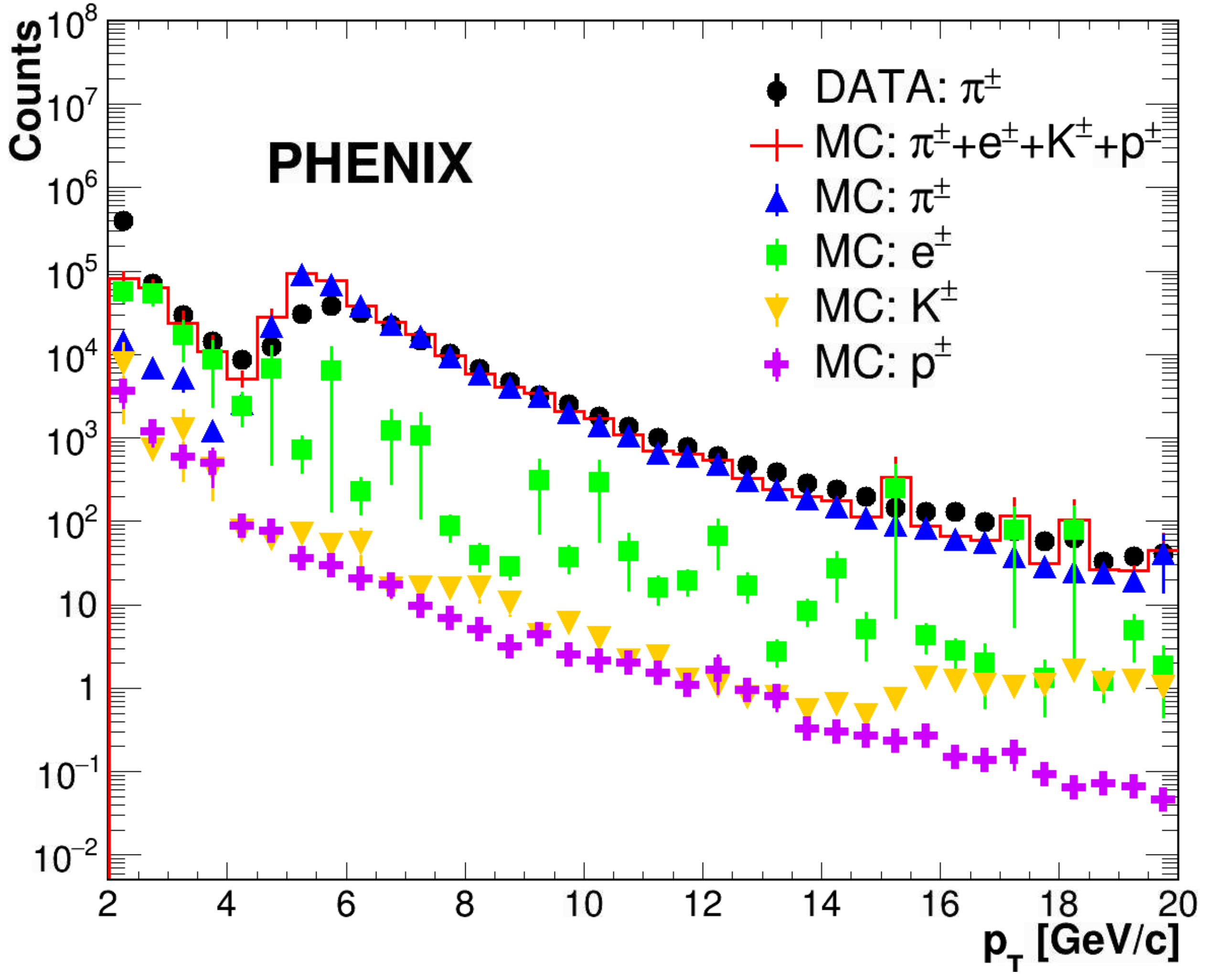


# pt

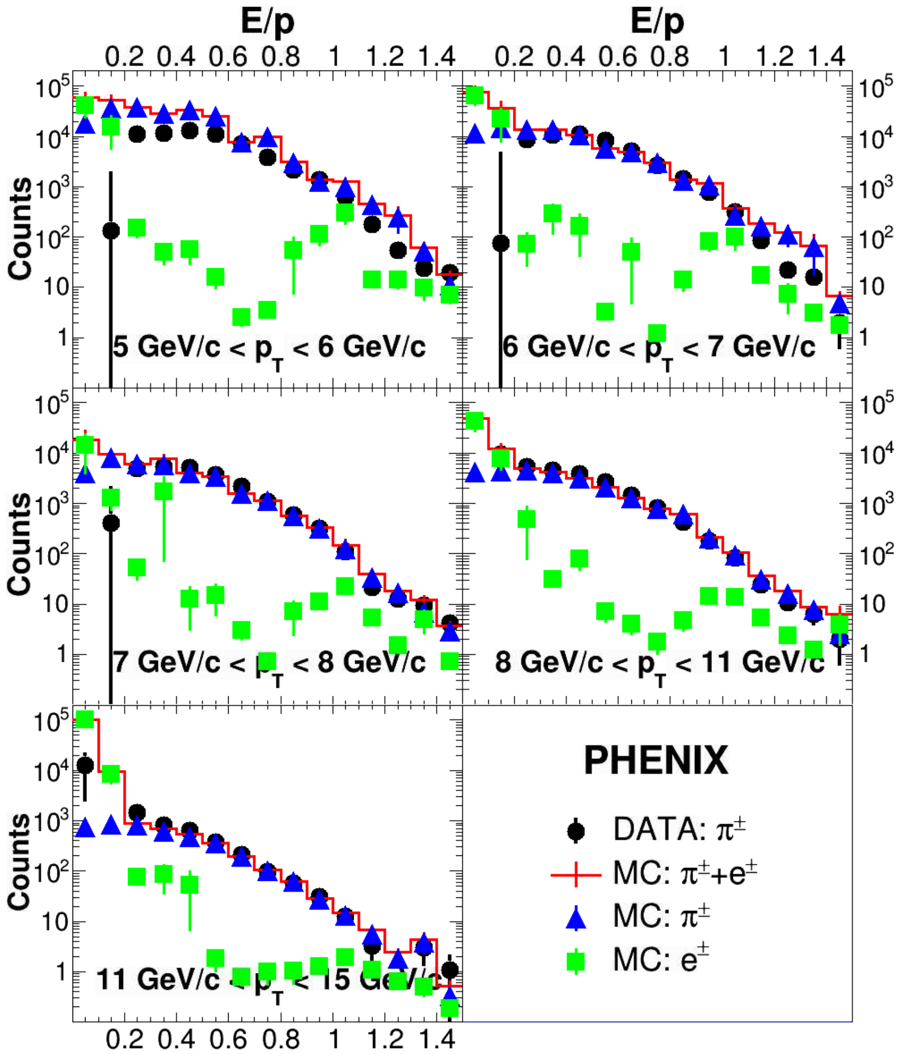
| before | after |
|---|---|

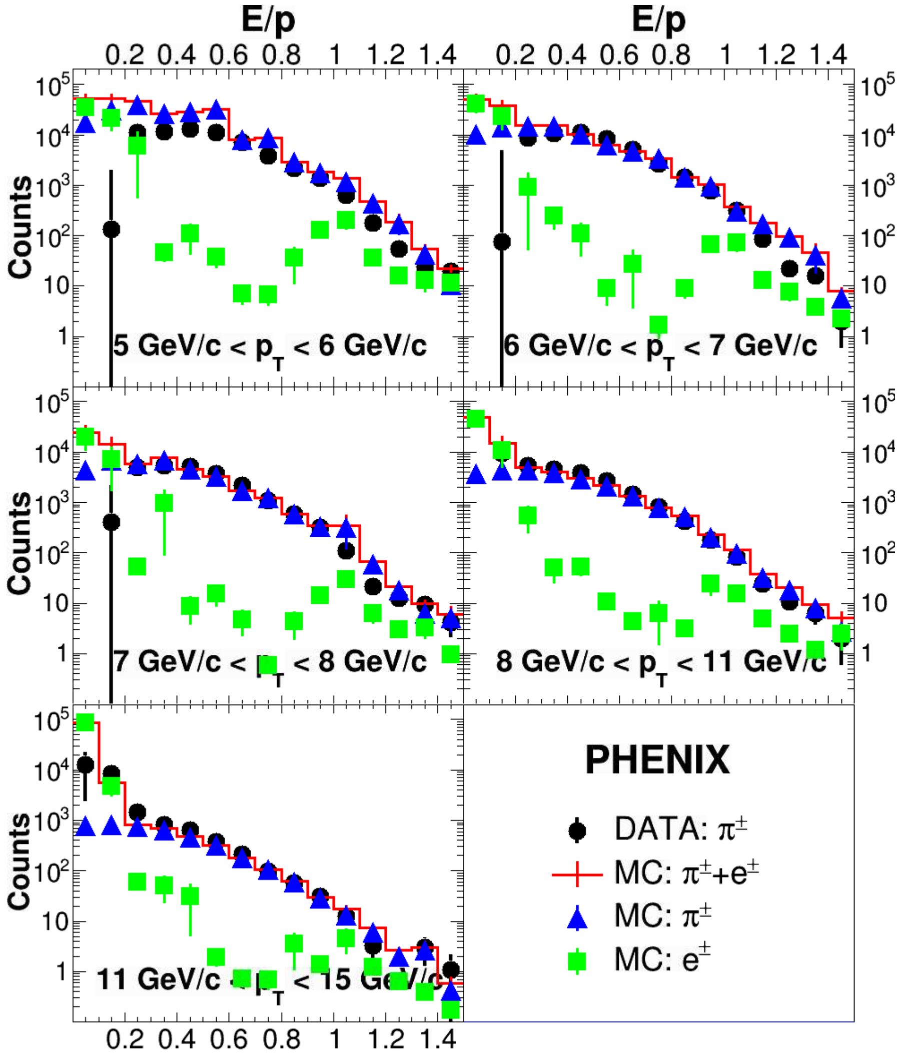


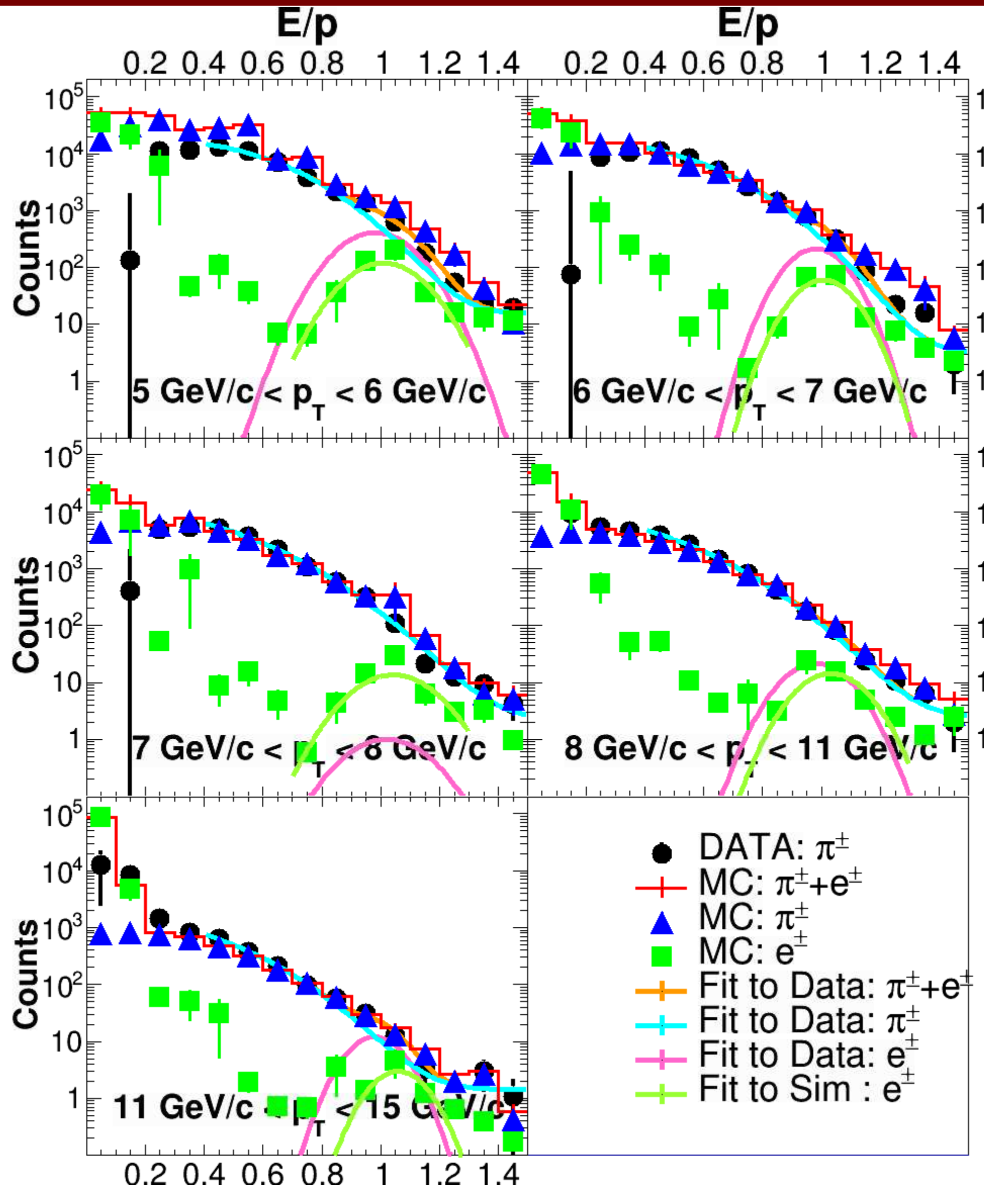
# e/p

| before | after |
| --- | --- |

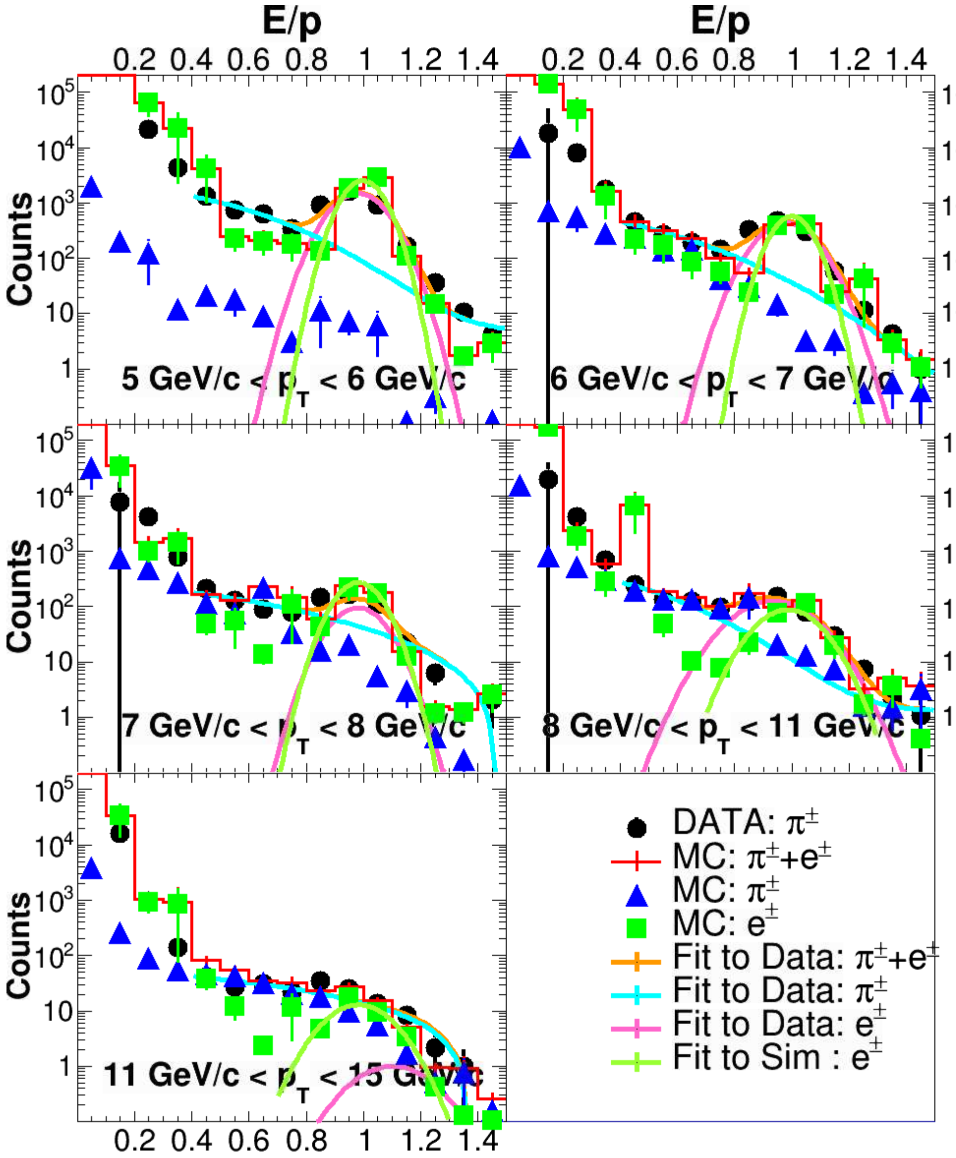


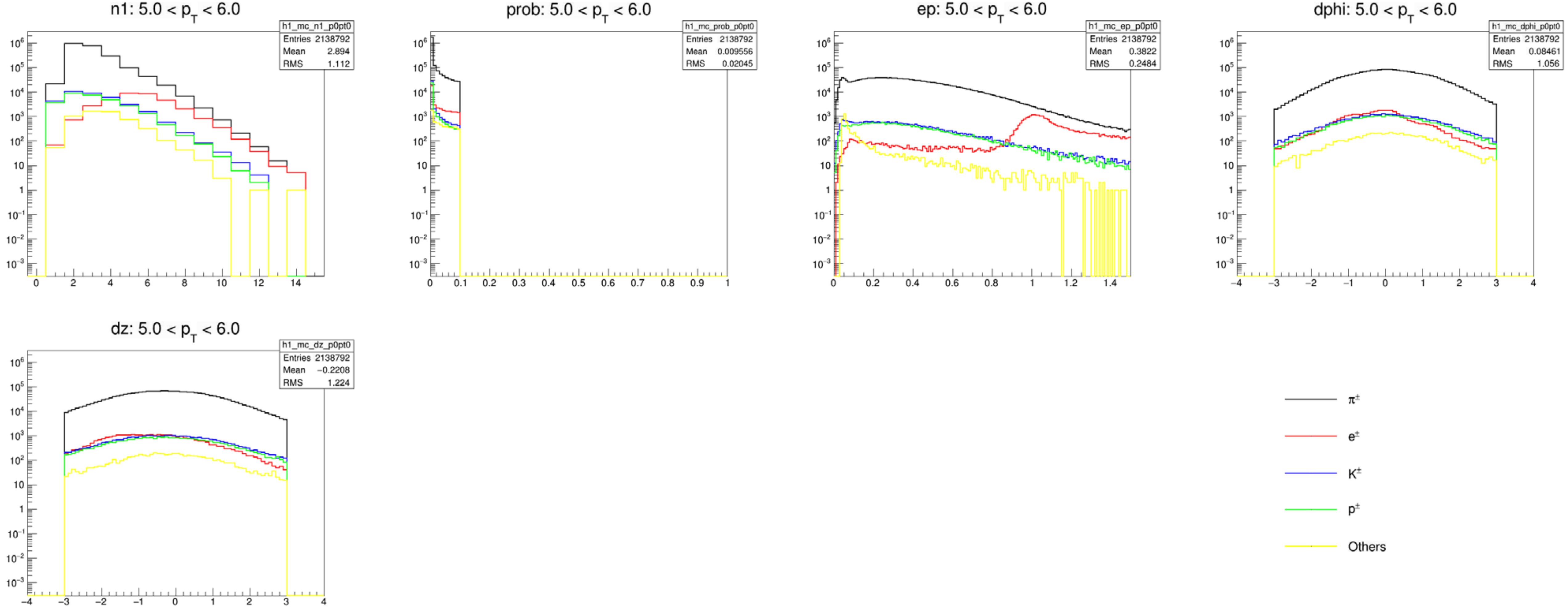
# Backgroud fraction (pion enhancement sample)



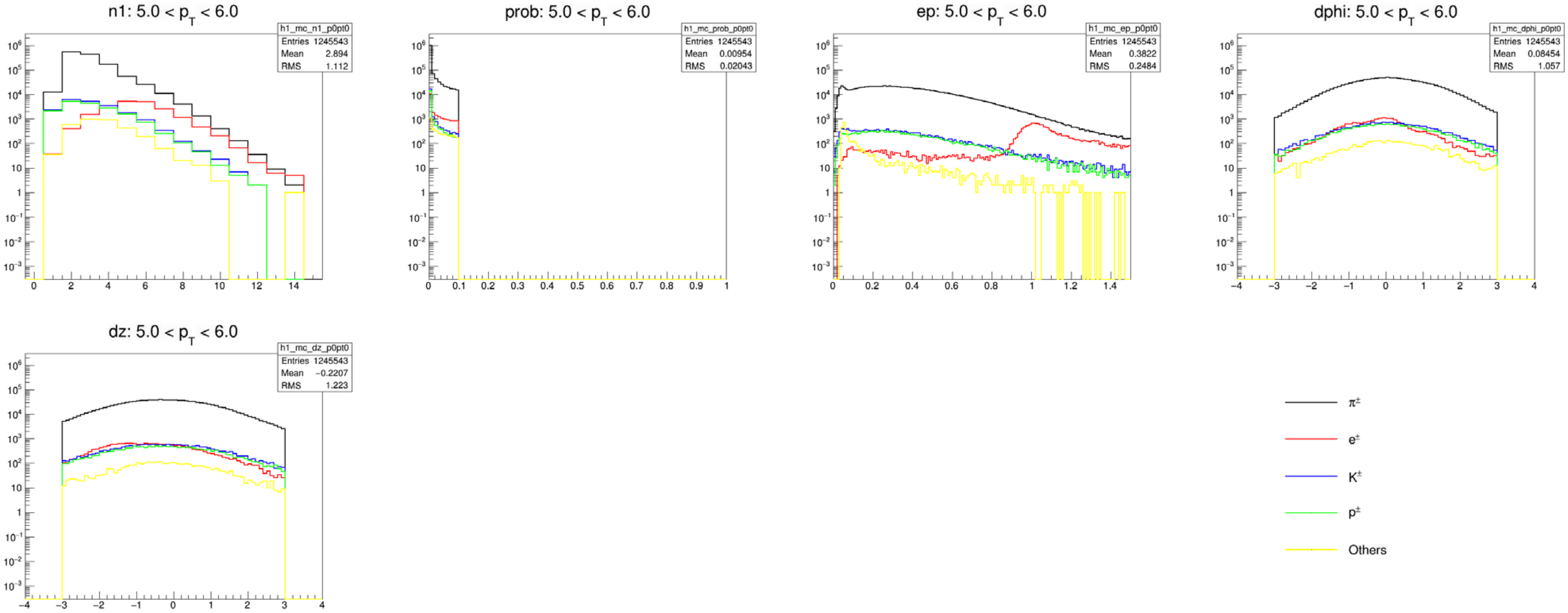
# Backgroud fraction (electron enhancement sample)



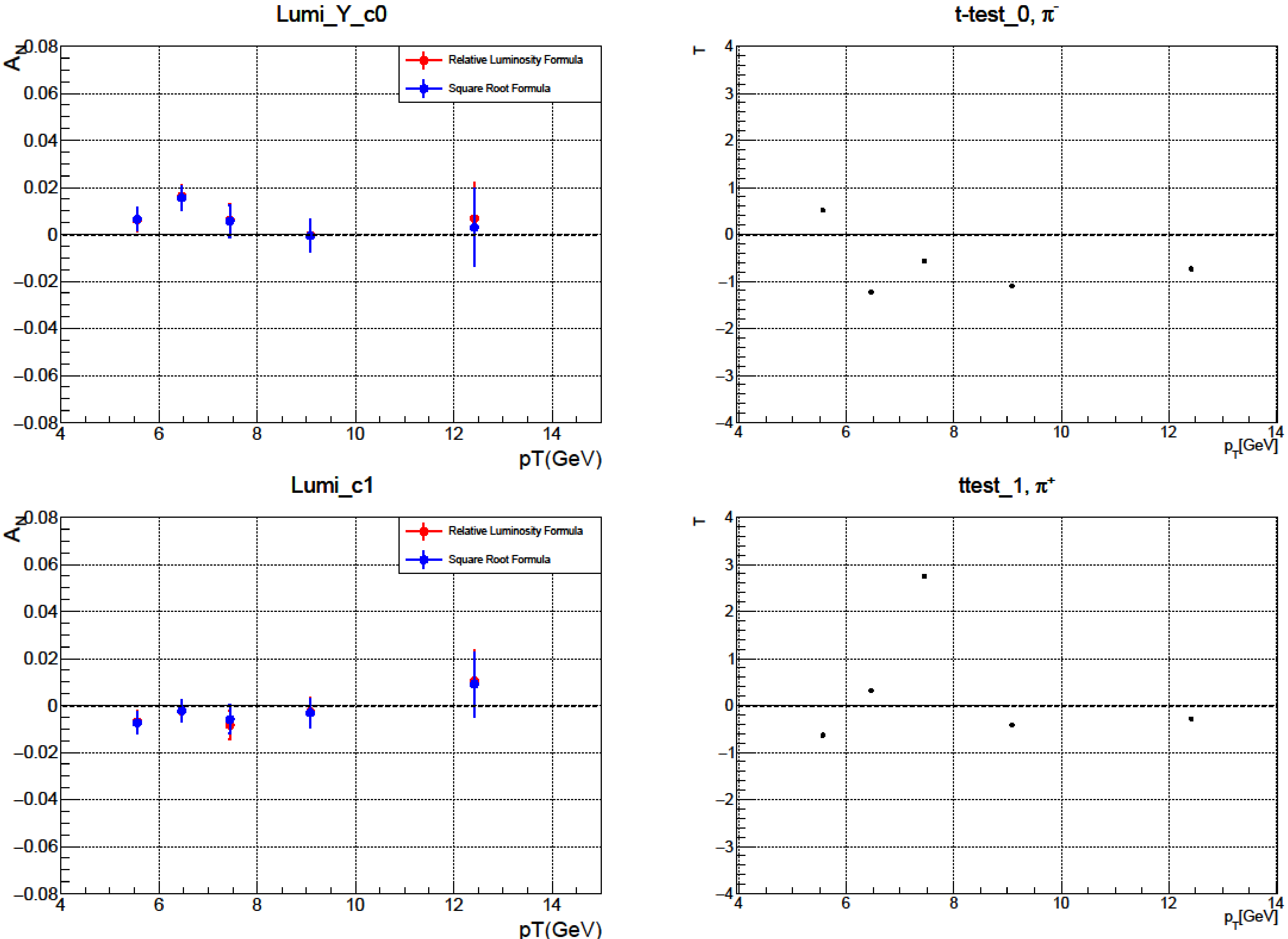
# Back up



n1: 5.0 < p_T < 6.0
h1_mc_n1_p0pt0
Entries 2138792
Mean 2.894
RMS 1.112
prob: 5.0 < p_T < 6.0
h1_mc_prob_p0pt0
Entries 2138792
Mean 0.009556
RMS 0.02045
ep: 5.0 < p_T < 6.0
h1_mc_ep_p0pt0
Entries 2138792
Mean 0.3822
RMS 0.2484
dphi: 5.0 < p_T < 6.0
h1_mc_dphi_p0pt0
Entries 2138792
Mean 0.08461
RMS 1.056
dz: 5.0 < p_T < 6.0
h1_mc_dz_p0pt0
Entries 2138792
Mean -0.2208
RMS 1.224
π±
e±
K±
p±
Others


n1: 5.0 < p_T < 6.0
h1_mc_n1_p0pt0
Entries 1245543
Mean 2.894
RMS 1.112
prob: 5.0 < p_T < 6.0
h1_mc_prob_p0pt0
Entries 1245543
Mean 0.00954
RMS 0.02043
ep: 5.0 < p_T < 6.0
h1_mc_ep_p0pt0
Entries 1245543
Mean 0.3822
RMS 0.2484
dphi: 5.0 < p_T < 6.0
h1_mc_dphi_p0pt0
Entries 1245543
Mean 0.08454
RMS 1.057
dz: 5.0 < p_T < 6.0
h1_mc_dz_p0pt0
Entries 1245543
Mean −0.2207
RMS 1.223
π±
e±
K±
p±
Others

# $A_N$ - Formula Comparison (Averaged)

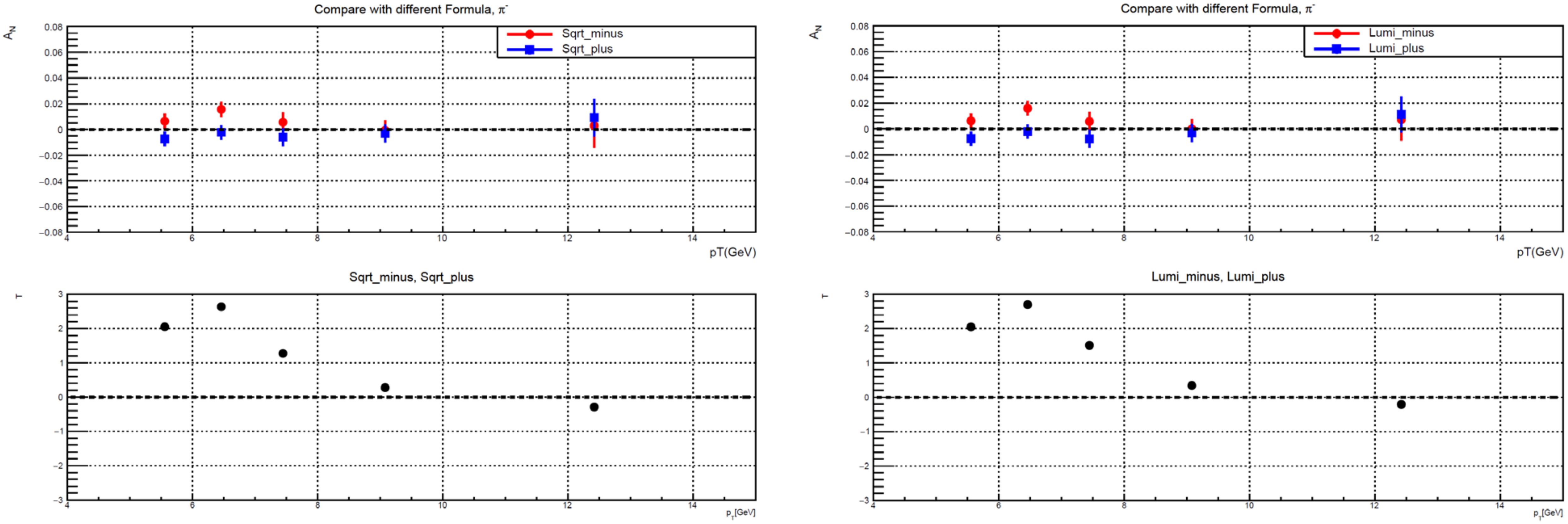



$$T(p_T) = \frac{A_N^{Sqrt} - A_N^{Lumi}}{\sqrt{|(\sigma^{Sqrt})^2 - (\sigma^{Lumi})^2|}}$$

No systematic error

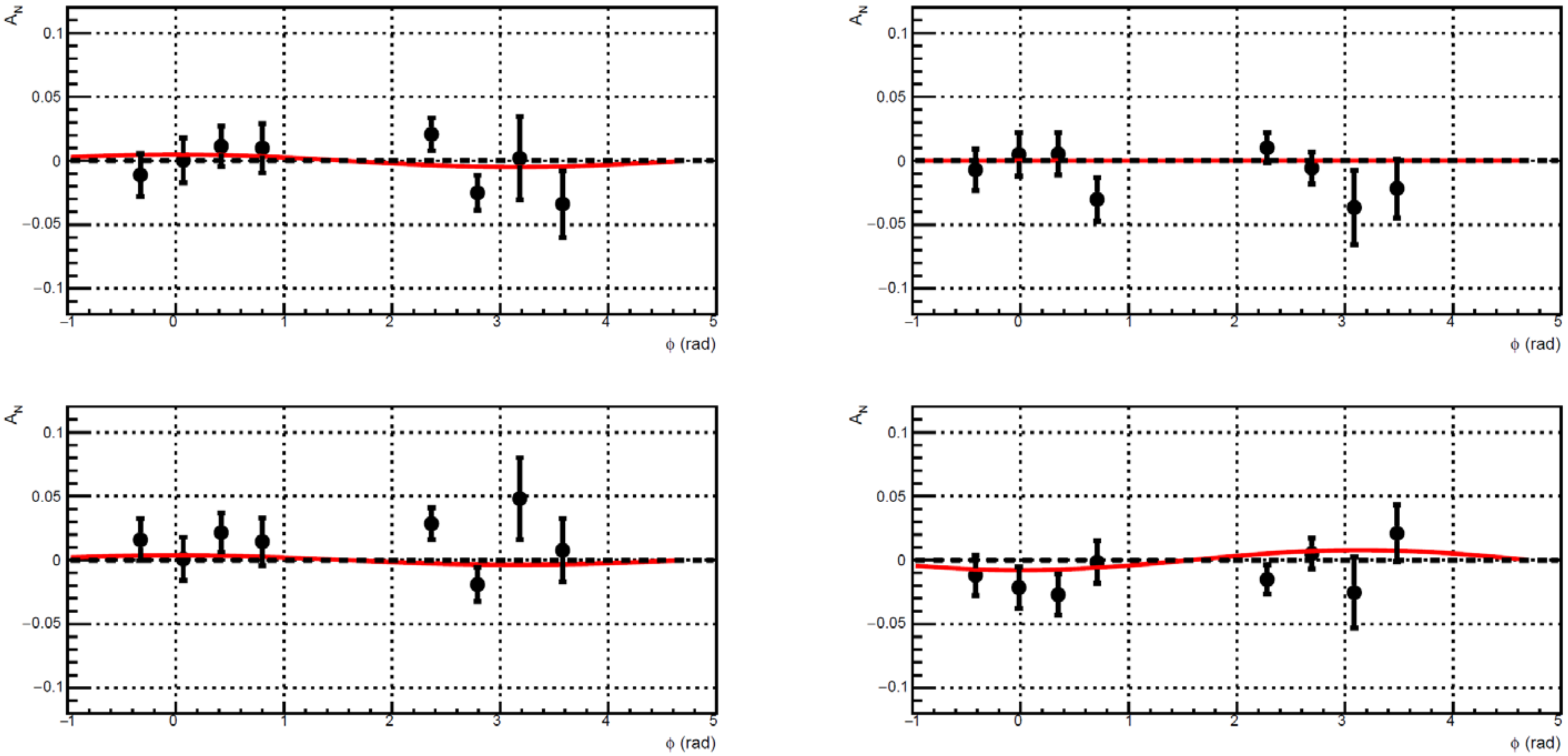
Before background correction

# $A_N$ - Charge Comparison




$$T(p_T) = \frac{A_N^{\pi^-} - A_N^{\pi^+}}{\sqrt{\left|(\sigma^{\pi^-})^2 + (\sigma^{\pi^+})^2\right|}}$$

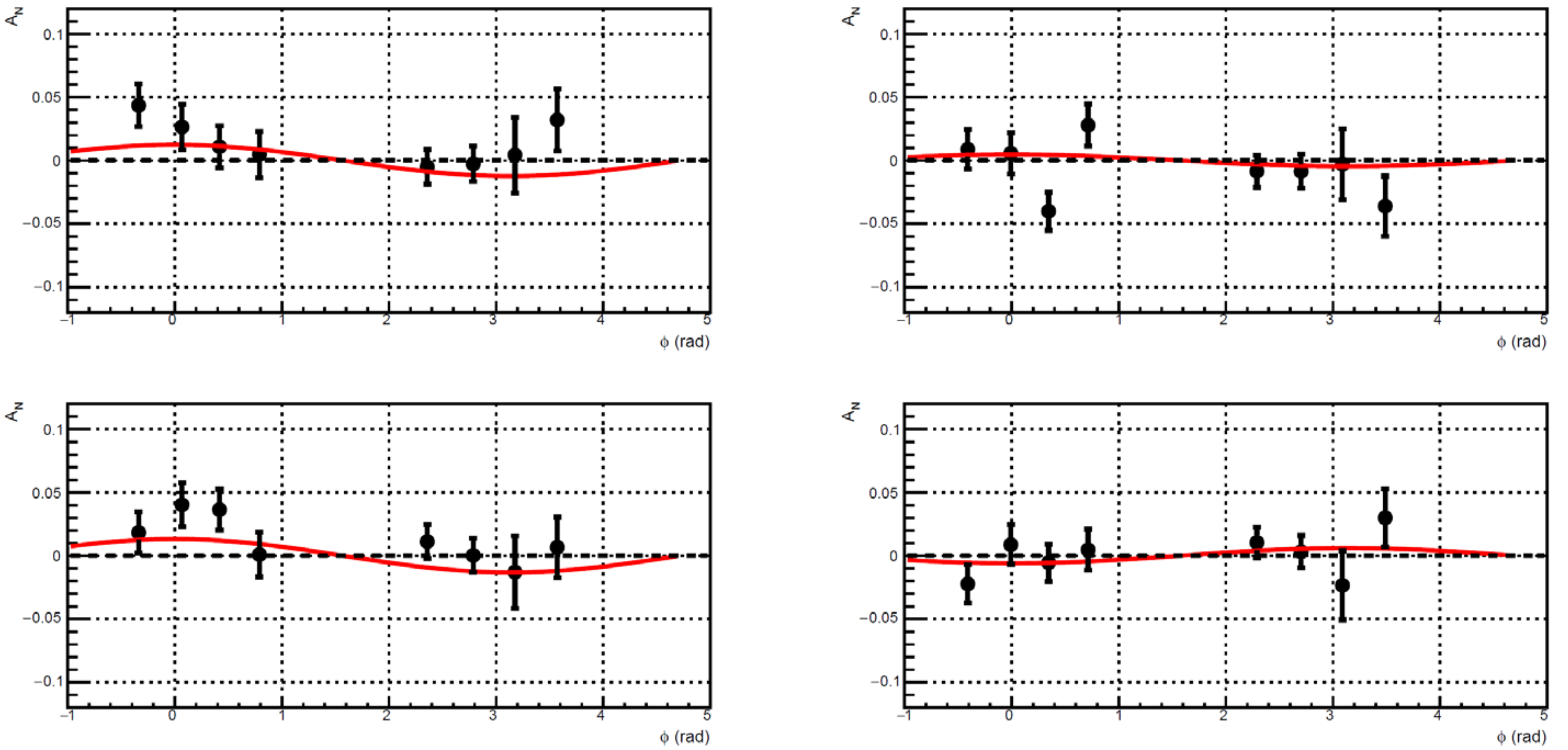
# Asymmetry as a function $\phi$ of for $5 < p_T < 6$ GeV



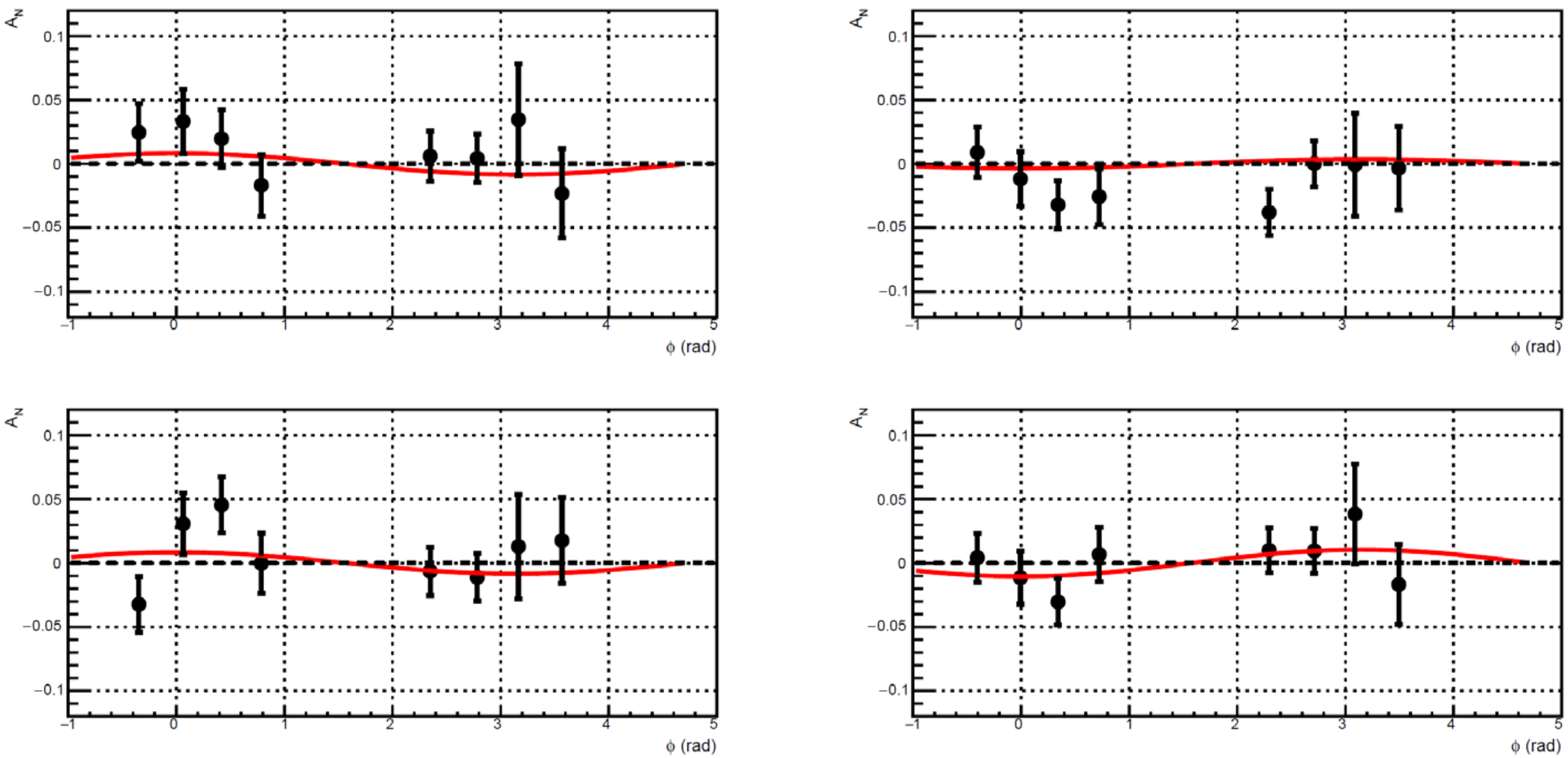

8 points mean 8 EMCal Sectors mean phi.

$$A_N \sin\phi_s = \frac{1}{P}\,\epsilon_N(\phi_s) = \frac{1}{P}\,\frac{N^{\uparrow}(\phi_s) - \mathcal{R}N^{\downarrow}(\phi_s)}{N^{\uparrow}(\phi_s) + \mathcal{R}N^{\downarrow}(\phi_s)}$$

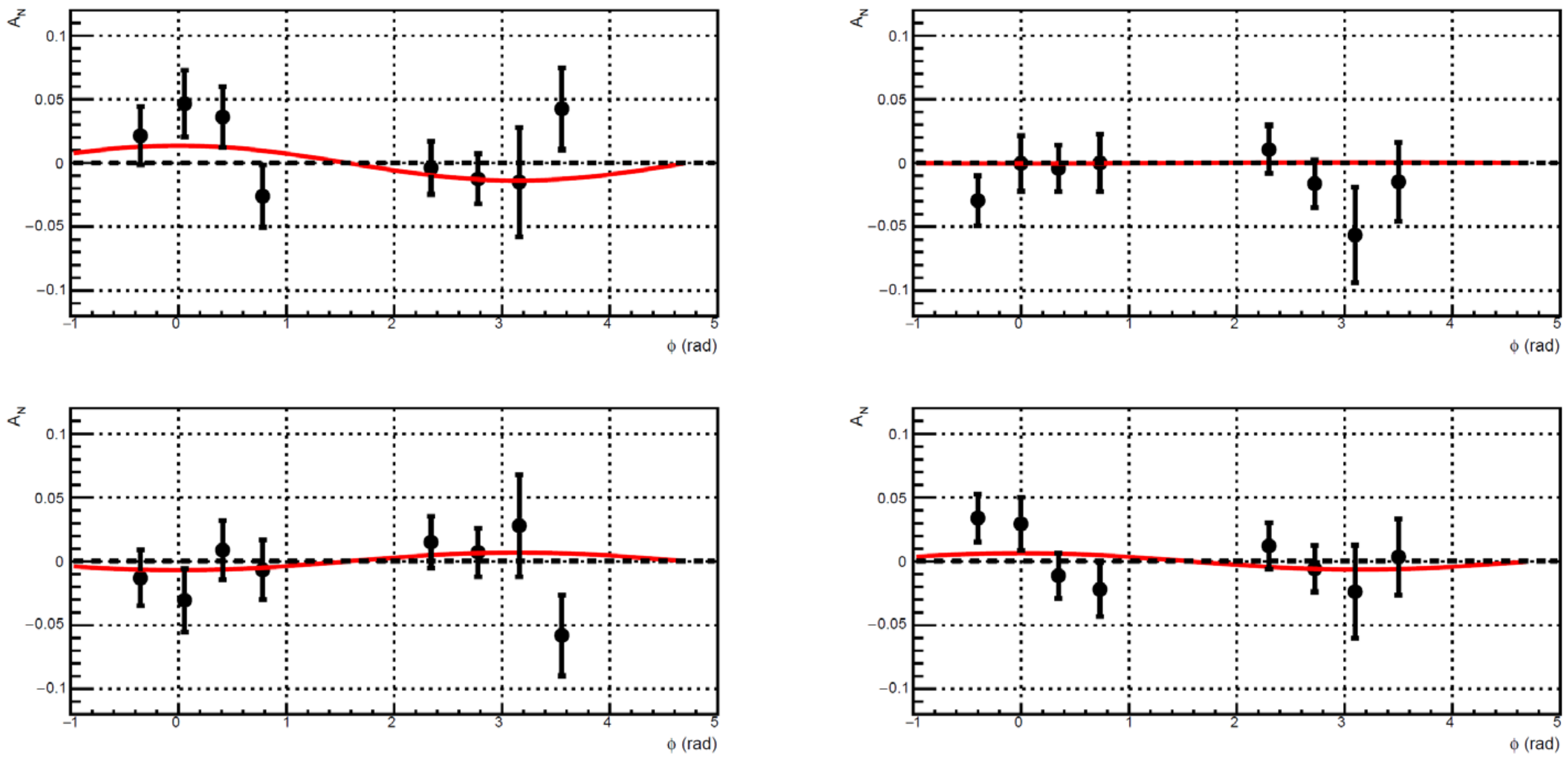
# Asymmetry as a function $\phi$ of for 6 $< p_T < 7$ GeV



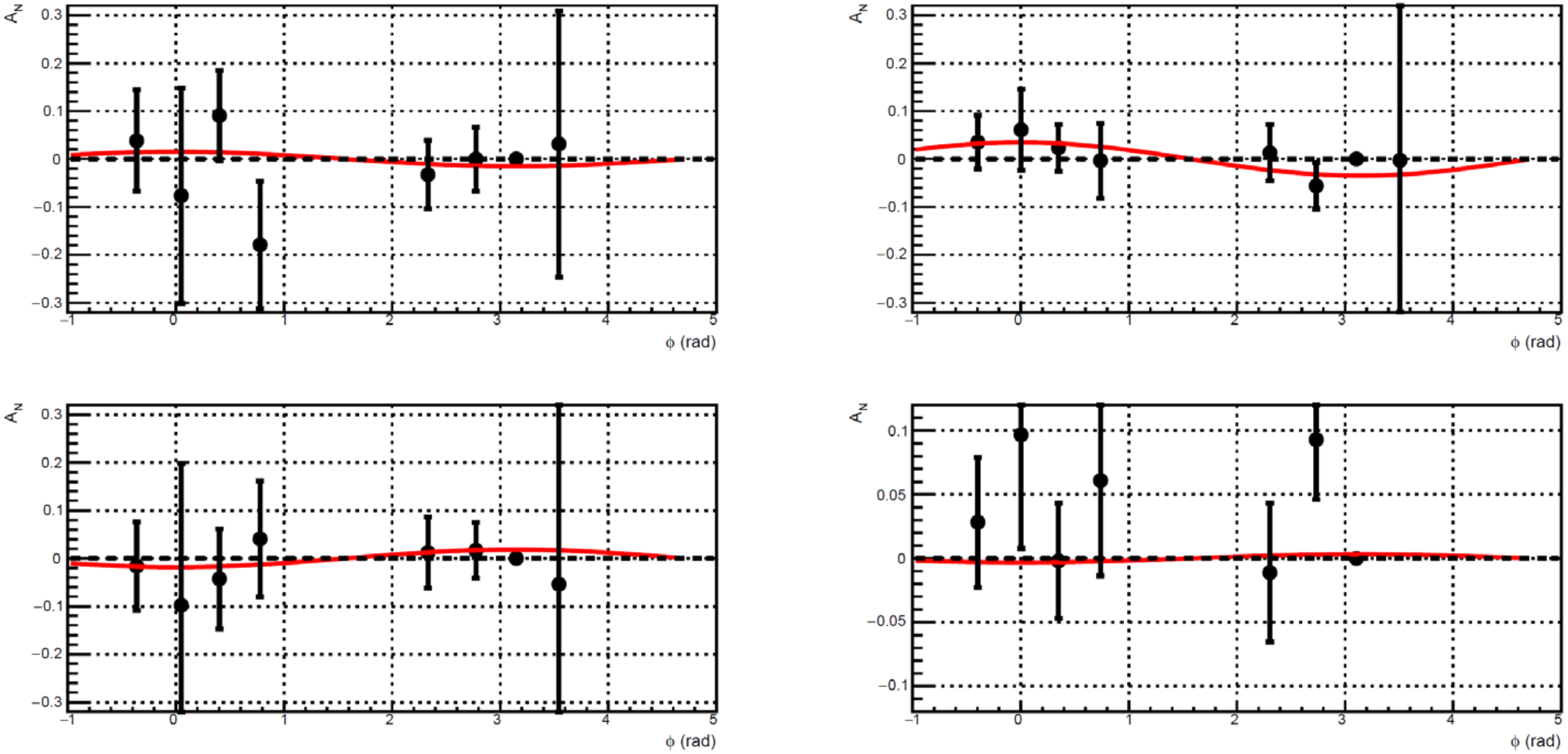
# Asymmetry as a function $\phi$ of for 7 $< p_T < 8$ GeV



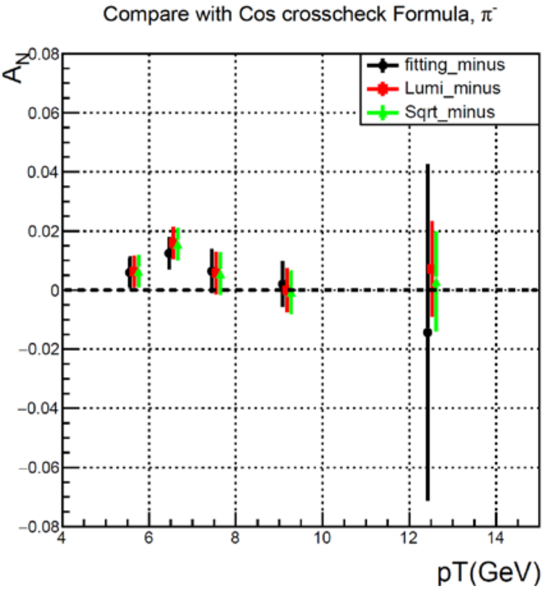
# Asymmetry as a function $\phi$ of for 8 $< p_T <$ *11* GeV

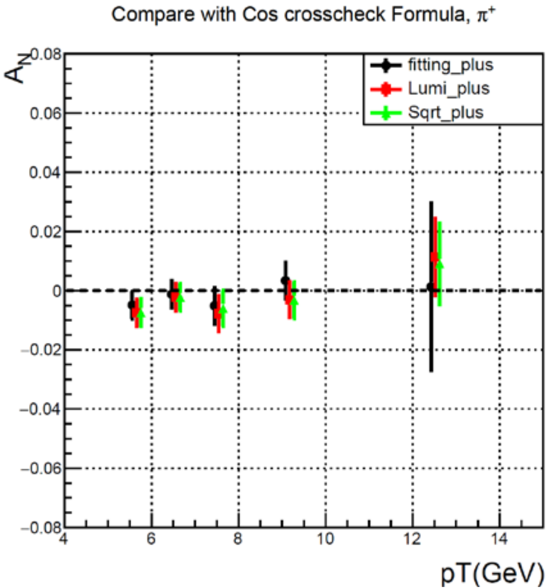


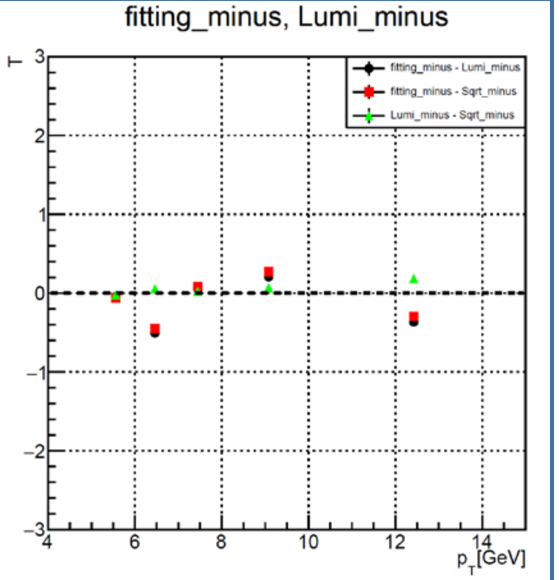
# Asymmetry as a function $\phi$ of for 11 $< p_T < 15$ GeV

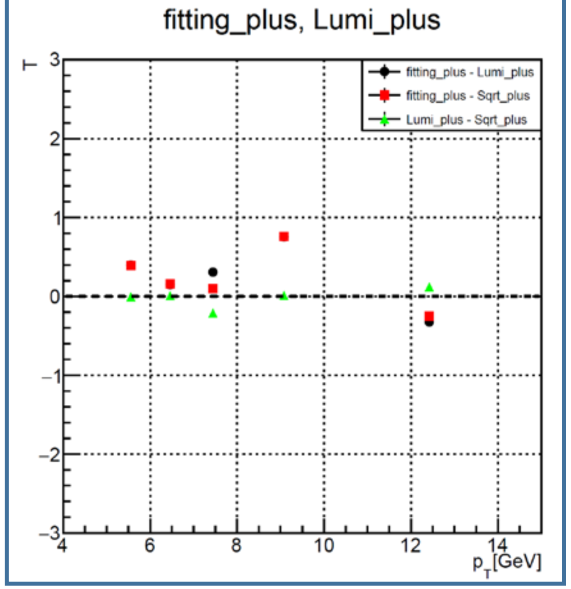


# $cos\phi$ Modulation Cross Check



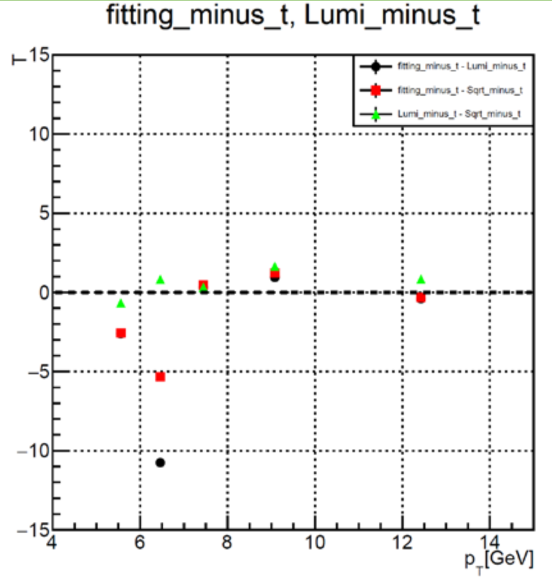



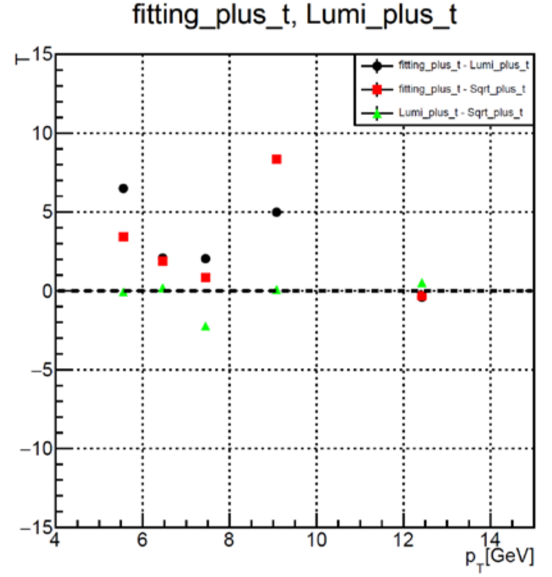



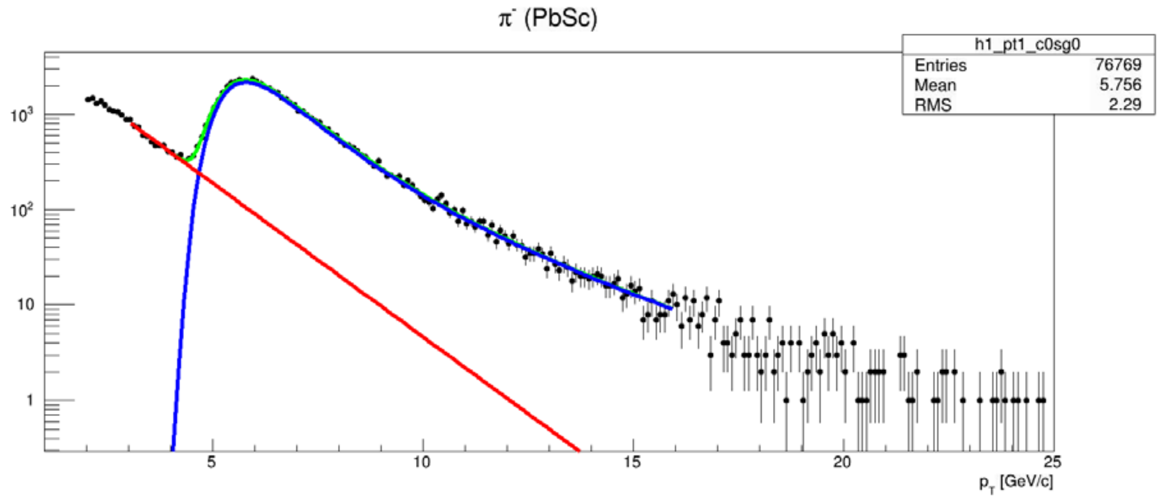

$$T(p_T) = \frac{A_N^{fit} - A_N^{Sqrt\ or\ Lumi}}{\sqrt{|(\sigma^{fit})^2 + (\sigma^{Sqrt\ or\ Lumi})^2|}}$$

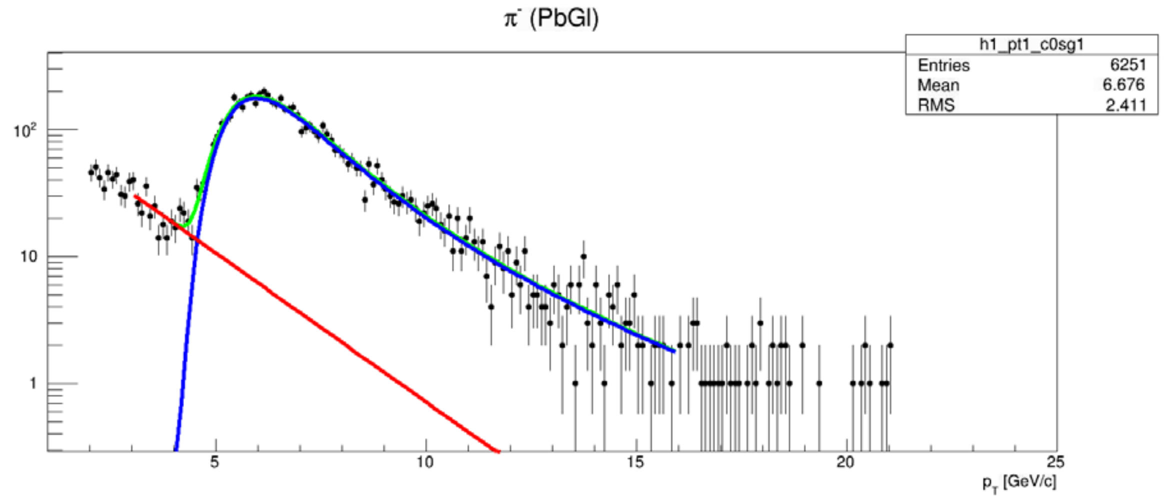
$$T(p_T) = \frac{A_N^{fit} - A_N^{Sqrt\ or\ Lumi}}{\sqrt{|(\sigma^{fit})^2 - (\sigma^{Sqrt\ or\ Lumi})^2|}}$$

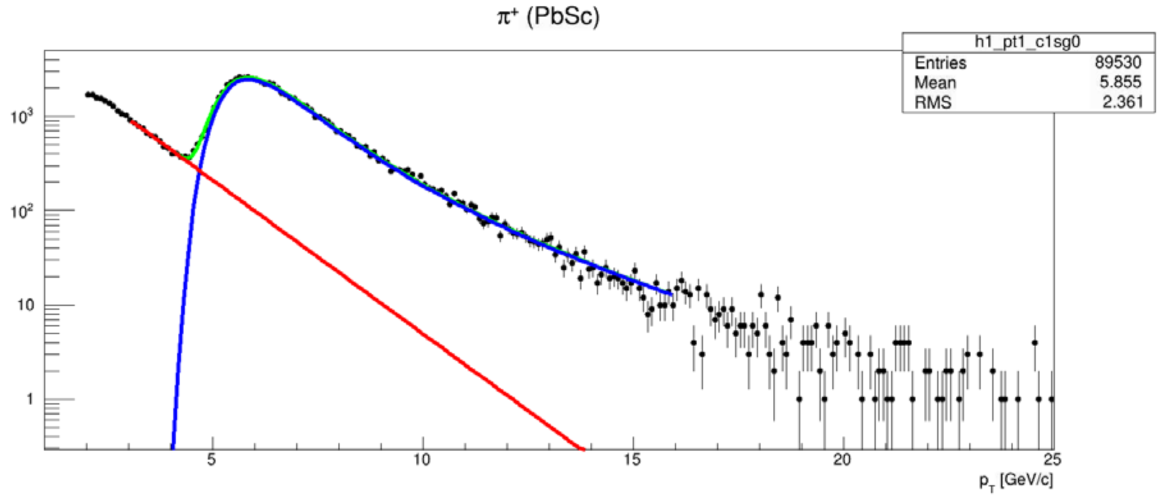


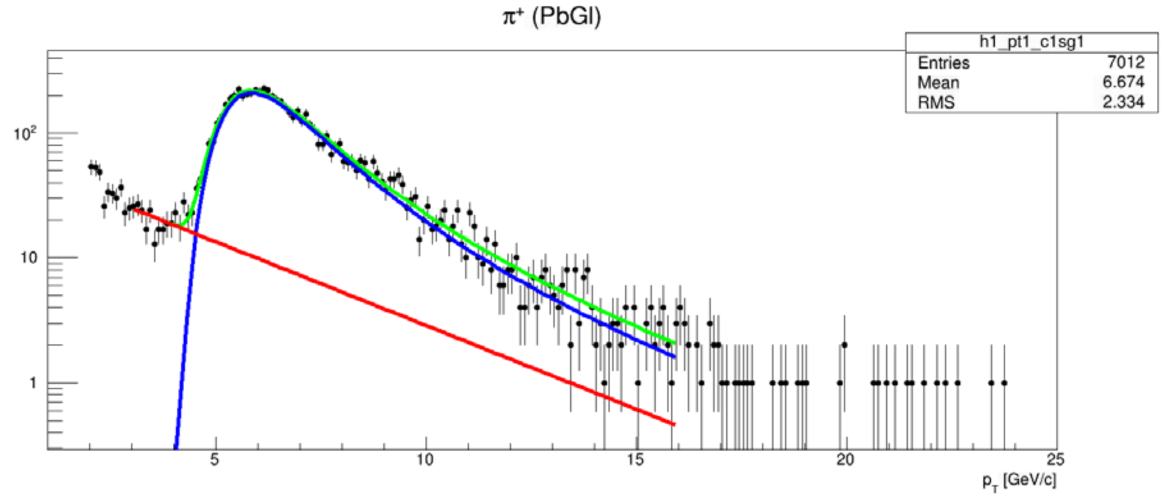



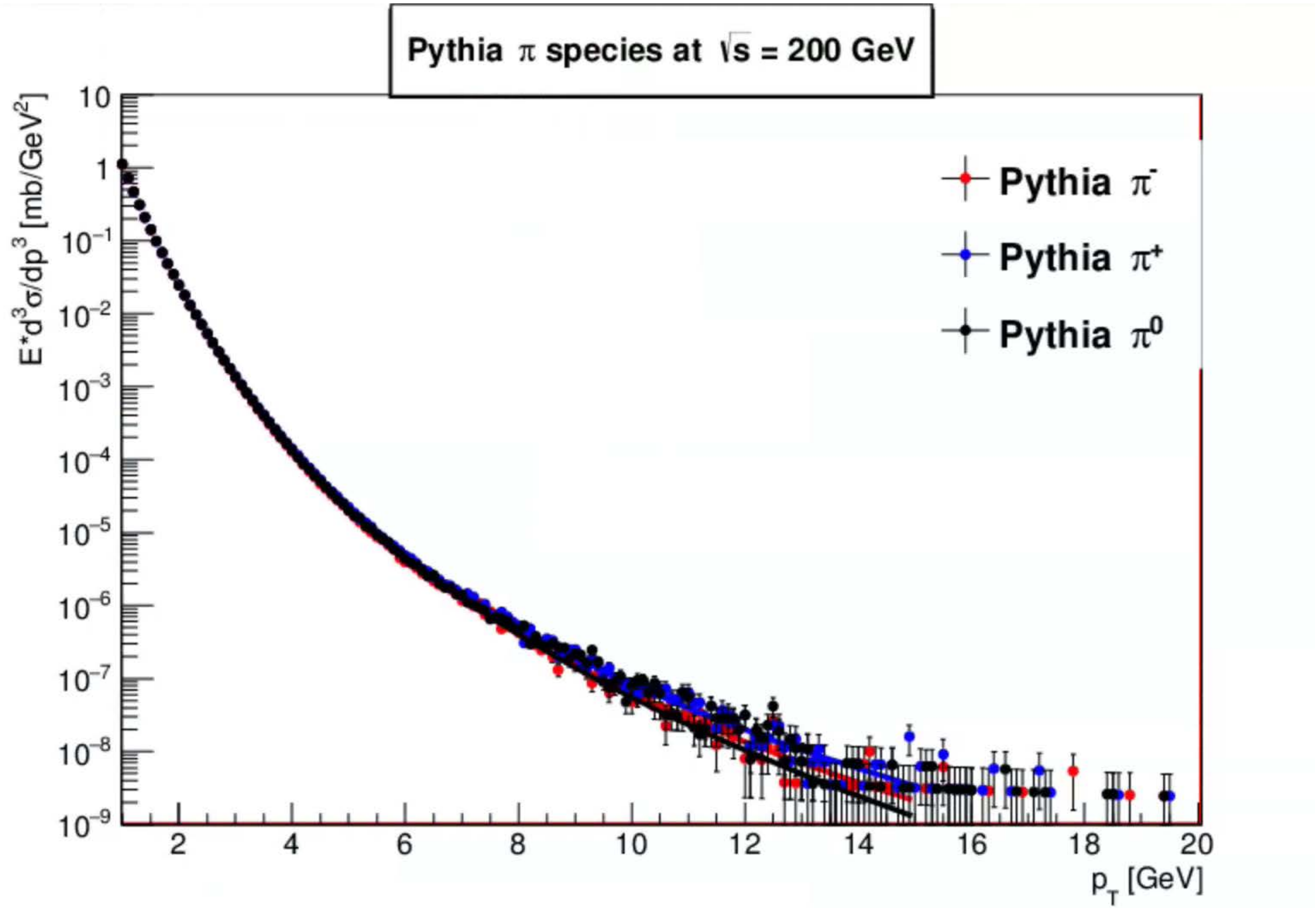
# Background Fraction



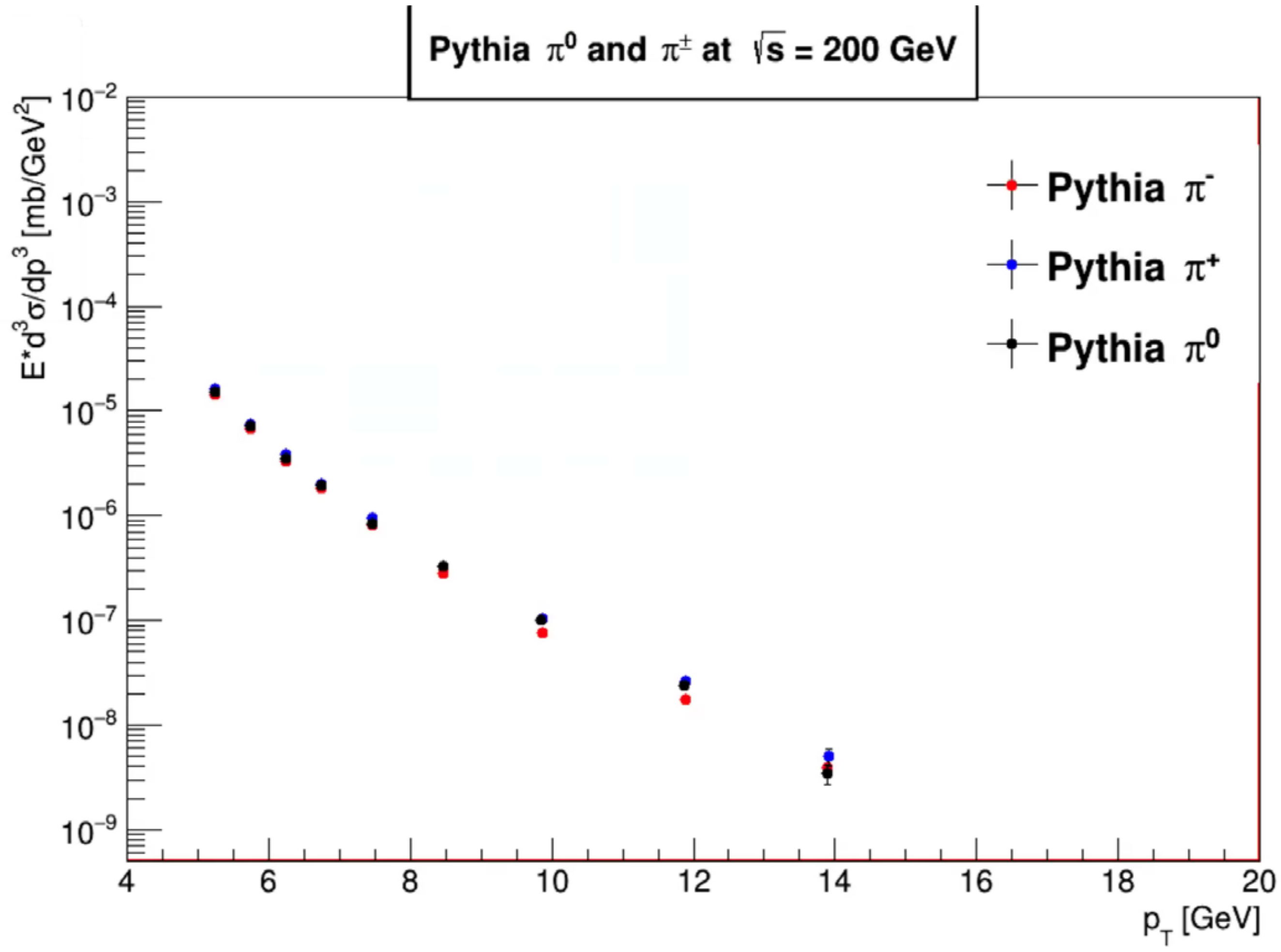





Pythia π species at √s = 200 GeV
E*d3σ/dp3 [mb/GeV2]
Pythia π-
Pythia π+
Pythia π0
pT [GeV]


Pythia $\pi^0$ and $\pi^\pm$ at $\sqrt{s}$ = 200 GeV
E*d^3σ/dp^3 [mb/GeV^2]
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
Pythia $\pi^-$
Pythia $\pi^+$
Pythia $\pi^0$
4
6
8
10
12
14
16
18
20
p_T [GeV]

# Hadron Background

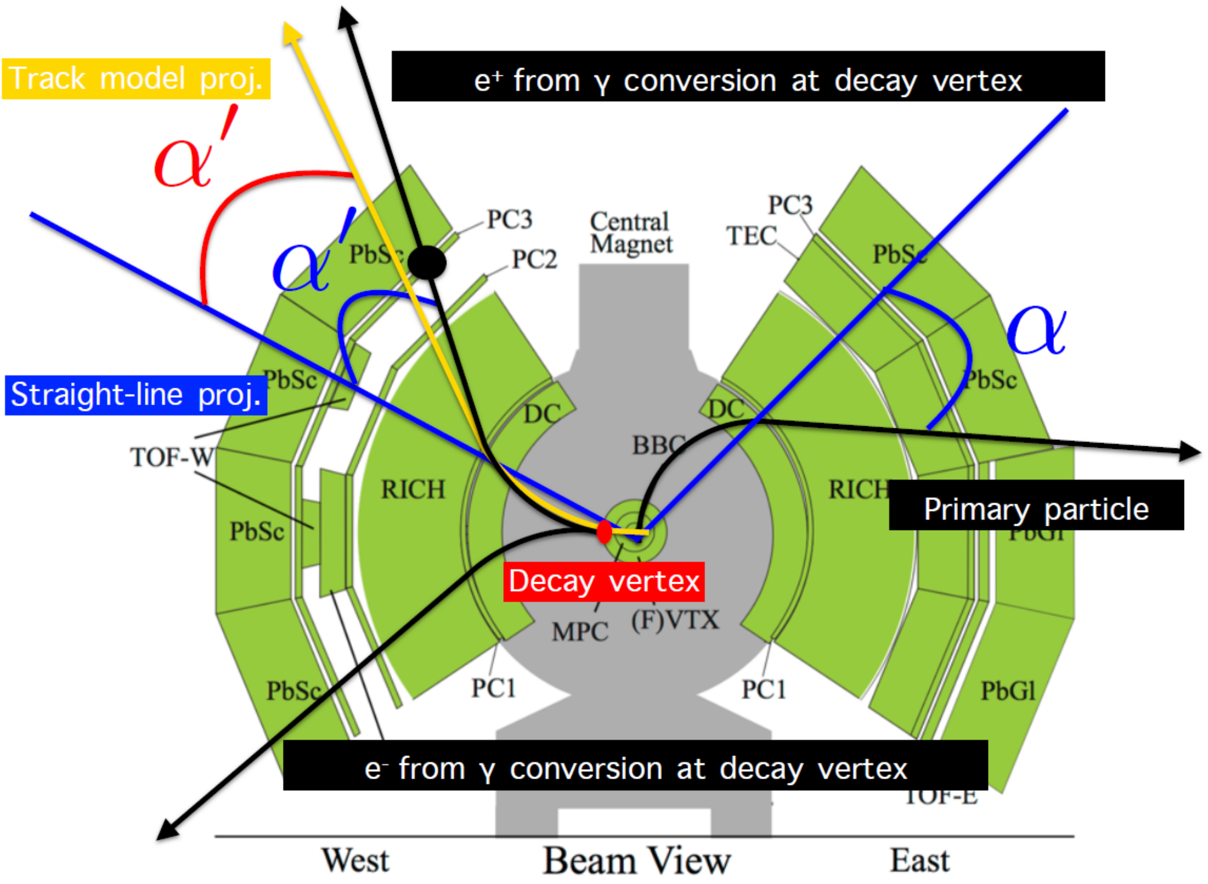
Tracks can be divided according to RICH response at 5 to 15 GeV/c.
Only electrons and pions can leave hits on the RICH PMT plane at 5 to 15 GeV/c but not for kaons and protons.
Pions below 5GeV/c do not create Cherenkov light and are therefore suppressed in the spectra.

| Particle | Electron | Pion | Proton | Kaon |
|---|---|---|---|---|
| Threshold [GeV/$c$] | 0.03 | 4.7 | 16 | 30 |

The energy threshold for the emission of Cherenkov radiation for each particle in the PHENIX RICH.

# Electron Background

Electron deposits most of their energy in the EM shower and the EMCal can be used to determine the probability that the shape of cluster associated with the track is electro-magnetic.
So primary electron can easily be distinguished with the deposited energy/momentum and shower shape cuts from π±. (e/p < 0.8 cut)
The other background is secondary electron from photon conversion. (e/p < 0.2)



# Background Subtraction

**$A_N$ Background correction method**

$$A_N^S = \frac{A_N^{S+B} - r A_N^B}{1-r}$$

$$\sigma_{A_N^S} = \frac{\sqrt{(\sigma_{A_N^{S+B}})^2 + r^2(\sigma_{A_N^B})^2}}{1-r}$$

$$r = N^B/(N^B + N^S)$$

**Questions**

$A_N^{S+B}$ is from data.

$A_N^B$ is from Pythia simulation?
- I think Pythia simulation isn't reflected in spin physics.
- or electron from data by using E/p cut?

$N^B$ is from Pythia simulation?
- I think It can be get from Pythia simulation
- Can I use # of electron from Cross section?

$N^S$ is from Pythia simulation?
- I think It can be get from Pythia simulation
- Can I use # of charged pion from Cross section?