Charged pion analysis

Cross Section

-Smearing effect
- final plot

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The differential cross section

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T\,\Delta y}$$

1st correction: $\varepsilon^{\pi^\pm}_{RICH}$

2nd correction: $\varepsilon^{\pi^\pm}_{ACC.REC}$

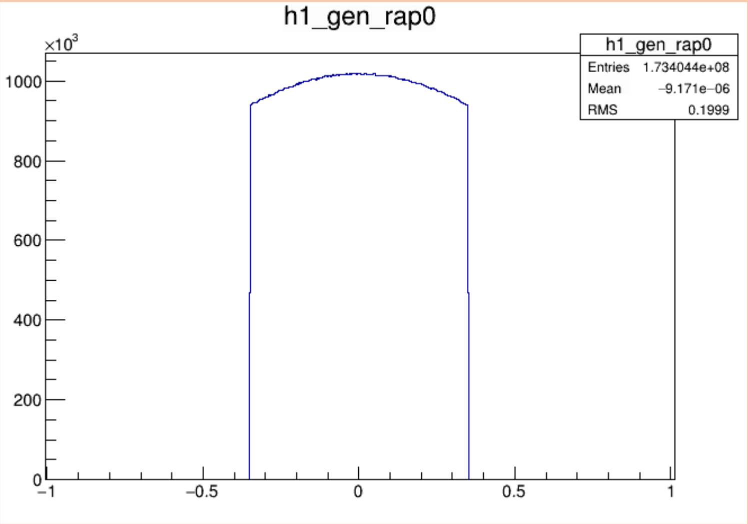
Last correction: $C_{smearing}$

Integrated Luminosity & MB trigger efficiency

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T \Delta y}$$

0.79
[from an1269 (Norbert Novitzky)]

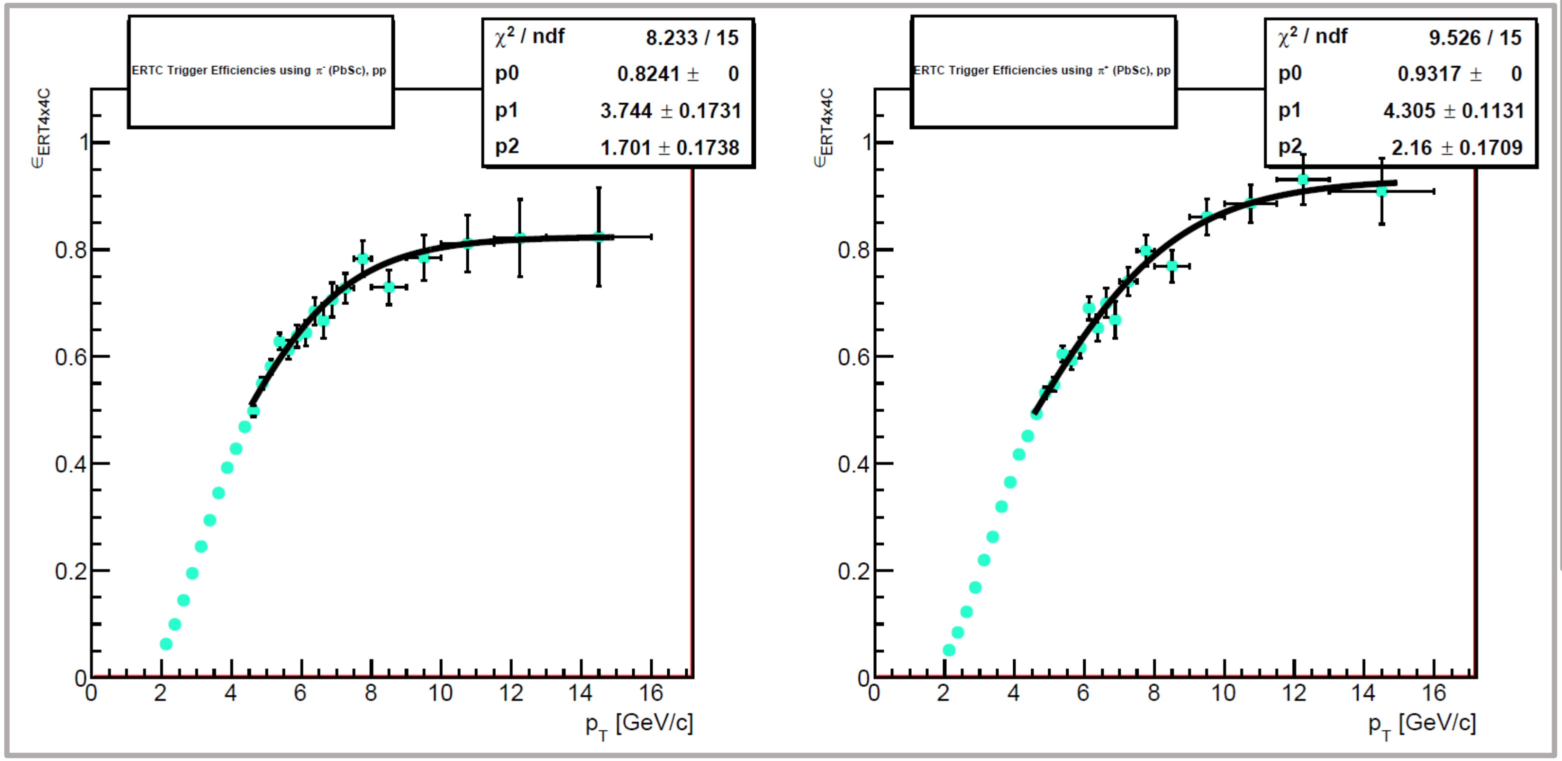
0.7



$$\int Ldt = \sum_{i=1}^{676} \frac{N^i_{ERTC\_scaled\&BBCNRW\_live\&|zbbc|<10cm}}{N^i_{BBCNRW\_scaled\&ERTC\_live\&|zbbc|<10cm}} \times \frac{N^i_{BBCNRW\_scaled\&|zbbc|<10cm}}{22.9mb} = 2.8886pb^{-1}$$

ERT4x4c trigger efficiency

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T\, \Delta y}$$



Data set : MB, MPC, MU, FVTX, OT
MB event : give no trigger cut
MB&ERT event : Check that pion was pired one of the ERT trigger modules.

```
// EMCal coordinate system should be used!
int arm = 1 - (int)_trk->get_dcarm(); // DC to EM system conversion
int sect    = (int)_trk->get_sect();
int yidx    = (int)_trk->get_ysect();
int zidx    = (int)_trk->get_zsect();

int towerkey = (int)ErtUtils::get_EMC_Towerkey_FromIndex(arm, sect, yidx, zidx);
int sm       = -999;
int trigger  = 0; // 0 if (1) trigger is not fired (2) or tower/module is dead

// true or false
// function passes in EMCal tower key index and returns EMC arm, sector and supermodue
if ( ErtUtils::get_EMC_smID_FromTowerkey(towerkey, arm, sect, sm) )
  {
    trigger = _ertout->get_ERTbit(_triggermode, arm, sect, sm);
  }

return trigger;
```

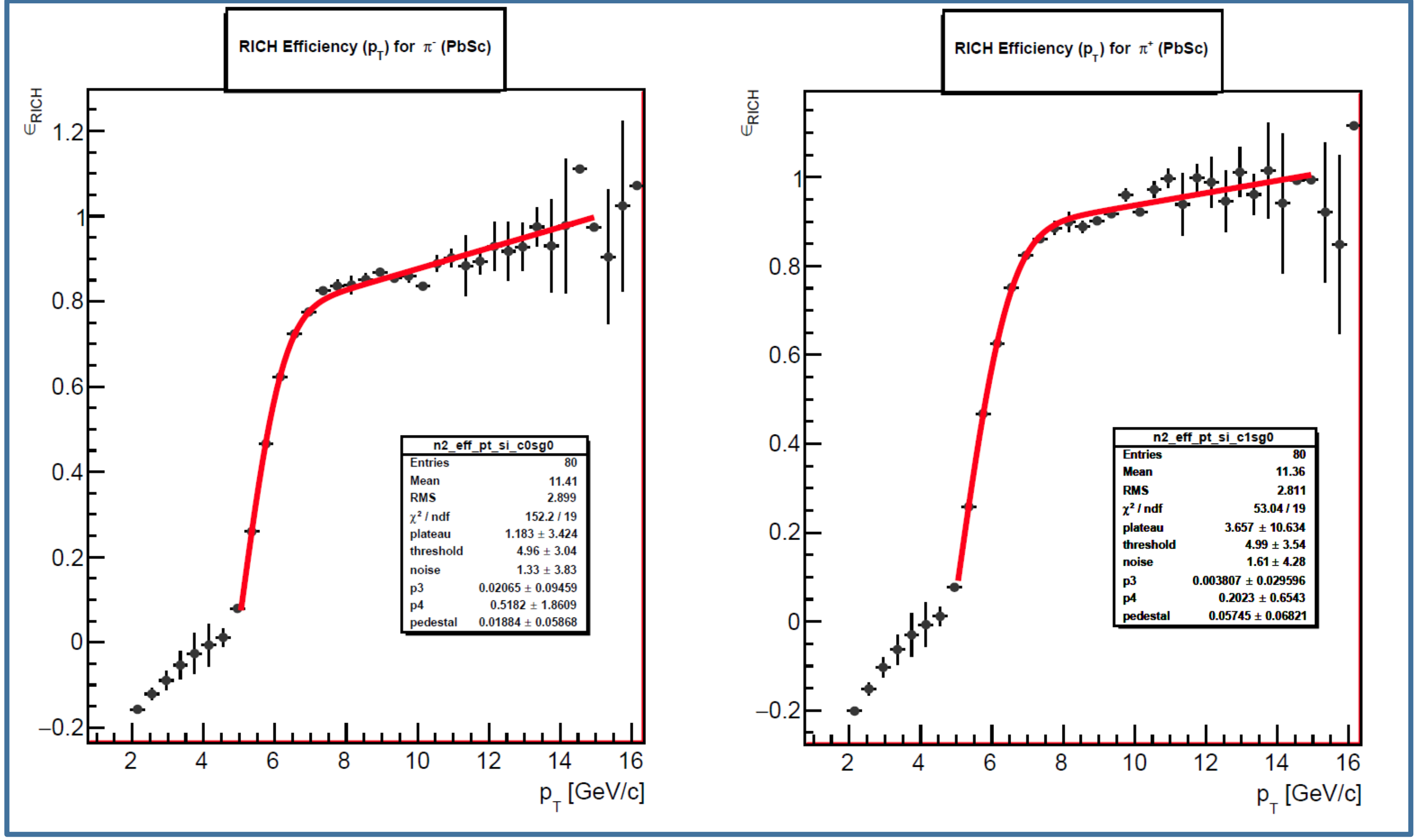
Fit : Using fermi funchtion

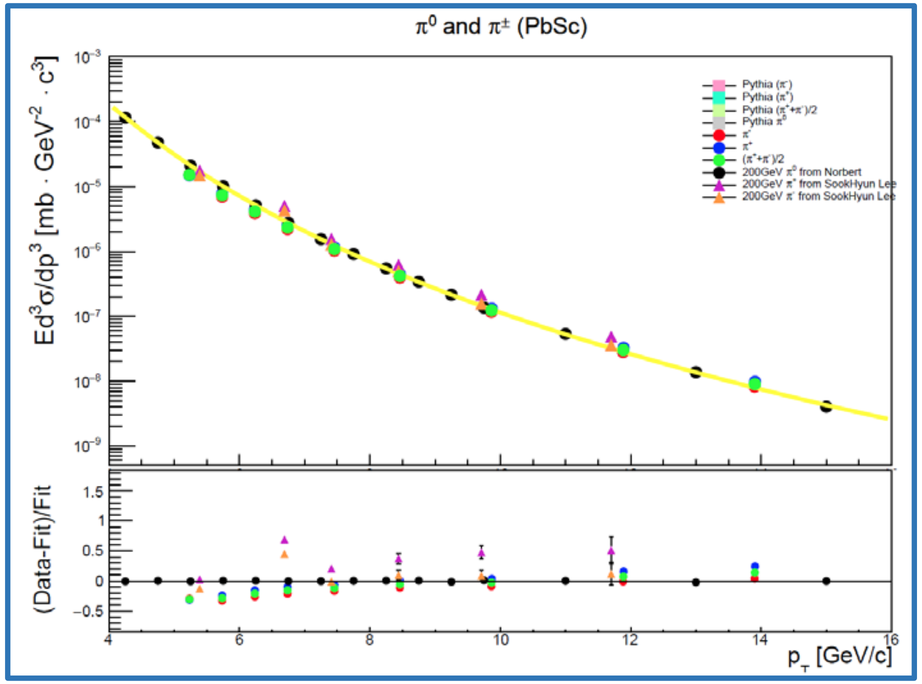
0.9317*(1-1/(1+exp((pt-[1])/[2]))) (for π^+)

0.8241*(1-1/(1+exp((pt-[1])/[2]))) (for π^-)

RICH efficiency (n1 cut)

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T\,\Delta y}$$



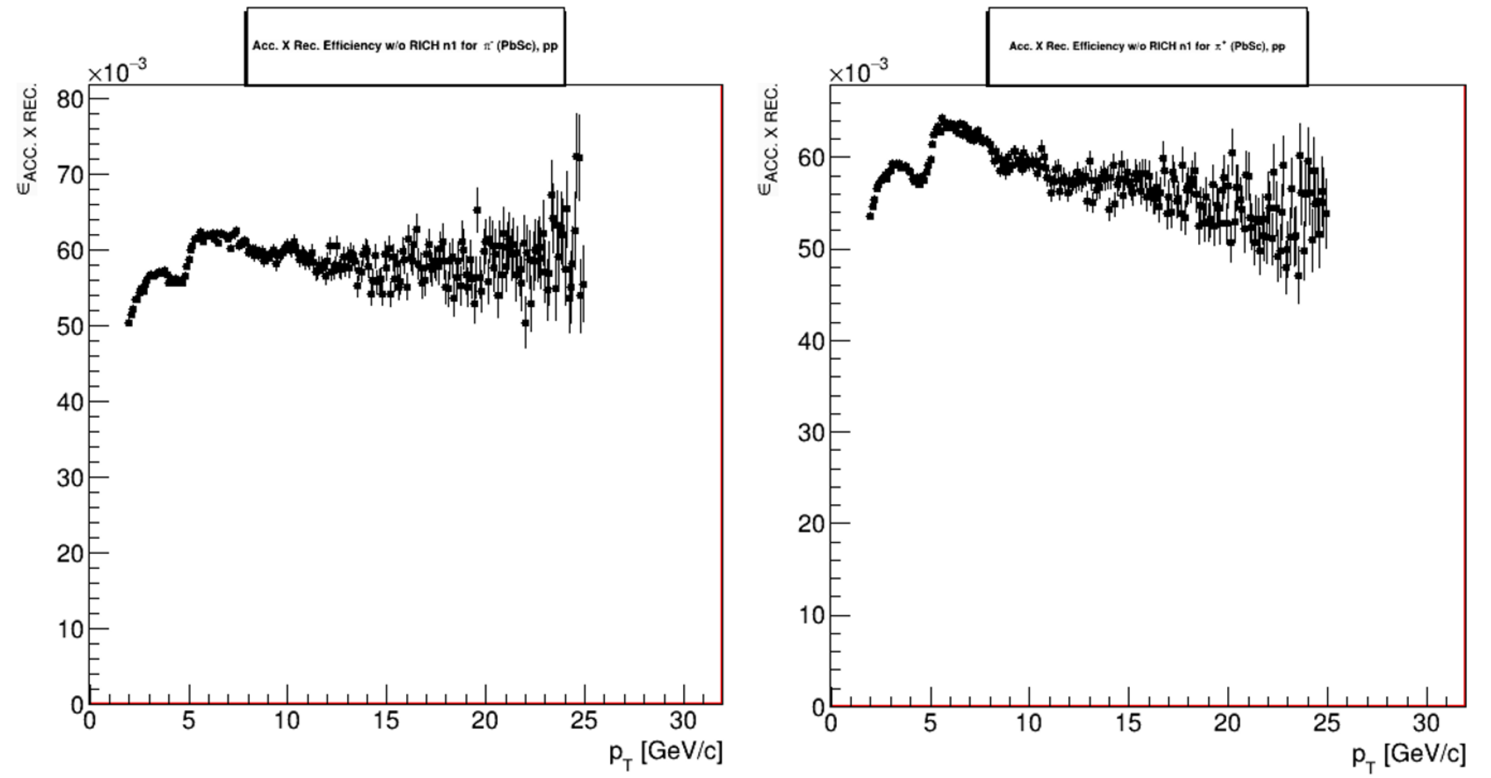


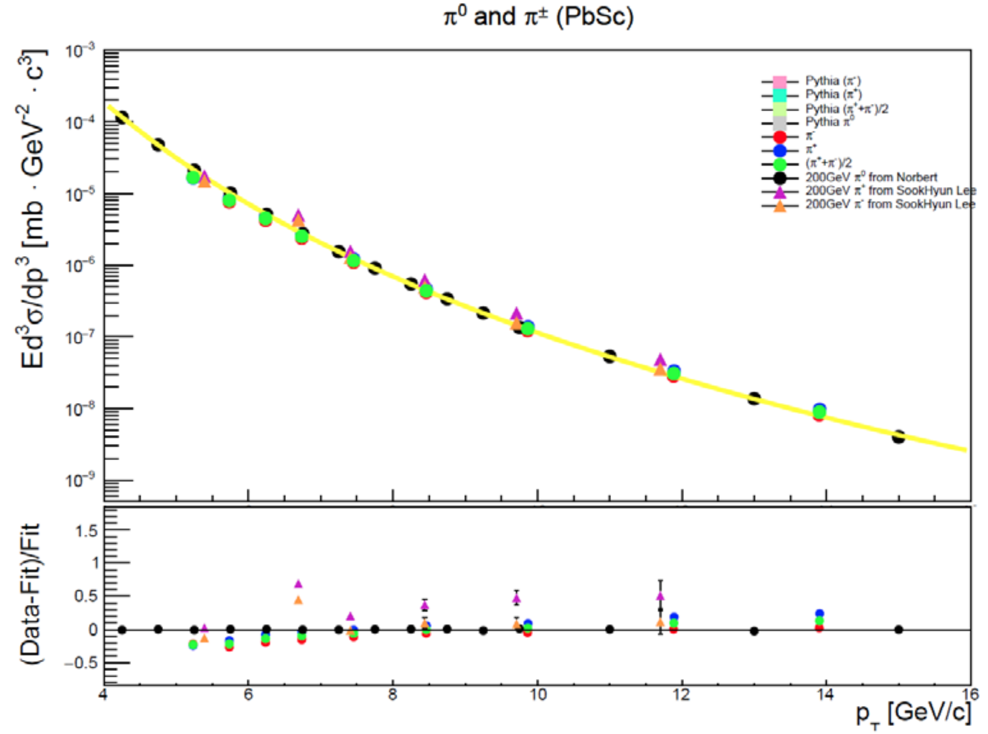
Fit : Using follow funchtion

par[0]*(TMath::Erf((pt-par[1])/par[2]))
***(par[3]*pt+par[4])+par[5]**

The differential cross section

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T\,\Delta y}$$





The differential cross section

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T\,\Delta y}$$

1st correction ($\varepsilon^{\pi^\pm}_{RICH}$)

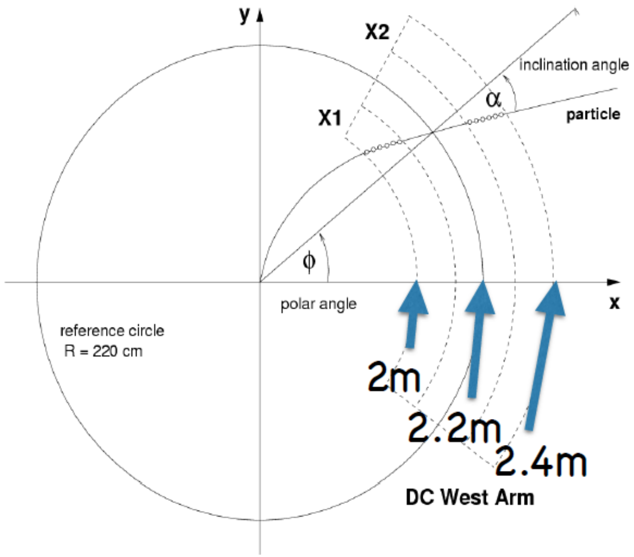
2nd correction ($\varepsilon^{\pi^\pm}_{ACC.REC}$)

Last correction ($C_{smearing}$)

Smearing effect

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{2\pi p_T}\frac{N^{\pi^\pm}}{\int L\,dt \times \varepsilon^{\pi^\pm}_{ACC.REC} \times \varepsilon^{\pi^\pm}_{RICH} \times \varepsilon^{\pi^\pm}_{ERT4x4c} \times \varepsilon^{\pi^\pm}_{MB} \times C_{smearing} \times \Delta p_T\,\Delta y}$$

Momentum reconstruction



- line crosses the track at r=2.2m
  - **pT** = K/α
  [K=86 (mrad * GeV/c)]

Smearing effect

- pT is measured with the DC using the **bending angle of a track** at the crossing point.
- Measured pT is shown an inherently **Gaussian distribution** with respect to its true pT .
- The standard deviation of this distribution determines the resolution of pT .
- The resolution has been shown to increases as $\sqrt{(1.74)^2 + (1.48 * pT)^2}$ % .
- This pT resolution becomes sufficiently significant **at high pT above ~10 GeV/c** to affect measurements of rapidly falling spectra by artificially moving events from one pT bin to another.

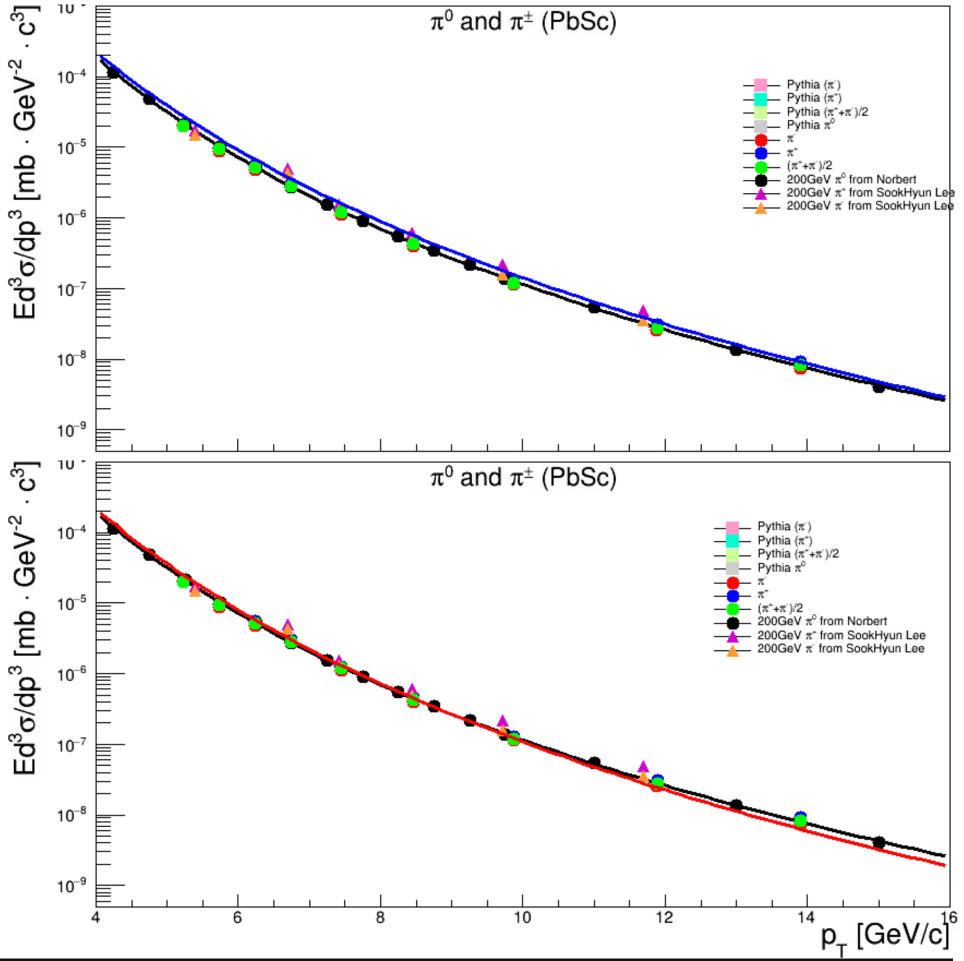
Unfolding : using the **TSVDUnfolding** package of ROOT

Resolution & Smearing effect

pT_min	pT_max	pT_mean (μ)	resolution (σ)	μ - σ	μ + σ
5	5.5	5.23	0.415	4.815	5.645
5.5	6	5.74	0.498	5.242	6.238
6	6.5	6.24	0.586	5.654	6.826
6.5	7	6.74	0.682	6.058	7.422
7	8	7.46	0.834	6.626	8.294
8	9	8.46	1.069	7.391	9.529
9	11	9.87	1.452	8.418	11.322
11	13	11.9	2.106	9.794	14.006
13	15	13.9	2.870	11.030	16.770

Pars_pip[]

Pars_pim[]




```
Double_t Reconstruct(  Double_t pt, TRandom3& R, TF1* momres )
{
  const double pt_smear = R.Gaus(0.0, pt*momres->Eval(pt)/100.0);
  return pt+pt_smear;
}
```

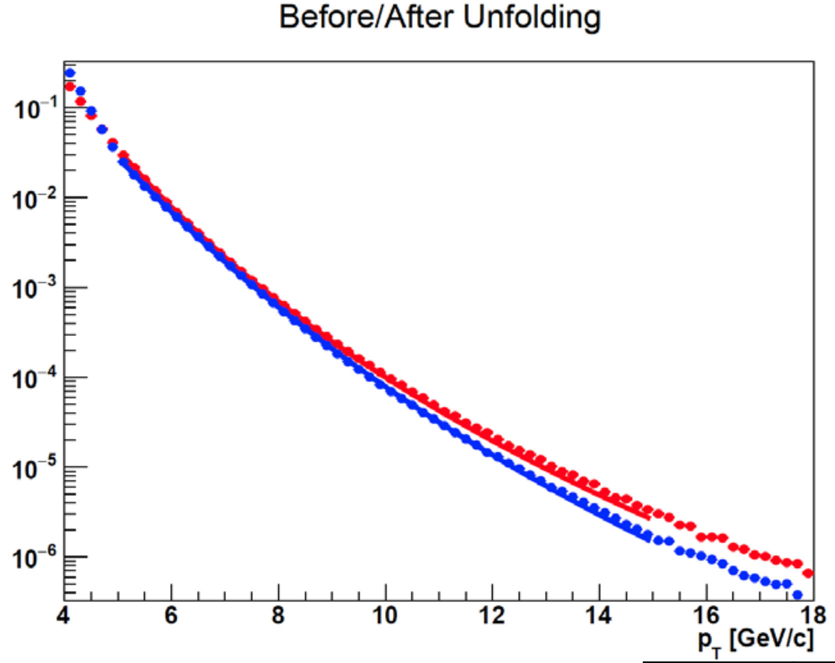
```
Double_t pt_true = f_mc->GetRandom();
Double_t pt_rec = Reconstruct( pt_true, R, f_momres );
```

```
TF1 *f_momres = new TF1("momres","sqrt([0]*[0]+[1]*[1]*x*x)",pt_gen_min,pt_gen_max);
f_momres->SetParameter(0,1.74);
f_momres->SetParameter(1,1.48);
```

```
TF1* f_mc    = new TF1("true_mc","(1/(1+exp((x-[5])/[6]))*[0]/pow(1+x/[1],[2])+(1-1/(1+exp((x-[5])/[6])))*[3]/pow(x,[4]))",pt_gen_min,pt_gen_max);

TF1* f_true = new TF1("true_rd","(1/(1+exp((x-[5])/[6]))*[0]/pow(1+x/[1],[2])+(1-1/(1+exp((x-[5])/[6])))*[3]/pow(x,[4]))",pt_gen_min,pt_gen_max);
```

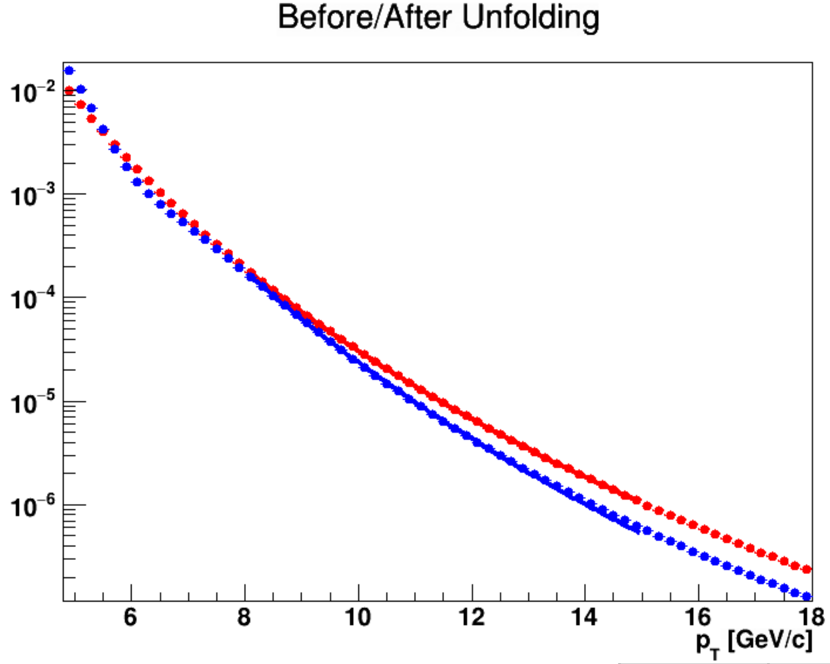
```
const double pars_pim[] = { 1.32186e+05, 4.71318e-01, 8.97461e+00, -9.24374e+03, 1.04740e+01, 1.31568e+03, 2.17678e+02 };
const double pars_pip[] = { 1.02481e+05, 4.49788e-01, 8.67342e+00, -3.41215e+03, 9.53795e+00, 1.18292e+03, 2.02100e+02 };
```

Smearing effect



pT	Correction factor
5.23624	1.20001
5.73709	1.1521
6.23788	1.13025
6.73862	1.12487
7.41803	1.13504
8.46417	1.17666
9.87854	1.2656
11.8988	1.43718
13.913	1.64967

Generated pT : 4 ~ 18 [GeV/c]
Fitting range : 5 ~ 15 [GeV/c]

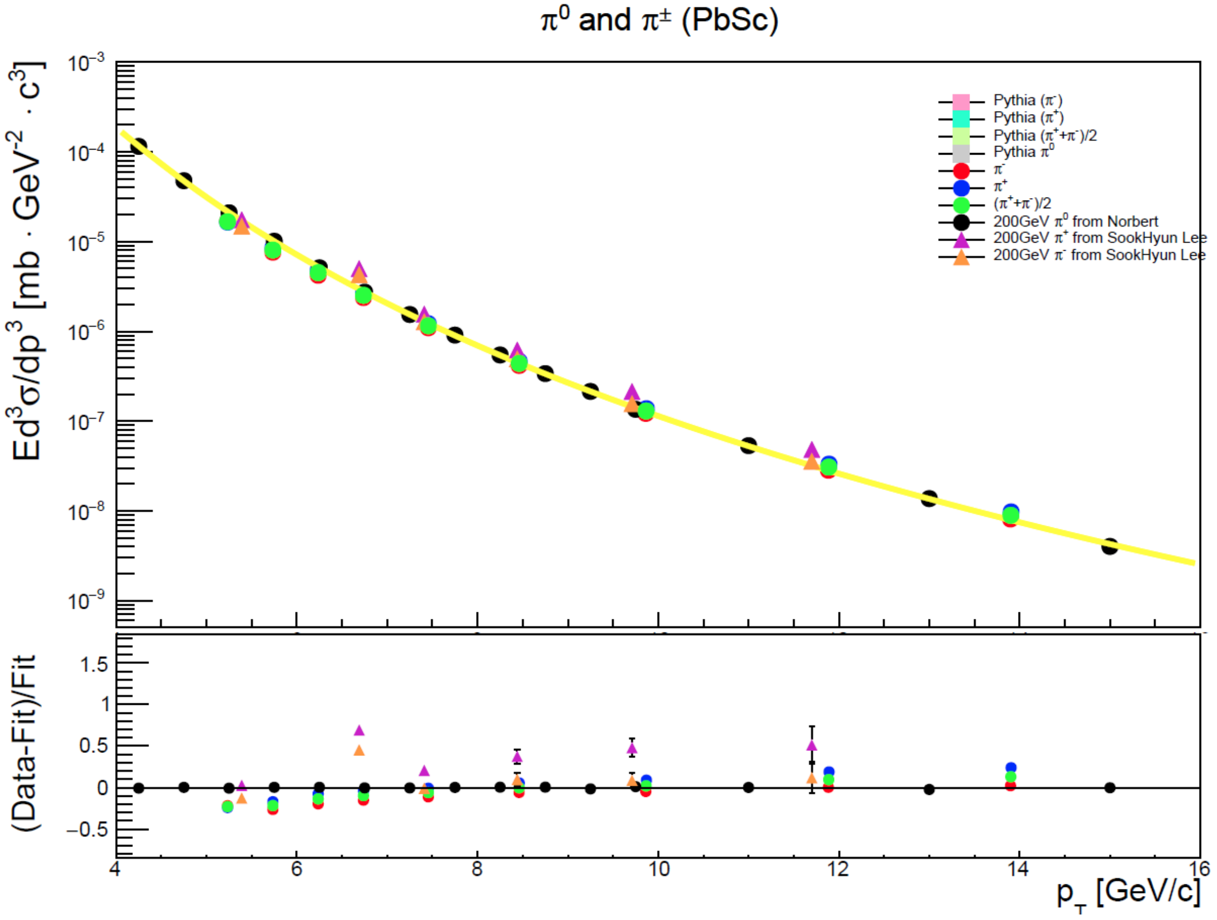


pT	Correction factor
5.23624	1
5.73709	1
6.23788	1
6.73862	1
7.41803	1
8.46417	1.21348
9.87854	1.36043
11.8988	1.56643
13.913	1.75899

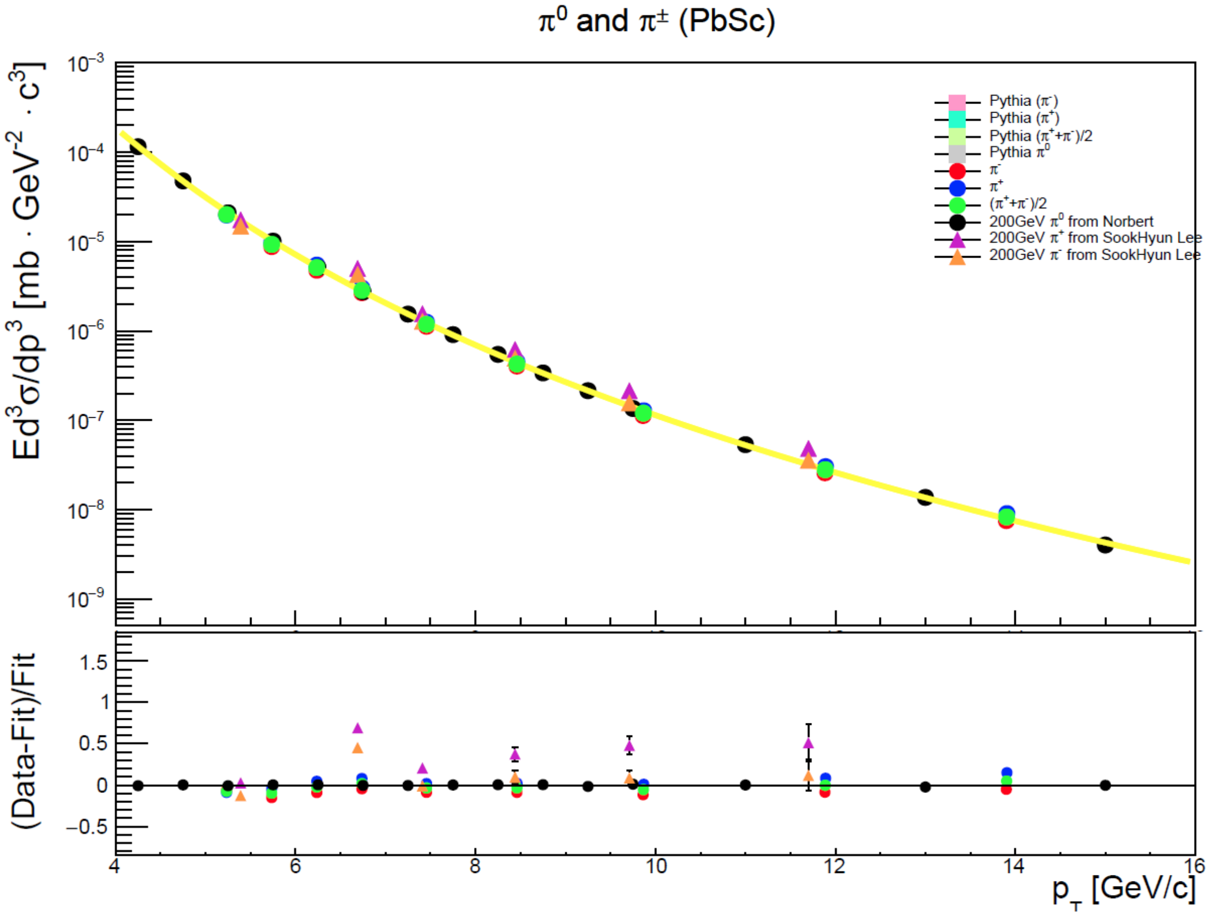
Generated pT : 4.8 ~ 18 [GeV/c]
Fitting range : 8 ~ 15 [GeV/c]

Smearing effect

previous



now



Resolution & Smearing effect

RICH

chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.293458
	5.735	-0.329543
	6.236	-0.262757
	6.737	-0.212906
	7.455	-0.167186
	8.46	-0.112332
	9.862	-0.0902257
	11.88	-0.0103979
	13.9	0.0375308
+	5.233	-0.31453
	5.735	-0.241883
	6.236	-0.15713
	6.737	-0.102046
	7.456	-0.0659335
	8.461	0.00153077
	9.87	0.0360192
	11.89	0.15722
	13.91	0.241889

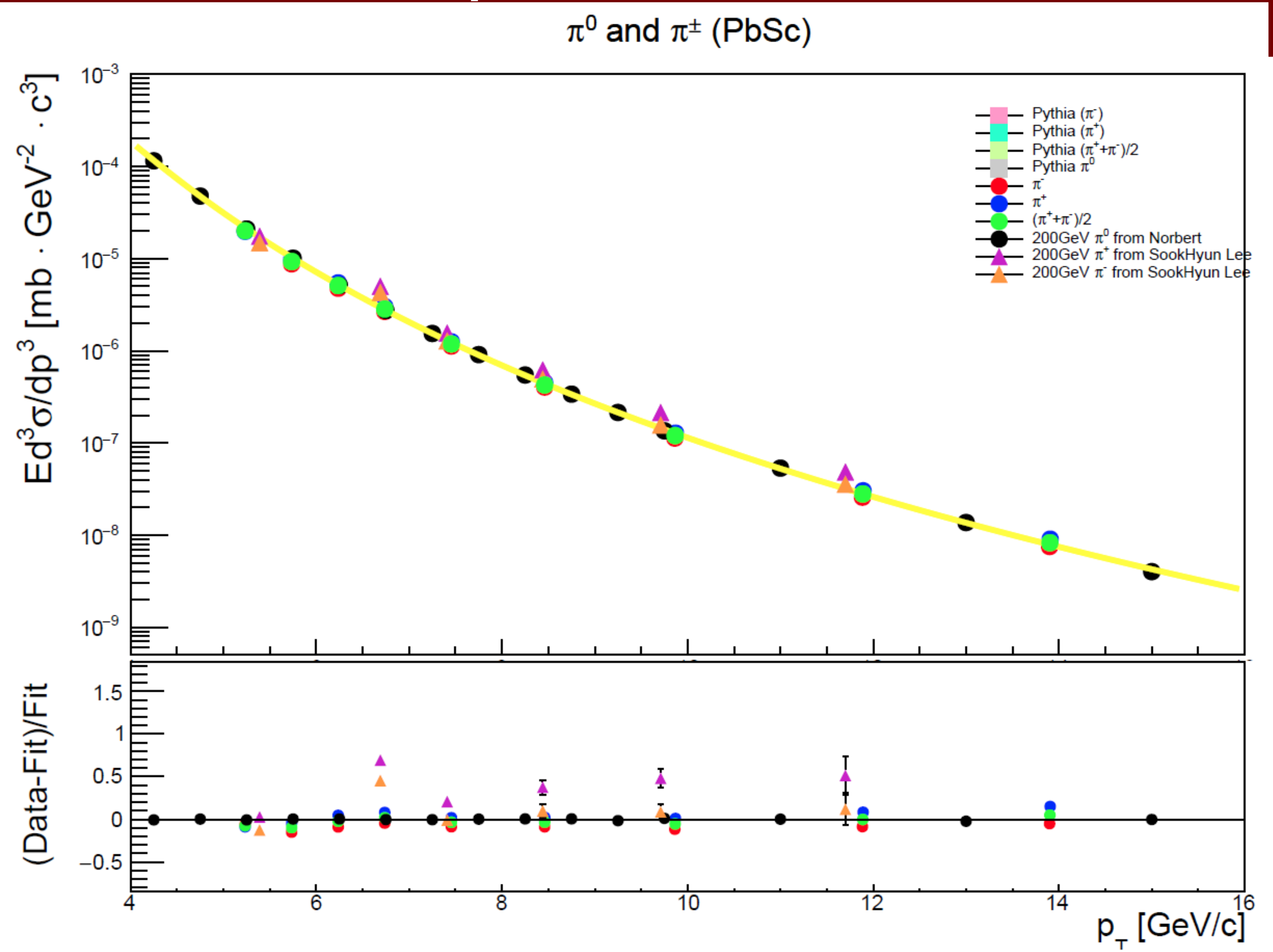
Acc.Rec

chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.217671
	5.735	-0.263807
	6.236	-0.196314
	6.737	-0.152033
	7.455	-0.111597
	8.46	-0.0589163
	9.862	-0.0473179
	11.88	0.00305179
	13.9	0.02206
+	5.233	-0.240699
	5.735	-0.169673
	6.236	-0.0748128
	6.737	-0.0403035
	7.456	-0.00756501
	8.461	0.0554353
	9.87	0.0896555
	11.89	0.189062
	13.91	0.239429

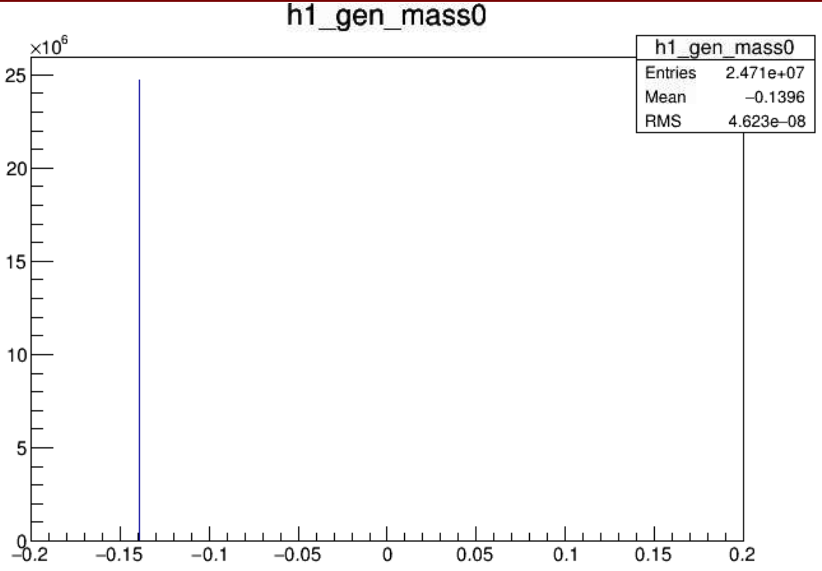
Smearing

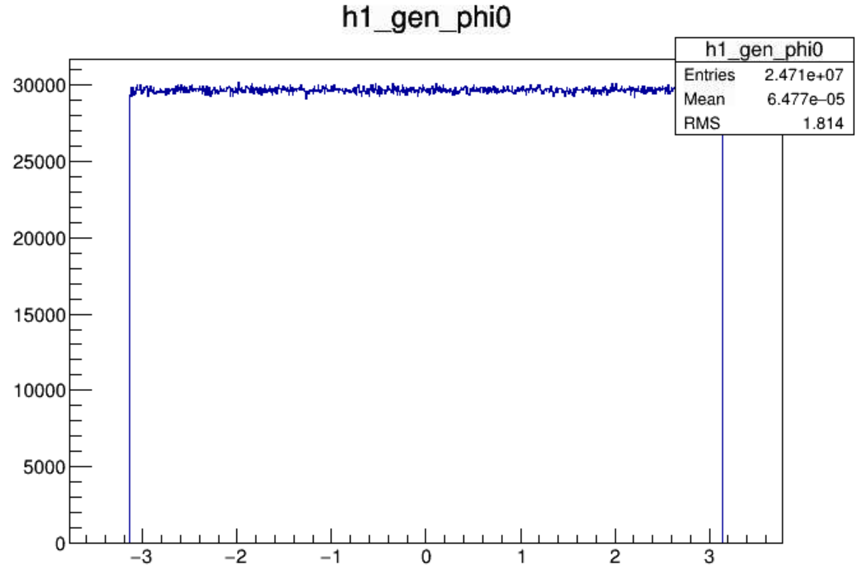
chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.0608869
	5.735	-0.151089
	6.236	-0.0907176
	6.737	-0.0453583
	7.455	-0.0875545
	8.46	-0.0884556
	9.862	-0.116636
	11.88	-0.0860706
	13.9	-0.0513091
+	5.233	-0.088528
	5.735	-0.0425417
	6.236	0.0467476
	6.737	0.0804291
	7.456	0.0192886
	8.461	0.0223057
	9.87	0.0103736
	11.89	0.0834129
	13.91	0.150456

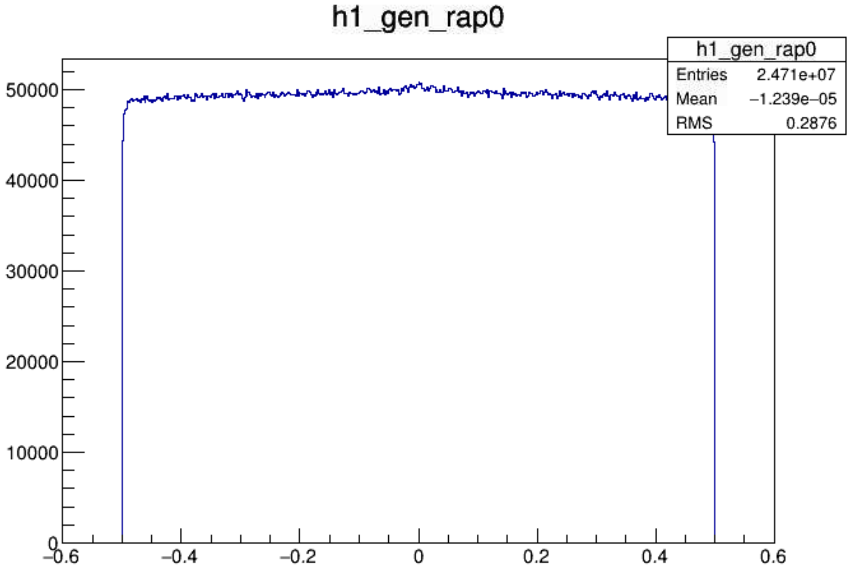
Final Cross-section plot

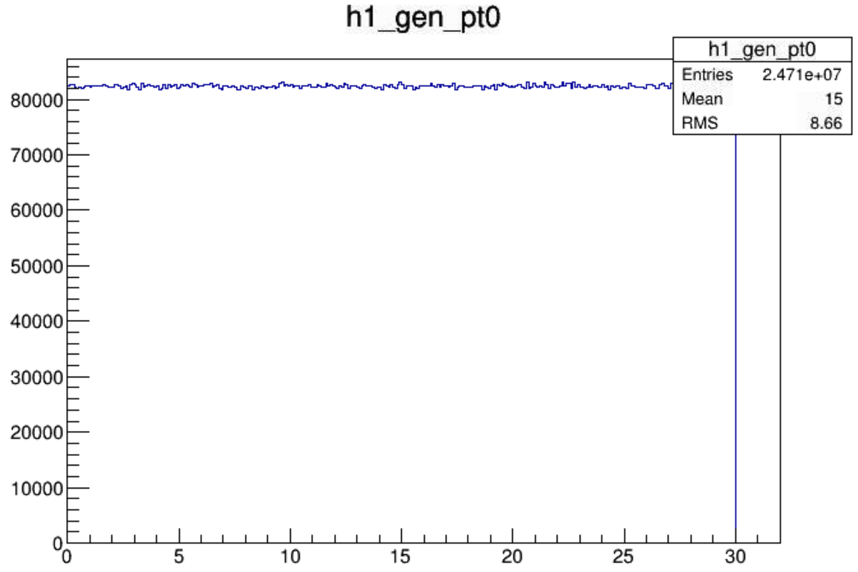


Generated particle information from simulation with $|\eta| < 0.5$ (Single particle generator). (original method)

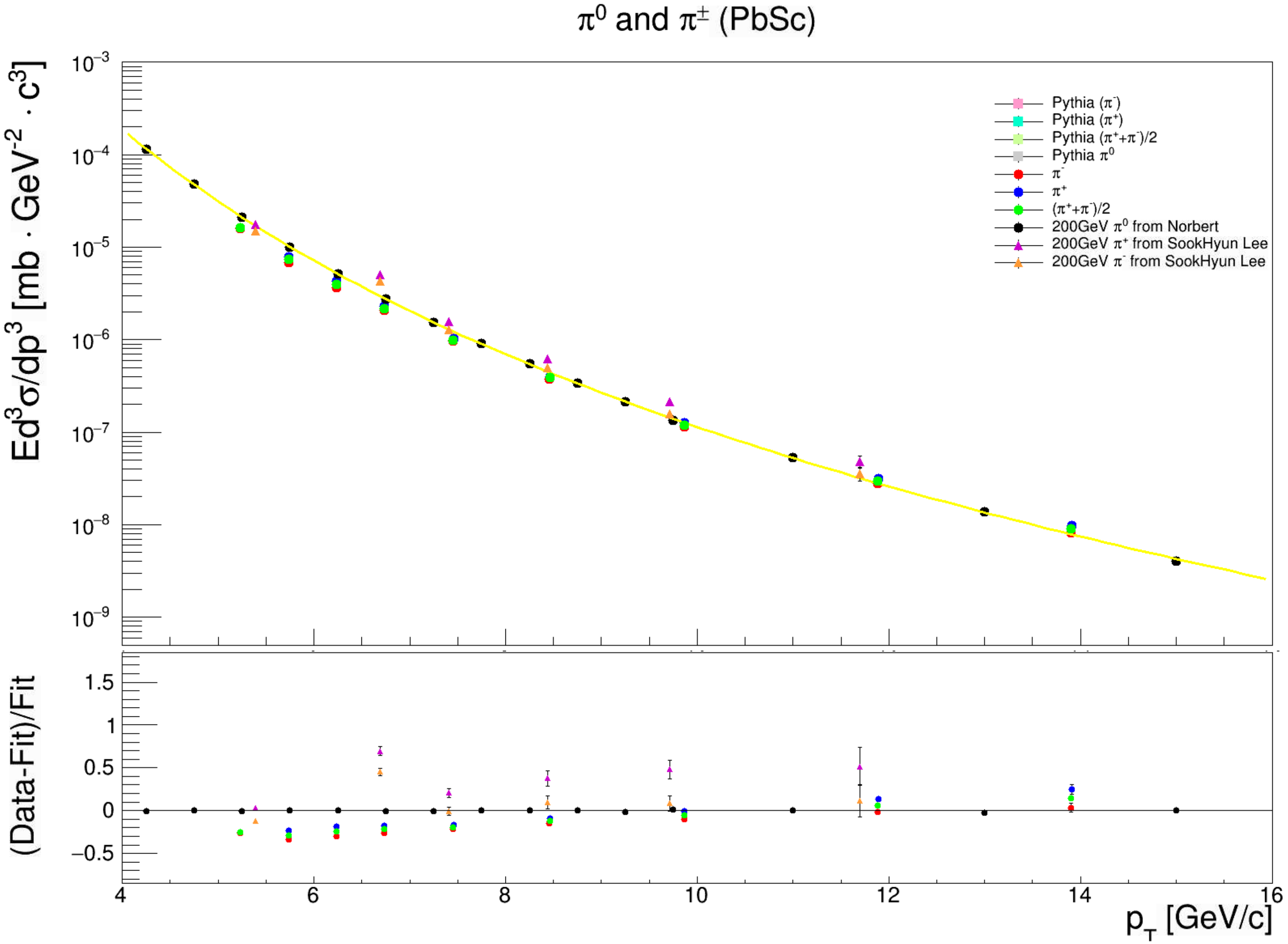






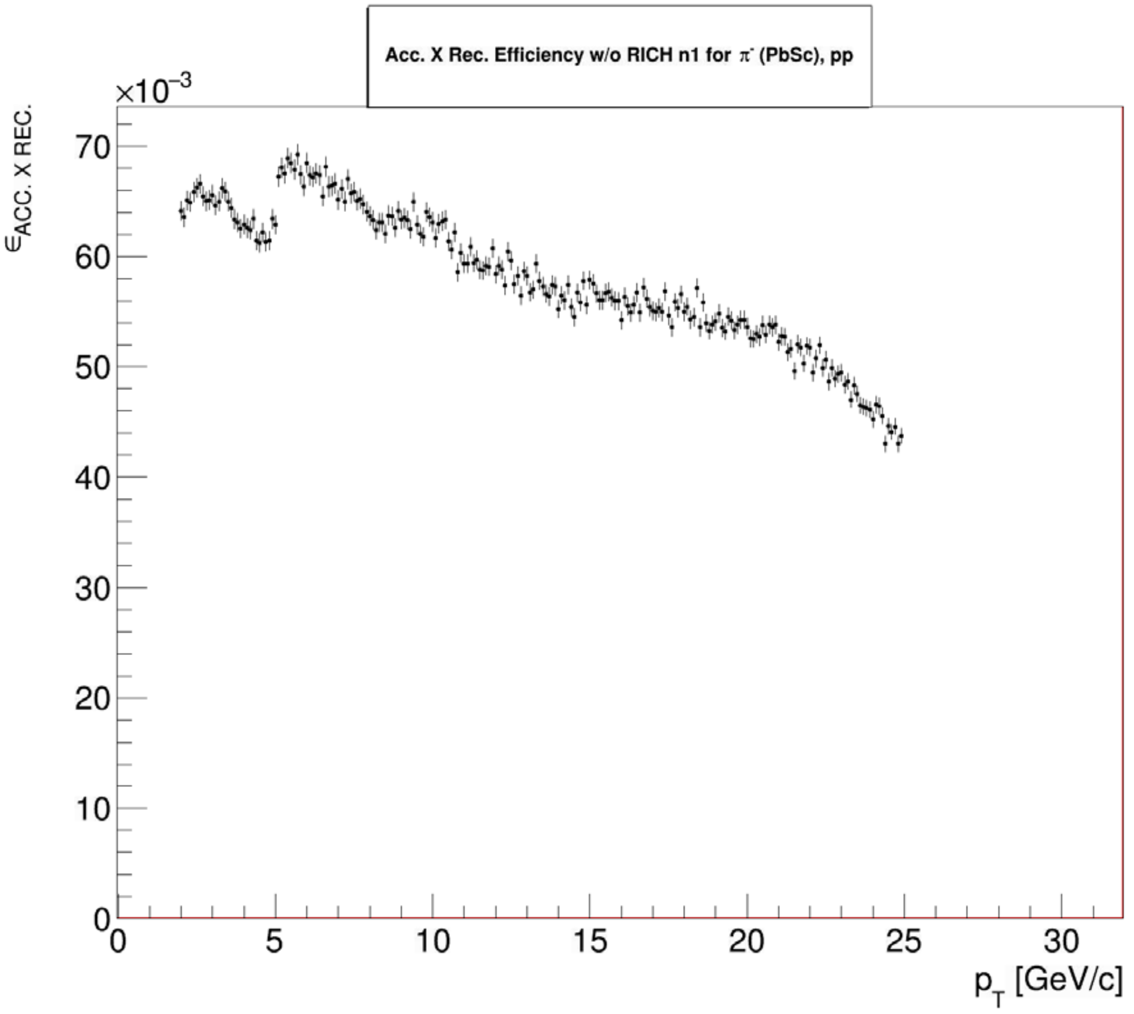


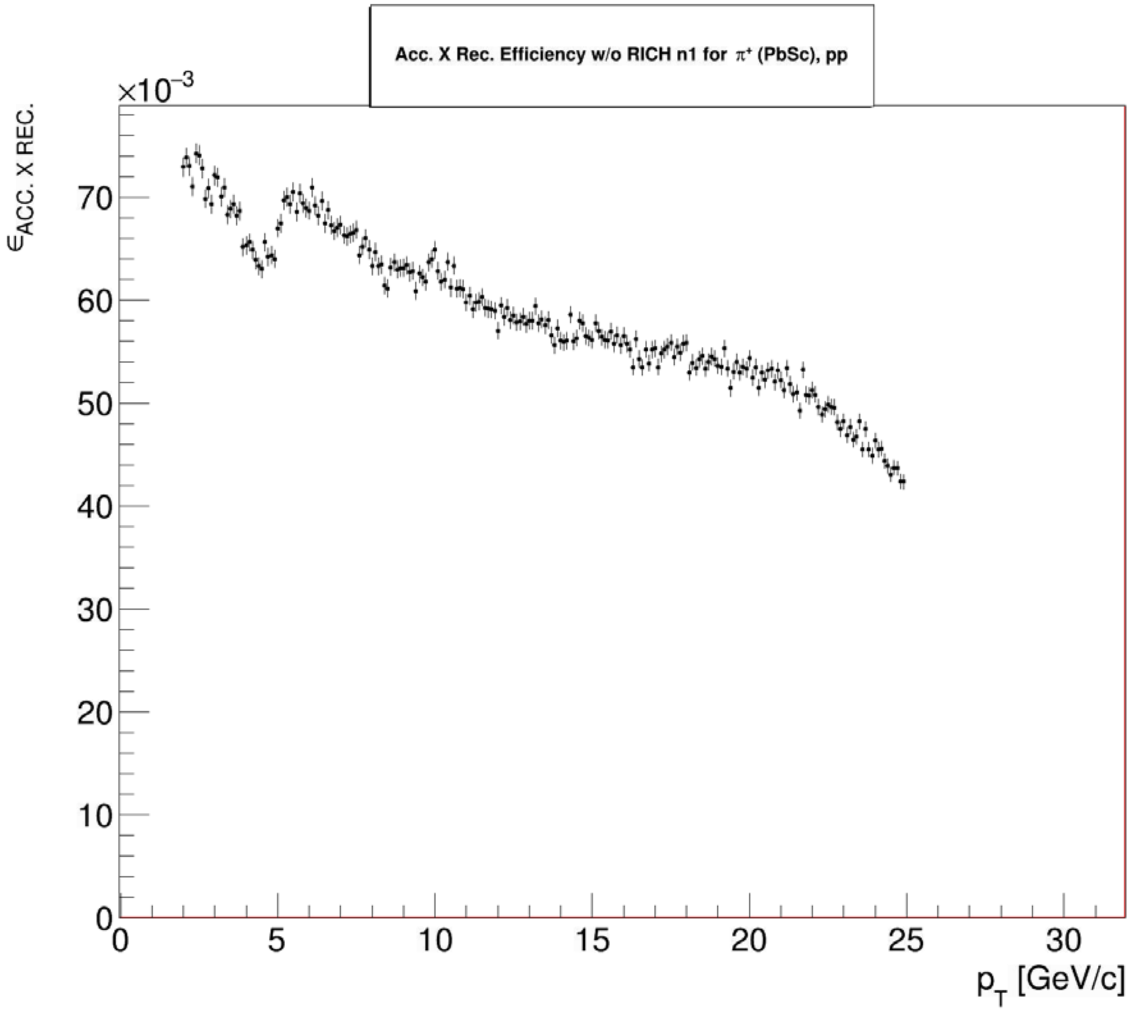
Cross Section from simulation with $|\eta| < 0.5$ (Single particle generator). (original method)



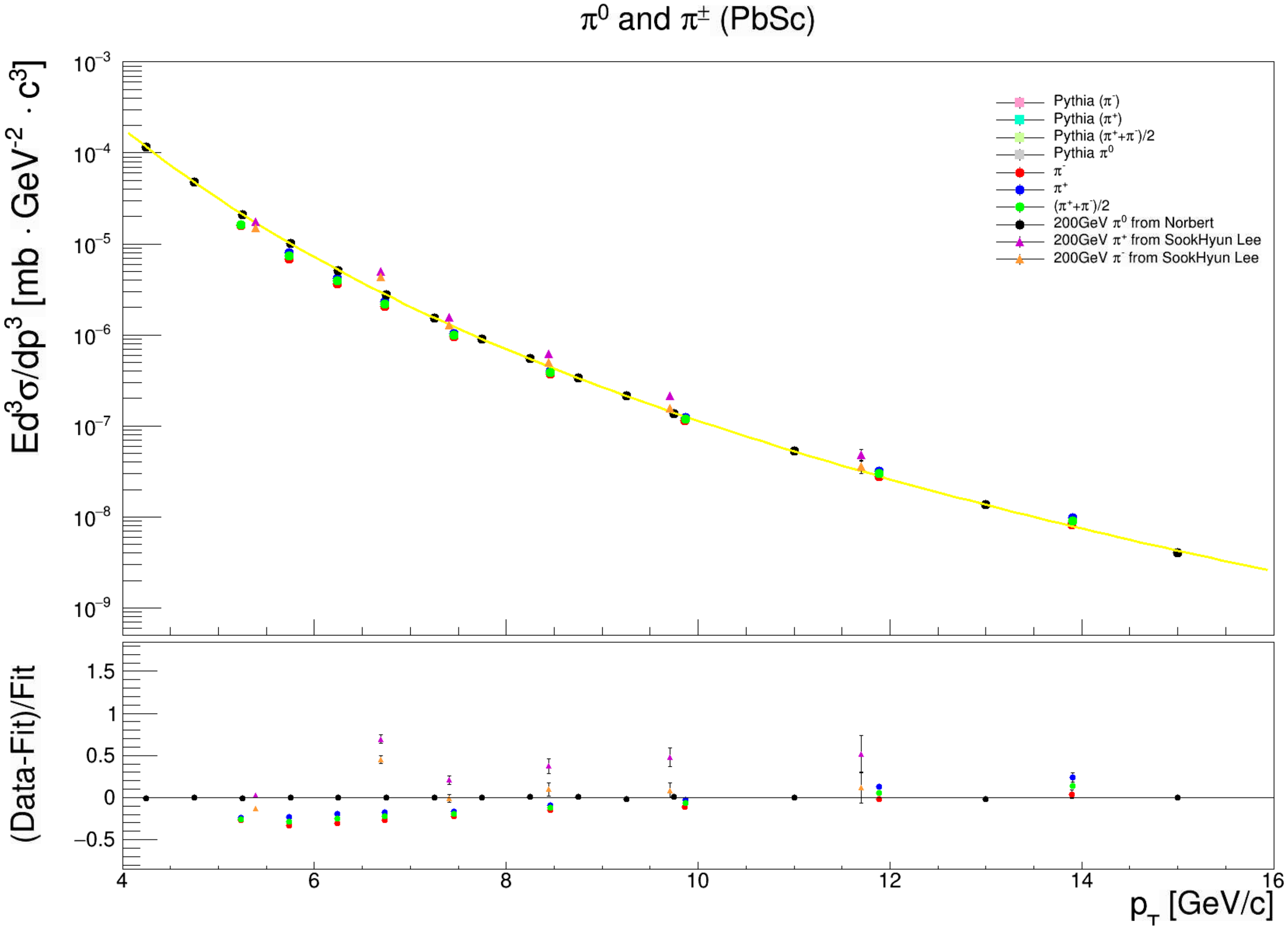
chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.259992
	5.735	-0.339909
	6.236	-0.296791
	6.737	-0.259366
	7.455	-0.216111
	8.46	-0.144875
	9.862	-0.101214
	11.88	-0.0144855
	13.9	0.0317682
+	5.233	-0.249511
	5.735	-0.237095
	6.236	-0.184641
	6.737	-0.176519
	7.456	-0.168133
	8.461	-0.0885648
	9.87	-0.0123032
	11.89	0.131579
	13.91	0.246774

Acc.Rec efficiency values from simulation with $|\eta| < 0.35$ (Single particle generator).





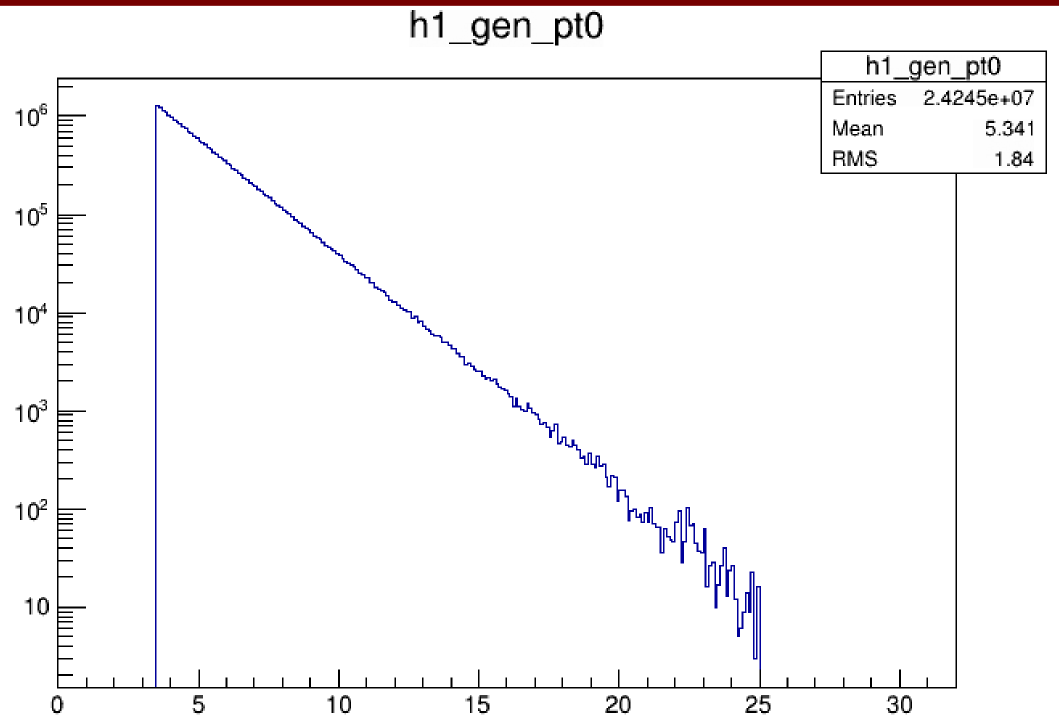
Cross Section from simulation with $|\eta| < 0.35$ (Single particle generator).

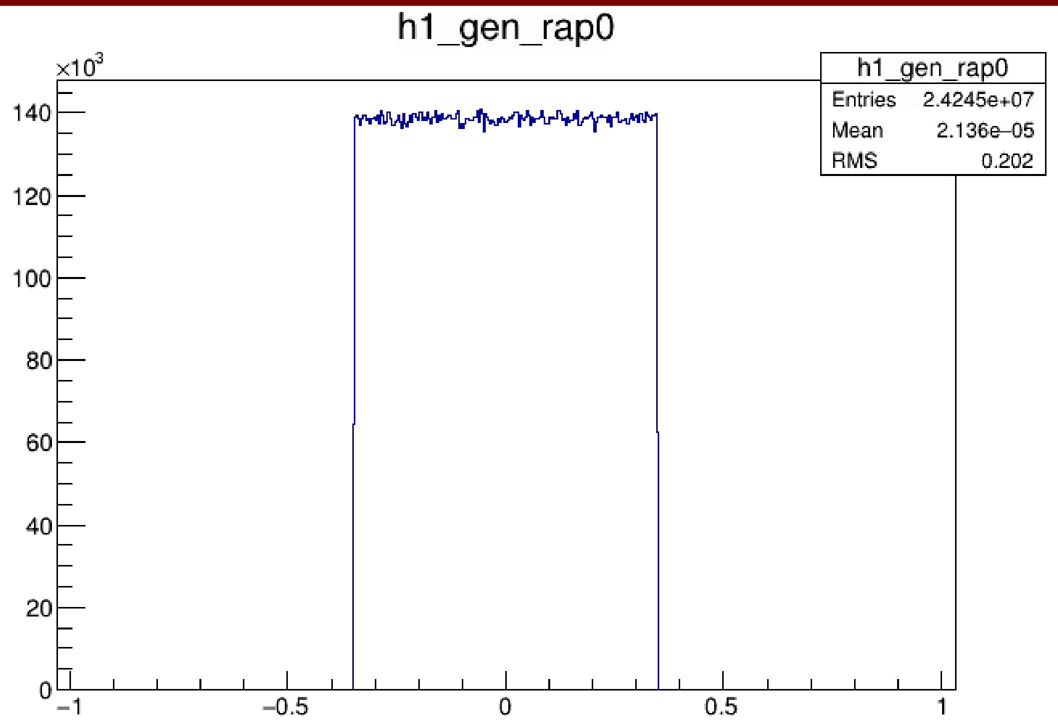


chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.269669
	5.735	-0.335208
	6.236	-0.303306
	6.737	-0.267313
	7.455	-0.222496
	8.46	-0.150574
	9.862	-0.109729
	11.88	-0.0156655
	13.9	0.0378244
+	5.233	-0.24339
	5.735	-0.23077
	6.236	-0.198631
	6.737	-0.177046
	7.456	-0.16514
	8.461	-0.0912113
	9.87	-0.0258288
	11.89	0.131283
	13.91	0.240243

Back up

Generated particle information from simulation with $|\eta| < 0.35$ and pT funchtion = exp (Single particle generator).



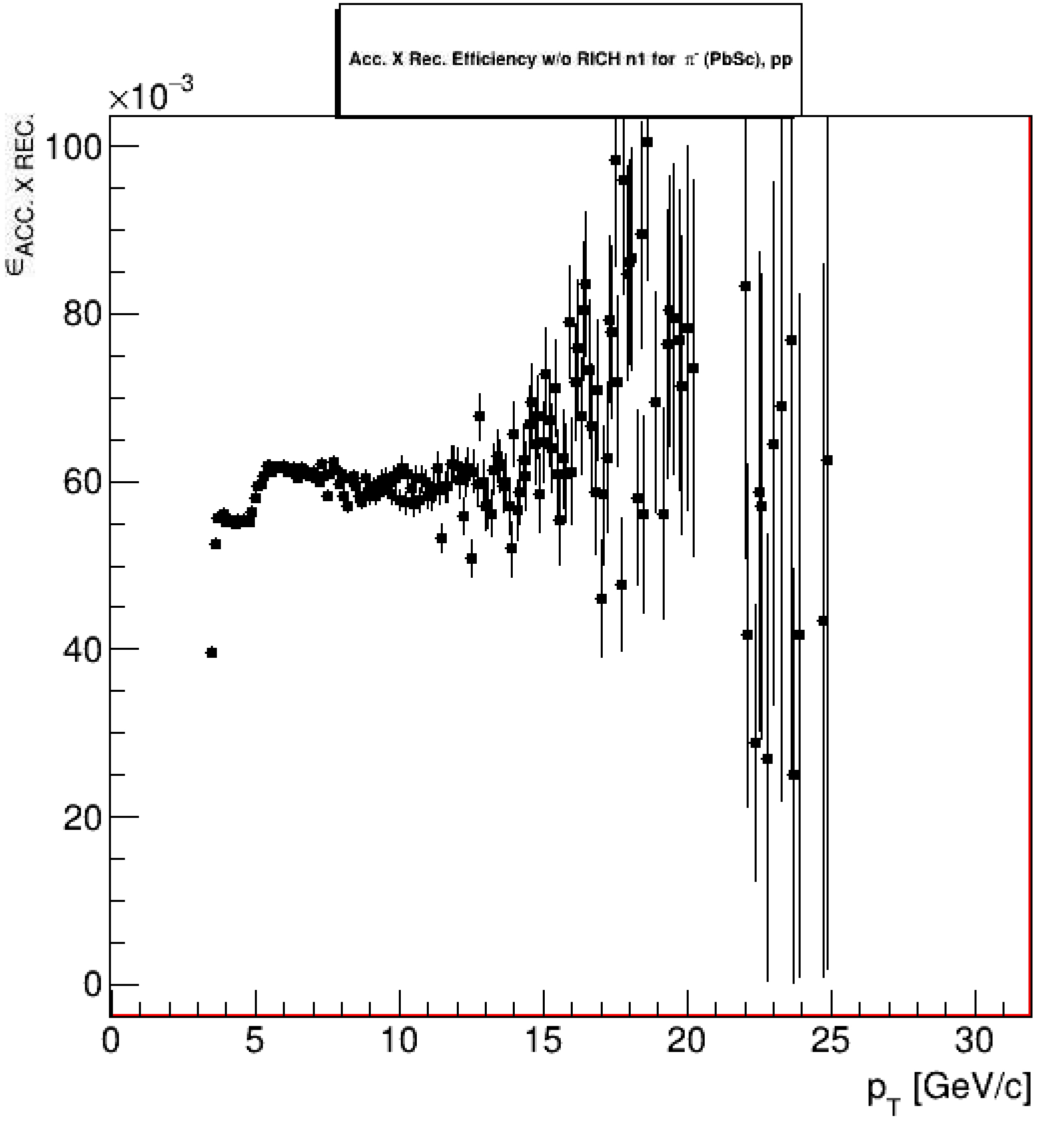


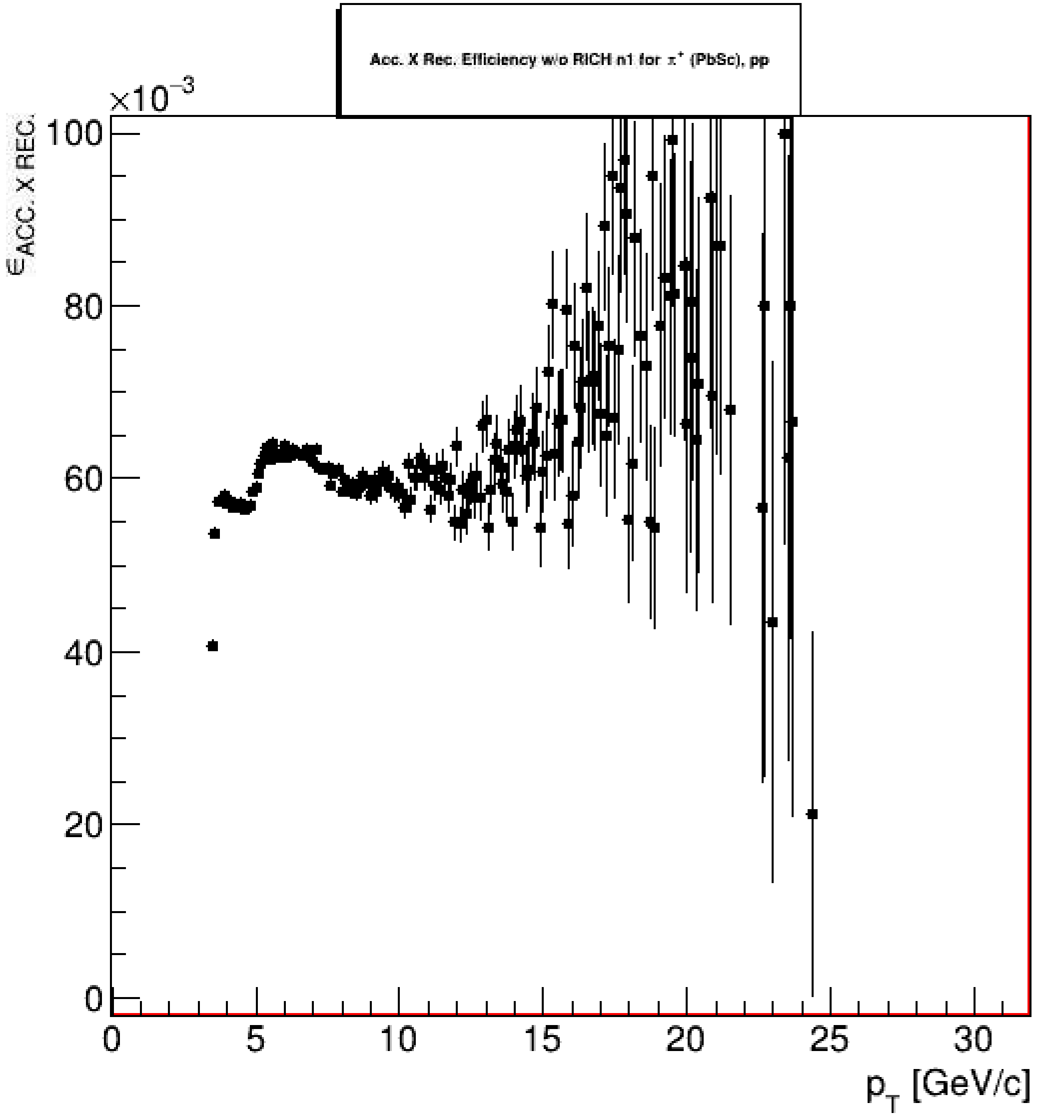
event_gen/src/PHParticleGen/TSingleParticleGenerator.C

$$p_T\ function = e^{-0.5426x}$$

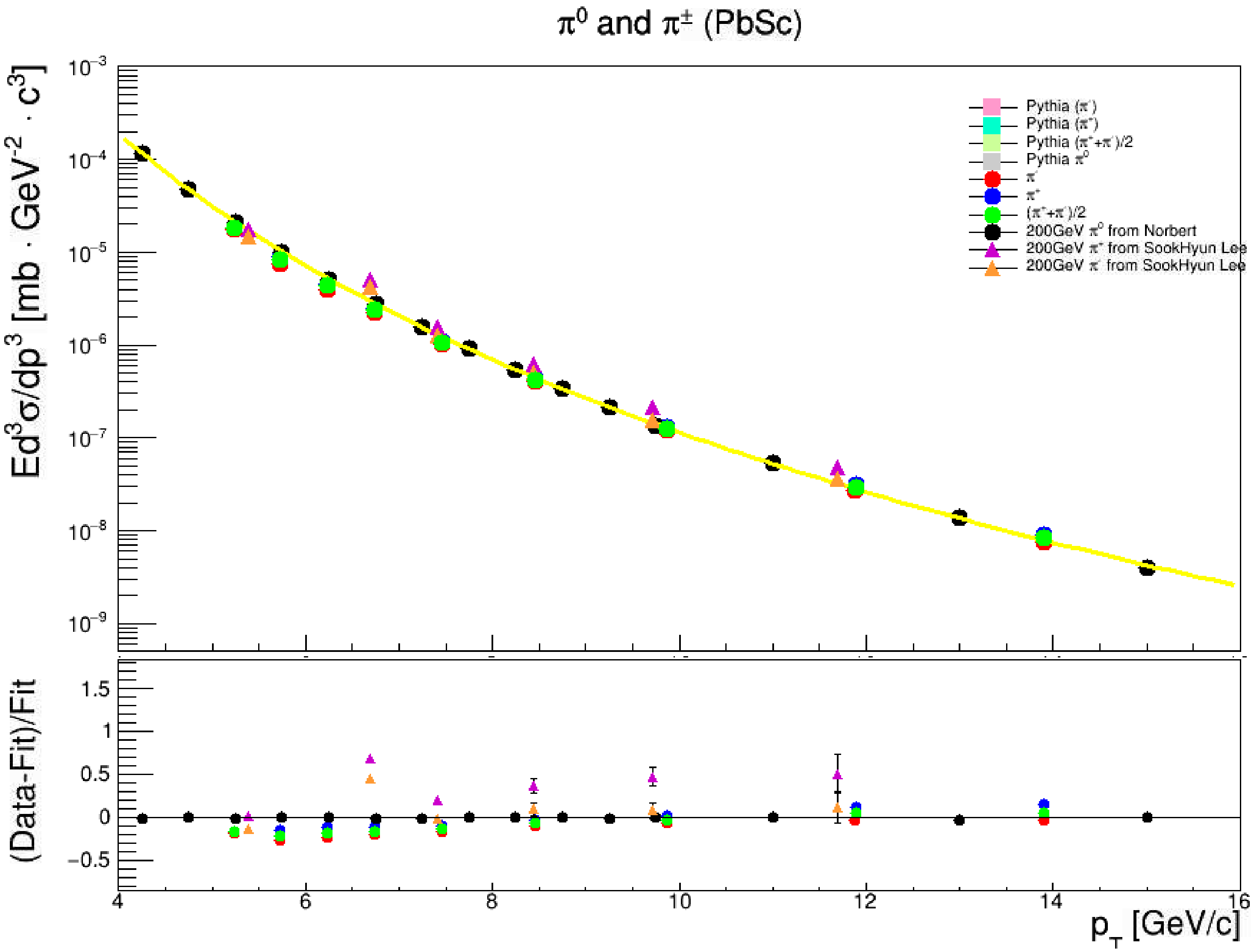
```
else if ( _momflag == EXP_PT )
  {
    TF1 ptfunc("ptfunc","TMath::Exp([0]*x)",_pMin, _pMax);
    TF1 etafunc("etafunc","TMath::Exp(-x*x/(2.0*[0]*[0]))",_etaMin,_etaMax);

    ptfunc.SetParameter(0,-5.42584e-01);
    //ptfunc.SetParameter(0,-8.67317e-01);
    etafunc.SetParameters(0,1.0);

    double pt = ptfunc.GetRandom();
    double eta = etafunc.GetRandom();

    v.SetPtEtaPhiM(pt,eta,phi,_mass);
```

Acc.Rec efficiency values from simulation with $|\eta| < 0.35$ and pT funchtion = exp (Single particle generator).



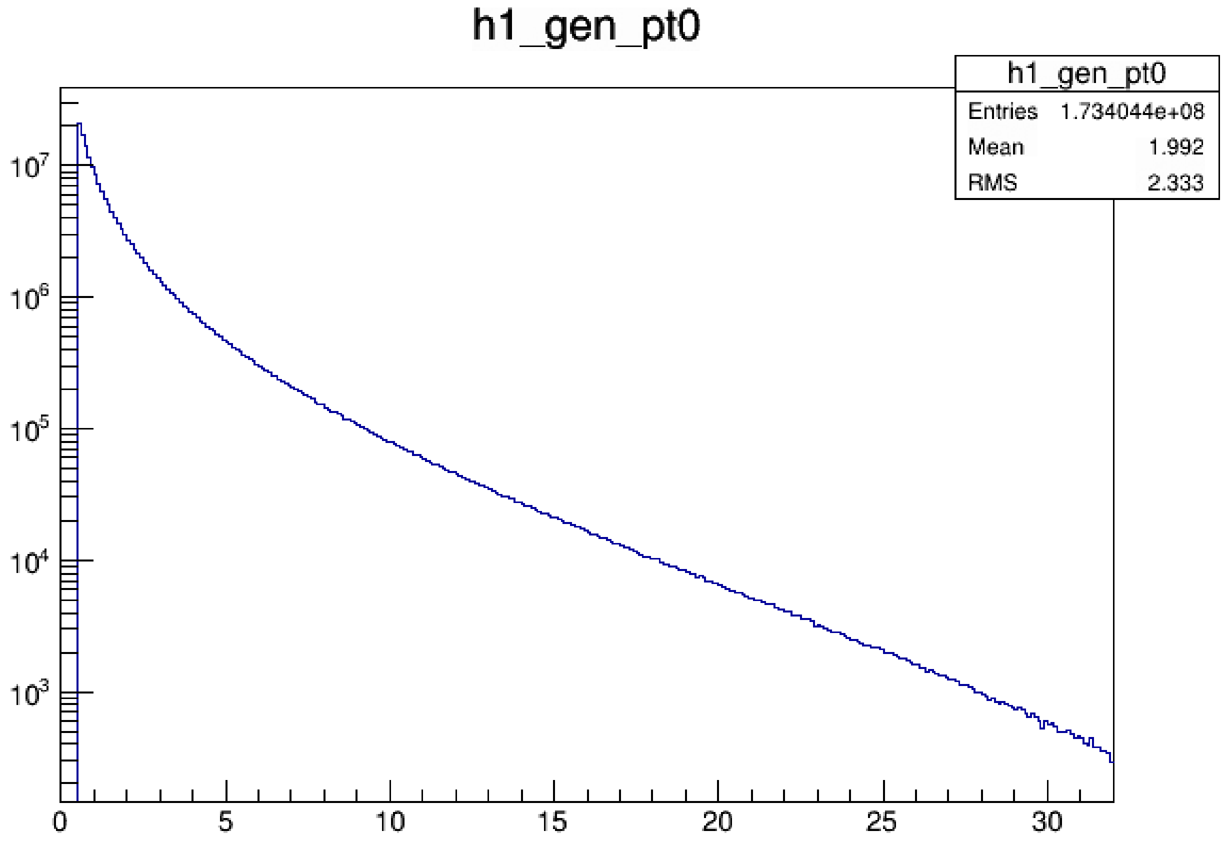


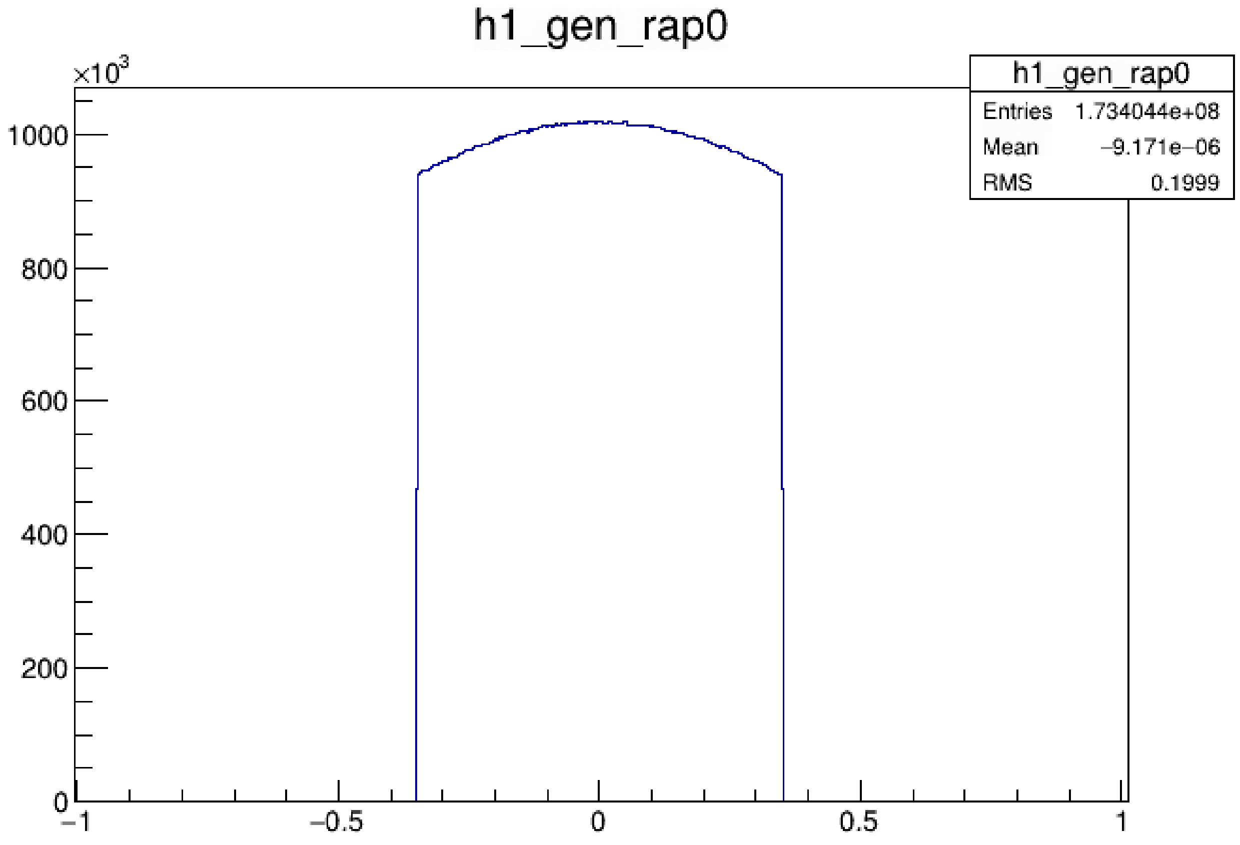
Cross Section from simulation with $|\eta| < 0.35$ and pT funchtion = exp (Single particle generator).



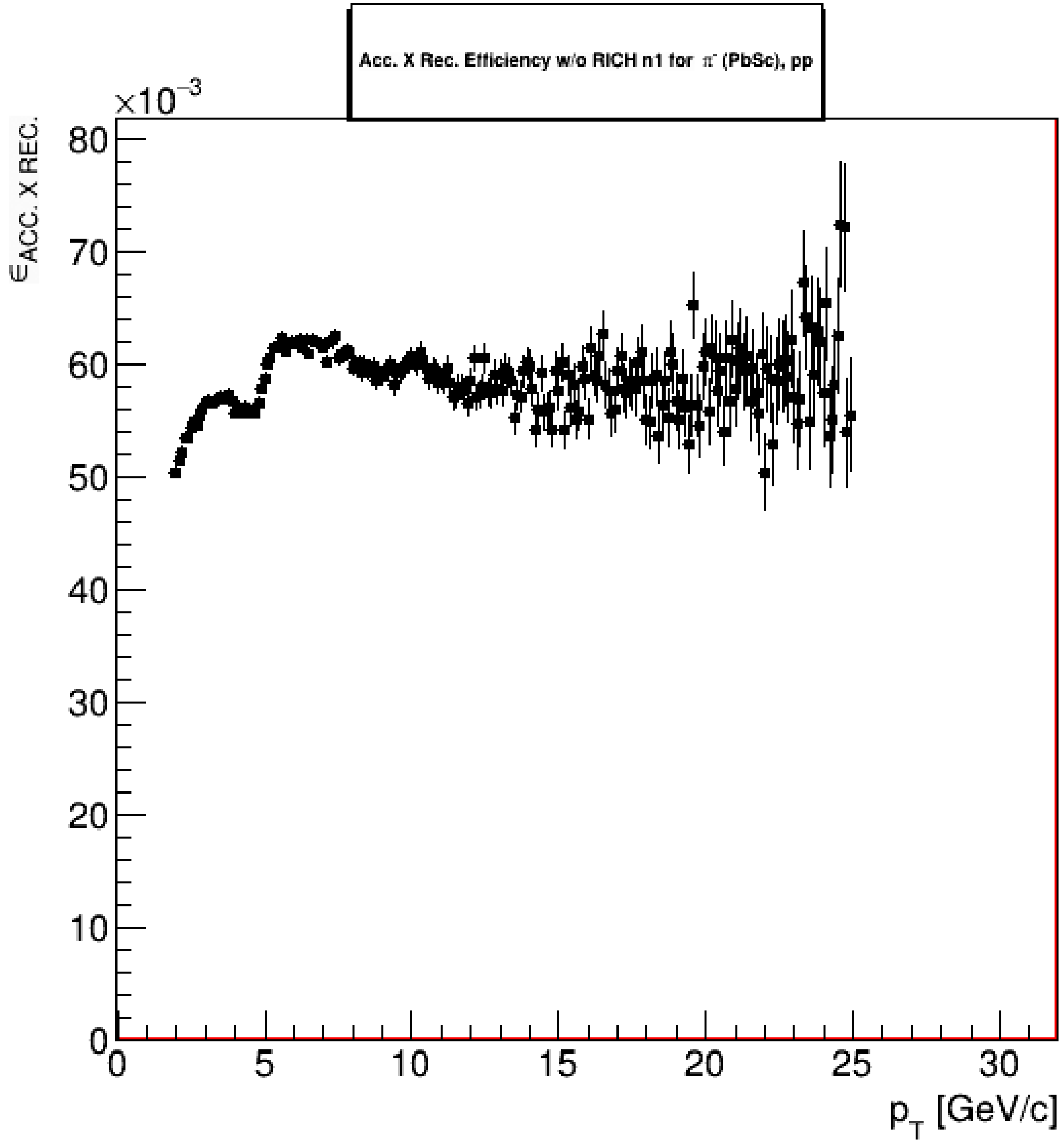
chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.184024
	5.735	-0.26687
	6.236	-0.233424
	6.737	-0.199413
	7.455	-0.161991
	8.46	-0.0933935
	9.862	-0.0625283
	11.88	-0.0259164
	13.9	-0.0312259
+	5.233	-0.15481
	5.735	-0.148205
	6.236	-0.117846
	6.737	-0.116284
	7.456	-0.0988476
	8.461	-0.0319322
	9.87	0.0230226
	11.89	0.126217
	13.91	0.147695

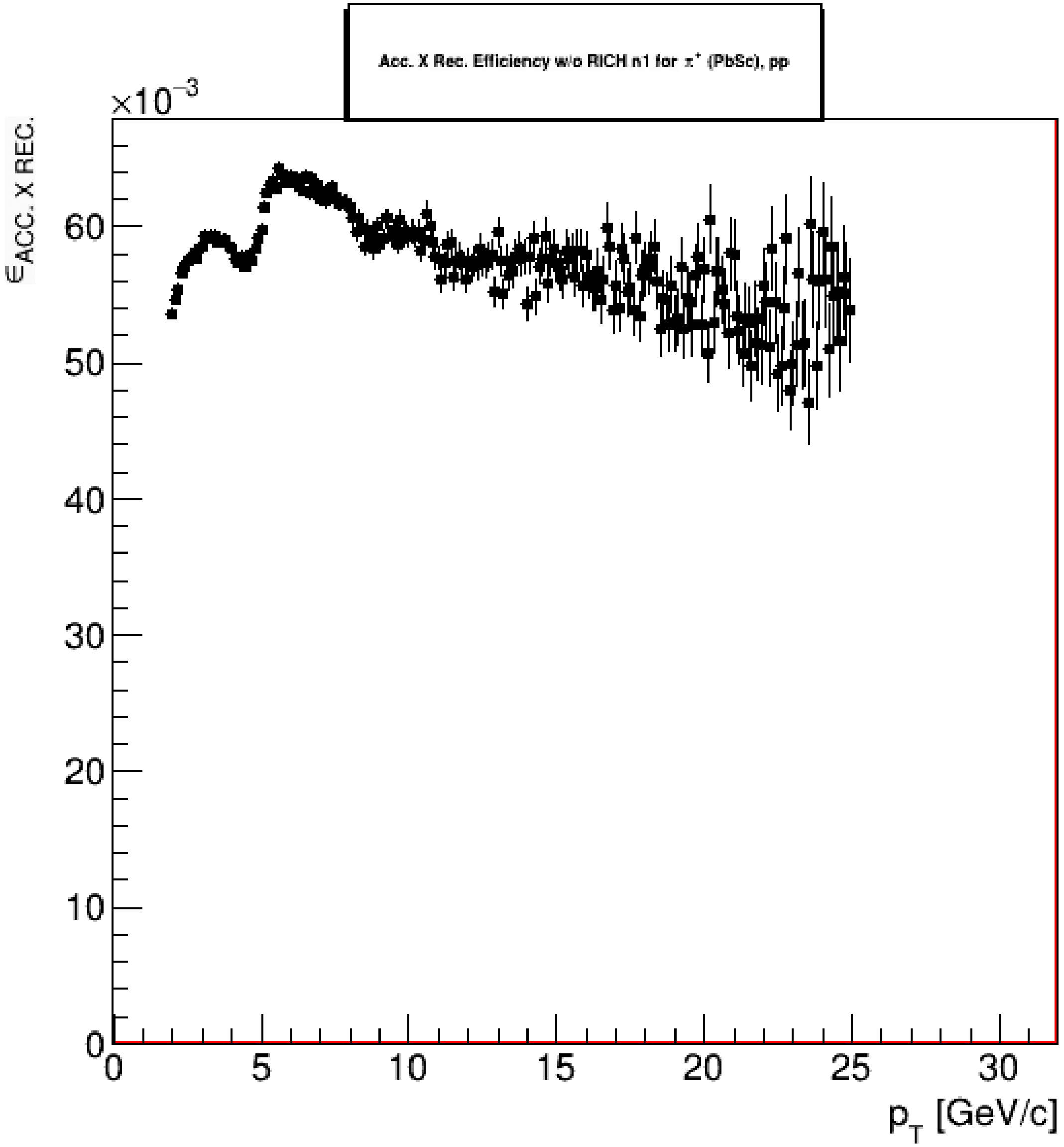
Generated particle information from simulation with $|\eta| < 0.35$ (Pythia simulation).



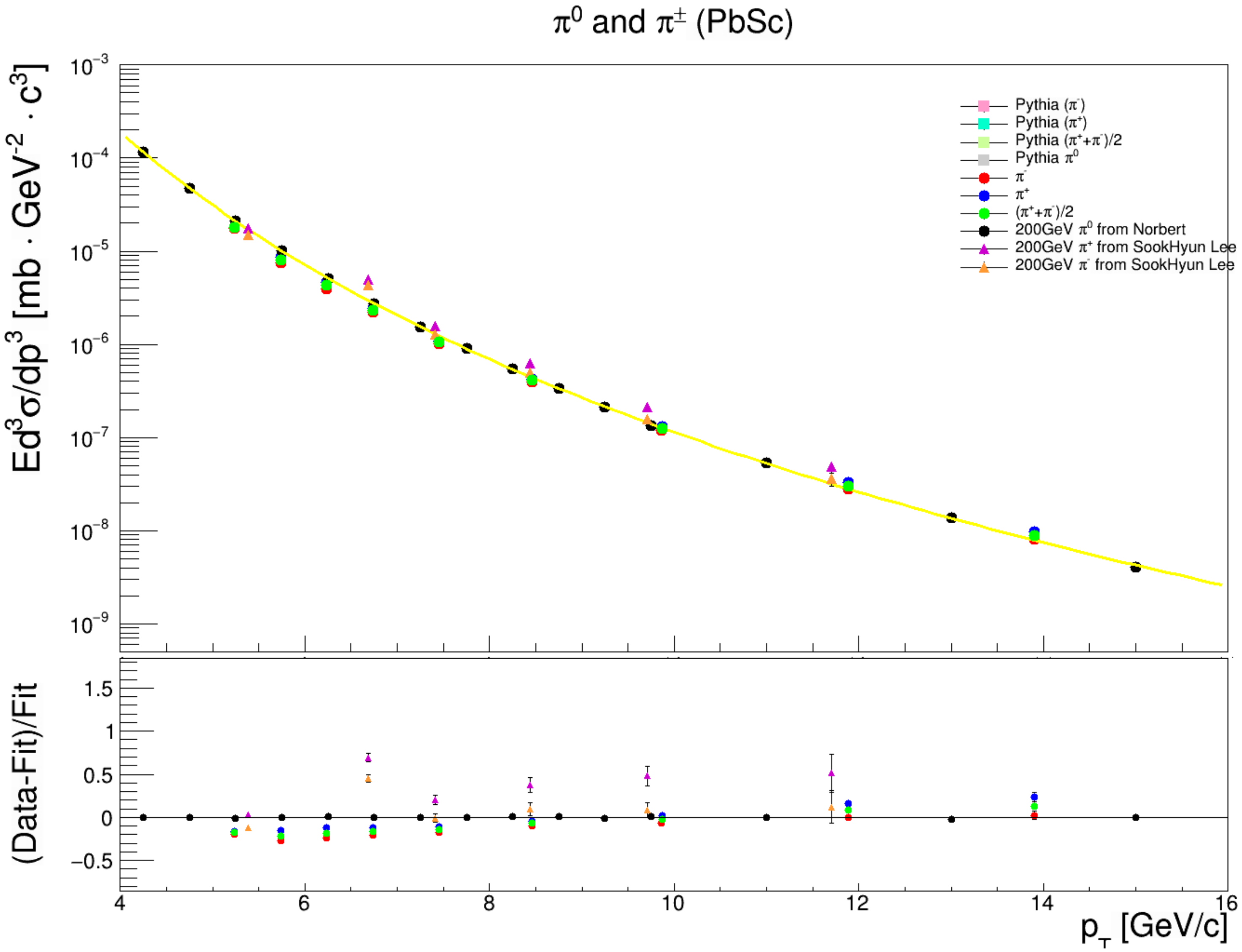


Acc.Rec efficiency values from simulation with $|\eta| < 0.35$ (Pythia simulation).





Cross Section from simulation with $|\eta| < 0.35$ (Pythia simulation).

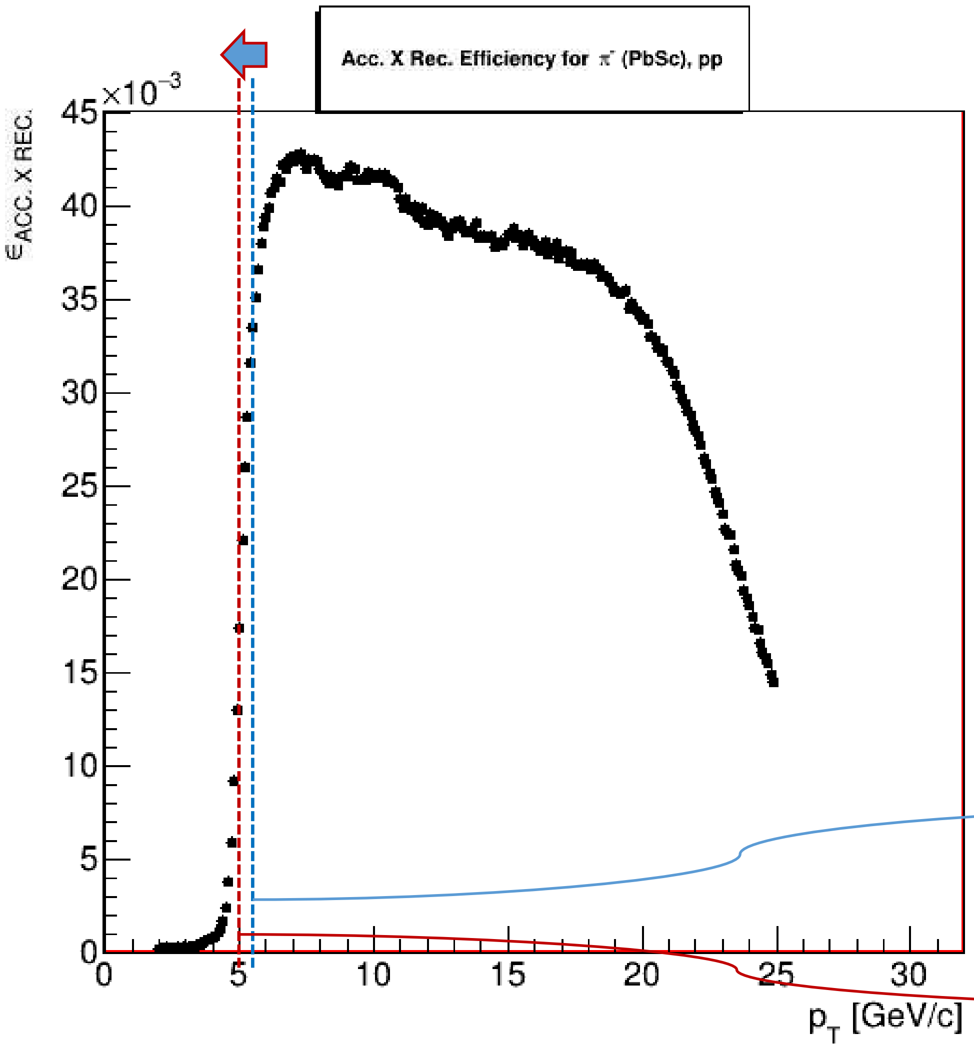


chg	pt	rel_diff [(Data-Fit)/Fit]
-	5.233	-0.19133
	5.735	-0.270028
	6.236	-0.240518
	6.737	-0.210647
	7.455	-0.170601
	8.46	-0.0994595
	9.862	-0.0677398
	11.88	-0.00228687
	13.9	0.0223485
+	5.233	-0.161897
	5.735	-0.157502
	6.236	-0.120368
	6.737	-0.120458
	7.456	-0.11297
	8.461	-0.0422981
	9.87	0.0246018
	11.89	0.16241
	13.91	0.237786

comparision

generator setting		Single particle generator			pythia generator
		pt = plat , | η | < 0.5	pt = plat , | η | < 0.35	pt = exponential , | η | < 0.35	| η | < 0.35
chg	pt	rel_diff [(Data-Fit)/Fit]	rel_diff [(Data-Fit)/Fit]	rel_diff [(Data-Fit)/Fit]	rel_diff [(Data-Fit)/Fit]
-	5.23318	-0.259992	-0.269669	-0.184024	-0.19133
	5.73477	-0.339909	-0.335208	-0.26687	-0.270028
	6.23624	-0.296791	-0.303306	-0.233424	-0.240518
	6.73746	-0.259366	-0.267313	-0.199413	-0.210647
	7.45526	-0.216111	-0.222496	-0.161991	-0.170601
	8.46014	-0.144875	-0.150574	-0.0933935	-0.0994595
	9.86243	-0.101214	-0.109729	-0.0625283	-0.0677398
	11.8834	-0.0144855	-0.0156655	-0.0259164	-0.00228687
	13.8995	0.0317682	0.0378244	-0.0312259	0.0223485
+	5.23349	-0.249511	-0.24339	-0.15481	-0.161897
	5.73495	-0.237095	-0.23077	-0.148205	-0.157502
	6.2363	-0.184641	-0.198631	-0.117846	-0.120368
	6.73746	-0.176519	-0.177046	-0.116284	-0.120458
	7.45575	-0.168133	-0.16514	-0.0988476	-0.11297
	8.46136	-0.0885648	-0.0912113	-0.0319322	-0.0422981
	9.86975	-0.0123032	-0.0258288	0.0230226	0.0246018
	11.8907	0.131579	0.131283	0.126217	0.16241
	13.9059	0.246774	0.240243	0.147695	0.237786

Change applied Acc.Rec. efficiency by move mean pT for cross section systematic uncertainty (previous)



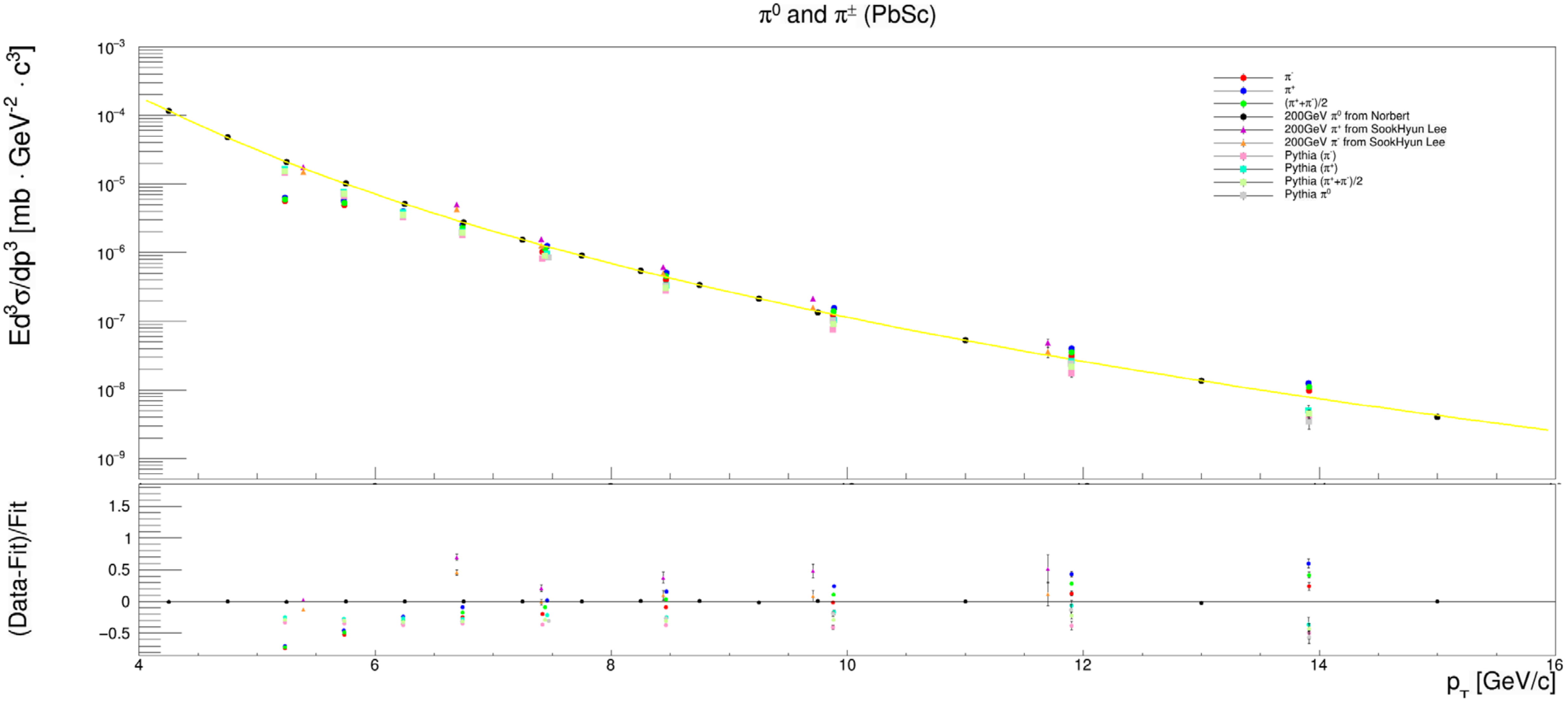
When we get Acc. Rec. efficiency, we can not seek accurate efficiency nearby RICH n1 cut because Efficiency increases dramatically nearby RICH n1 cut.
I think this efficiency was calculated larger than real data or moved to large pT.

So, I just use not efficiency of **mean pT** but I use efficiency of **mean pT – 0.5** for apply cross section calculation.

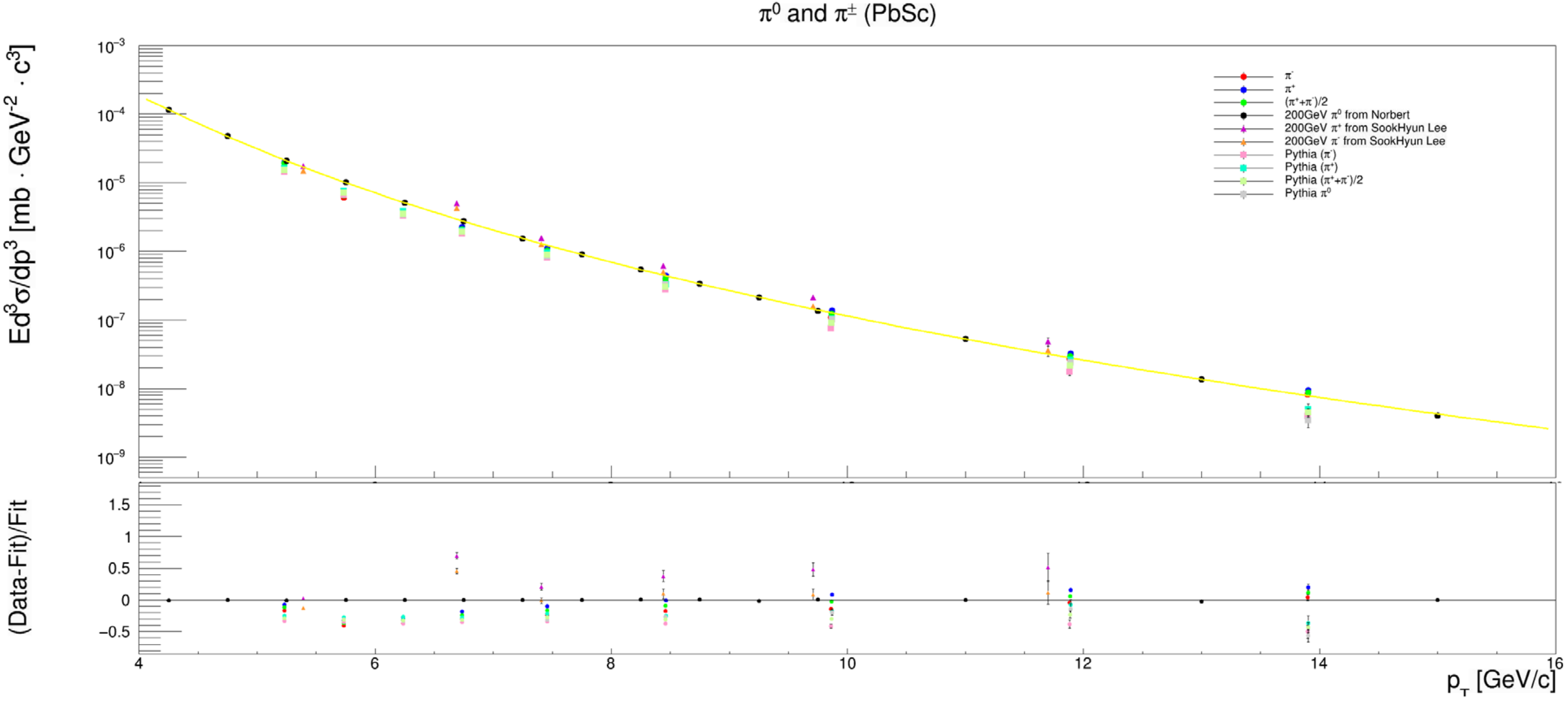
pT = 5.5 GeV

pT = 5 GeV

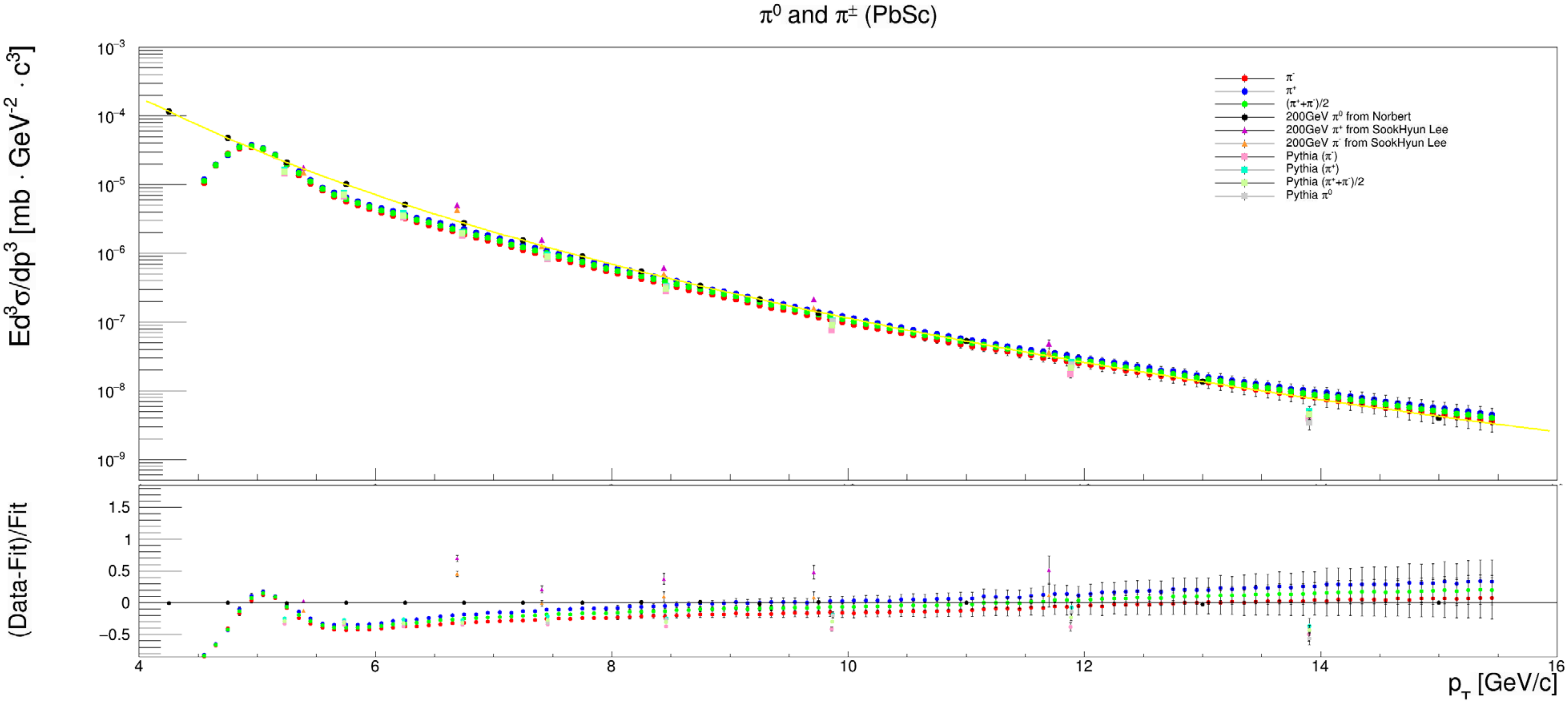
Cross section with pythia_200gev_yuehang.cfg
: use Acc.Rec. efficiency (mean_pT) values. (previous)



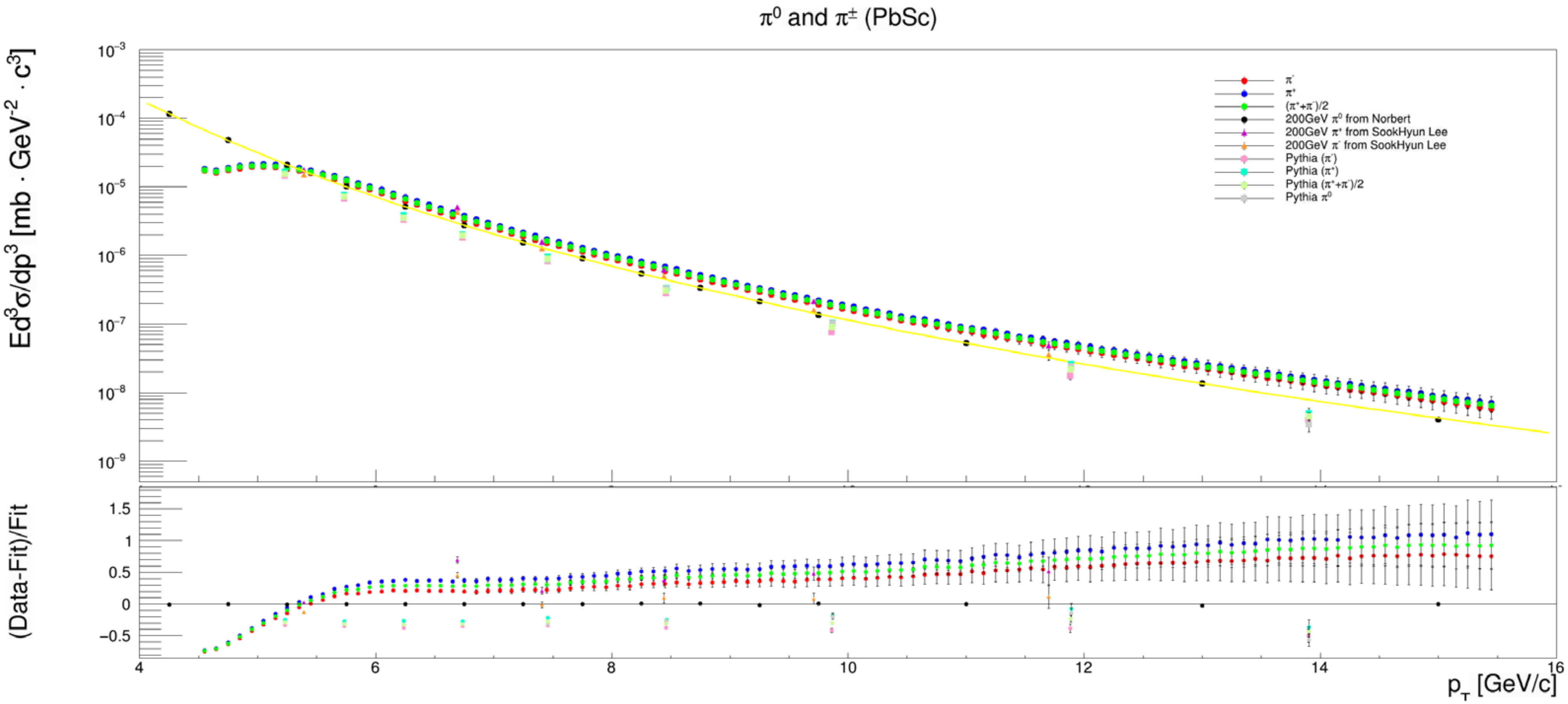
Cross section with pythia_200gev_yuehang.cfg
: use Acc.Rec. efficiency (mean_pT – 0.5) values. (previous)



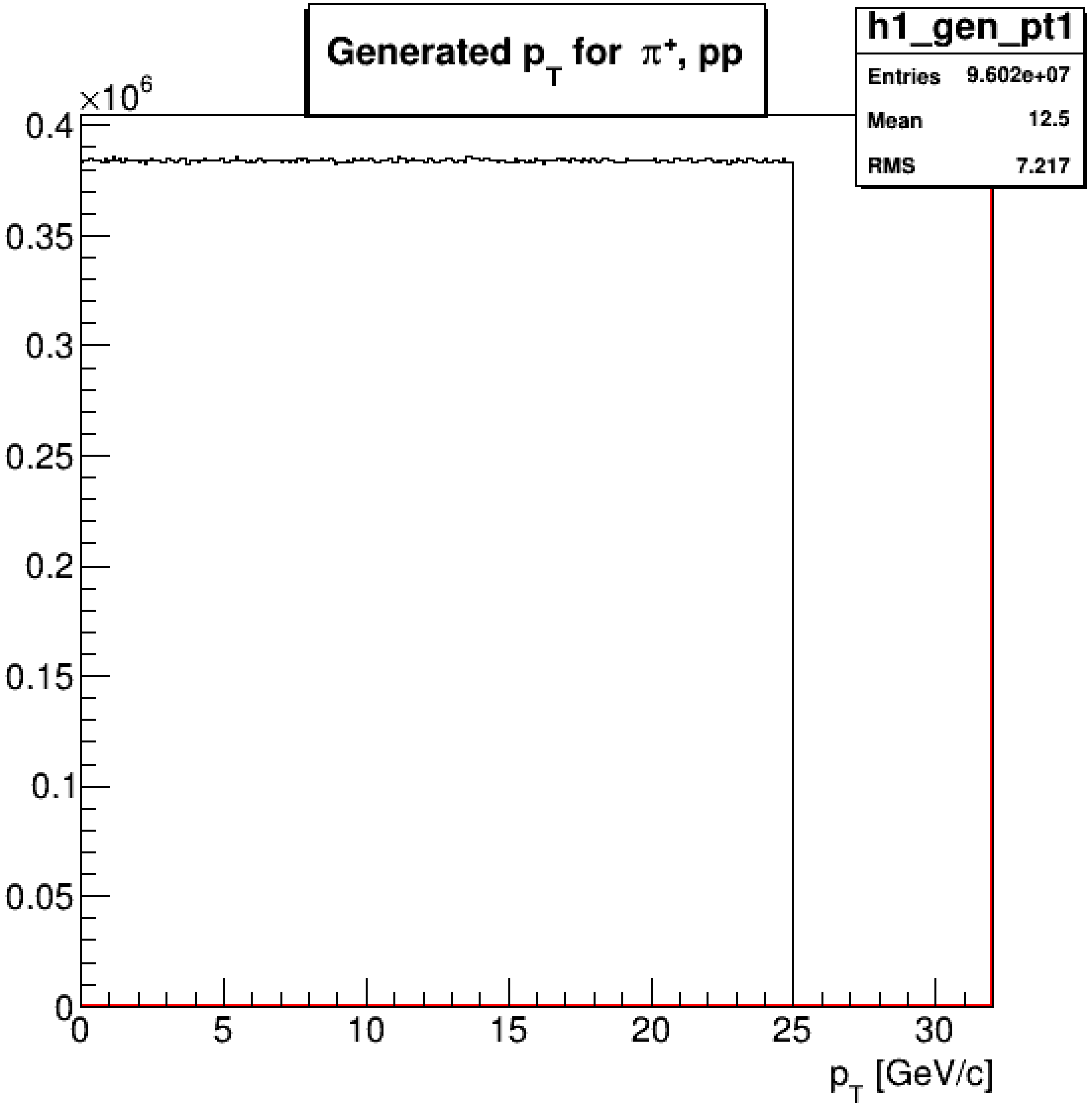
Cross section with pythia_200gev_yuehang.cfg
: use Acc.Rec. efficiency (mean_pT – 0.5GeV) values. (110 bins)

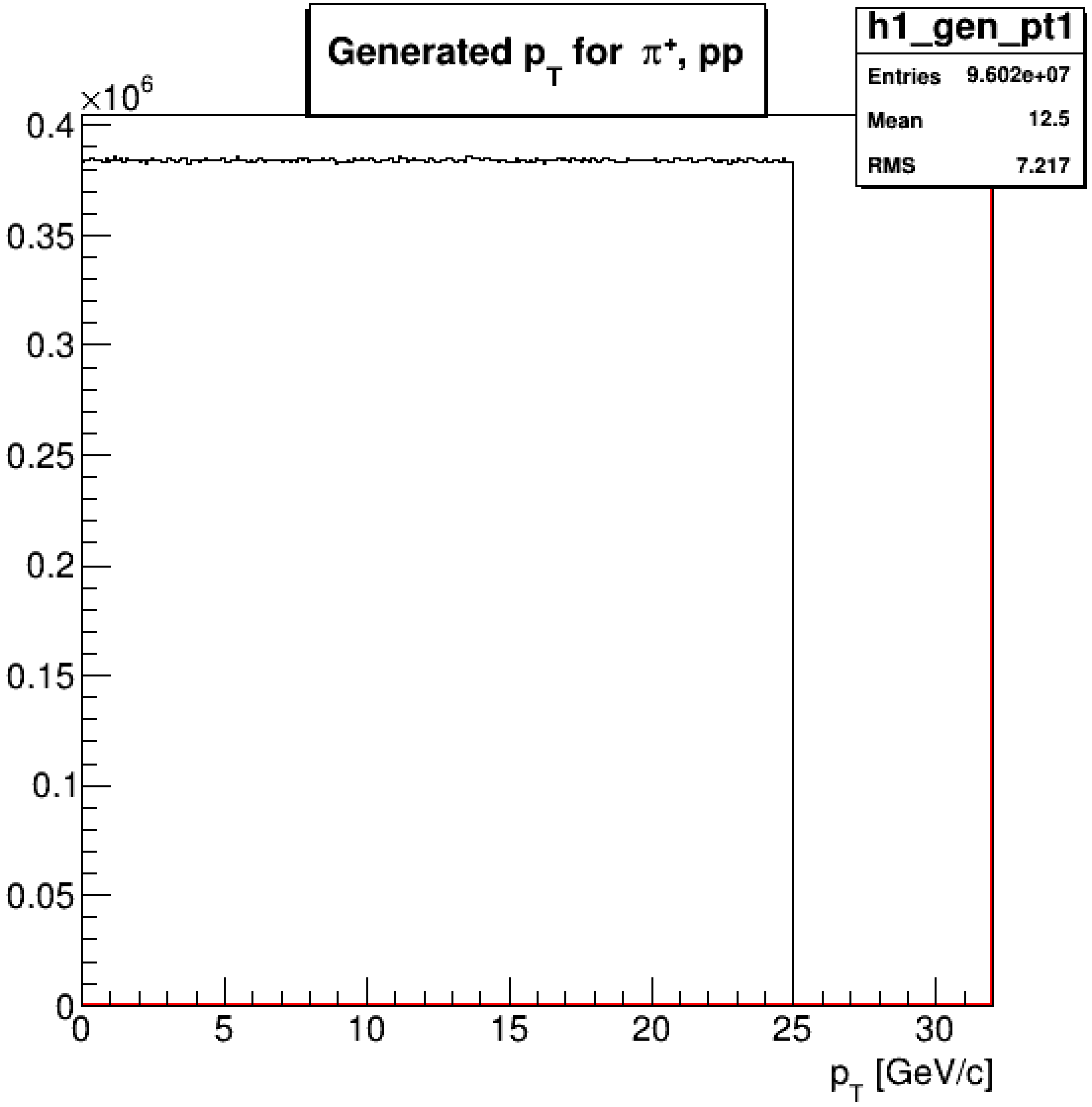


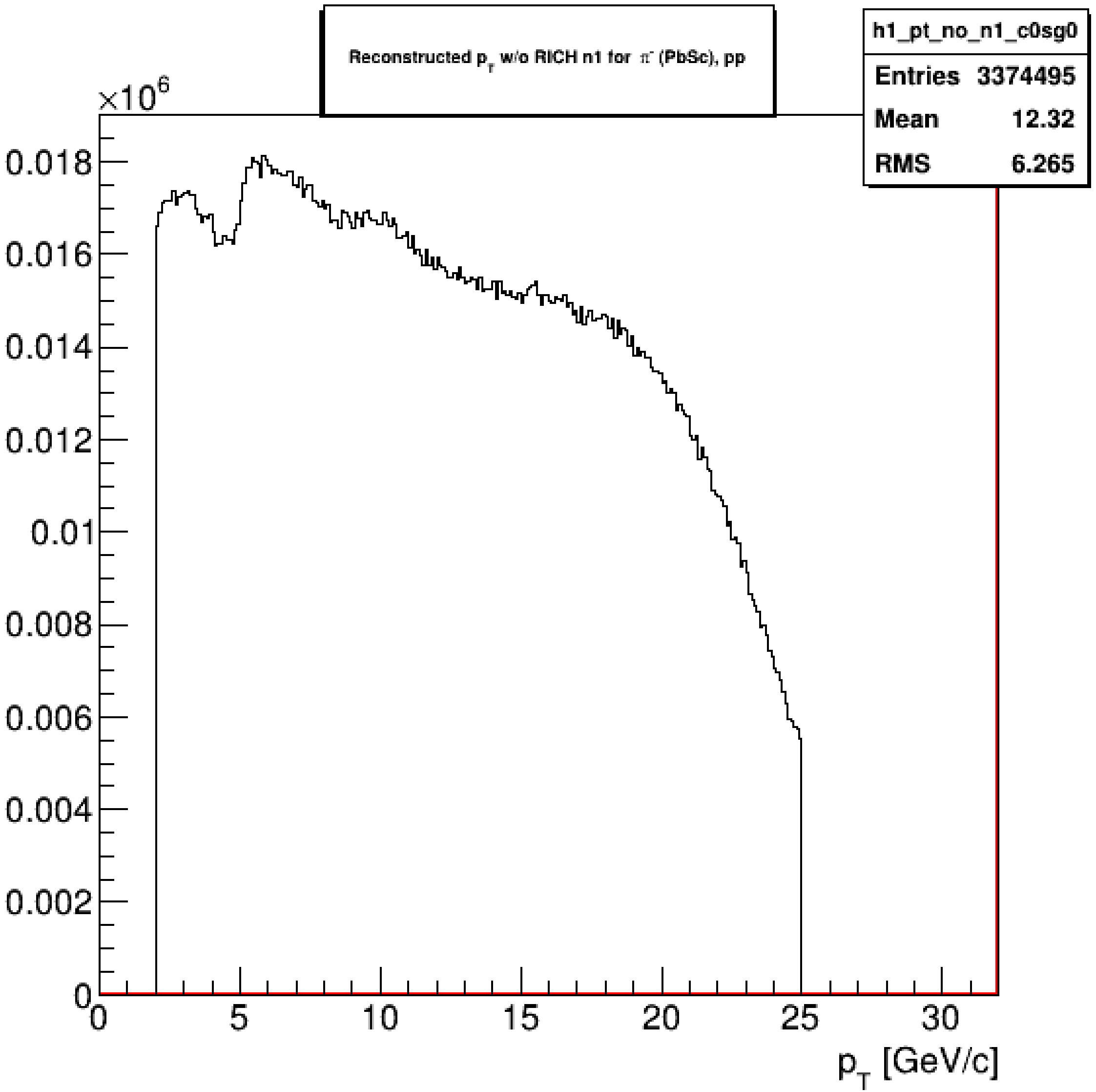
Cross section with pythia_200gev_yuehang.cfg : use RICH efficiency values from data without correction. (110 bins)



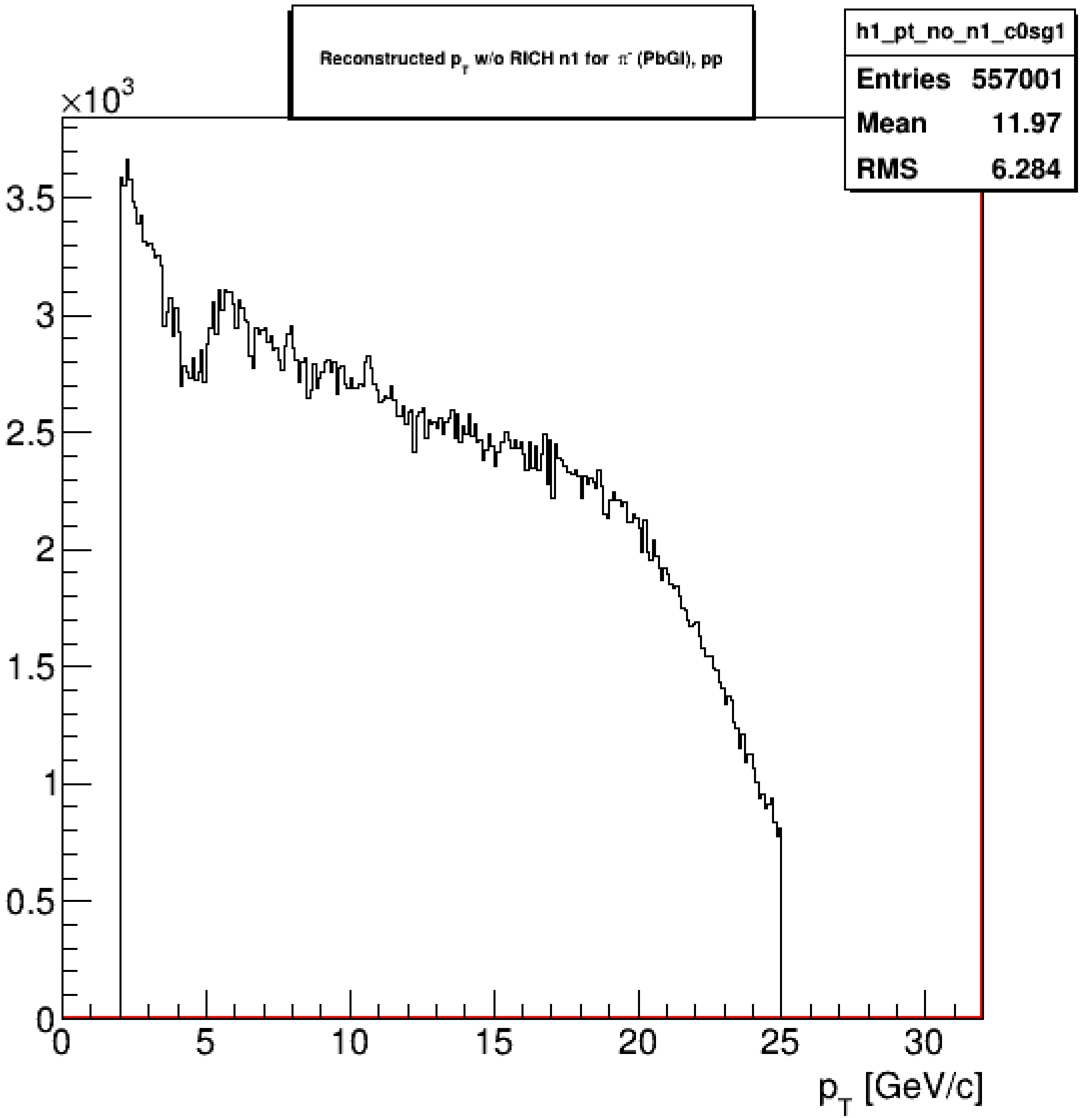
Overall, the value came out large at pt > 5.3 GeV/c


Generated p_T for π^+, pp
h1_gen_pt1
Entries 9.602e+07
Mean 12.5
RMS 7.217
$\times 10^6$
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
p_T [GeV/c]

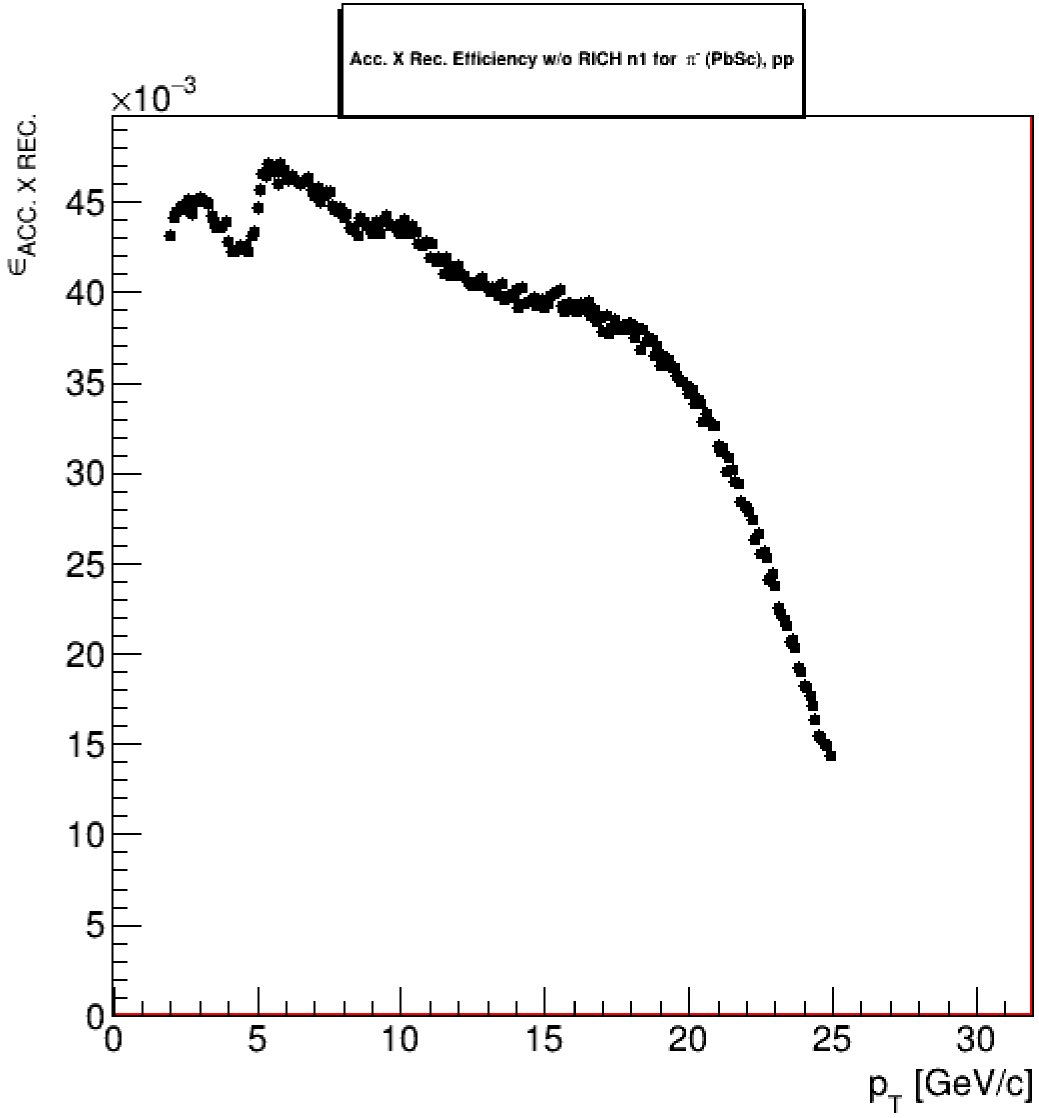

Generated p_T for π^+, pp
h1_gen_pt1
Entries 9.602e+07
Mean 12.5
RMS 7.217
$\times 10^6$
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
p_T [GeV/c]

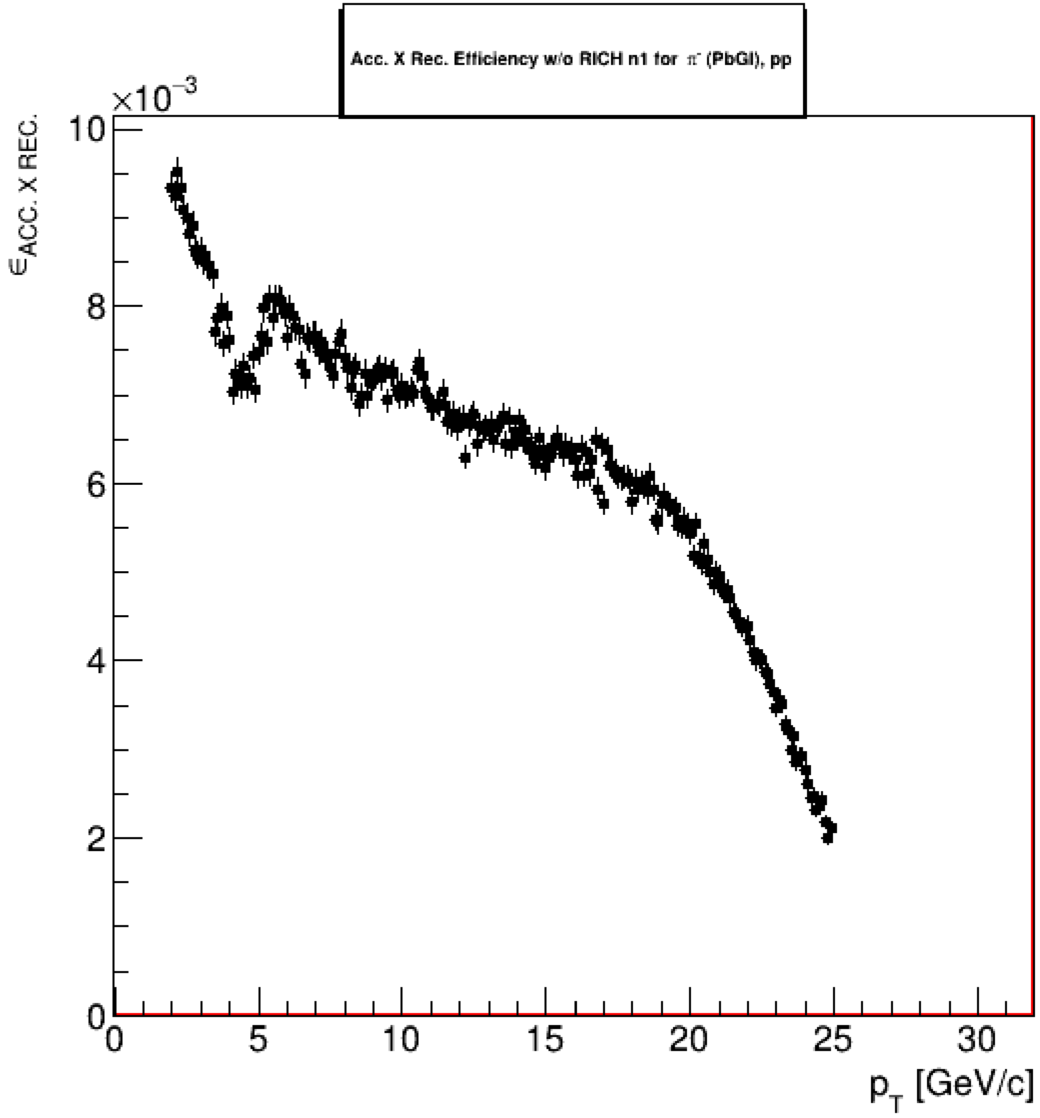


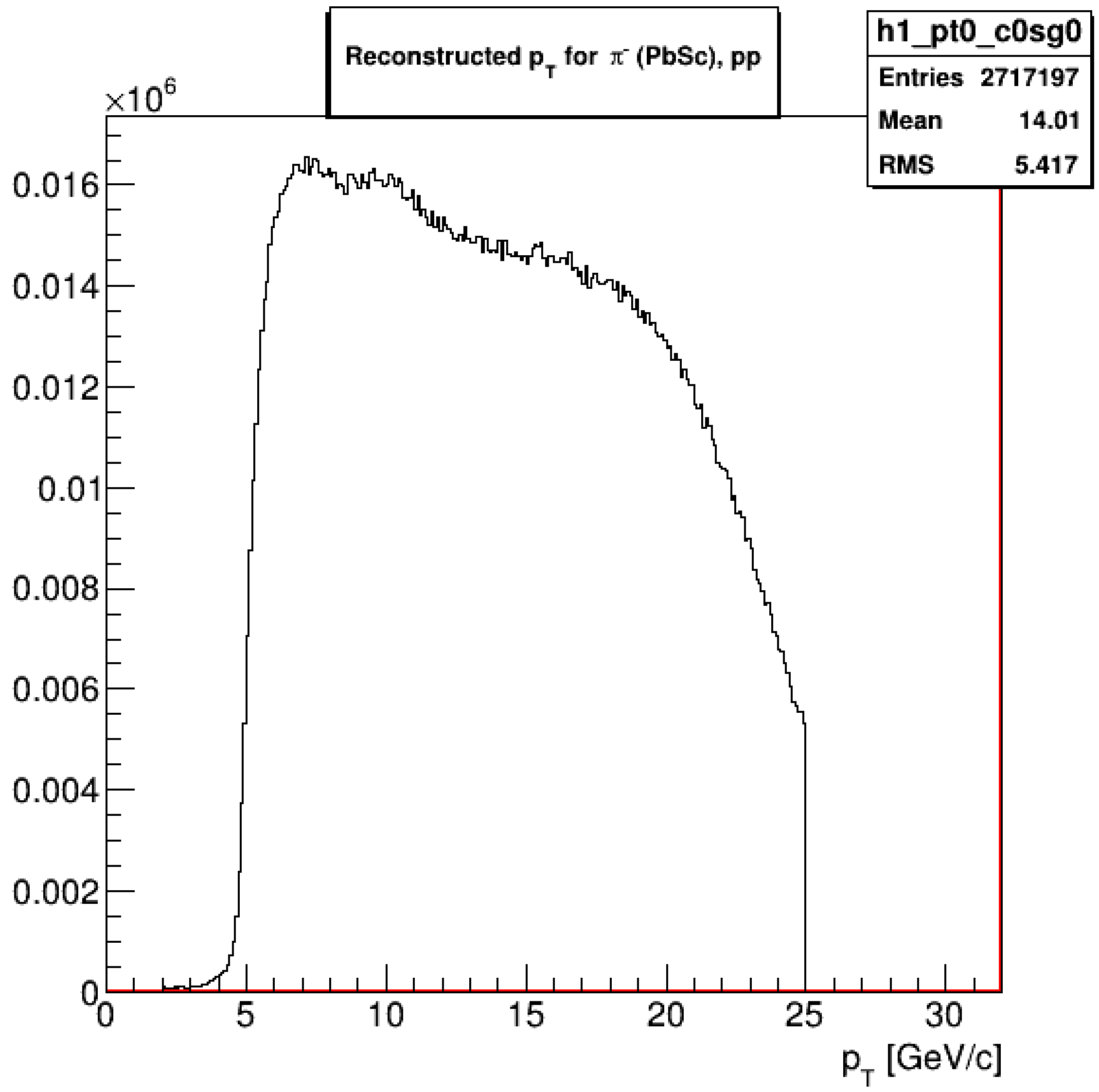
Reconstructed p_T w/o RICH n1 for π^- (PbSc), pp
h1_pt_no_n1_c0sg0
Entries 3374495
Mean 12.32
RMS 6.265
$\times10^6$
p_T [GeV/c]



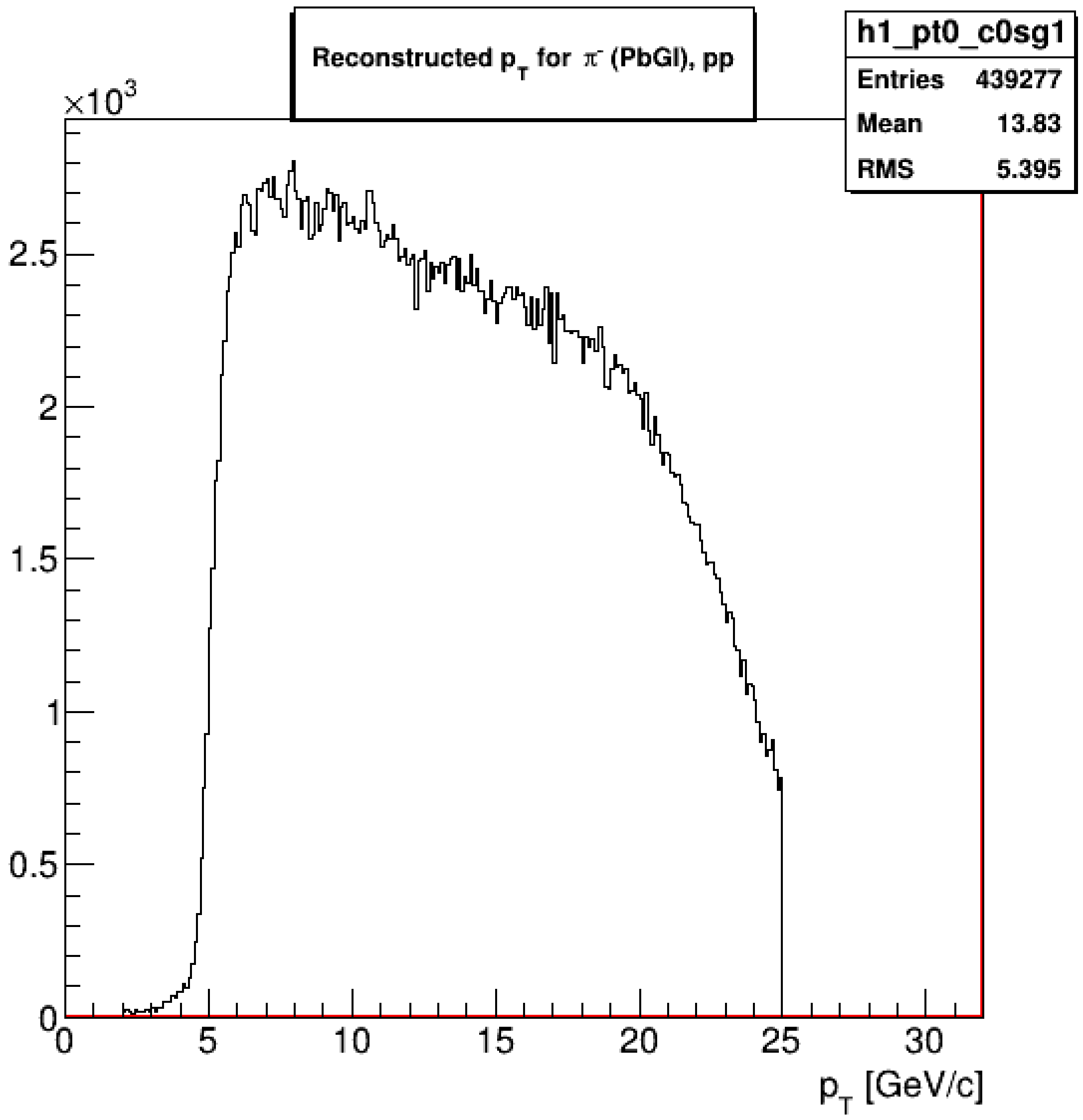
Reconstructed p_T w/o RICH n1 for π^- (PbGl), pp
h1_pt_no_n1_c0sg1
Entries 557001
Mean 11.97
RMS 6.284
$\times10^3$
p_T [GeV/c]


Acc. X Rec. Efficiency w/o RICH n1 for π^- (PbSc), pp
$\times10^{-3}$
$\epsilon_{ACC.\ X\ REC.}$
0
5
10
15
20
25
30
35
40
45
0
5
10
15
20
25
30
p_T [GeV/c]

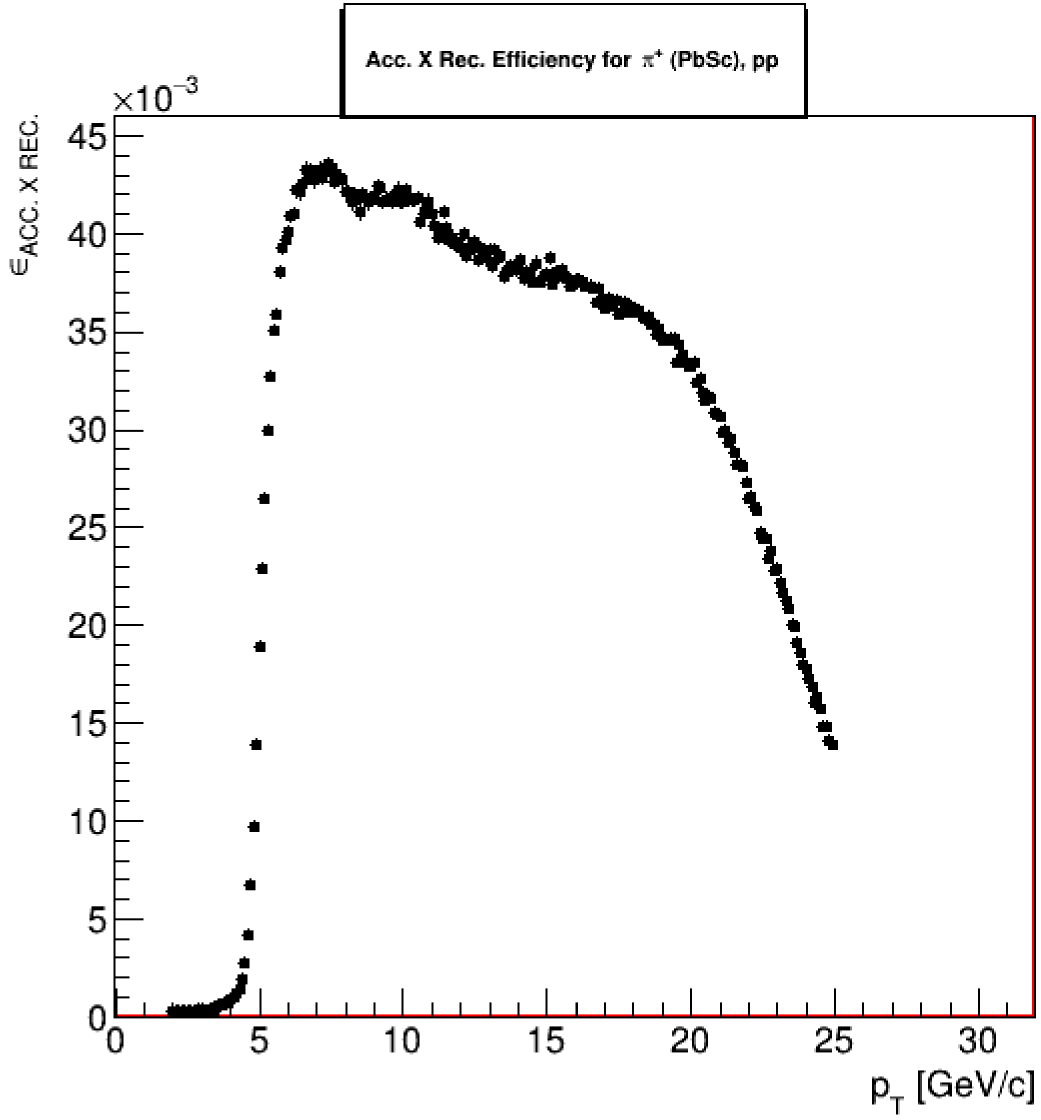

Acc. X Rec. Efficiency w/o RICH n1 for π^- (PbGl), pp
$\times10^{-3}$
$\epsilon_{ACC.\ X\ REC.}$
0
2
4
6
8
10
0
5
10
15
20
25
30
p_T [GeV/c]



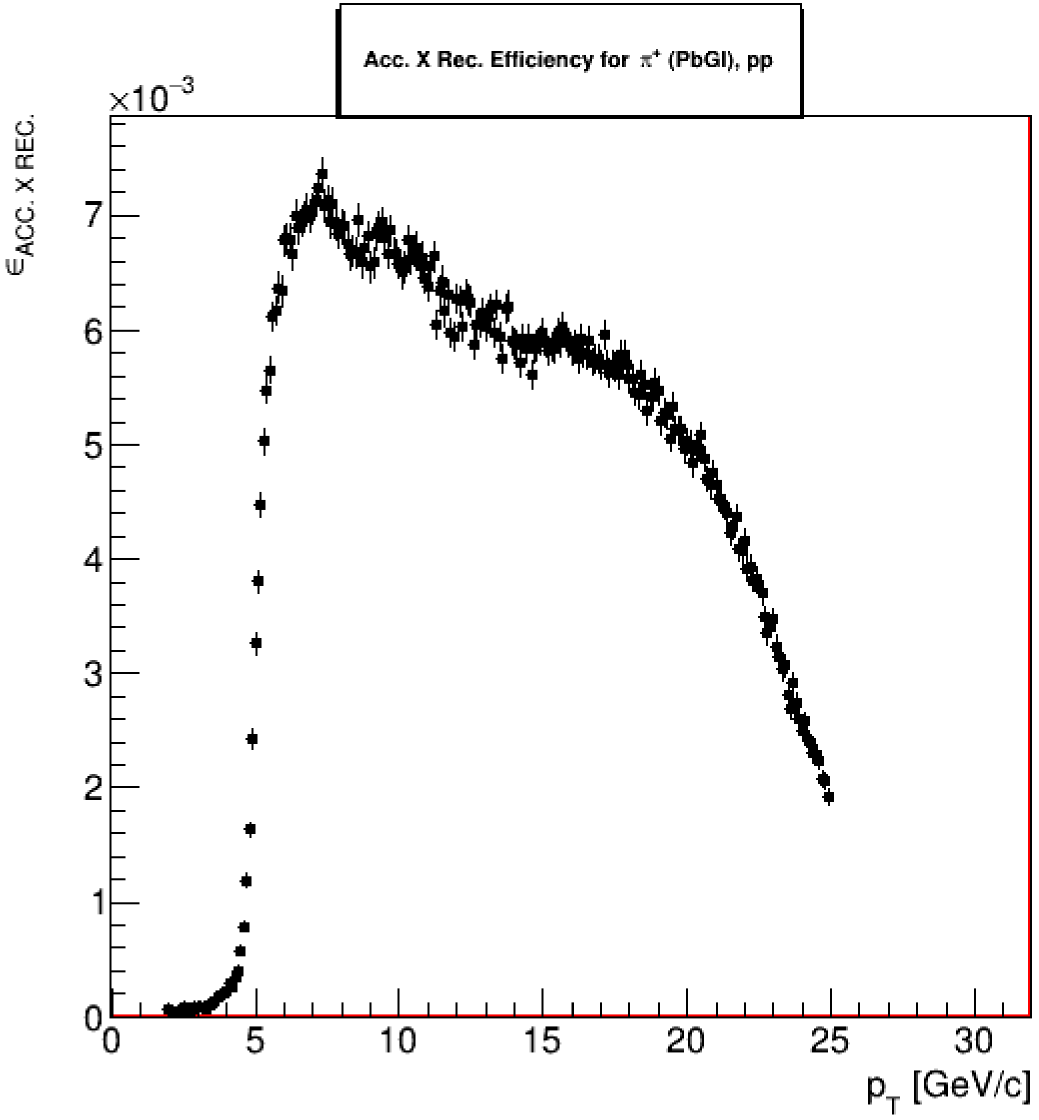
Reconstructed p_T for π^- (PbSc), pp
h1_pt0_c0sg0
Entries 2717197
Mean 14.01
RMS 5.417
$\times 10^6$
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0 5 10 15 20 25 30
p_T [GeV/c]



Reconstructed p_T for π^- (PbGl), pp
h1_pt0_c0sg1
Entries 439277
Mean 13.83
RMS 5.395
$\times 10^3$
2.5
2
1.5
1
0.5
0
0 5 10 15 20 25 30
p_T [GeV/c]

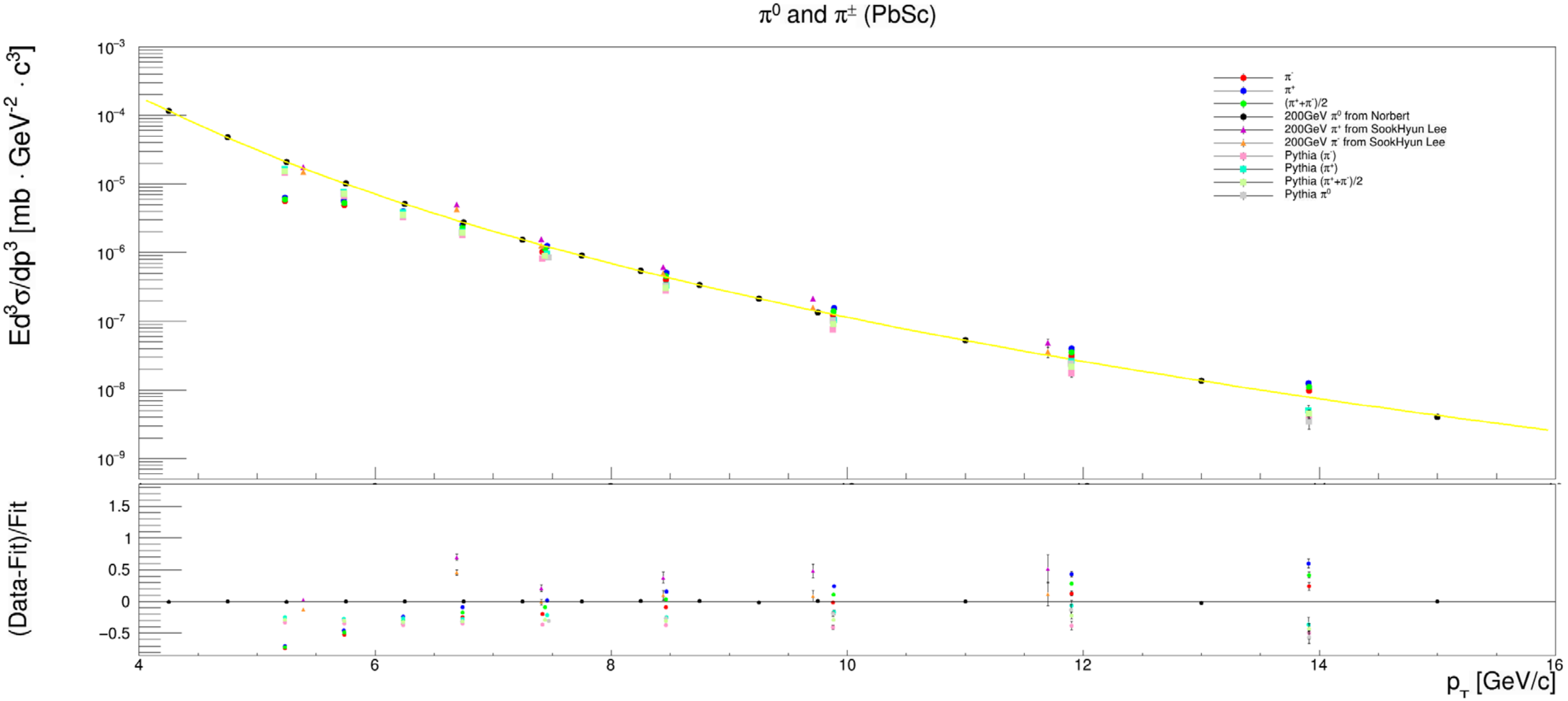


Acc. X Rec. Efficiency for π⁺ (PbSc), pp
×10⁻³
ε ACC. X REC.
0
5
10
15
20
25
30
35
40
45
0
5
10
15
20
25
30
p_T [GeV/c]

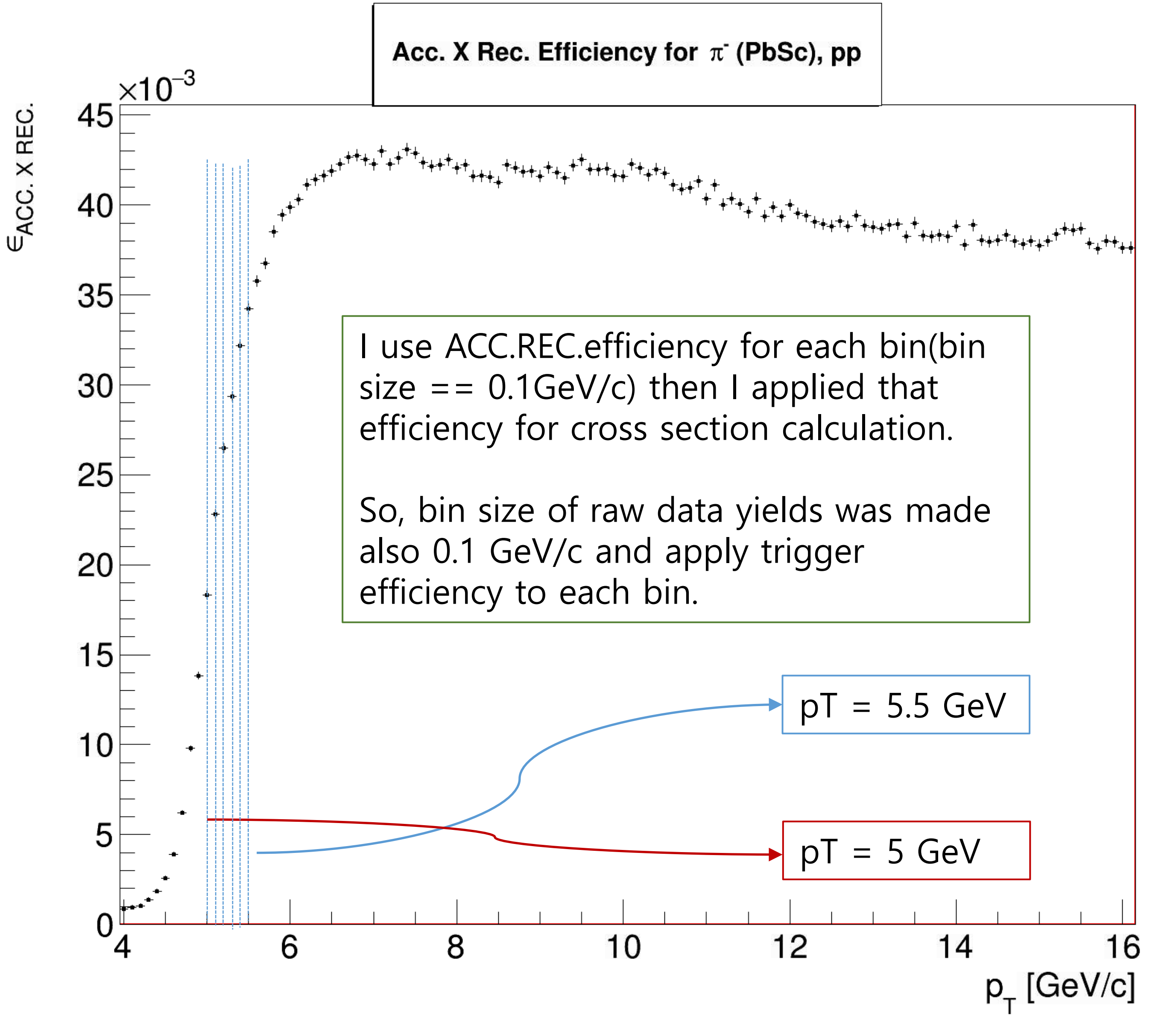


Acc. X Rec. Efficiency for π⁺ (PbGl), pp
×10⁻³
ε ACC. X REC.
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30
p_T [GeV/c]

Cross section with pythia_200gev_yuehang.cfg
: use Acc.Rec. efficiency (mean_pT) values. (9 bins)



Change applied Acc.Rec. efficiency by move mean pT for cross section systematic uncertainty



I use ACC.REC.efficiency for each bin(bin size == 0.1GeV/c) then I applied that efficiency for cross section calculation.

So, bin size of raw data yields was made also 0.1 GeV/c and apply trigger efficiency to each bin.

9 bins

pt_low	pt_high
5	5.5
5.5	6
6	6.5
6.5	7
7	8
8	9
9	11
11	13
13	15

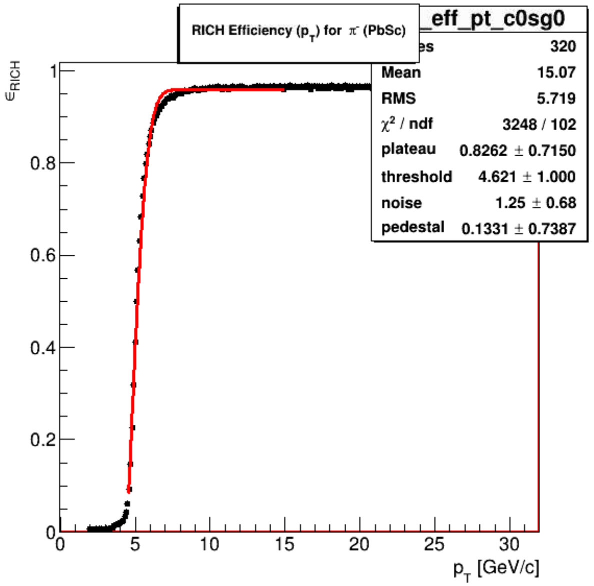
110 bins

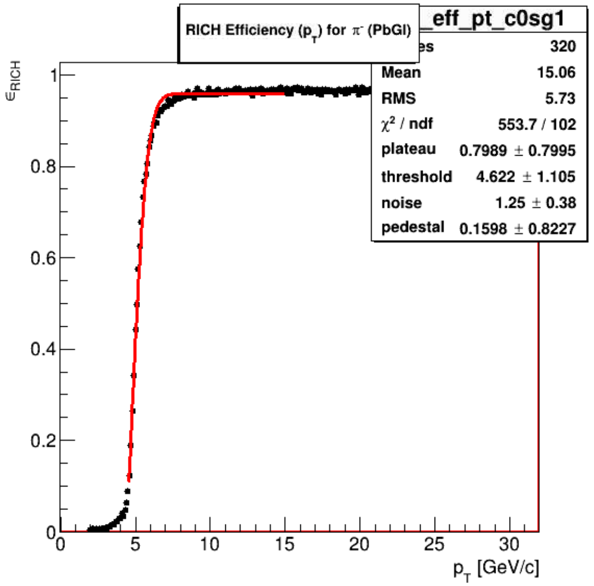
pt_low	pt_high
4.5	4.6
4.6	4.7
4.7	4.8
4.8	4.9
4.9	5
5	5.1
5.1	5.2
5.2	5.3
5.3	5.4
5.4	5.5
5.5	5.6
5.6	5.7
5.7	5.8
5.8	5.9
5.9	6
6	6.1
6.1	6.2
6.2	6.3
6.3	6.4
6.4	6.5
6.5	6.6
6.6	6.7
6.7	6.8
6.8	6.9
6.9	7
7	7.1
7.1	7.2
7.2	7.3
7.3	7.4
7.4	7.5
7.5	7.6
7.6	7.7
7.7	7.8
7.8	7.9
7.9	8

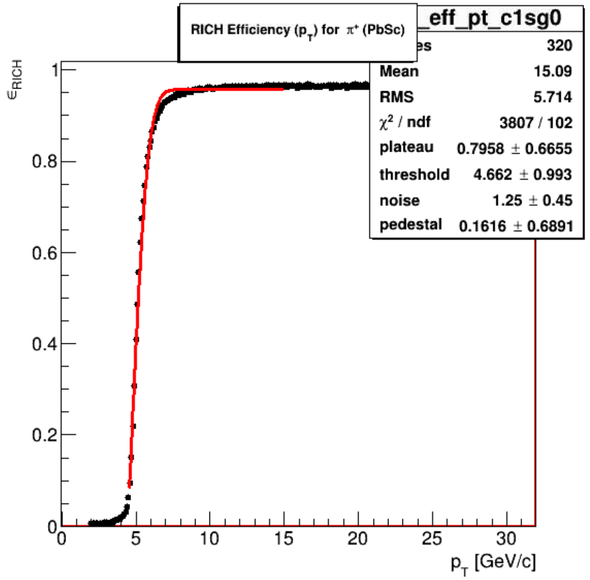
8	8.1
8.1	8.2
8.2	8.3
8.3	8.4
8.4	8.5
8.5	8.6
8.6	8.7
8.7	8.8
8.8	8.9
8.9	9
9	9.1
9.1	9.2
9.2	9.3
9.3	9.4
9.4	9.5
9.5	9.6
9.6	9.7
9.7	9.8
9.8	9.9
9.9	10
10	10.1
10.1	10.2
10.2	10.3
10.3	10.4
10.4	10.5
10.5	10.6
10.6	10.7
10.7	10.8
10.8	10.9
10.9	11
11	11.1
11.1	11.2
11.2	11.3
11.3	11.4
11.4	11.5
11.5	11.6
11.6	11.7
11.7	11.8
11.8	11.9
11.9	12

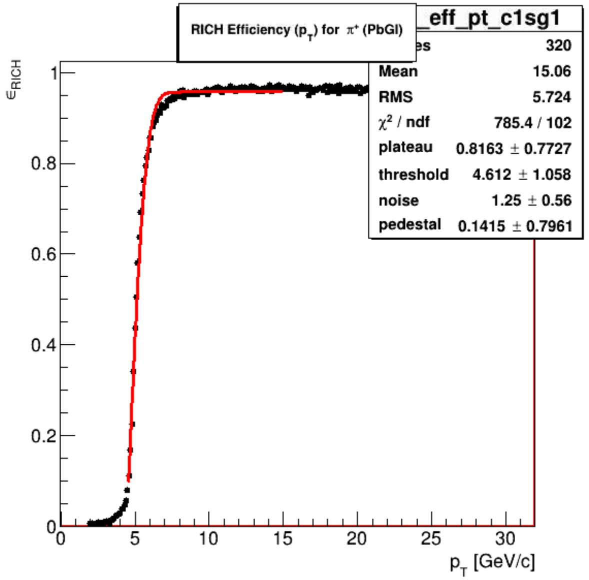
12	12.1
12.1	12.2
12.2	12.3
12.3	12.4
12.4	12.5
12.5	12.6
12.6	12.7
12.7	12.8
12.8	12.9
12.9	13
13	13.1
13.1	13.2
13.2	13.3
13.3	13.4
13.4	13.5
13.5	13.6
13.6	13.7
13.7	13.8
13.8	13.9
13.9	14
14	14.1
14.1	14.2
14.2	14.3
14.3	14.4
14.4	14.5
14.5	14.6
14.6	14.7
14.7	14.8
14.8	14.9
14.9	15
15	15.1
15.1	15.2
15.2	15.3
15.3	15.4
15.4	15.5

RICH efficiency values from simulation(Single particle generator). (original method)

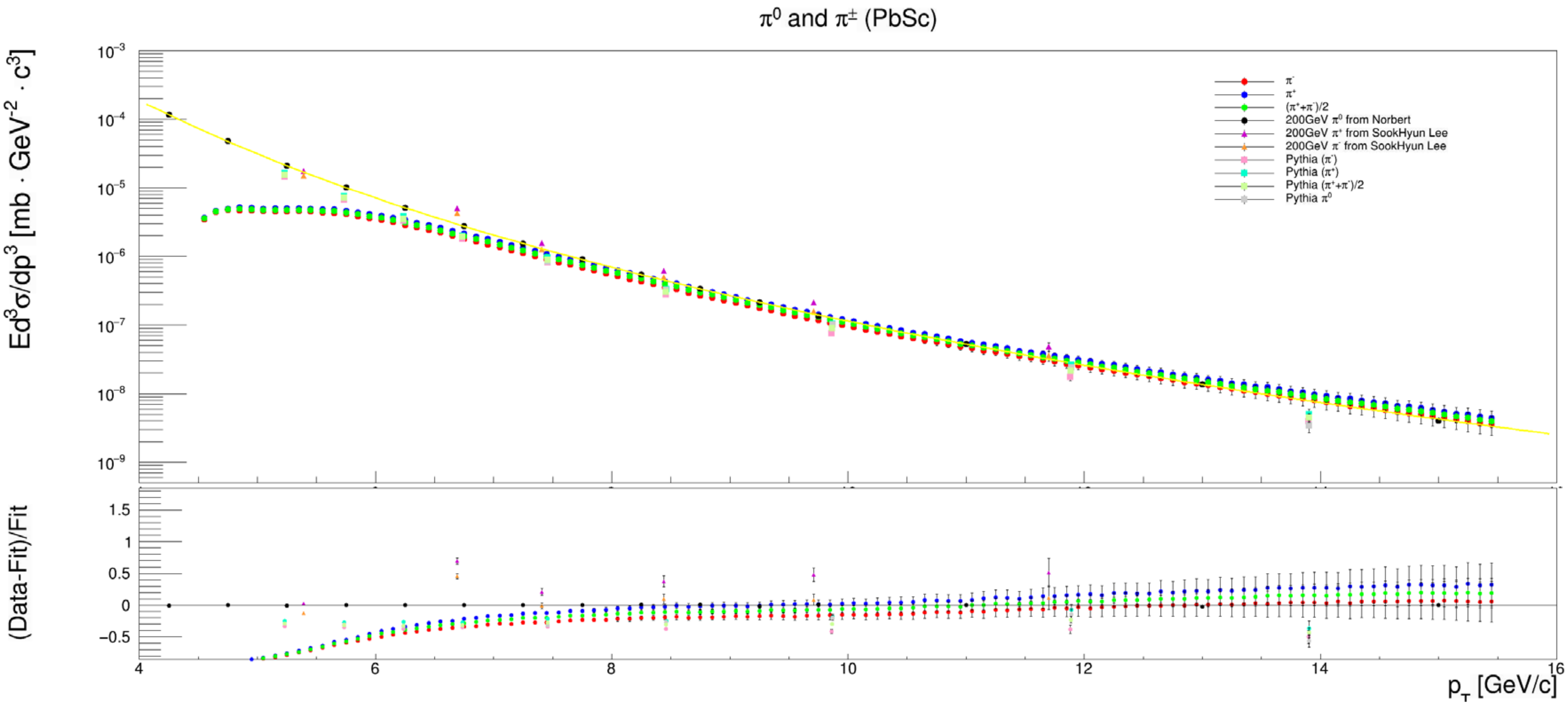




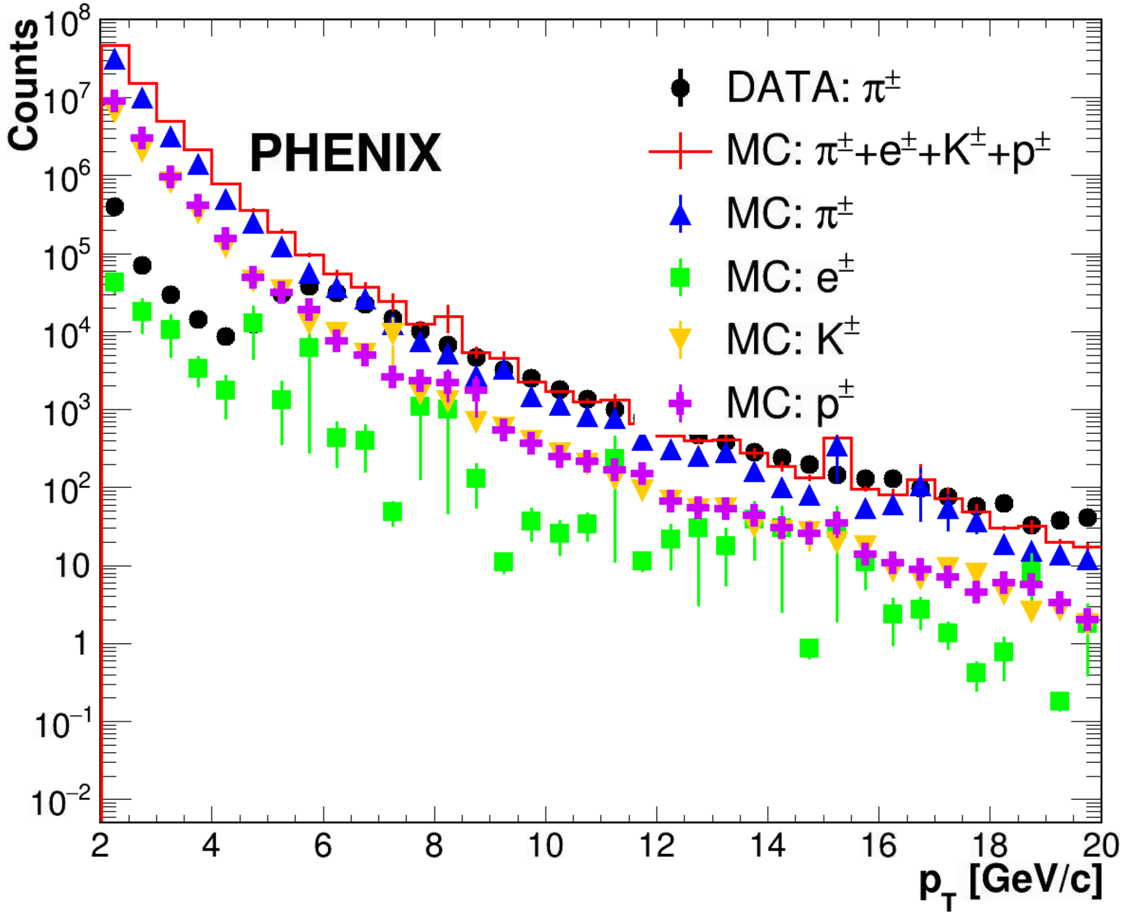




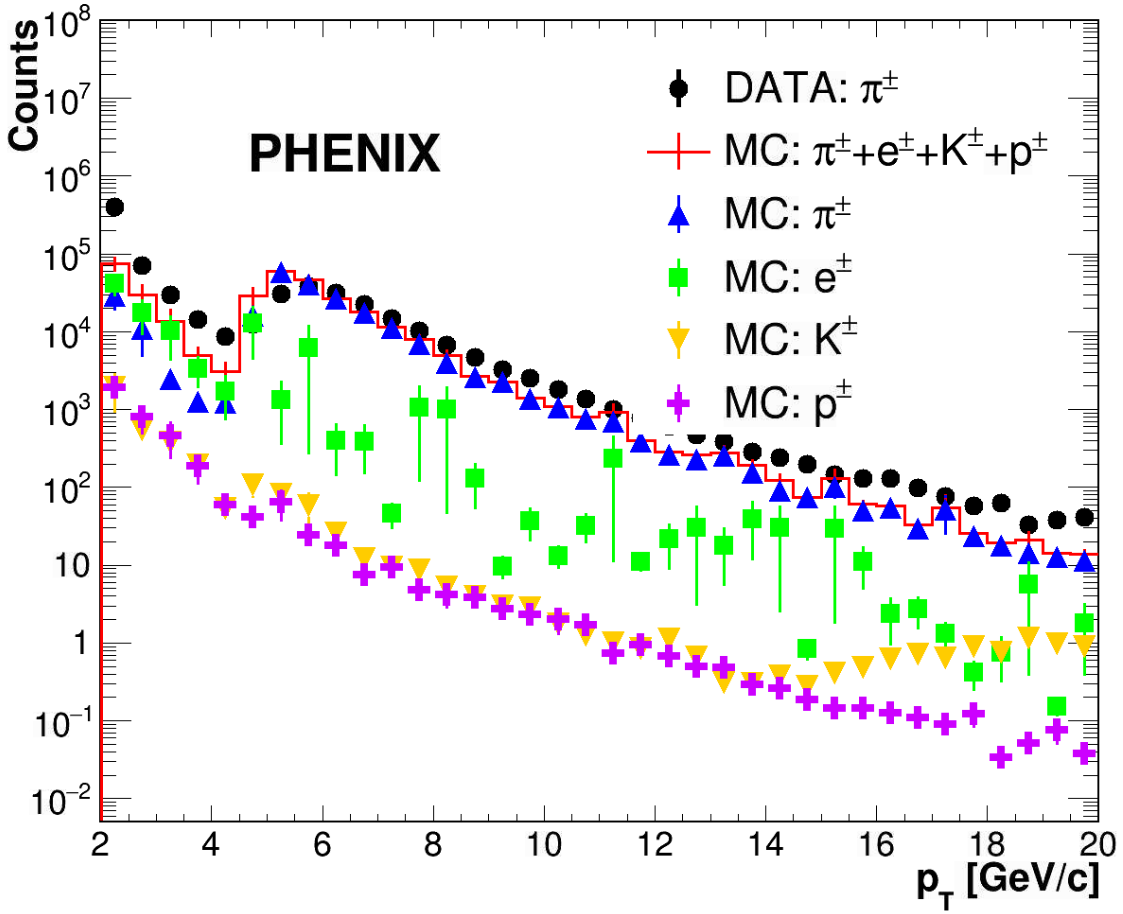
Cross section with pythia_200gev_yuehang.cfg : use RICH efficiency values from simulation(Single particle generator). (original method)



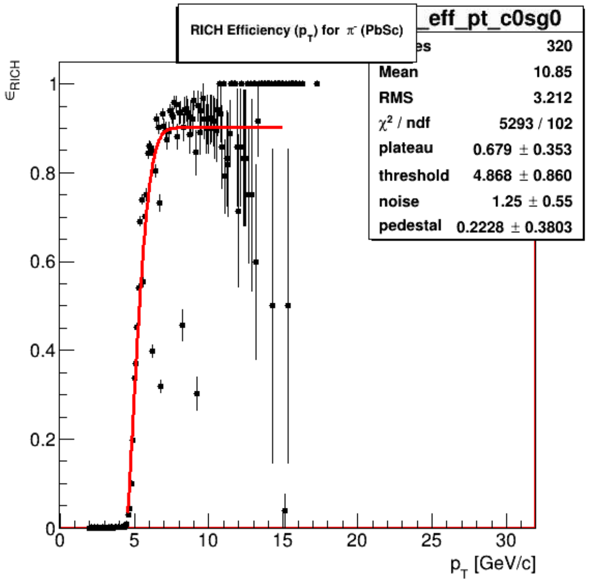
Without n1 cut from and Pythia

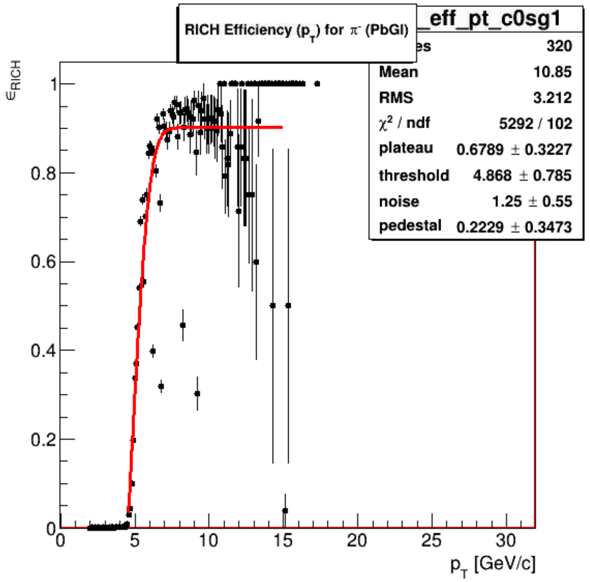


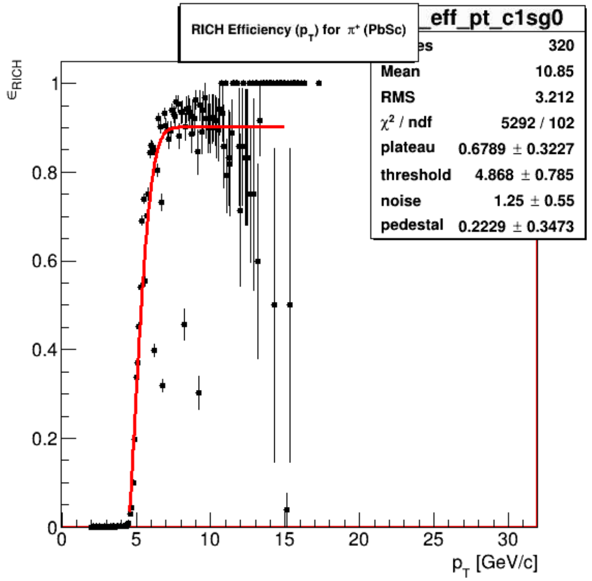
With n1 cut from data and Pythia

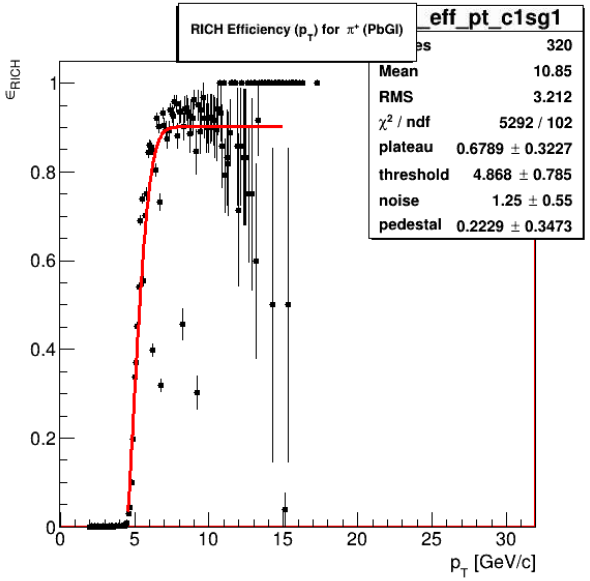


RICH efficiency values from Pythia simulation. (110 bins)

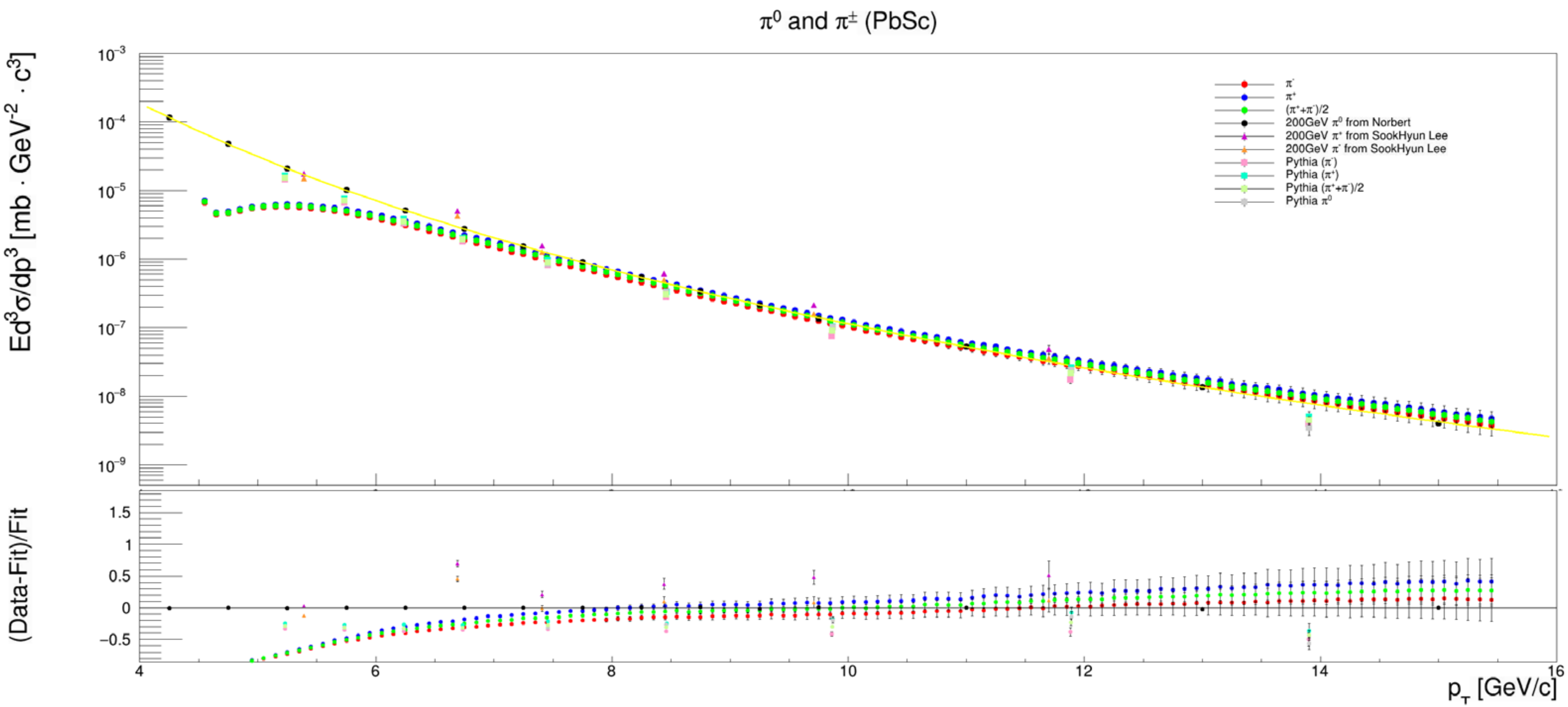






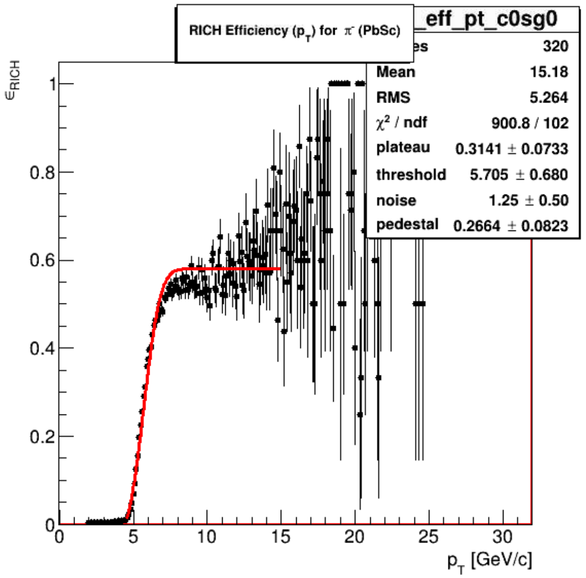


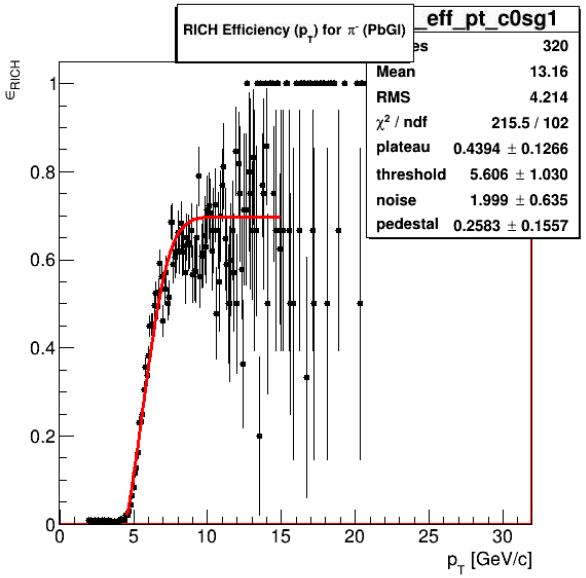
Cross section with pythia_200gev_yuehang.cfg
: use RICH efficiency values from Pythia simulation.(110 bins)

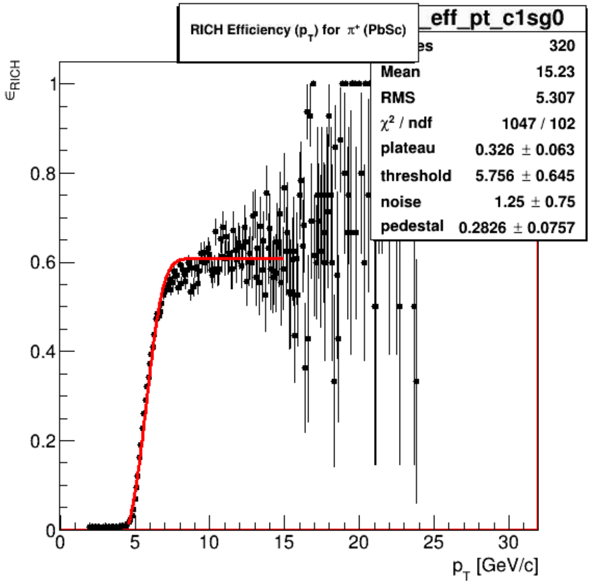


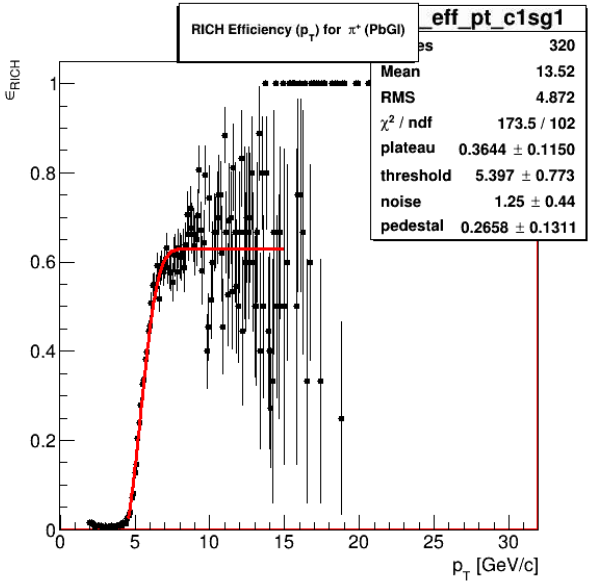
Overall, the value came out similar with single particle generator results.

RICH efficiency values from data without correction. (110 bins)

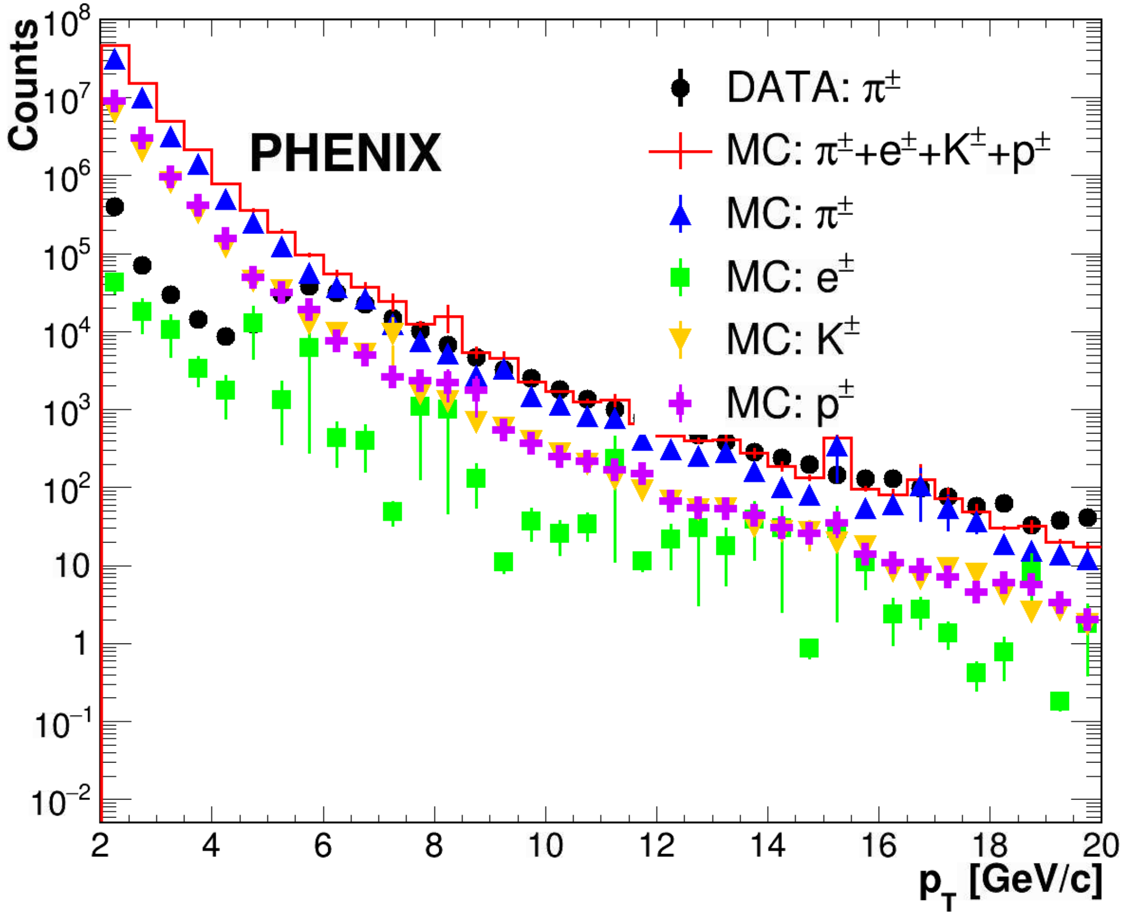




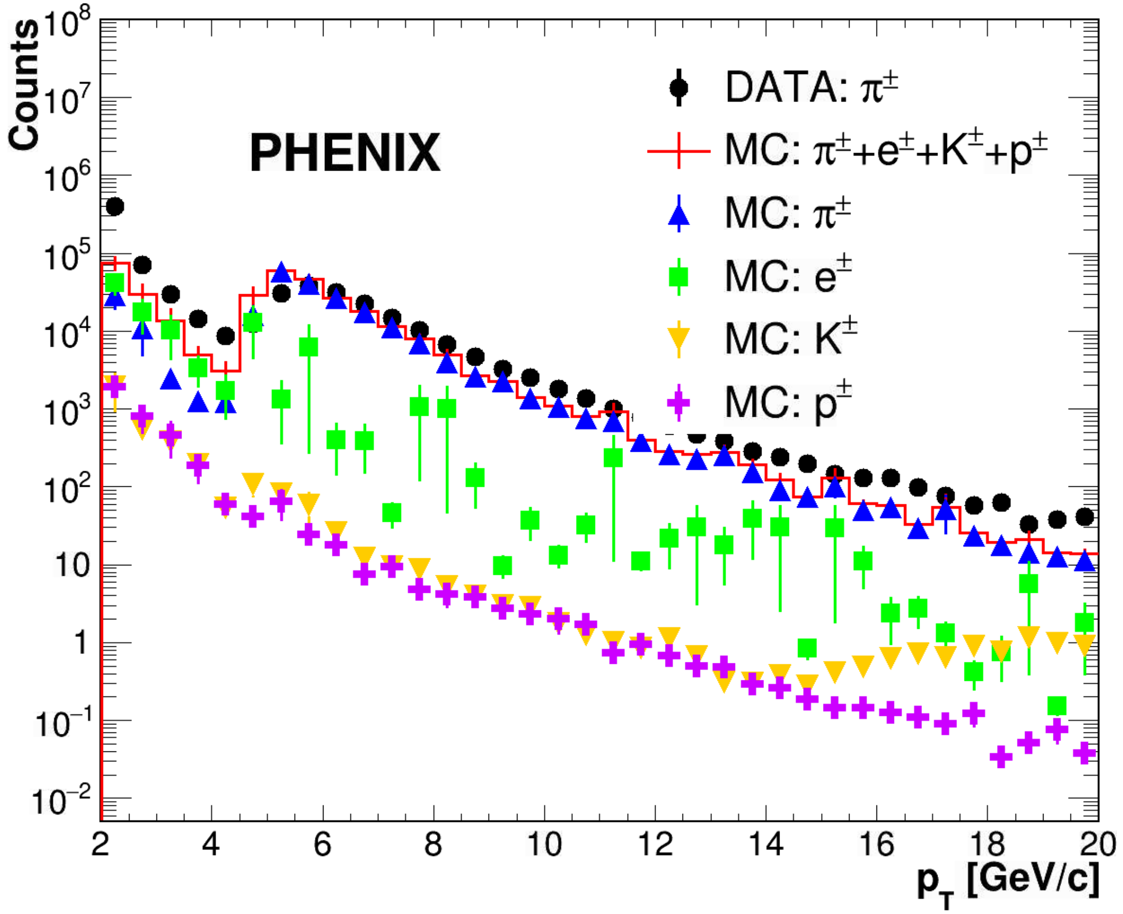




Without n1 cut from and Pythia



With n1 cut from data and Pythia



Rejection power

- $$\varepsilon_{data}^{RICH_{n1}>0} = \frac{\left(N_{\pi^\pm} + N_{e^\pm} + \cancel{N_{K^\pm}} + \cancel{N_{p^\pm}}\right)_{w/\,n1\,cut}}{\left(N_{\pi^\pm} + N_{e^\pm} + N_{K^\pm} + N_{p^\pm}\right)_{w/o\,n1\,cut}} \simeq \frac{\left(N_{\pi^\pm} + N_{e^\pm}\right)_{w/\,n1\,cut}}{\left(N_{\pi^\pm} + N_{e^\pm} + N_{K^\pm} + N_{p^\pm}\right)_{w/o\,n1\,cut}}$$

  ($N_{K^\pm} \approx 0$, $N_{p^\pm} \approx 0$)

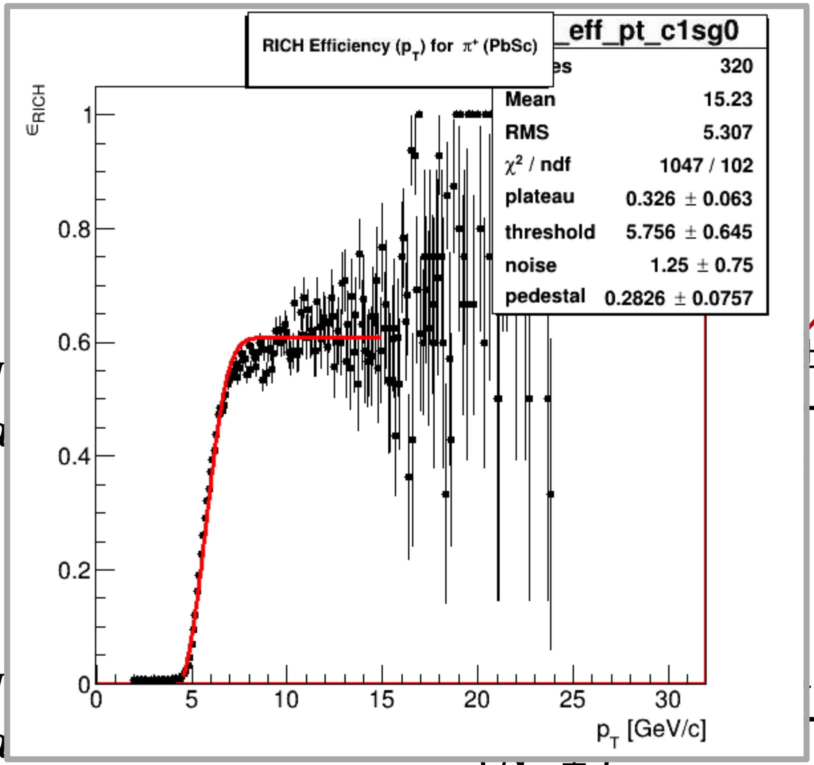
- $$\varepsilon_{data}^{RICH_{n1}>0} for\ \pi^\pm = \frac{\left(N_{\pi^\pm}\right)_{w/\,n1\,cut}}{\left(N_{\pi^\pm}\right)_{w/o\,n1\,cut}}$$

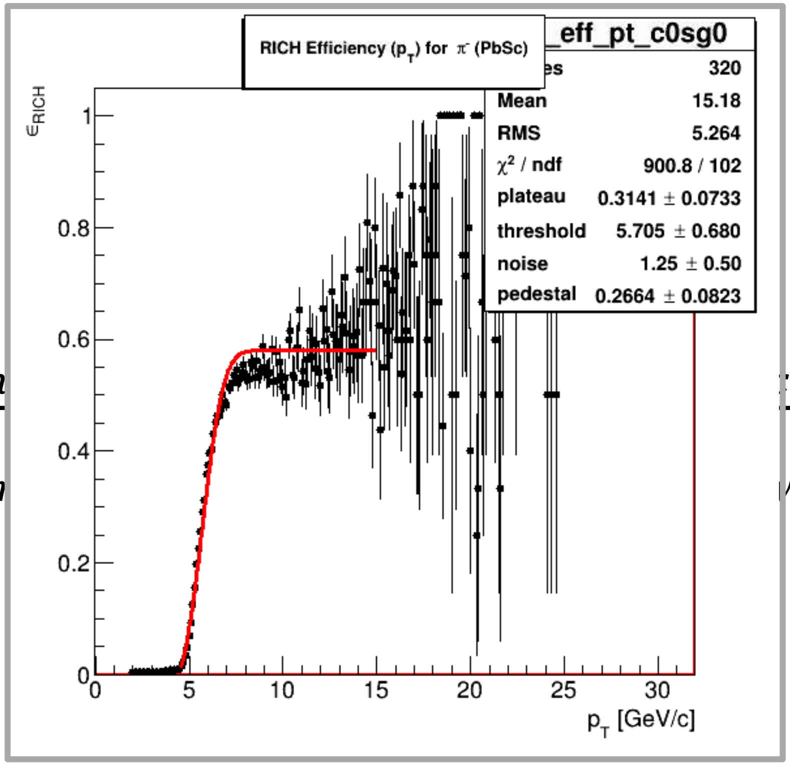
$$\simeq \frac{\left(N_{\pi^\pm} + N_{e^\pm}\right)_{w/\,n1\,cut}}{\left(N_{\pi^\pm} + N_{e^\pm} + N_{K^\pm} + N_{p^\pm}\right)_{w/o\,n1\,cut}} \times \left(\frac{N_{\pi^\pm} + N_{e^\pm} + N_{K^\pm} + N_{p^\pm}}{N_{\pi^\pm}}\right)_{w/o\,n1\,cut} \times \left(\frac{N_{\pi^\pm}}{N_{\pi^\pm} + N_{e^\pm}}\right)_{w/\,n1\,cut}$$

From Data

From M.C.

Rejection power





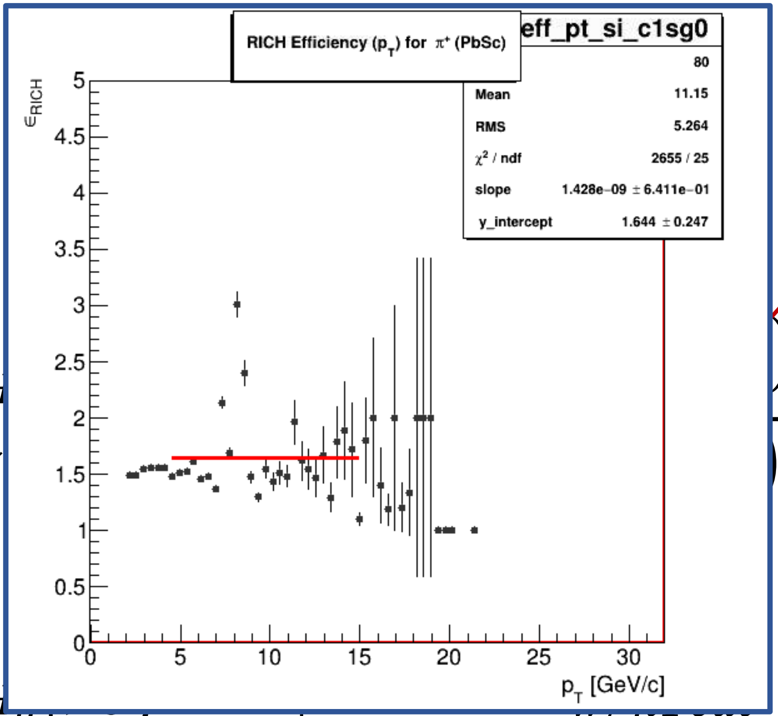
- ε_{da}^{RI} … $)_{w/\,n}$ … $)_{w/o\,n}$ … ≈ 0 … ut … $w/o\,n1\,cut$
- ε_{da}^{RI} … $(N_{\pi^\pm})_{w/o\,n1\,cut}$

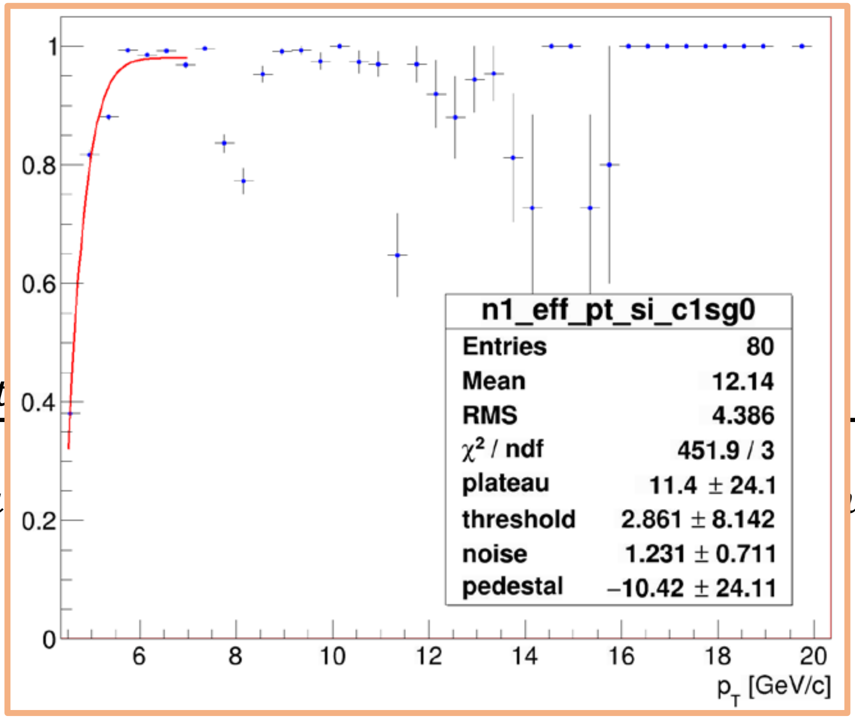
$$\simeq \frac{(N_{\pi^\pm} + N_{e^\pm})_{w/\,n1\,cut}}{(N_{\pi^\pm} + N_{e^\pm} + N_{K^\pm} + N_{p^\pm})_{w/o\,n1\,cut}} \times \left(\frac{N_{\pi^\pm} + N_{e^\pm} + N_{K^\pm} + N_{p^\pm}}{N_{\pi^\pm}}\right)_{w/o\,n1\,cut} \times \left(\frac{N_{\pi^\pm}}{N_{\pi^\pm} + N_{e^\pm}}\right)_{w/\,n1\,cut}$$

From Data

From M.C.

Rejection power





- $\varepsilon_{data}^{RICH}$ … ≈ 0 … $)_{w/\,n1\,cut}$ … $)_{w/o\,n1\,cut}$

- $\varepsilon_{data}^{RICH\,n1}\ for\ \pi^{\pm} = \frac{(\ldots)_{w/\,n1\,cut}}{(N_{\pi^{\pm}})_{w/o\,n1\,cut}}$

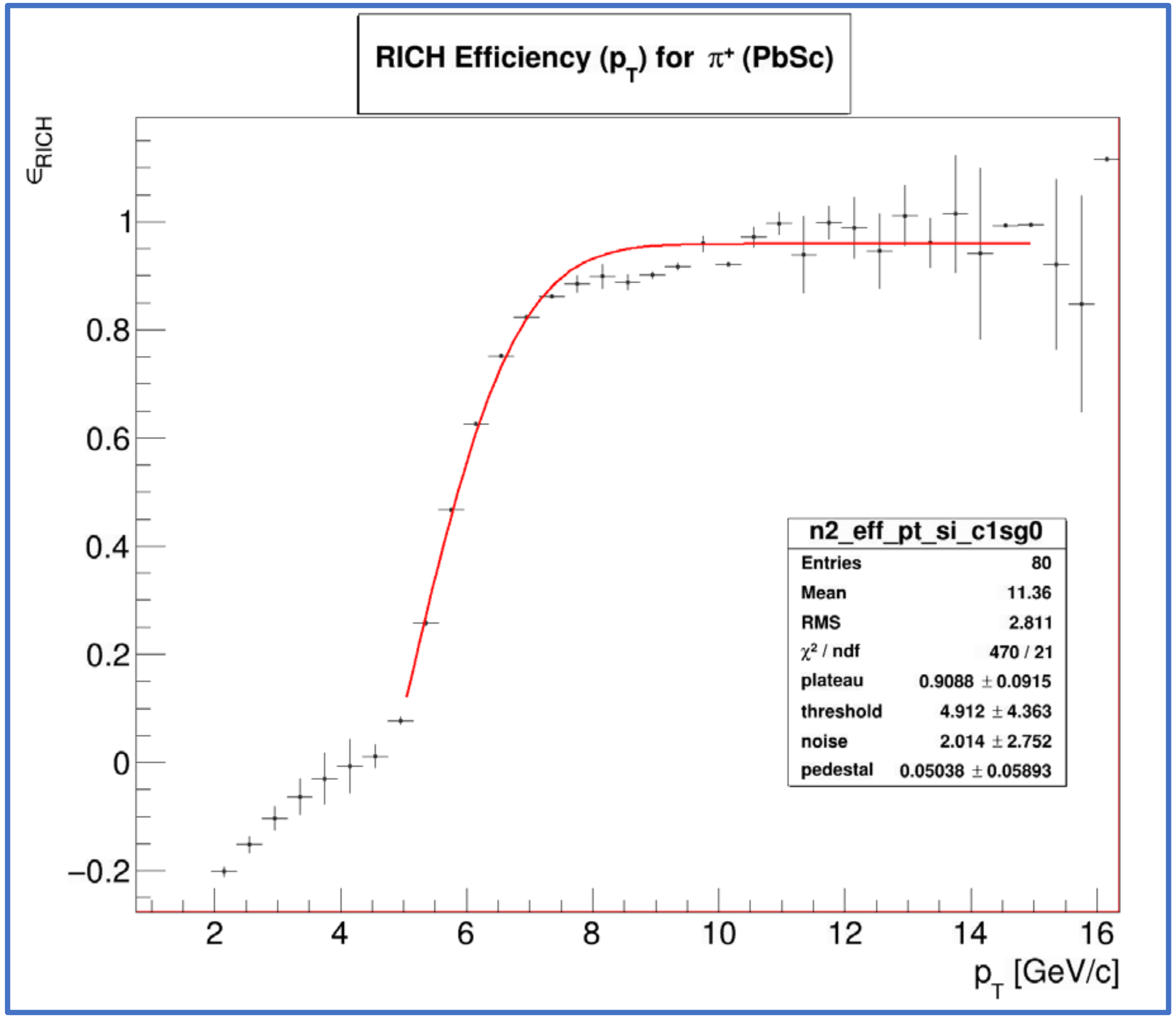
$$\simeq \frac{(N_{\pi^{\pm}} + N_{e^{\pm}})_{w/\,n1\,cut}}{(N_{\pi^{\pm}} + N_{e^{\pm}} + N_{K^{\pm}} + N_{p^{\pm}})_{w/o\,n1\,cut}} \times \left(\frac{N_{\pi^{\pm}} + N_{e^{\pm}} + N_{K^{\pm}} + N_{p^{\pm}}}{N_{\pi^{\pm}}}\right)_{w/o\,n1\,cut} \times \left(\frac{N_{\pi^{\pm}}}{N_{\pi^{\pm}} + N_{e^{\pm}}}\right)_{w/\,n1\,cut}$$

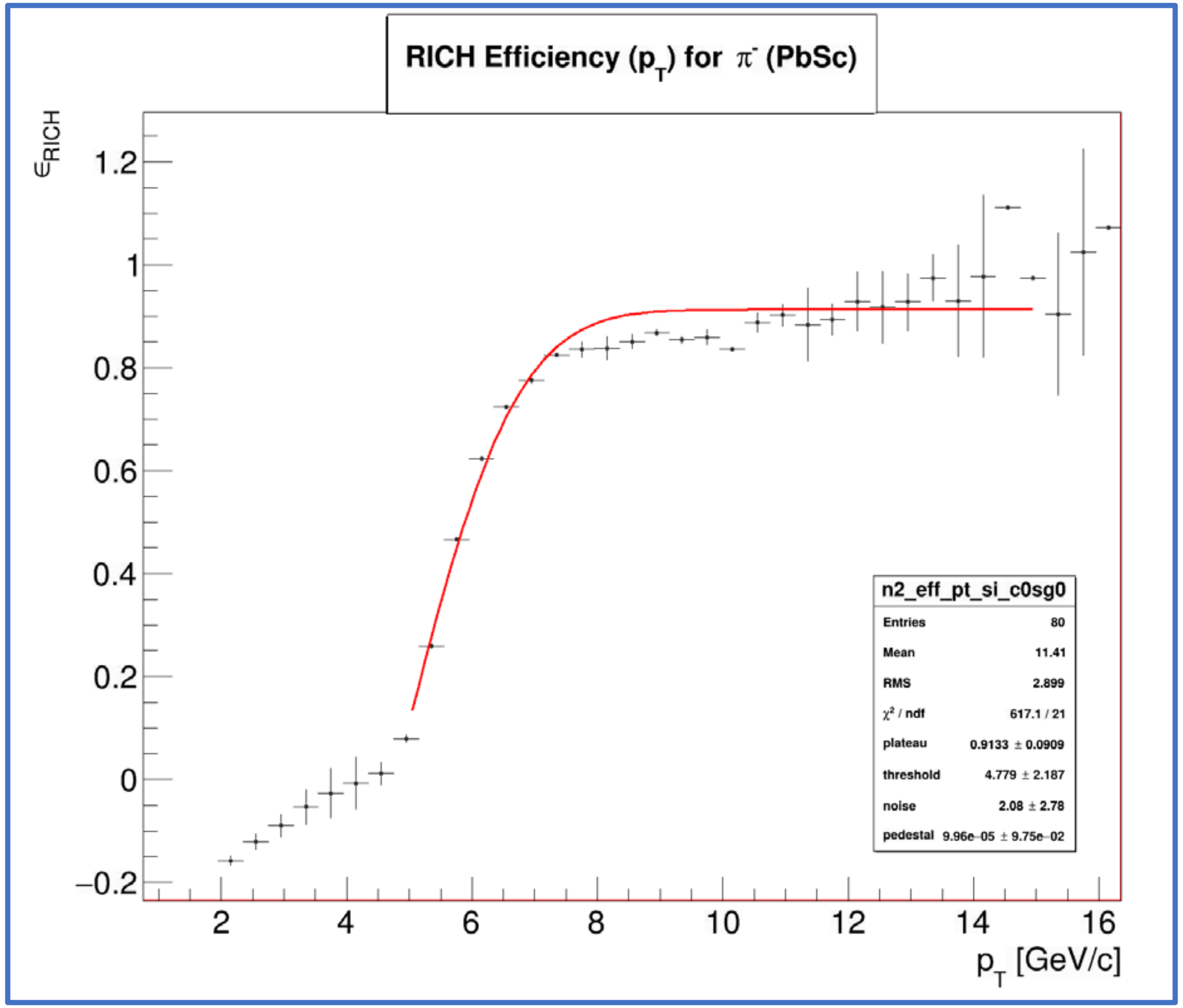
From Data

From M.C.

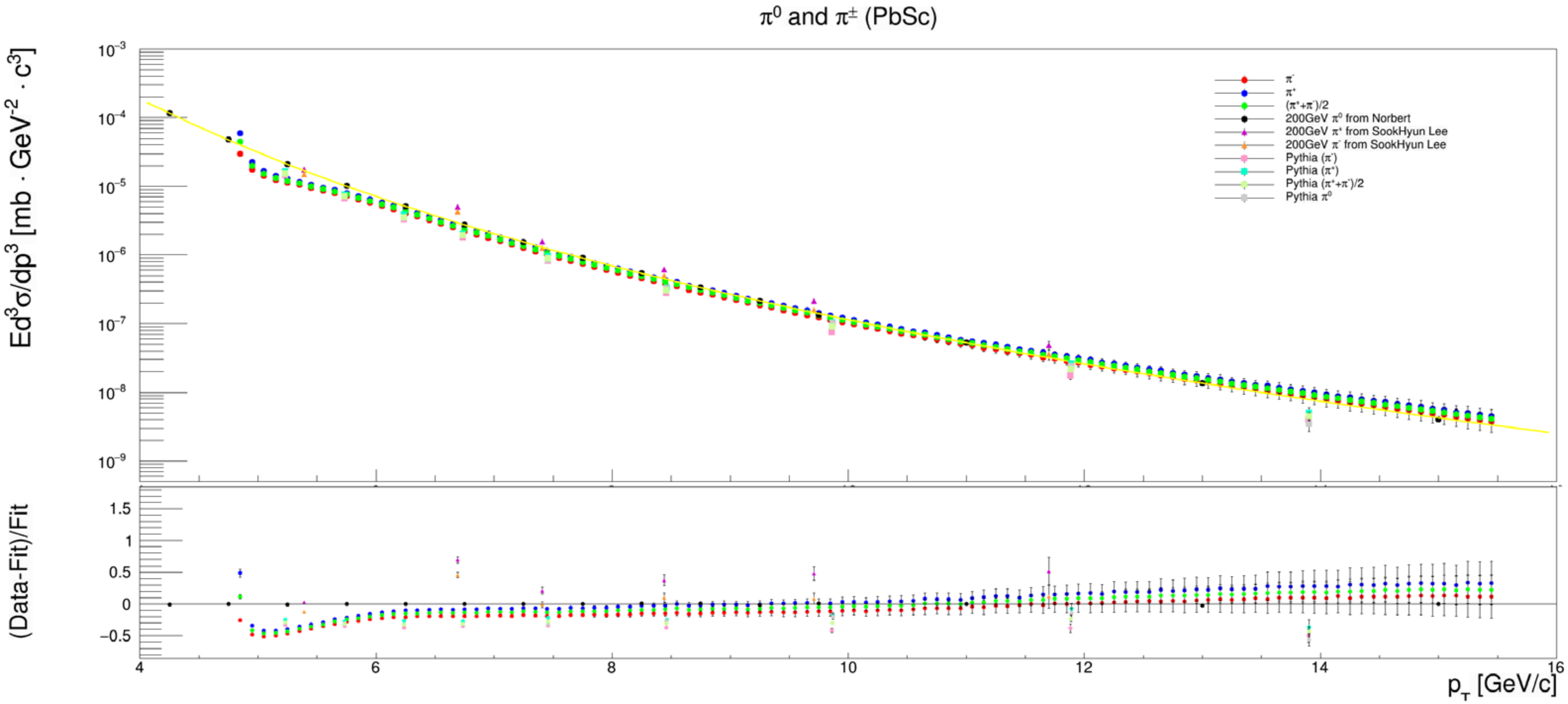
- $\varepsilon_{data}^{RICH_{n1}>0} \; for \; \pi^{\pm} = \frac{\left(N_{\pi^{\pm}}\right)_{w/\,n1\,cut}}{\left(N_{\pi^{\pm}}\right)_{w/o\,n1\,cut}}$

$$\simeq \frac{\left(N_{\pi^{\pm}} + N_{e^{\pm}}\right)_{w/\,n1\,cut}}{\left(N_{\pi^{\pm}} + N_{e^{\pm}} + N_{K^{\pm}} + N_{p^{\pm}}\right)_{w/o\,n1\,cut}} \times \left(\frac{N_{\pi^{\pm}} + N_{e^{\pm}} + N_{K^{\pm}} + N_{p^{\pm}}}{N_{\pi^{\pm}}}\right)_{w/o\,n1\,cut} \times \left(\frac{N_{\pi^{\pm}}}{N_{\pi^{\pm}} + N_{e^{\pm}}}\right)_{w/\,n1\,cut}$$



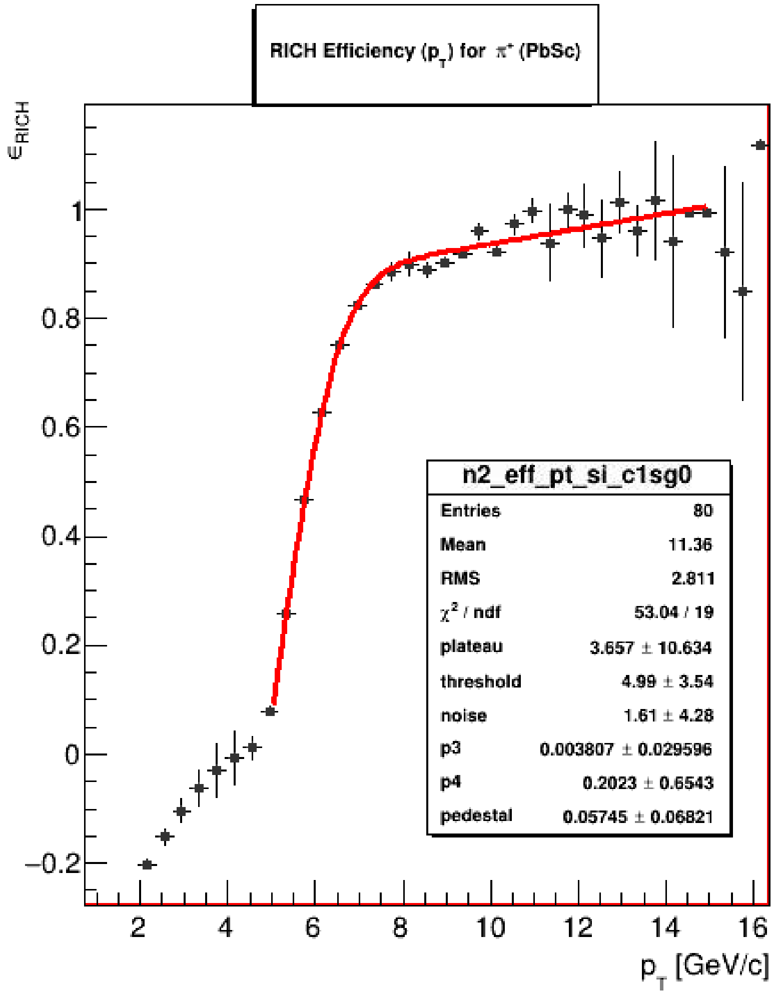


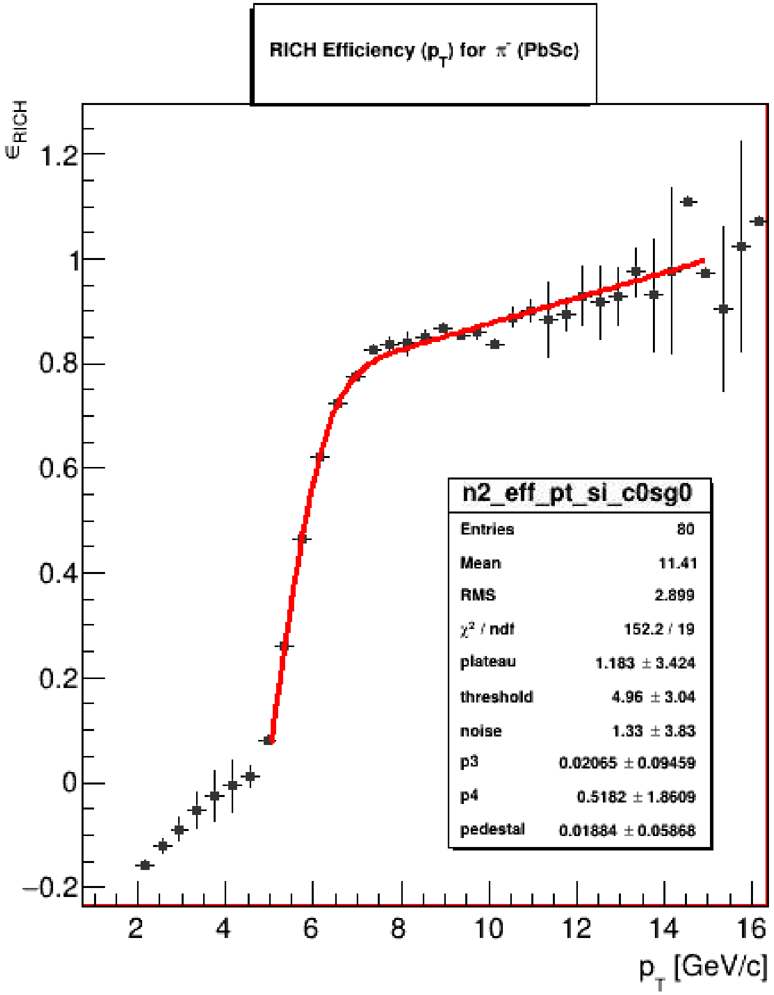
Cross section with pythia_200gev_yuehang.cfg : use RICH efficiency values from data with correction. (110 bins)



Overall, the value came out large at pt > 5.3 GeV/c

RICH efficiency with new fit function

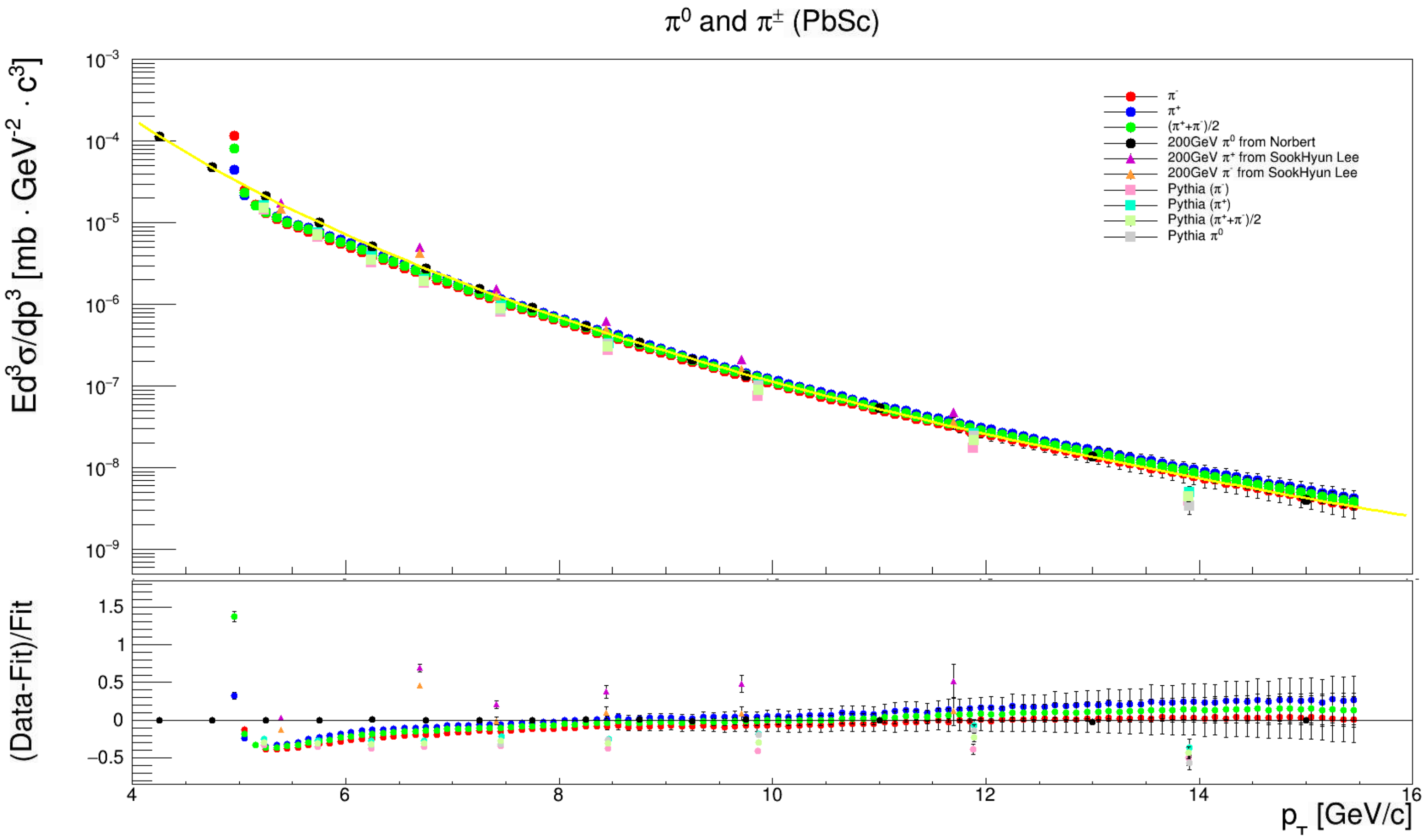




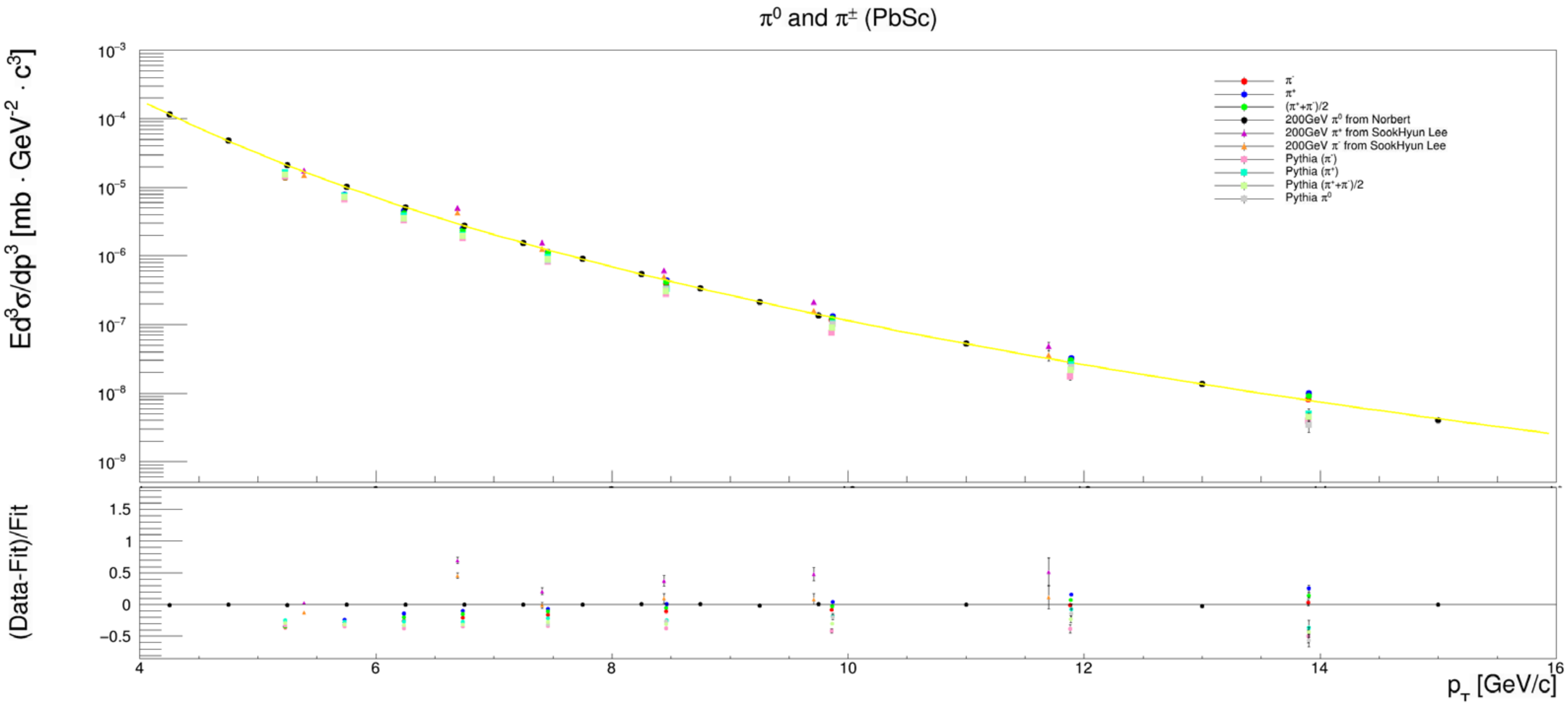
Using par[0]*(TMath::Erf((pt-par[1])/par[2]))+par[3]; (previous)

Using par[0]*(TMath::Erf((pt-par[1])/par[2]))*(par[3]*pt+par[4])+par[5]; (now)

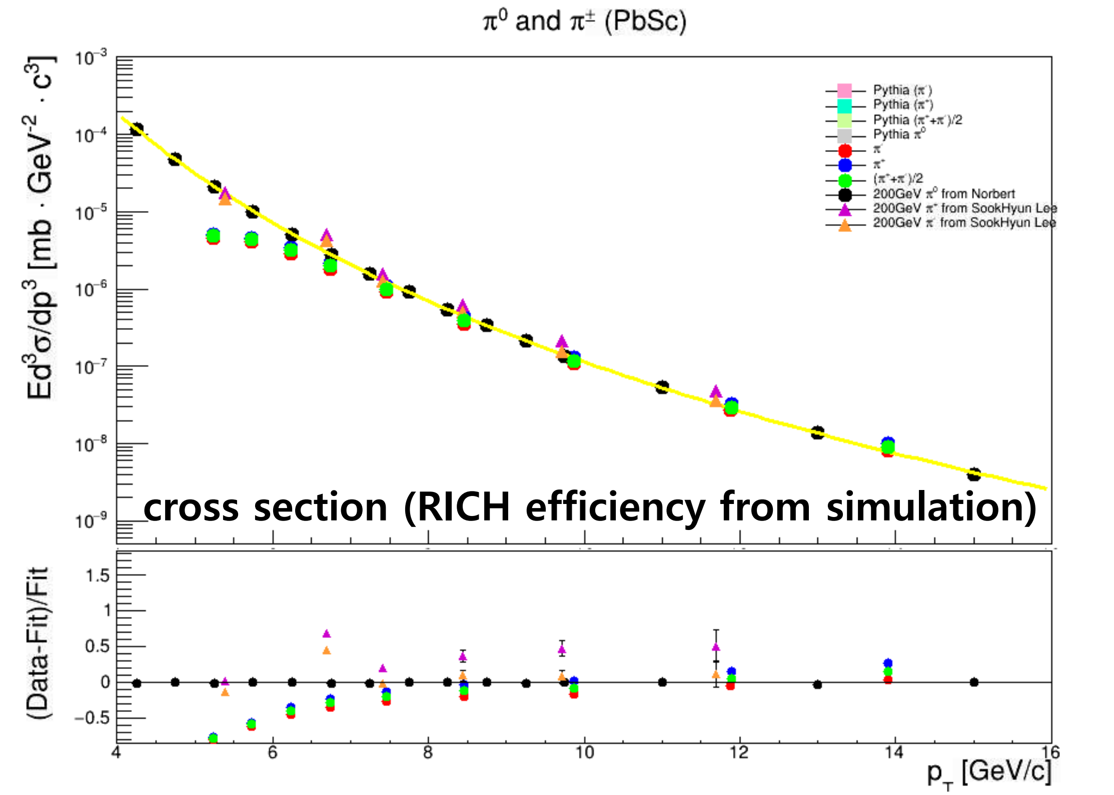
Cross section : use RICH efficiency values from data with correction. (110 bins)

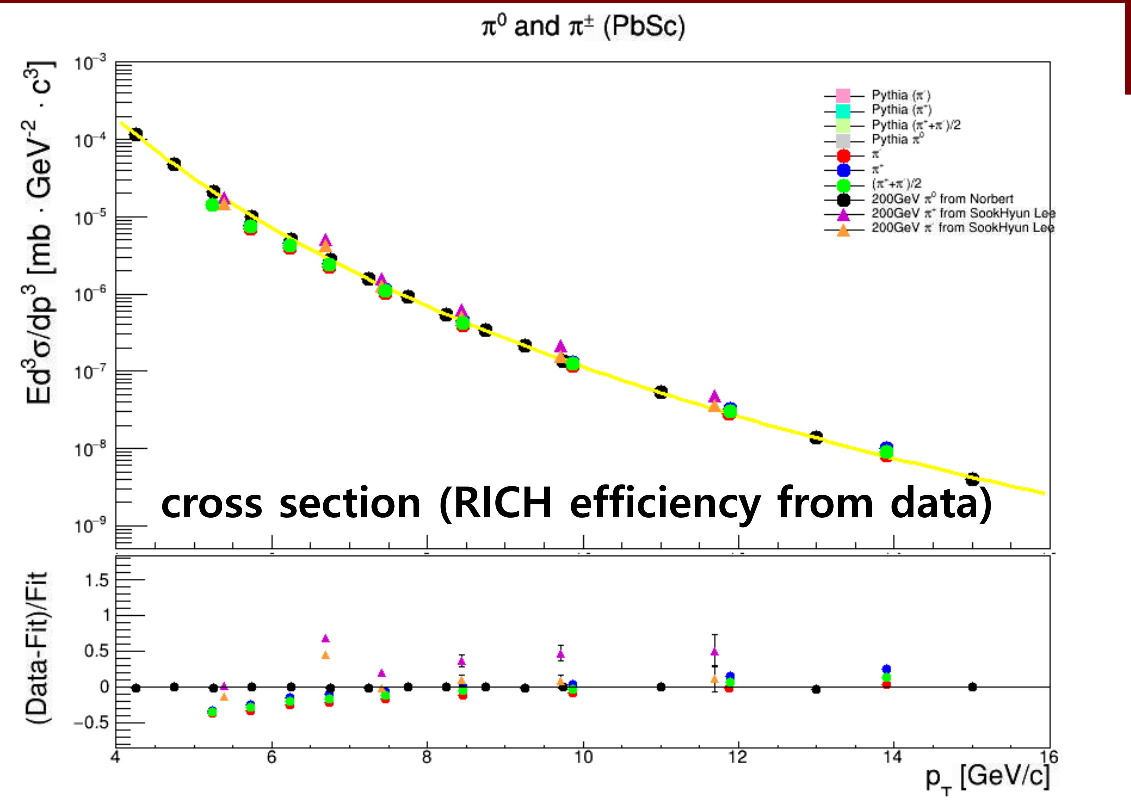


Cross section : use RICH efficiency values from data with correction. (9 bins)



Systematic uncertainty from RICH efficiency

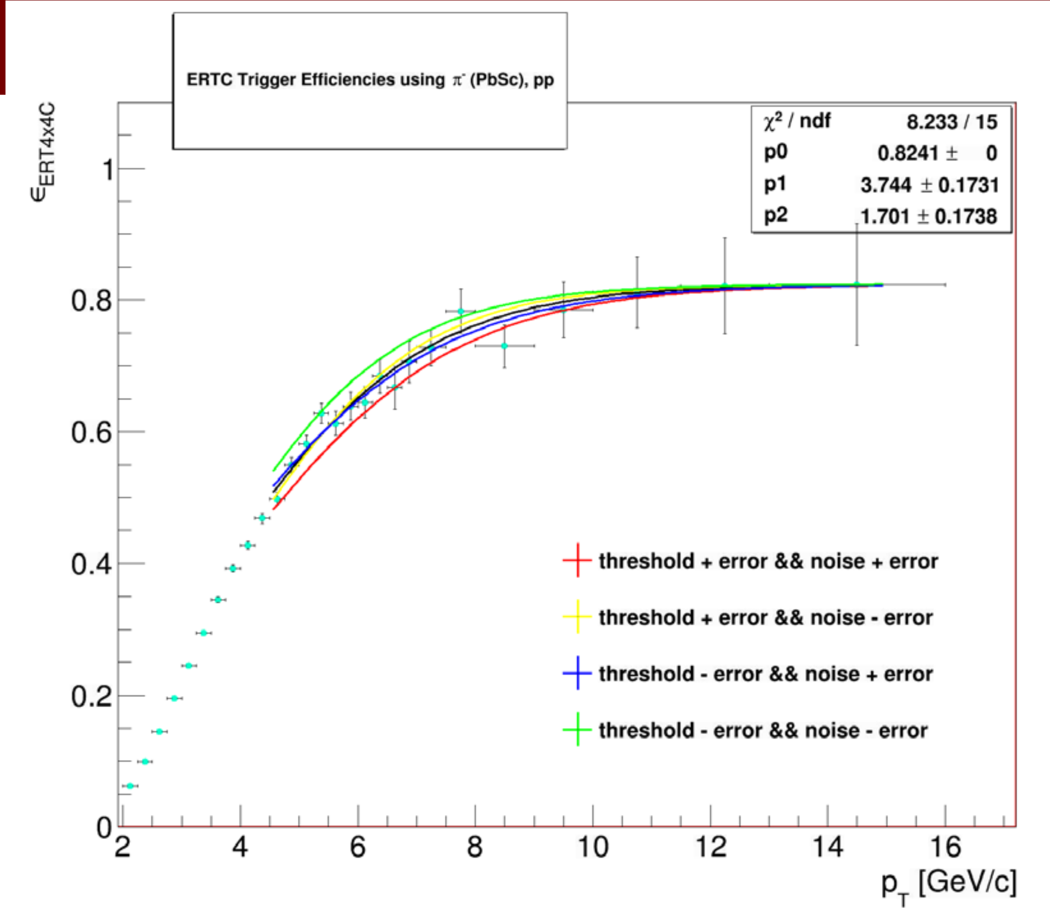


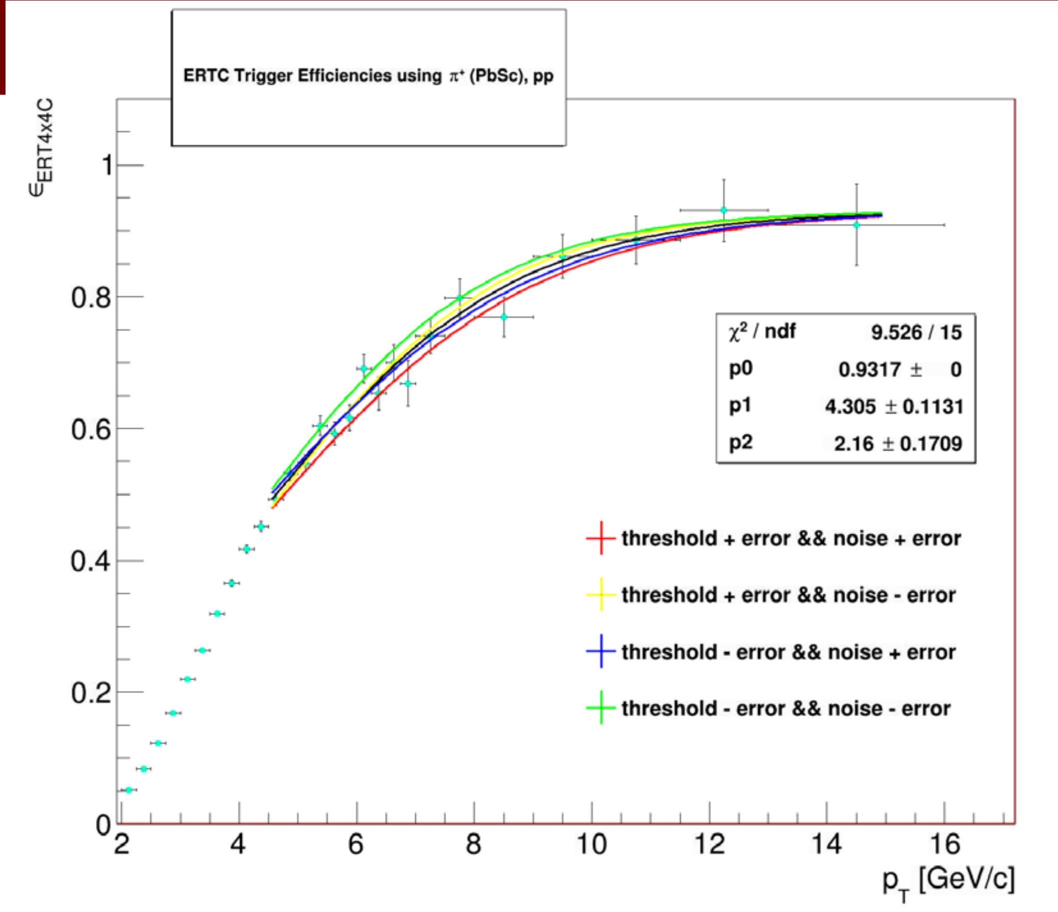


chg	pt	cross section (RICH efficiency from data)	cross section (RICH efficiency from simulation)	syst_RICH
−	5.2332	1.366.E-05	4.589.E-06	**9.069.E-06**
	5.7348	6.898.E-06	4.042.E-06	**2.856.E-06**
	6.2362	3.925.E-06	2.892.E-06	**1.032.E-06**
	6.7375	2.241.E-06	1.828.E-06	**4.131.E-07**
	7.4553	1.052.E-06	9.006.E-07	**1.511.E-07**
	8.4601	4.016.E-07	3.522.E-07	**4.933.E-08**
	9.8624	1.175.E-07	1.067.E-07	**1.082.E-08**
	11.8834	2.793.E-08	2.675.E-08	**1.177.E-09**
	13.8995	8.163.E-09	8.224.E-09	**-6.179.E-11**

chg	pt	cross section (RICH efficiency from data)	cross section (RICH efficiency from simulation)	syst_RICH
+	5.2335	1.430.E-05	5.062.E-06	**9.237.E-06**
	5.7350	7.777.E-06	4.571.E-06	**3.206.E-06**
	6.2363	4.486.E-06	3.381.E-06	**1.105.E-06**
	6.7375	2.521.E-06	2.165.E-06	**3.557.E-07**
	7.4558	1.155.E-06	1.076.E-06	**7.897.E-08**
	8.4614	4.458.E-07	4.279.E-07	**1.789.E-08**
	9.8698	1.322.E-07	1.288.E-07	**3.376.E-09**
	11.8907	3.229.E-08	3.228.E-08	**1.090.E-11**
	13.9059	9.789.E-09	1.006.E-08	**-2.693.E-10**

ERT efficiency





Fit : Using fermi funchtion

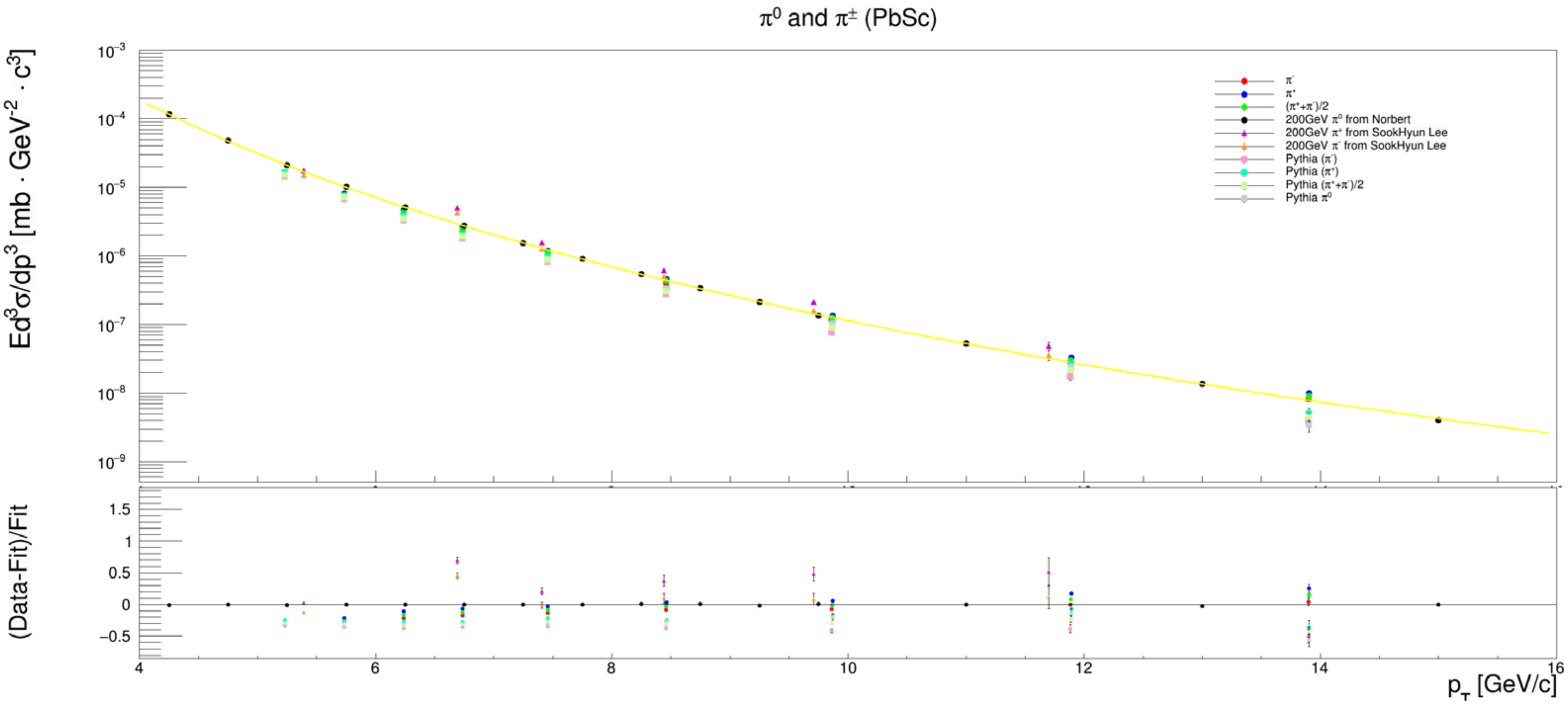
0.9317*(1-1/(1+exp((pt-[1])/[2]))) (for π^+)

0.8241*(1-1/(1+exp((pt-[1])/[2]))) (for π^-)

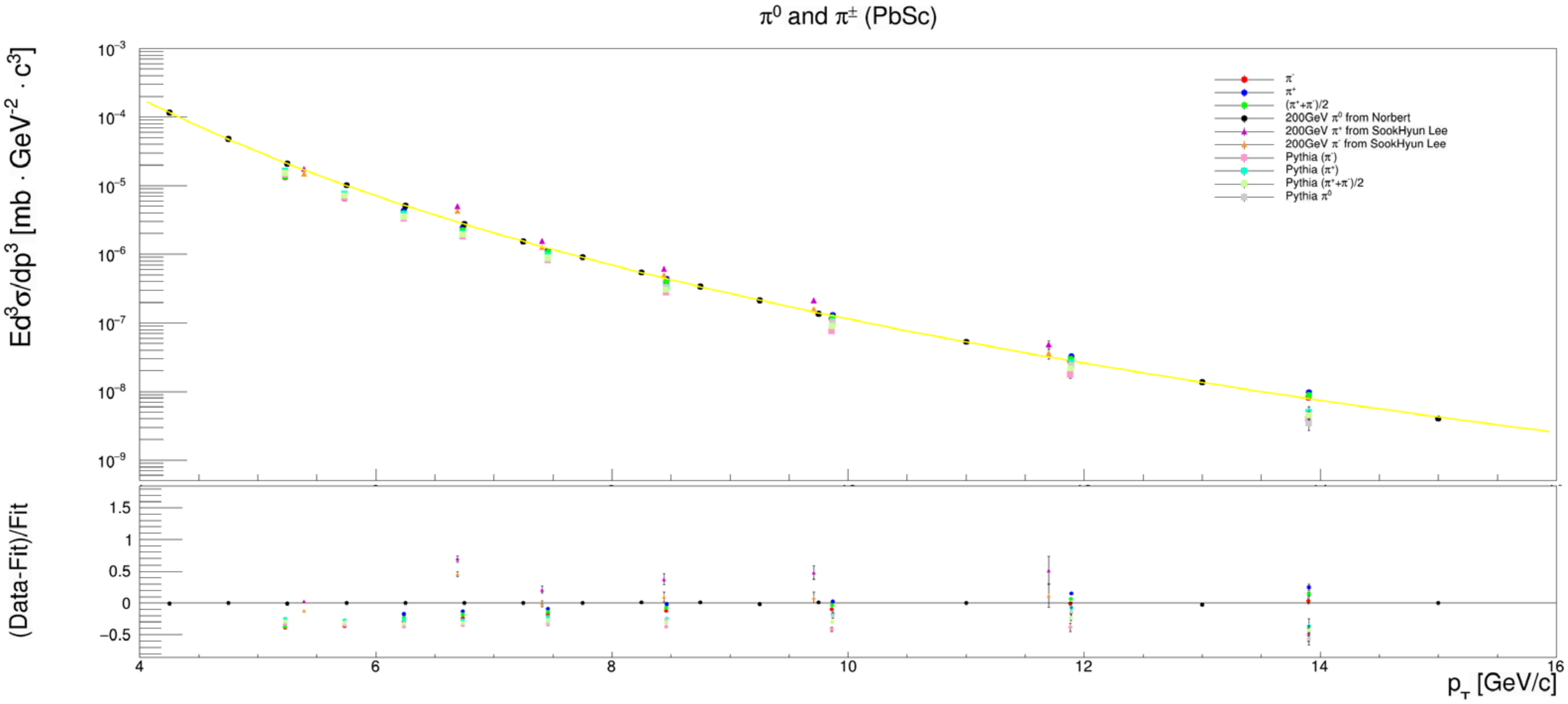
1. **1-1/(1+exp((pt-(p1+err_p1))/(p2+err_p2))))**
2. **1-1/(1+exp((pt-(p1+err_p1))/(p2-err_p2))))**
3. **1-1/(1+exp((pt-(p1-err_p1))/(p2+err_p2))))**
4. **1-1/(1+exp((pt-(p1-err_p1))/(p2-err_p2))))**

Using 1 and 4 for Systemaic study

1-1/(1+exp((pt-(p1+err_p1))/(p2+err_p2)))



1-1/(1+exp((pt-(p1-err_p1))/(p2-err_p2))))

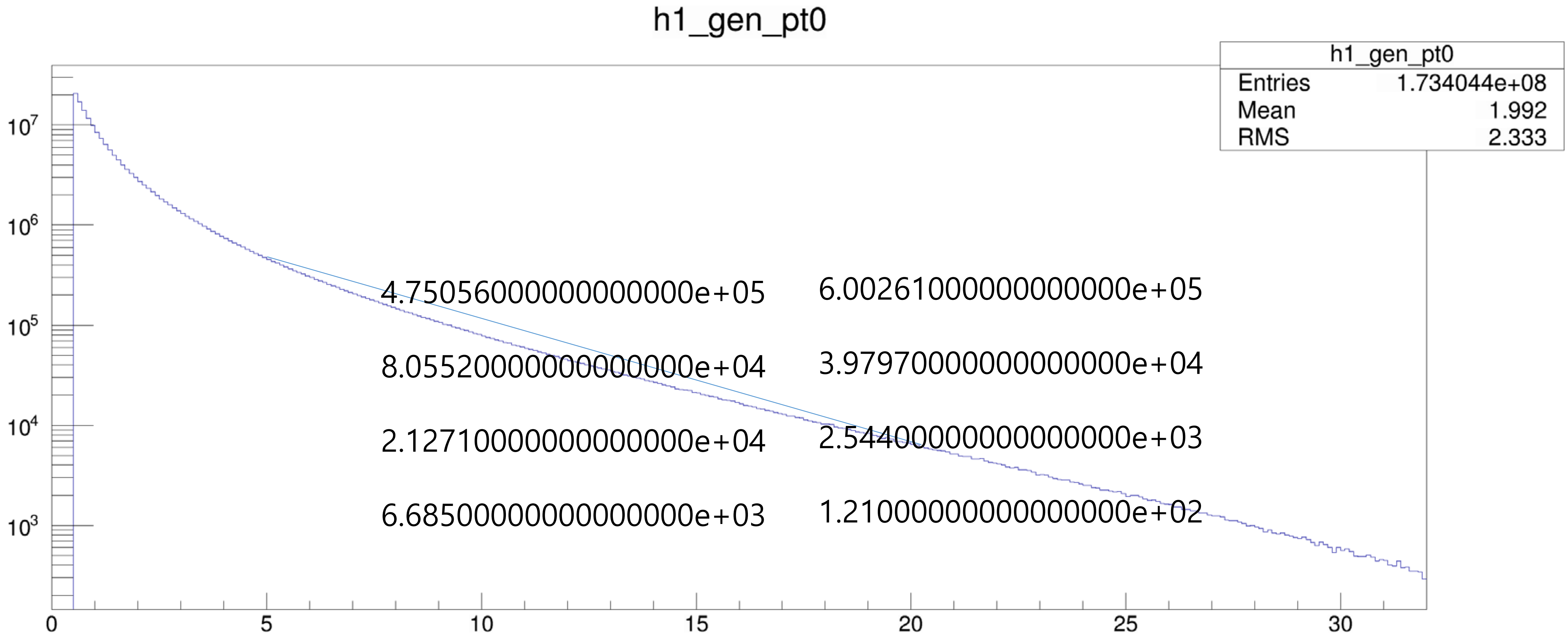


Systematic uncertainty from ERT efficiency

chg	pt	cross section	cross section (1)	cross section (4)	syst_ERT
-	5.2332	1.397.E-05	1.474.E-05	1.318.E-05	1.566.E-06
	5.7348	6.941.E-06	7.307.E-06	6.582.E-06	7.245.E-07
	6.2362	3.905.E-06	4.093.E-06	3.726.E-06	3.668.E-07
	6.7375	2.215.E-06	2.309.E-06	2.127.E-06	1.822.E-07
	7.4553	1.035.E-06	1.071.E-06	1.003.E-06	6.781.E-08
	8.4601	3.957.E-07	4.054.E-07	3.876.E-07	1.786.E-08
	9.8624	1.165.E-07	1.181.E-07	1.152.E-07	2.916.E-09
	11.8834	2.790.E-08	2.806.E-08	2.779.E-08	2.755.E-10
	13.8995	8.178.E-09	8.197.E-09	8.166.E-09	3.034.E-11
+	5.2335	1.435.E-05	1.482.E-05	1.384.E-05	9.774.E-07
	5.7350	7.804.E-06	8.074.E-06	7.518.E-06	5.560.E-07
	6.2363	4.491.E-06	4.649.E-06	4.328.E-06	3.206.E-07
	6.7375	2.517.E-06	2.603.E-06	2.429.E-06	1.740.E-07
	7.4558	1.150.E-06	1.186.E-06	1.114.E-06	7.261.E-08
	8.4614	4.432.E-07	4.550.E-07	4.320.E-07	2.303.E-08
	9.8698	1.318.E-07	1.343.E-07	1.295.E-07	4.759.E-09
	11.8907	3.241.E-08	3.275.E-08	3.213.E-08	6.192.E-10
	13.9059	9.869.E-09	9.921.E-09	9.828.E-09	9.268.E-11

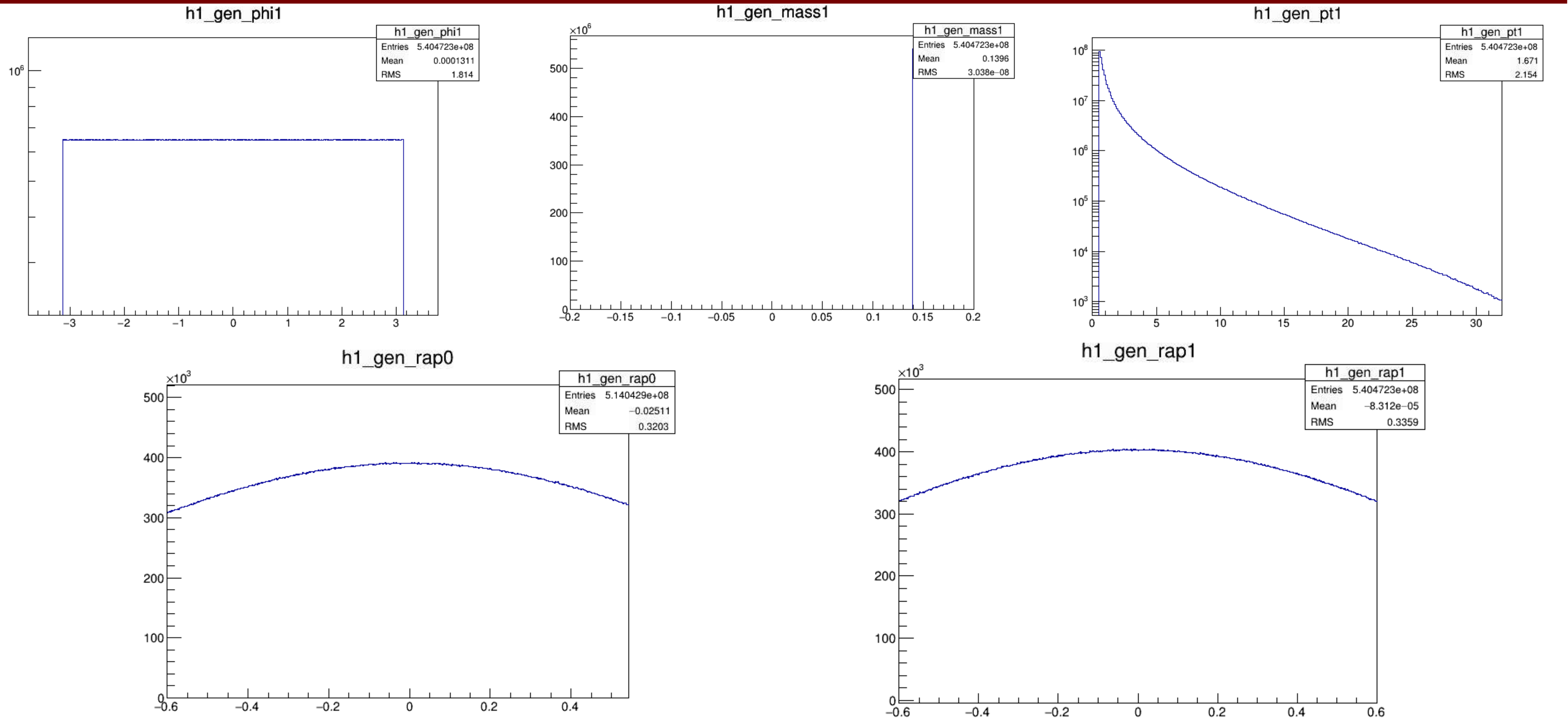
Cross Section with Stat. & Syst. uncertainties

chg	pt	cross section	stat_uncertainty	syst_RICH	syst_ERT
-	5.2332	1.397.E-05	1.514.E-07	9.069.E-06	1.566.E-06
	5.7348	6.941.E-06	6.368.E-08	2.856.E-06	7.245.E-07
	6.2362	3.905.E-06	3.823.E-08	1.032.E-06	3.668.E-07
	6.7375	2.215.E-06	2.545.E-08	4.131.E-07	1.822.E-07
	7.4553	1.035.E-06	1.115.E-08	1.511.E-07	6.781.E-08
	8.4601	3.957.E-07	6.263.E-09	4.933.E-08	1.786.E-08
	9.8624	1.165.E-07	2.099.E-09	1.082.E-08	2.916.E-09
	11.8834	2.790.E-08	8.770.E-10	1.177.E-09	2.755.E-10
	13.8995	8.178.E-09	4.066.E-10	-6.179.E-11	3.034.E-11
+	5.2335	1.435.E-05	1.542.E-07	9.237.E-06	9.774.E-07
	5.7350	7.804.E-06	6.868.E-08	3.206.E-06	5.560.E-07
	6.2363	4.491.E-06	4.101.E-08	1.105.E-06	3.206.E-07
	6.7375	2.517.E-06	2.640.E-08	3.557.E-07	1.740.E-07
	7.4558	1.150.E-06	1.108.E-08	7.897.E-08	7.261.E-08
	8.4614	4.432.E-07	6.163.E-09	1.789.E-08	2.303.E-08
	9.8698	1.318.E-07	2.061.E-09	3.376.E-09	4.759.E-09
	11.8907	3.241.E-08	8.746.E-10	1.090.E-11	6.192.E-10
	13.9059	9.869.E-09	4.175.E-10	-2.693.E-10	9.268.E-11

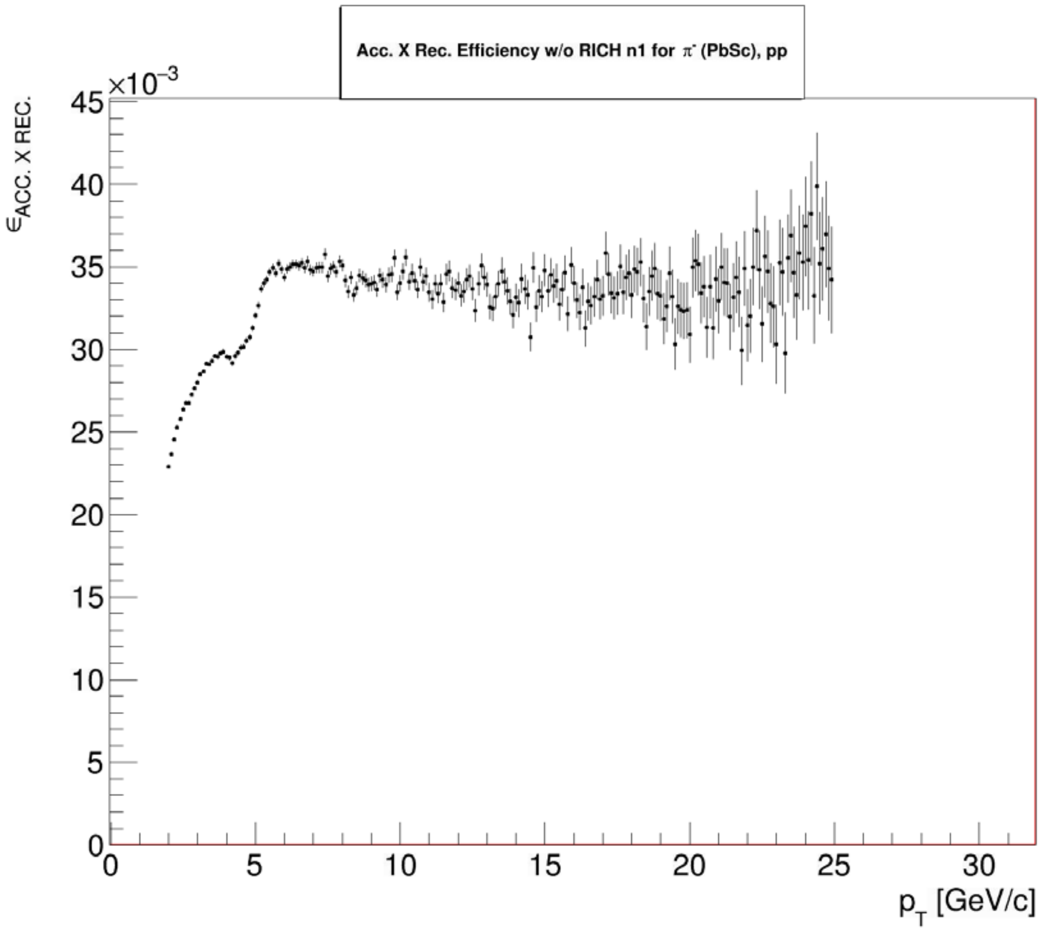


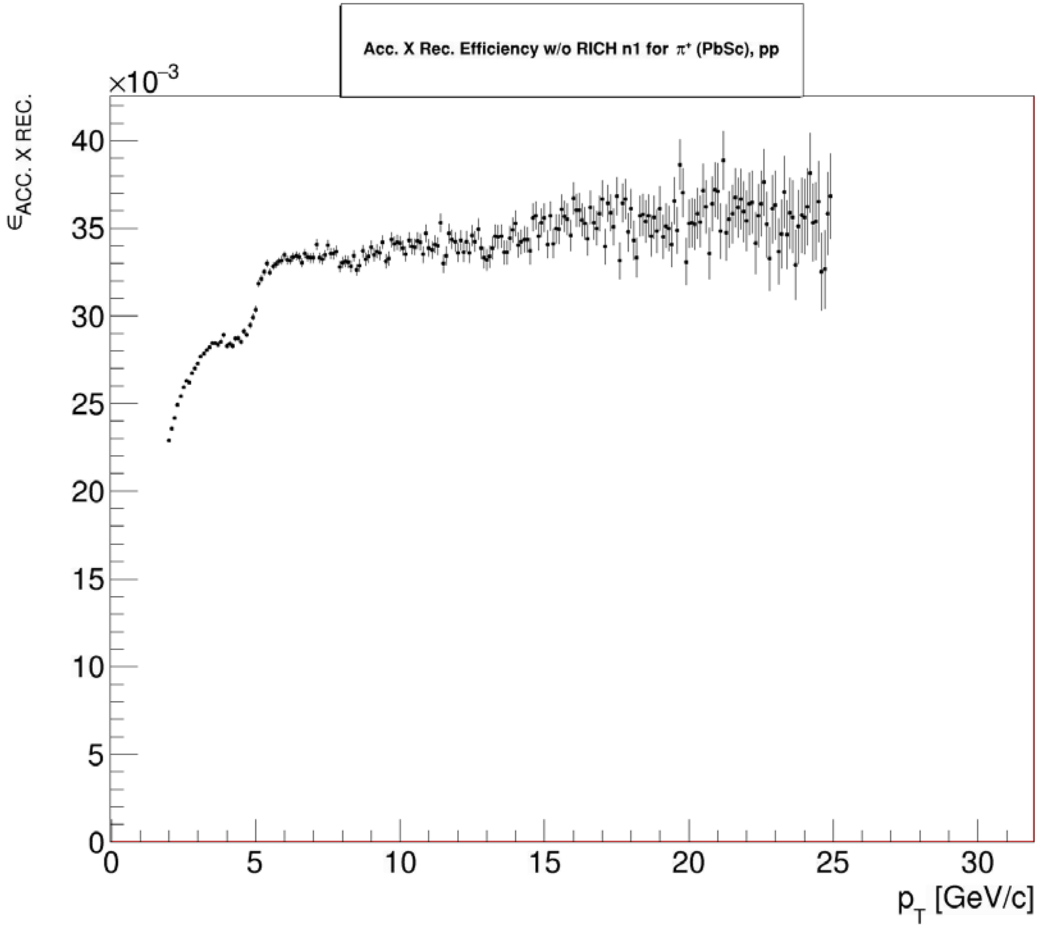
h1_gen_pt0
h1_gen_pt0
Entries 1.734044e+08
Mean 1.992
RMS 2.333
4.75056000000000000e+05
6.00261000000000000e+05
8.05520000000000000e+04
3.97970000000000000e+04
2.12710000000000000e+04
2.54400000000000000e+03
6.68500000000000000e+03
1.21000000000000000e+02
10^7
10^6
10^5
10^4
10^3
0
5
10
15
20
25
30

Generated particle information from simulation with $|\eta| < 0.6$ (Pythia simulation). (**Wrong rapidity cut**)

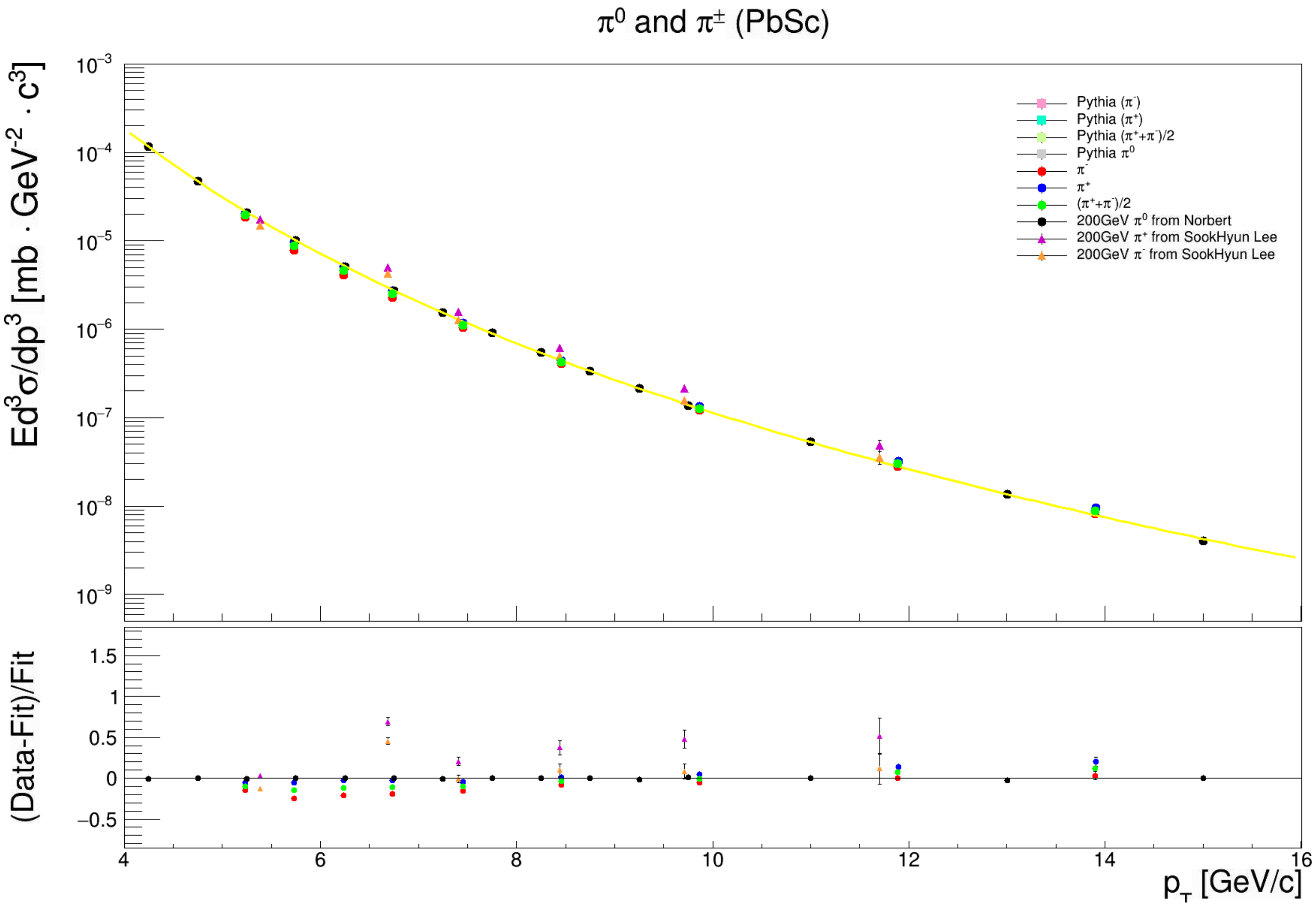


Acc.Rec efficiency values from simulation with $|\eta| < 0.6$ (Pythia simulation).

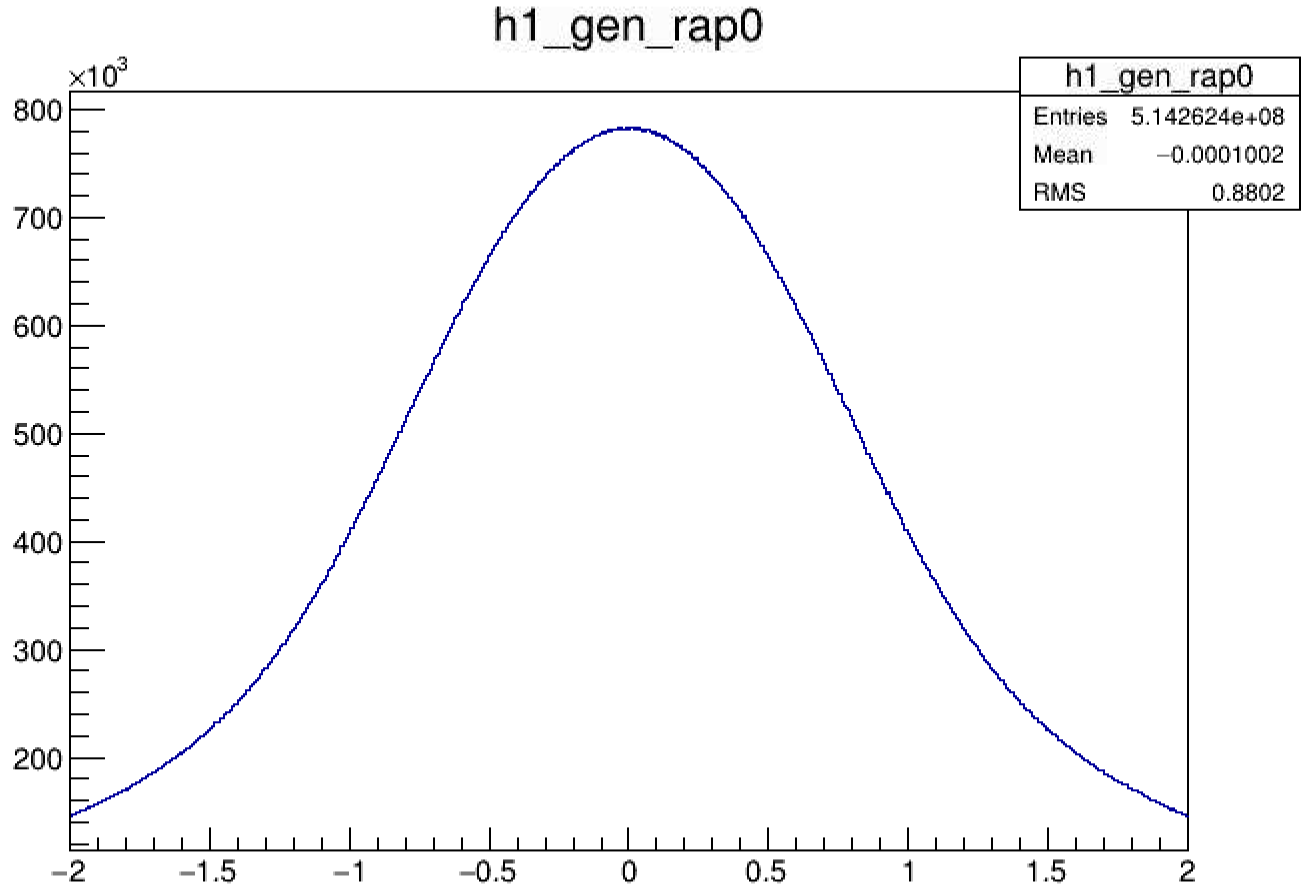




Cross Section from simulation with $|\eta| < 0.6$ (Pythia simulation).



Acc.Rec efficiency values from simulation with $|\eta| < 0.6$ (Pythia simulation)




```
root [3] h1_gen_rap0->Integral(-0.6,0.6)
(const Double_t)3.630185600000000e+07
```