Non-Photonic Electron and Hadron Azimuthal Correlations in 200 GeV p+p Collisions at STAR

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Sep 9, 2020

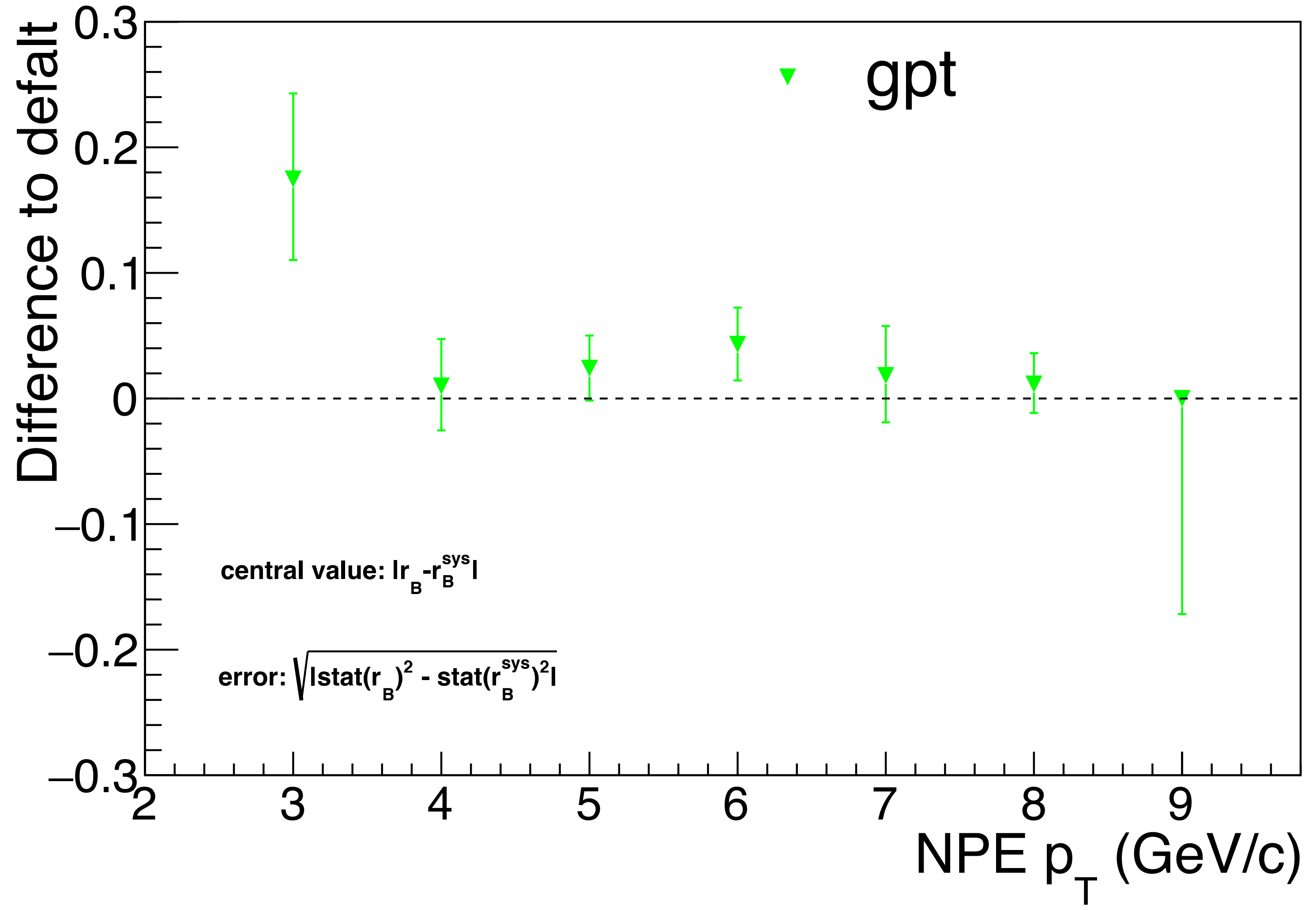
Weekly meeting

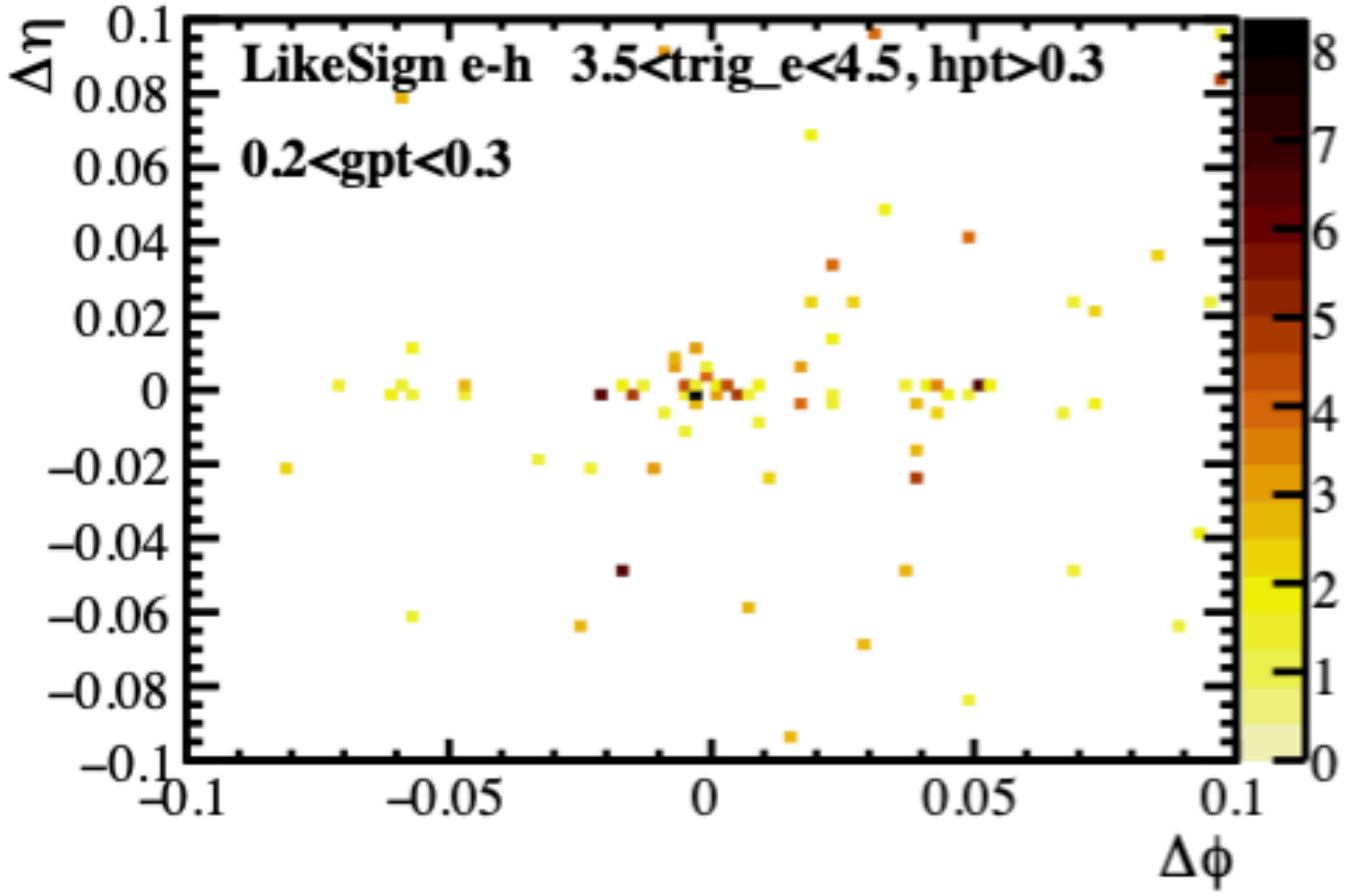
Outline

- Systematic study for gpt cut(default gpt<0.3 to gpt<0.2 GeV/c)
  - description of the problem we find in the systematic study
  - add a cut for associated track
  - use different formular to get final npe-h correlation

- Cross check of the pythia generated jpsi and npe spectrum
  - tried different pythia tune, compare with the result shown in the website

https://www.star.bnl.gov/protected/heavy/ullrich/pythia8/

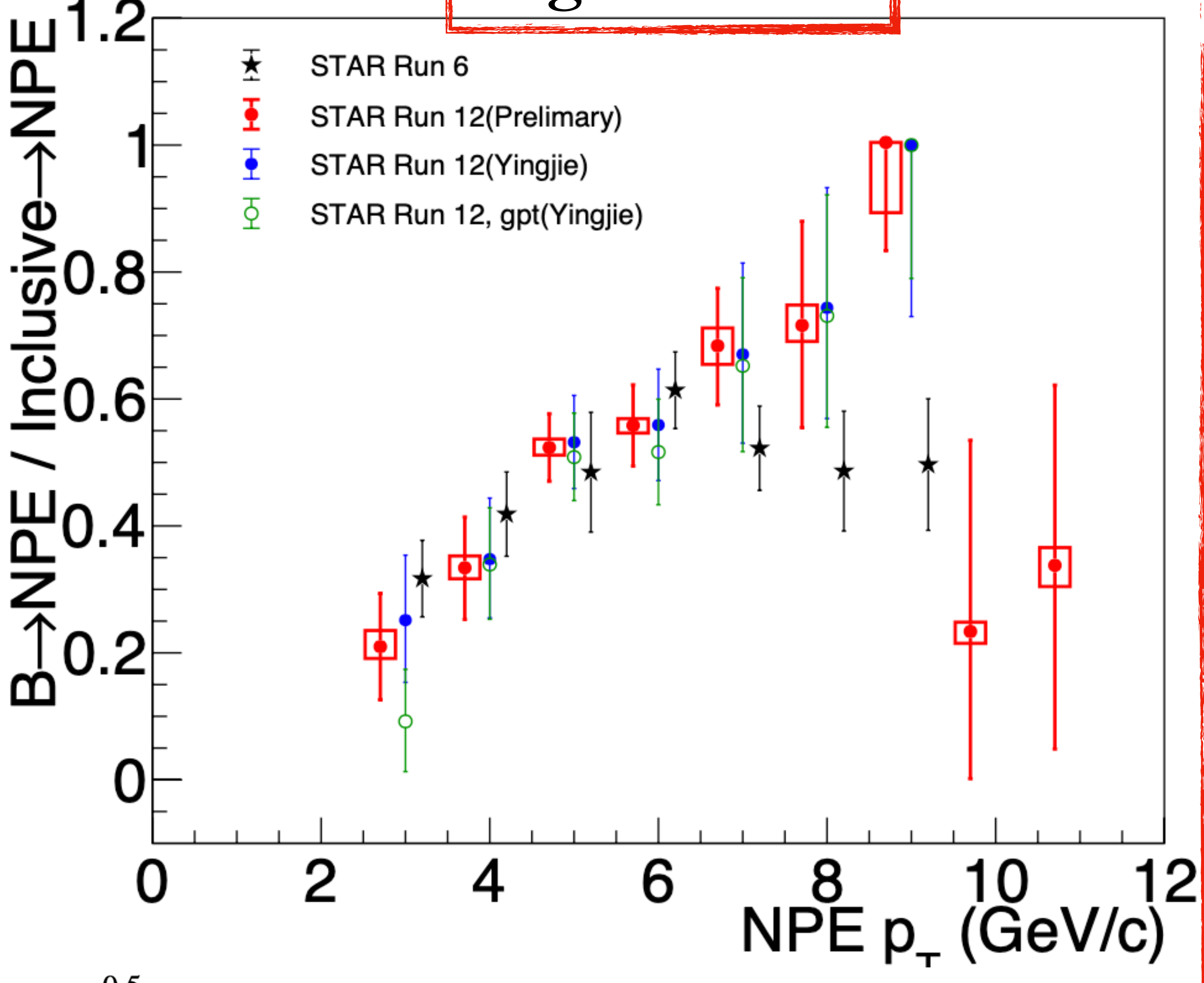


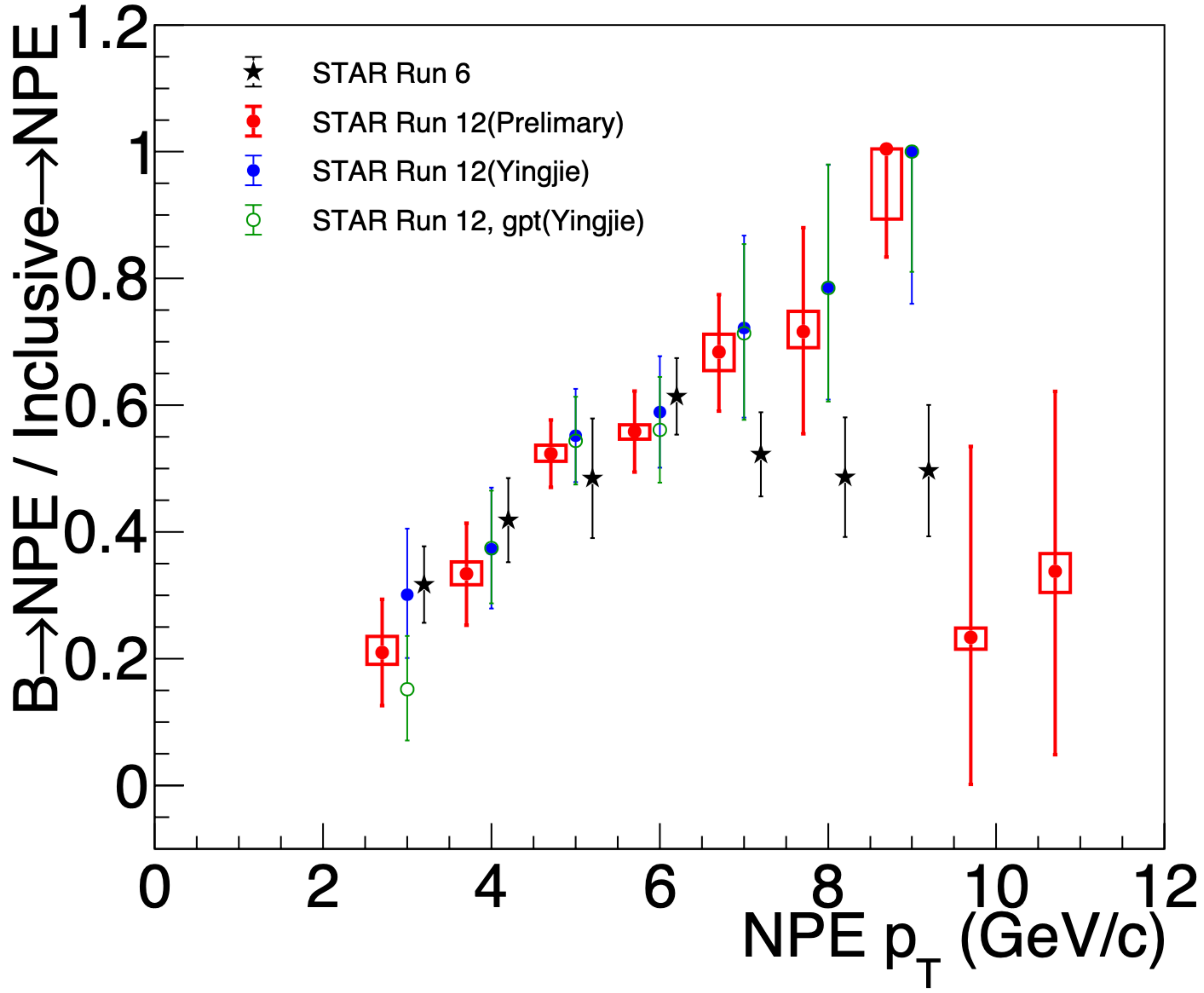


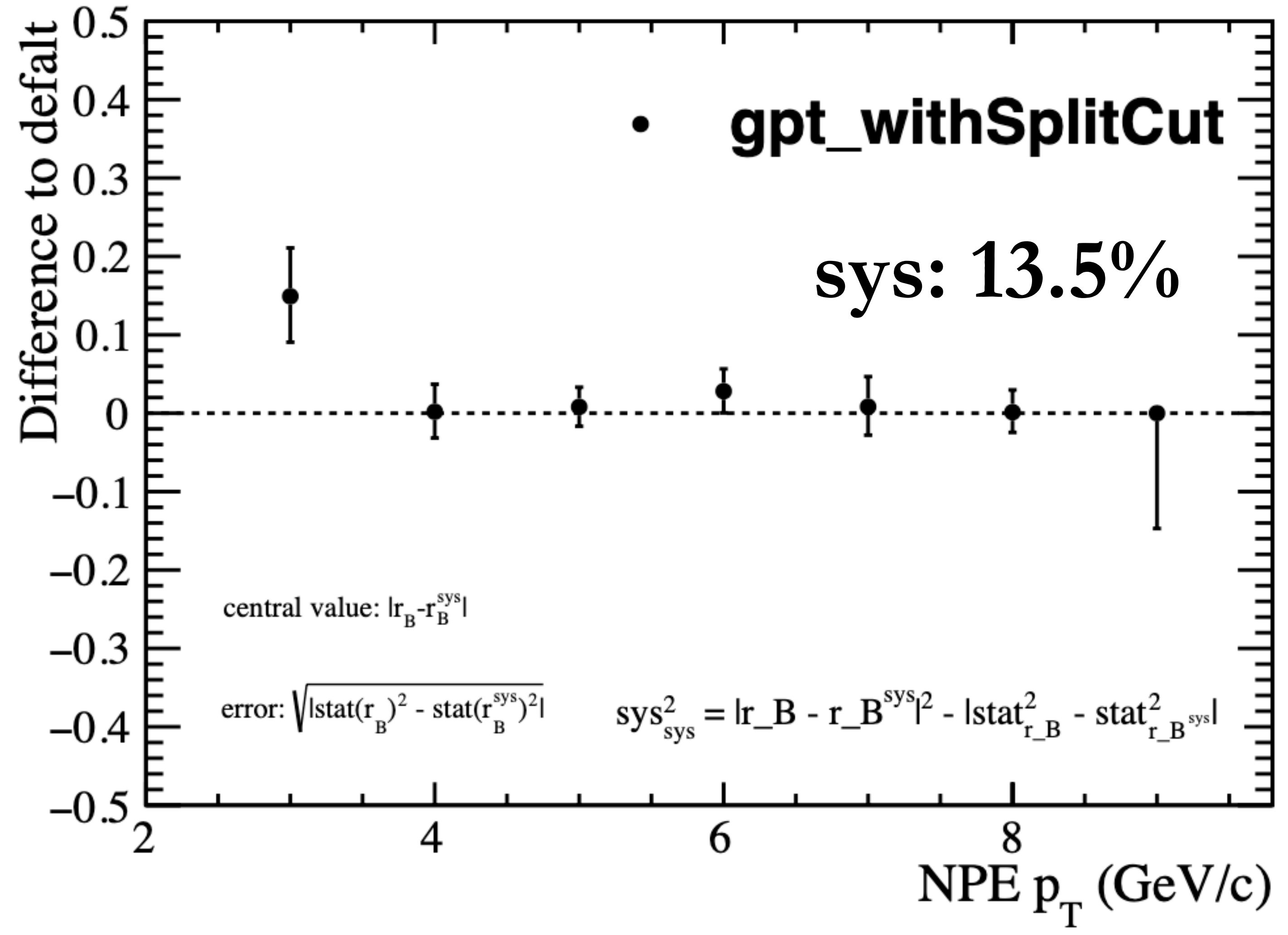
$$\Delta\phi_{NPE} = \Delta\phi_{Semi} - (\frac{1}{\varepsilon} - 1)(\Delta\phi_{US-not-reco} - \Delta\phi_{LS-not-reco}) + \Delta\phi_{LS-not-reco} - (1 - \varepsilon_{purity})\Delta\phi_{HadHad}$$

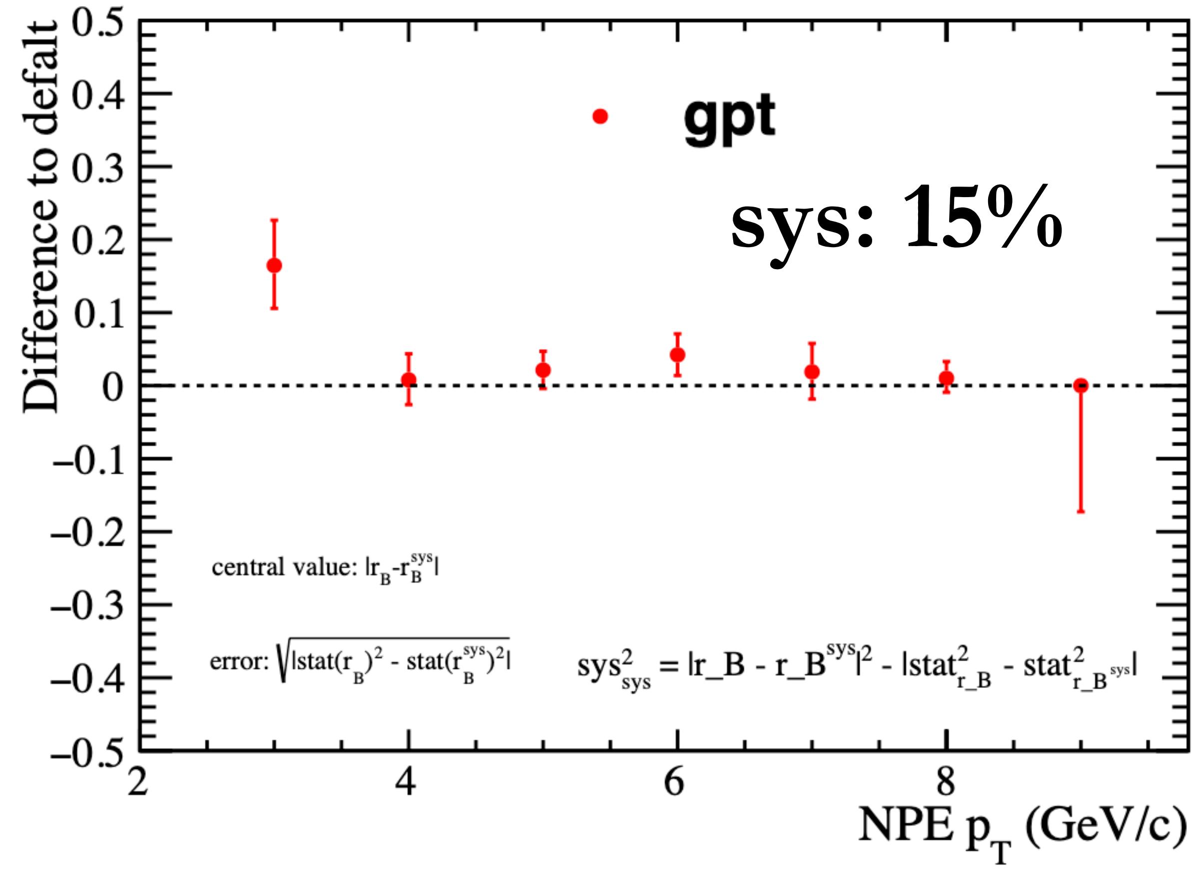
without use partner track

original result









add split cut:
-2<nsigma_e < 3 &&
(delta_phi<0.05&&delta_eta<0.05)

- sys is a little bit small, b is a little bit highe

Q: without partner track in associated hadron, how doet "split track" work ?

non-photonic electrons and charged hadrons is calculated by using the semi-inclusive electron sample as;

$$\Delta\phi_{e_{non\gamma}-h} = \Delta\phi_{e_{semi}-h} + \Delta\phi_{e_{like}-h} - \Delta\phi_{e_{\gamma}^{not-reco}-h} \quad (6)$$

, where each angular correlation on the right side was experimentally determined. Associated particle p_T was requested larger than 0.3 GeV/c and $|\eta| < 1.05$. The distribution for $e_{\gamma}^{not-reco}$ was calculated from the azimuthal correlation between photonic electron and hadron ($\Delta\phi_{e_\gamma} - h$). Since $e_{\gamma}^{not-reco}$ misses its partner electron in the reconstruction of photonic electrons, we removed the partner electron from $\Delta\phi_{e_\gamma - h}$ and corrected with the reconstruction efficiency $(1/\varepsilon_{e_\gamma} - 1)$ to calculate $\Delta\phi_{e_{\gamma}^{not-reco}-h}$ (Fig. 12). The remaining backgrounds from hadrons were statistically subtracted in this analysis. We

$$\frac{dN^{e_{\mathrm{non}\gamma}-h}}{d(\Delta\phi)} = \frac{dN^{e_{\mathrm{semi}}-h}}{d(\Delta\phi)} + \frac{dN^{e_{\mathrm{like}}-h}}{d(\Delta\phi)} - \frac{dN^{e_{\gamma}^{\mathrm{not-reco}}-h}}{d(\Delta\phi)} - \frac{dN^{h-h}}{d(\Delta\phi)}, \quad (2)$$

where each term is normalized to be per nonphotonic electron trigger. Each angle-difference distribution on the right-hand side of Eq. (2) was experimentally determined. The distribution $dN^{e_{\gamma}^{\mathrm{not-reco}}-h}/d(\Delta\phi)$ was constructed from $dN^{e_{\gamma}^{\mathrm{reco}}-h}/d(\Delta\phi)$ by removing the conversion partner to account for the fact that the partner electron is not reconstructed. ?

code:
offline/paper/psn0471/Ana/Draw_dphi.C

```
//if(signID==0 && ecount_opp==1)
if(signID==0 && ecount_opp==1 && buff[atrk][14]!=gid)
{
  Hphi_corr_we[2][6] -> Fill(buff[itrk][1],phi_corr); // opp sign no partner
```

```
Hphi_corr_we[2][6] = new TH2F( "phi_corr_6_c2_we", "azm. corr opp sign no part art 0.3 we", 200, 0.0, 20.0, 256,
   -3.2, 3.2 ) ;
```

```
double pT = ((double)mim + (double)max -1.0)/20.0;
double eff = Geff->Eval(pT);
//double eff = 0.8;
double fac = (1.0/eff)-1.0;
dphi_inc[j]   = phi_inc  -> ProjectionY(name0,mim,max); // inclusive
dphi_semi[j]  = phi_semi -> ProjectionY(name1,mim,max); // semi
dphi_opp0[j]  = phi_opp0 -> ProjectionY(name2,mim,max); // opp keep
dphi_same0[j] = phi_same0 -> ProjectionY(name3,mim,max); // same keep
dphi_same[j] = phi_same -> ProjectionY(name4,mim,max); // same keep
dphi_hadron[j] = phi_hadron -> ProjectionY(name5,mim,max); // same keep
```

should be same no part

```
dphi_opp0[j]->Add(dphi_same[j],-1);
dphi_opp0[j]->Scale(fac);
dphi_semi[j]->Add(dphi_same[j],1);
dphi_semi[j]->Add(dphi_opp0[j],-1);

dphi_semi[j]->Scale(1.0/N_np);
```

```
TH2D *phi_inc   = phi_corr_0_c2_we->Clone("phi_inc");   // inclusive
TH2D *phi_semi  = phi_corr_4_c2_rc->Clone("phi_semi");  // semi
TH2D *phi_opp0  = phi_corr_6_c2_we->Clone("phi_opp0");  // opp no part
TH2D *phi_same0 = phi_corr_7_c2_we->Clone("phi_same0"); // same no part
TH2D *phi_same =  phi_corr_2_c2_rc->Clone("phi_same");
TH2D *phi_hadron = phi_corr_c2_hadron->Clone("phi_hadron");
```

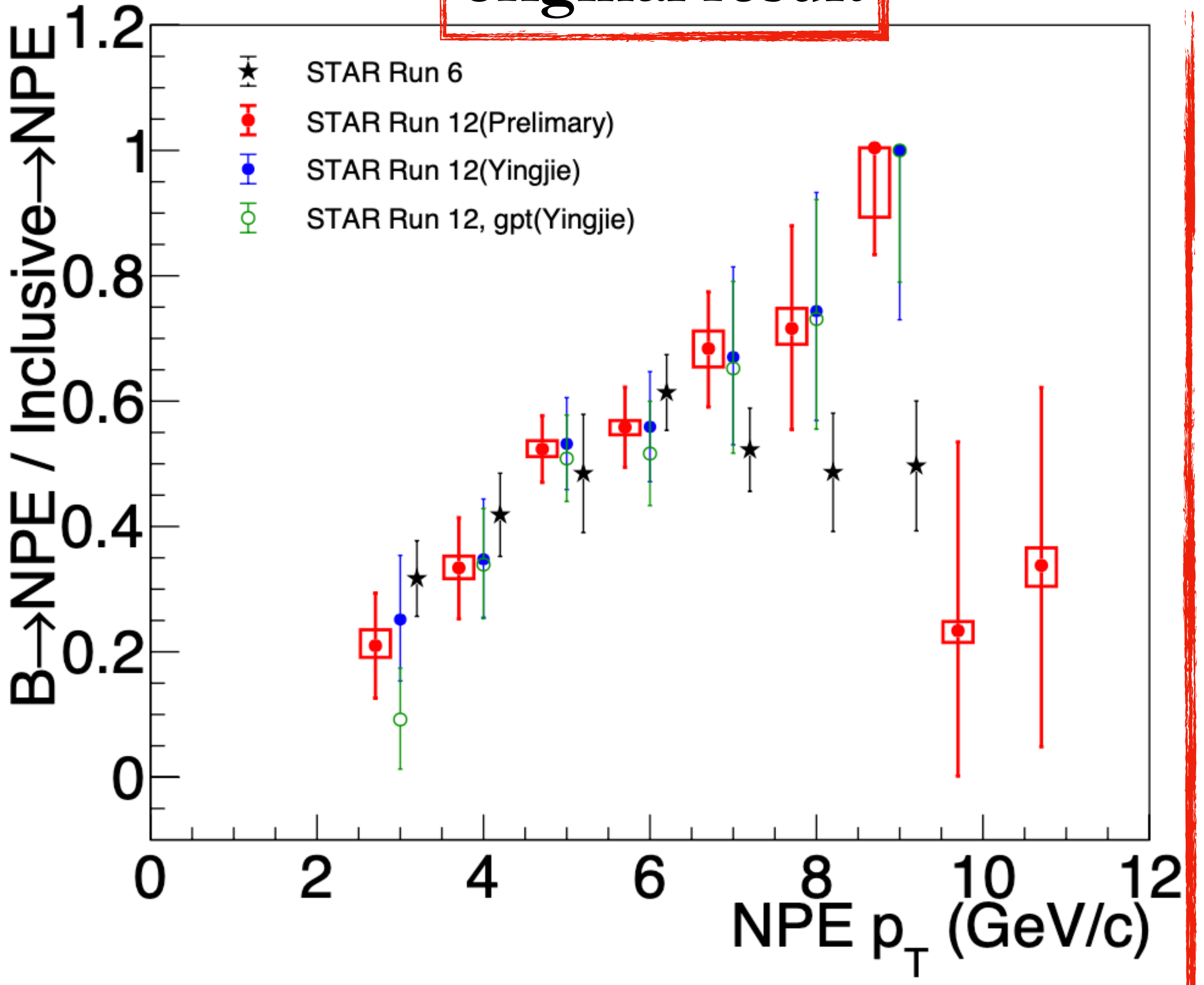
- the code looks use same sign with partner e

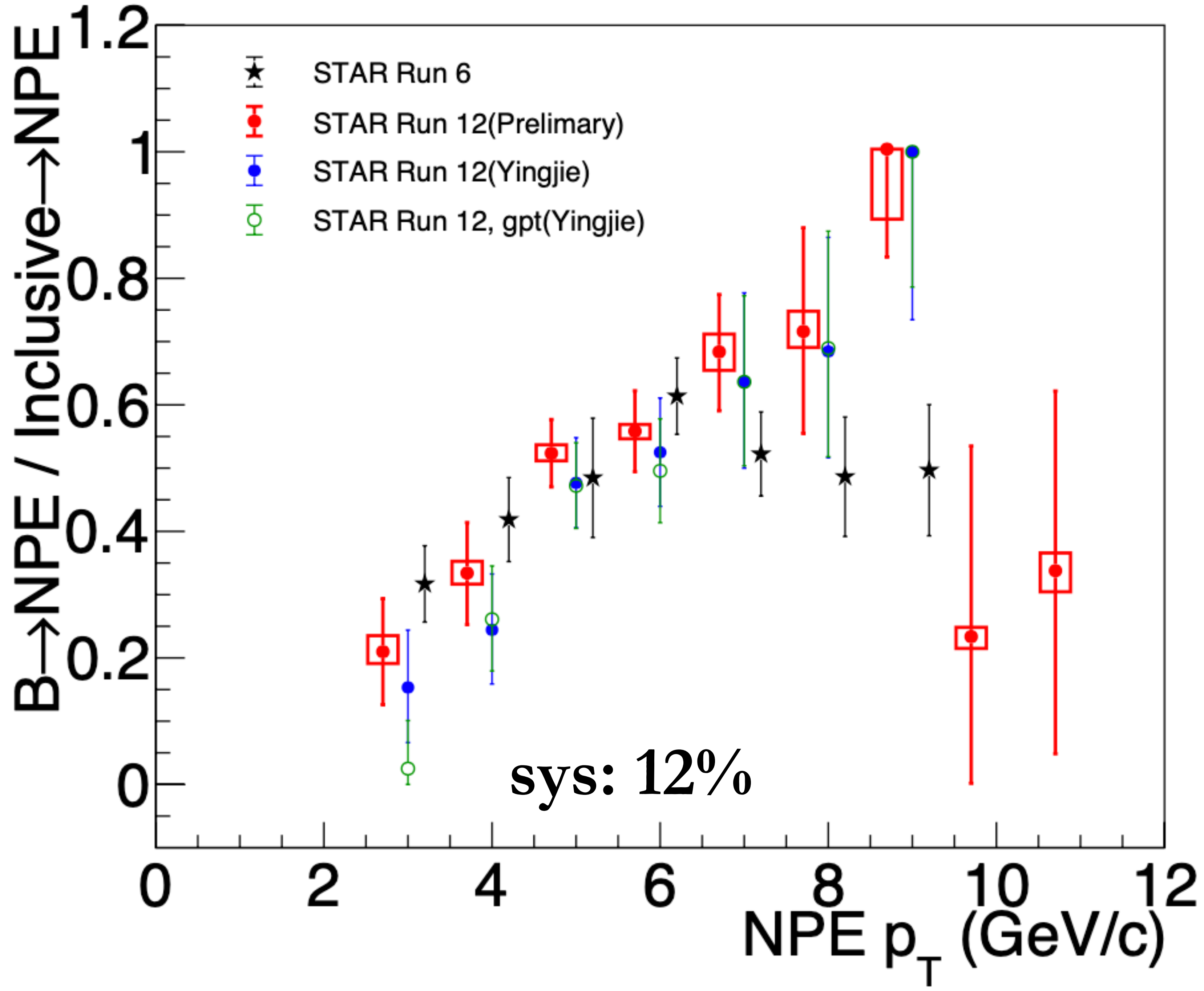
$$\Delta\phi_{NPE} = \Delta\phi_{Semi} - (\frac{1}{\varepsilon} - 1)(\Delta\phi_{US-not-reco} - \Delta\phi_{LS-reco}) + \Delta\phi_{LS-reco} - (1 - \varepsilon_{purity})\Delta\phi_{HadHad}$$

$$\Delta\phi_{NPE} = \Delta\phi_{Semi} - (\frac{1}{\varepsilon} - 1)(\Delta\phi_{US-not-reco} - \Delta\phi_{LS-not-reco}) + \Delta\phi_{LS-reco} - (1 - \varepsilon_{purity})\Delta\phi_{HadHad}$$

considering partner track, for likesign

original result





add split cut:
-2<nsigma_e < 3 &&
(delta_phi<0.05&&delta_eta<0.05)

- with peak around 0 in e-h correlation from like-sign with partner e, b is smaller and even close to 0 when gpt<0.2
- Should we use like-sign with partner track

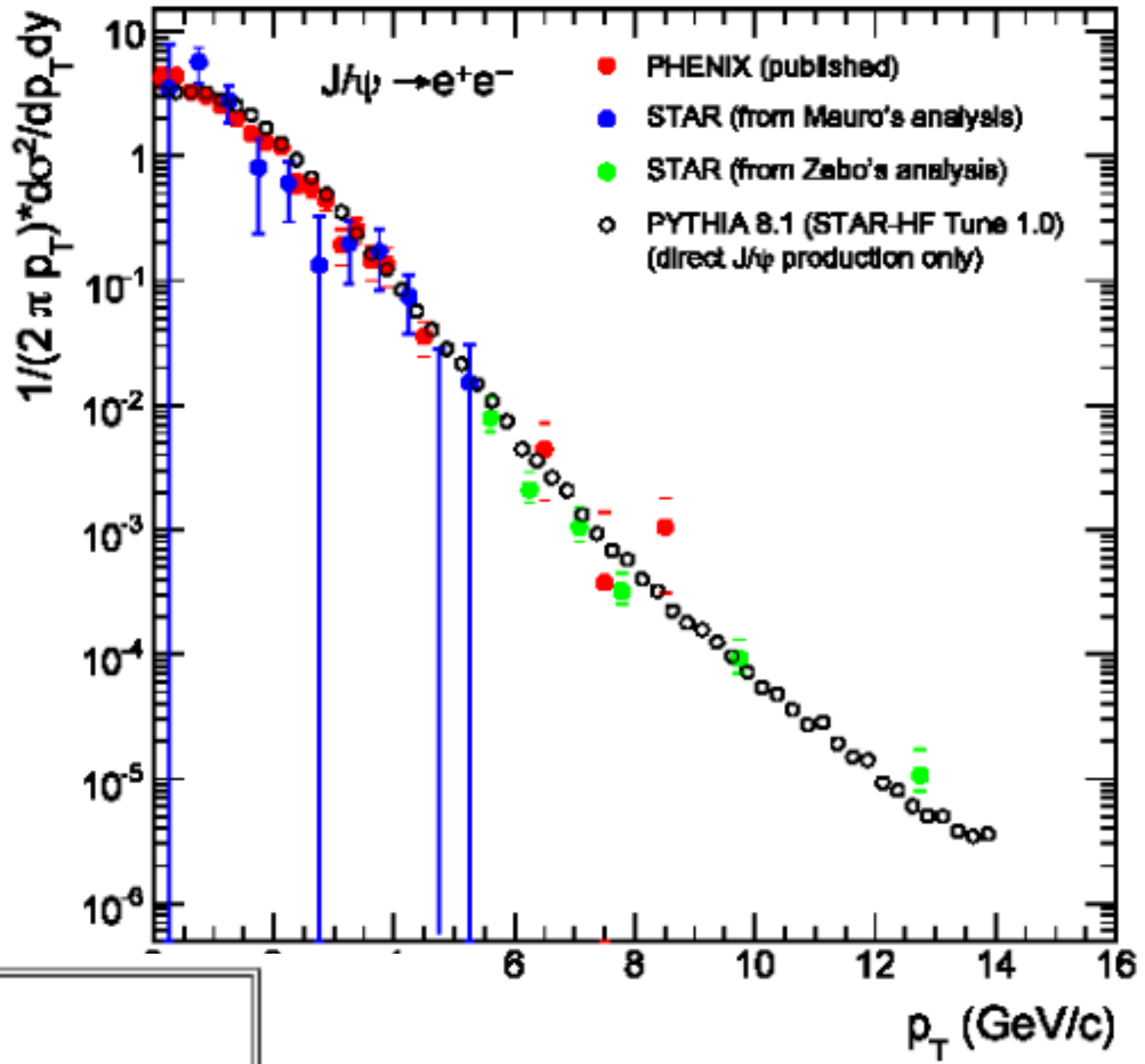
Jpsi

direct Jpsi cross section

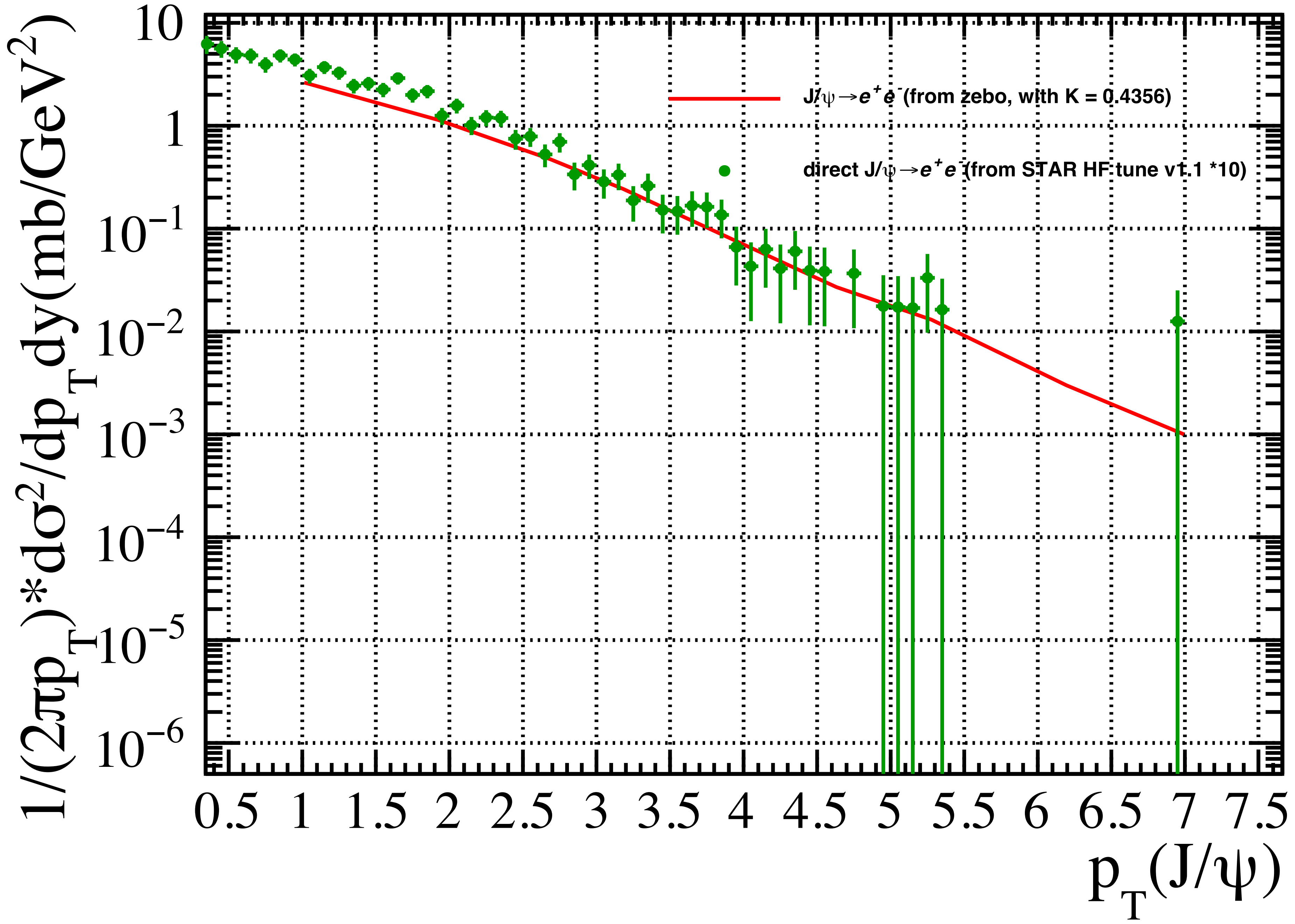
Main type	$c\bar{c}$ pair production	charmonium production	charmonium decay	Specific type
Prompt	$p\bar{p} \to c\bar{c} + X$	$c\bar{c} \to J/\psi$	—	Direct
		$c\bar{c} \to \chi_c$ $c\bar{c} \to \psi'$	$\chi_c \to J/\psi + \gamma$ $\psi' \to J/\psi + X$	—
Non-prompt	$p\bar{p} \to b\bar{c} + X$ $b\bar{c} \to c\bar{c} + \ell^- + \bar{\nu}_\ell$ etc	$c\bar{c} \to J/\psi$ $c\bar{c} \to \chi_c$	— $\chi_c \to J/\psi + \gamma$	—

Table 2.3: J/ψ production types.

pythia8108,lhapdf-5.5.0, MRSTMCal.LHgrid



pythia8135,lhapdf-5.9.1, MRSTMCal.LHgrid



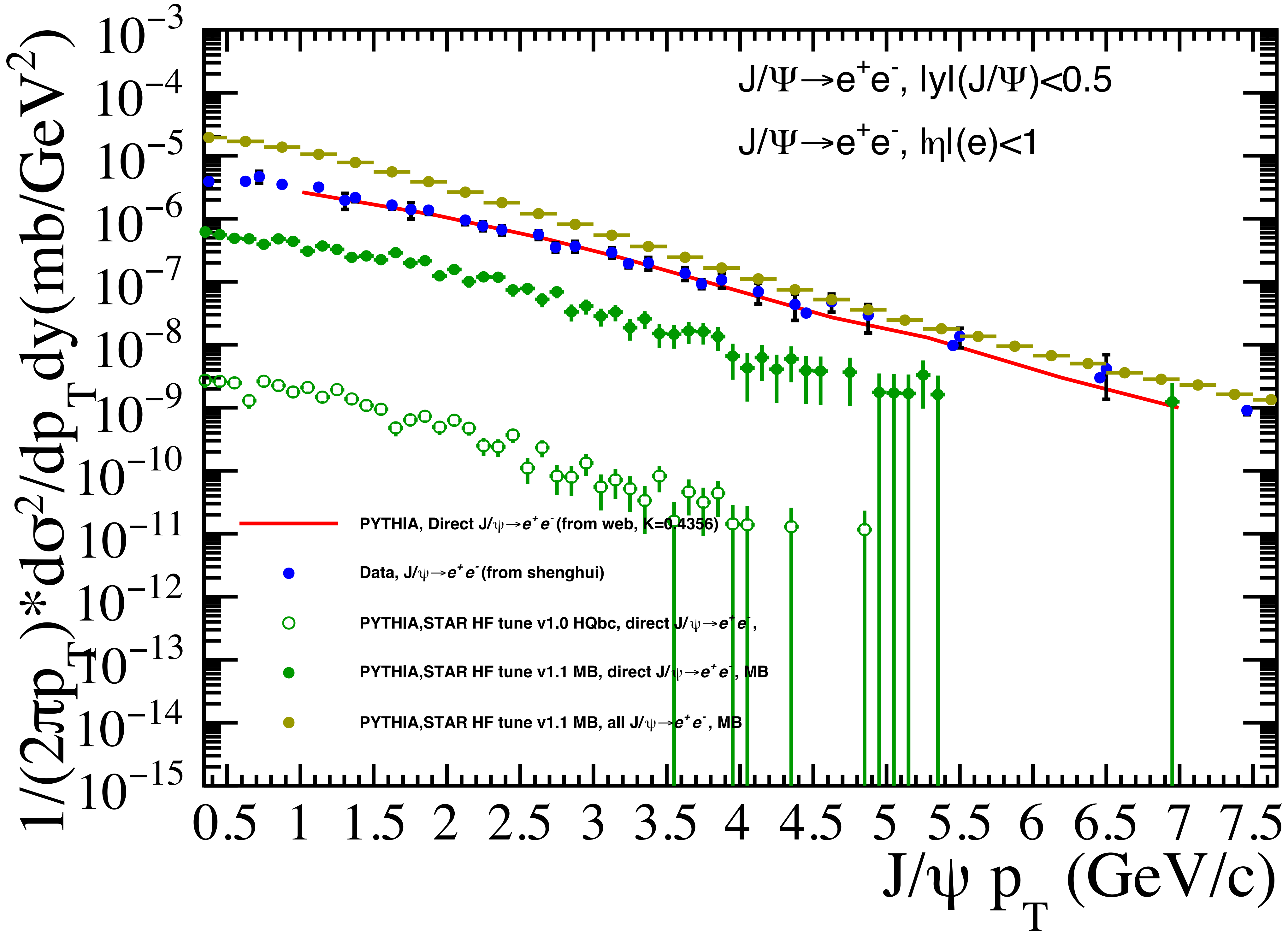
Process	K-factor	Descriptions
J/psi	0.4356	Direct J/psi production (no feed-down) normalized to BR*sigma=178 nb (PHENIX value)
Upsilon (1S)	0.6176	Gives 63 pb which is the current best estimate and supported by preliminary STAR data
NP-electrons	3	Gives a match somewhere in between PHENIX and STAR data. In Figure 2 applied to c and b.

Table 1: Approximate K Factors for the various processes for PYTHIA8 with STAR-HF Tune v1.0

compare with direct jpsi cross section from web

- pythia, star HF tune v1.1, MB: not consistent(even scaled by a const = 10)

direct Jpsi cross section



pythia8135,lhapdf-5.9.1, MRSTMCal.LHgrid

- **MB**
- **Hard QCD processes: heavy-flavour subset**

compare with direct jpsi cross section from web

- pythia, star HF tune v1.1, MB: not consistent
- pythia, star HF tune v1.0(seeting from web), HQ heavy: not consistent
- all jpsi, pythia, star HF tune v1.1, MB: not consistent
- data, from shenghui: consistent

e cross section

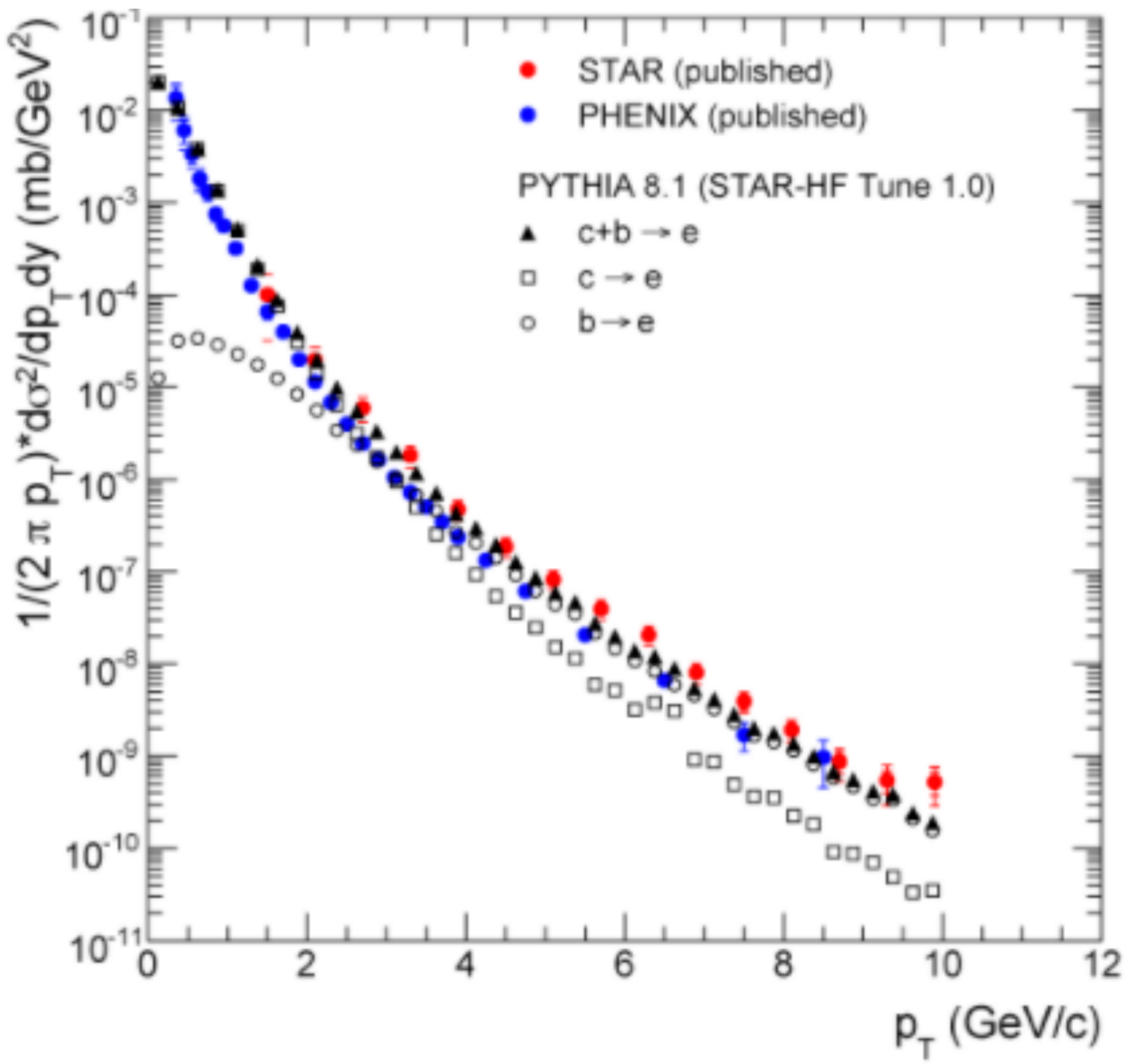
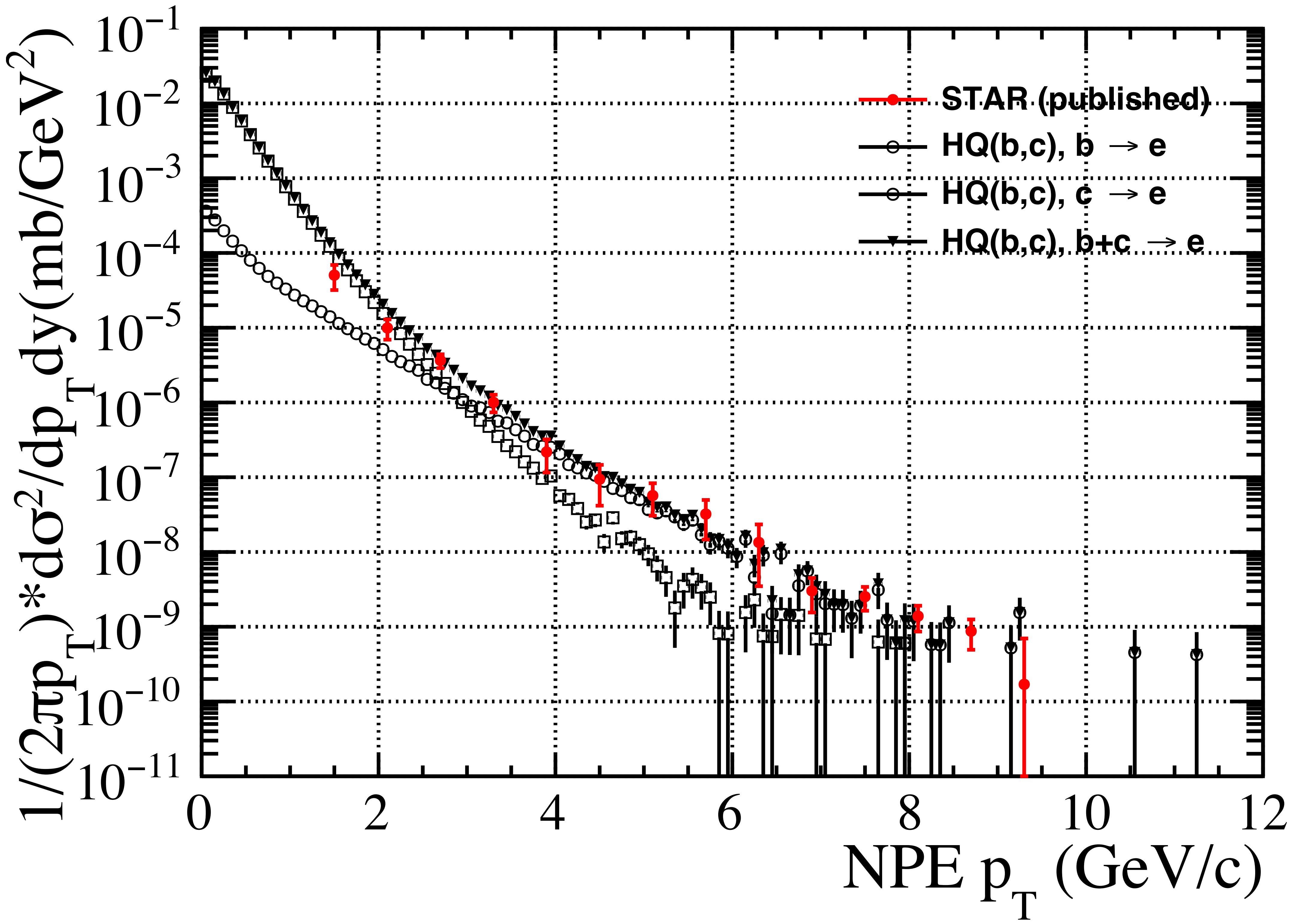


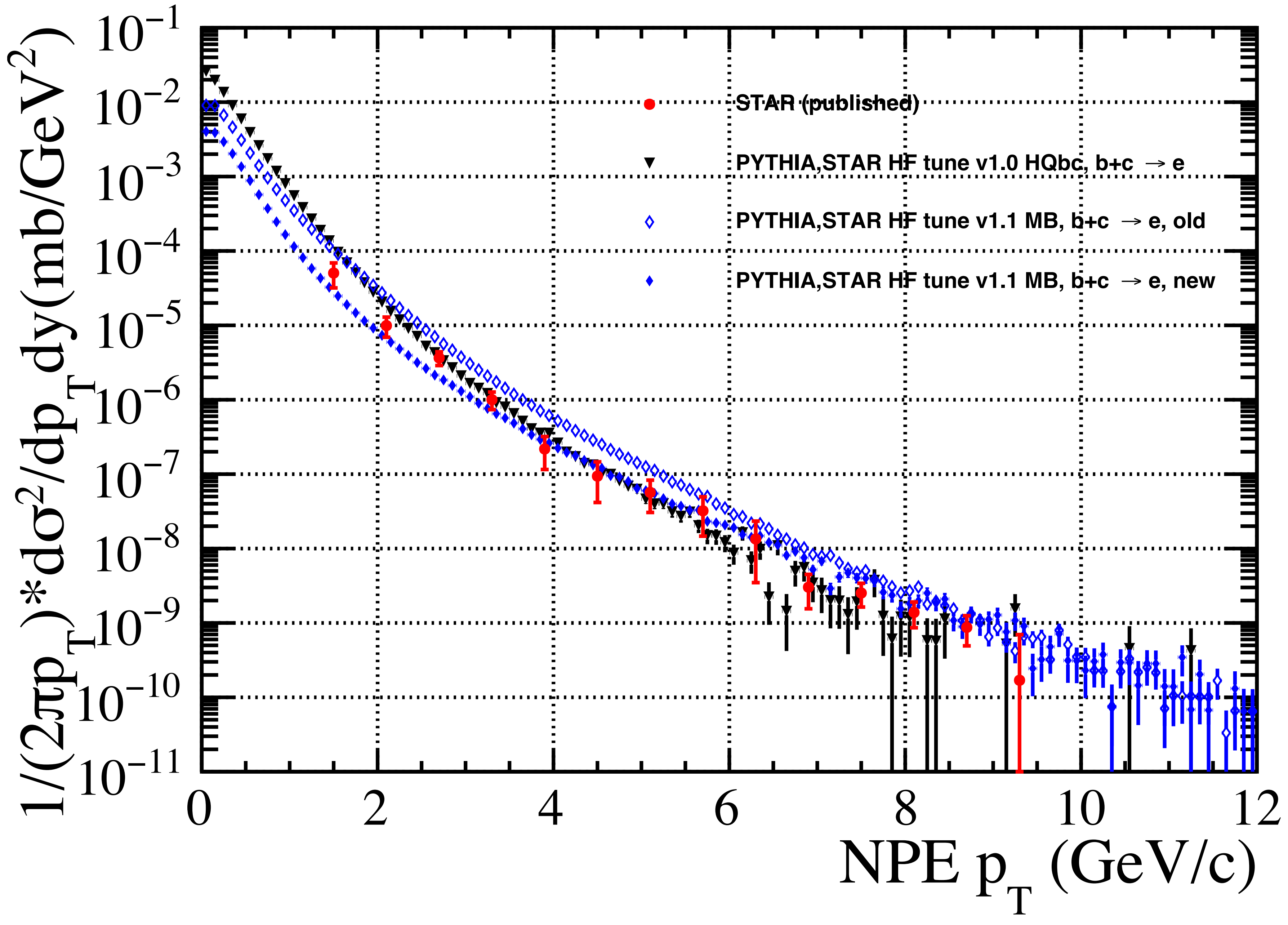
Figure 2: Comparison of NP-electrons data with results from PYTHIA8 with STAR-HF Tune v1.0 (-0.5 < y < 0.5).



compare with NPE cross section from web

- pythia, star HF tune v1.0(seeting from web), HQ heavy: not consistent
- low pt, don't see go down trend for b/c/npe decayed e

e cross section



compare with NPE cross section from web
- pythia, star HF tune v1.0(seeting from web), HQ heavy: not consistent
- pythia, star HF tune v1.1(old tune), MB: not consistent
- pythia, star HF tune v1.1 + CR(new tune), MB: not consistent

➡npe is also not consistent, either my code is wrong, or we don’t know how web get the result

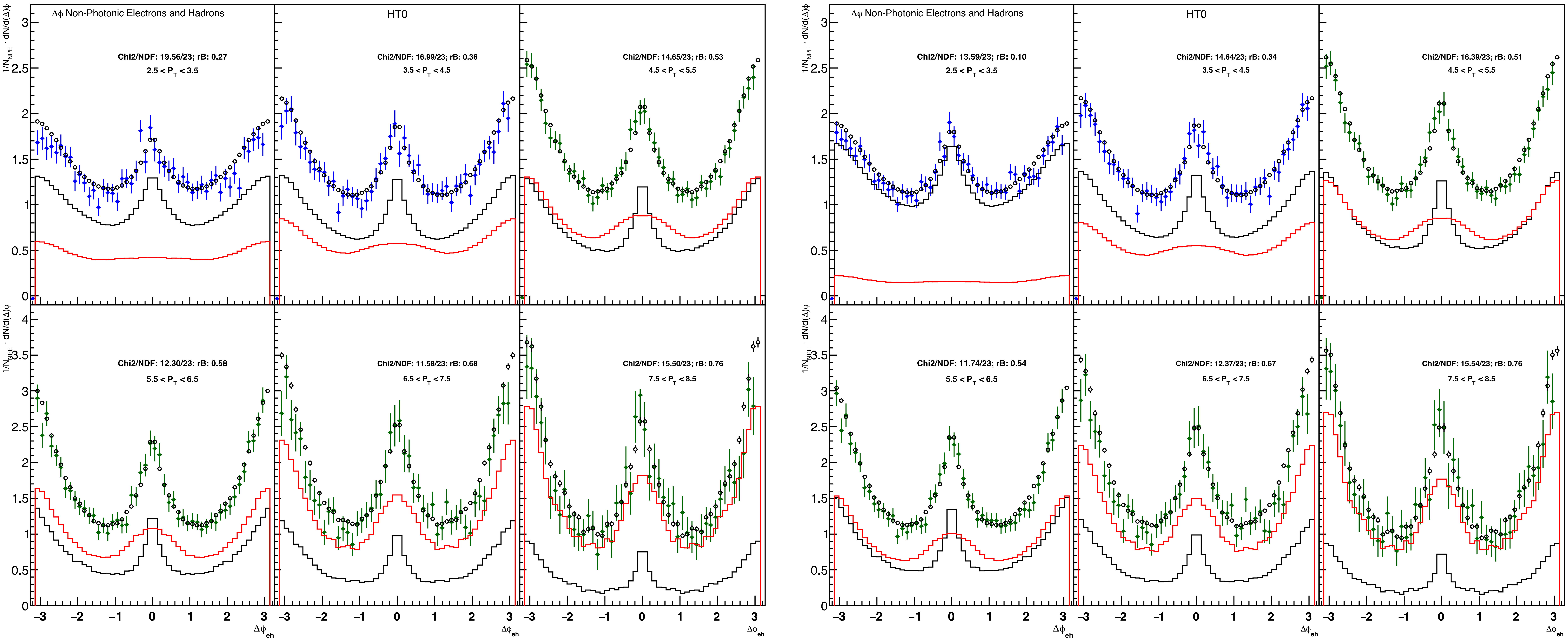
Summary for cross check

- compare with direct jpsi cross section from web
- data, from shenghui: consistent
- pythia, star HF tune v1.0(seeting from web), HQ heavy: not consistent
- pythia, star HF tune v1.1, MB: not consistent
- all jpsi, pythia, star HF tune v1.1, MB: not consistent

- compare with NPE cross section from web
- data, from shenghui:
- pythia, star HF tune v1.0(seeting from web), HQ heavy: not consistent
- pythia, star HF tune v1.1, MB: not consistent

backup

origin


Δφ Non-Photonic Electrons and Hadrons
HT0
Chi2/NDF: 19.56/23; rB: 0.27
2.5 < P_T < 3.5
Chi2/NDF: 16.99/23; rB: 0.36
3.5 < P_T < 4.5
Chi2/NDF: 14.65/23; rB: 0.53
4.5 < P_T < 5.5
Chi2/NDF: 12.30/23; rB: 0.58
5.5 < P_T < 6.5
Chi2/NDF: 11.58/23; rB: 0.68
6.5 < P_T < 7.5
Chi2/NDF: 15.50/23; rB: 0.76
7.5 < P_T < 8.5
Δφ Non-Photonic Electrons and Hadrons
HT0
Chi2/NDF: 13.59/23; rB: 0.10
2.5 < P_T < 3.5
Chi2/NDF: 14.64/23; rB: 0.34
3.5 < P_T < 4.5
Chi2/NDF: 16.39/23; rB: 0.51
4.5 < P_T < 5.5
Chi2/NDF: 11.74/23; rB: 0.54
5.5 < P_T < 6.5
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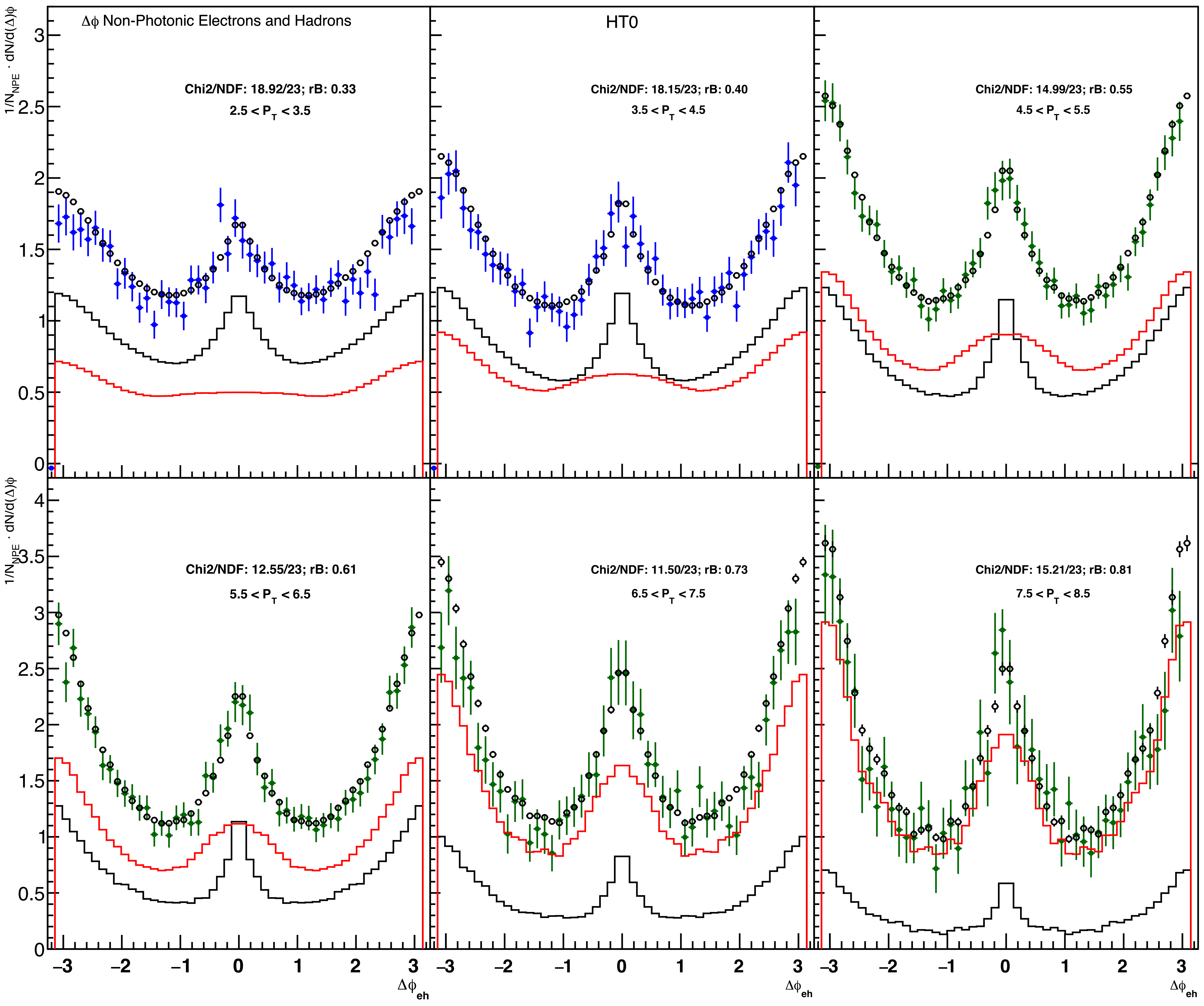
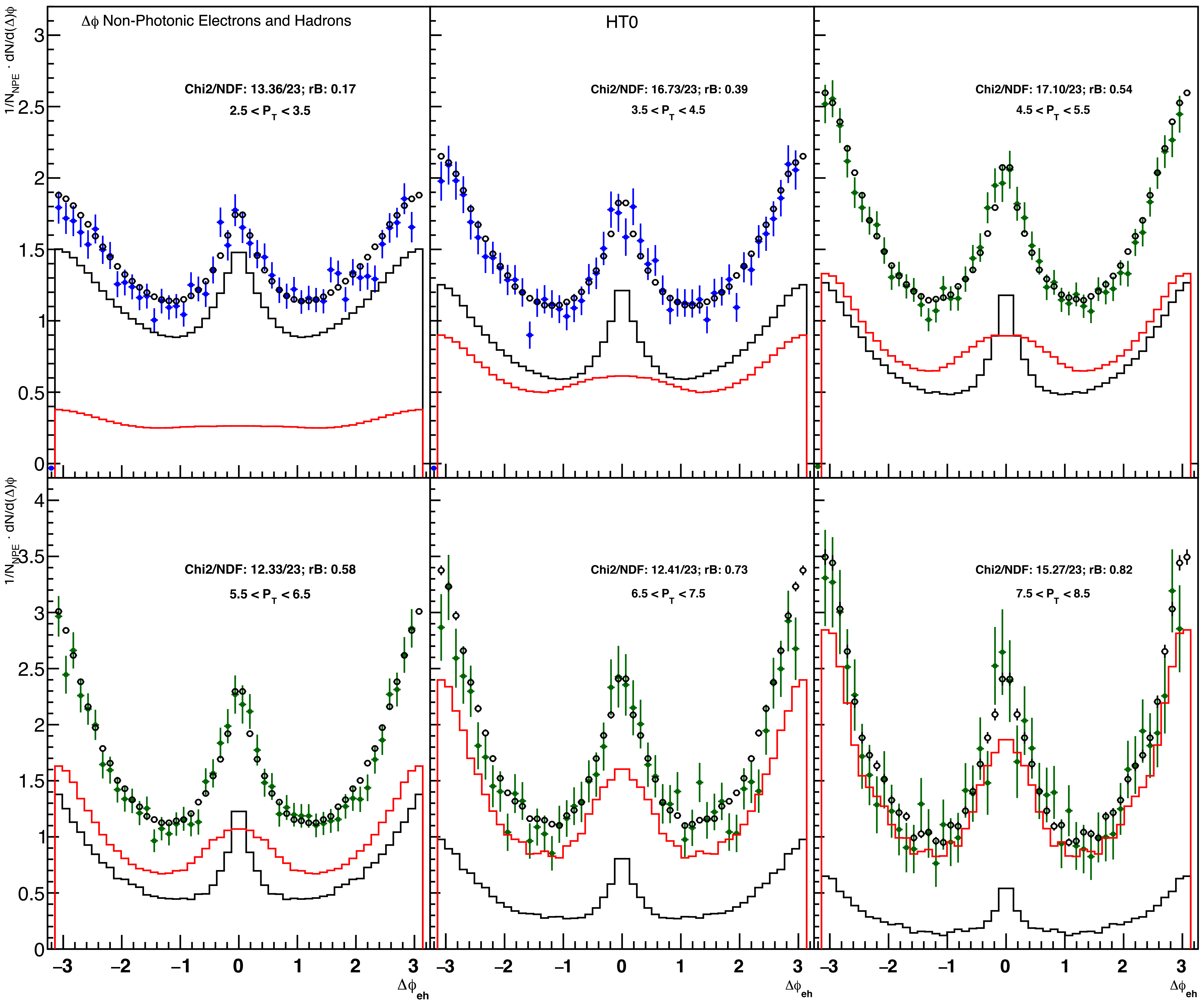
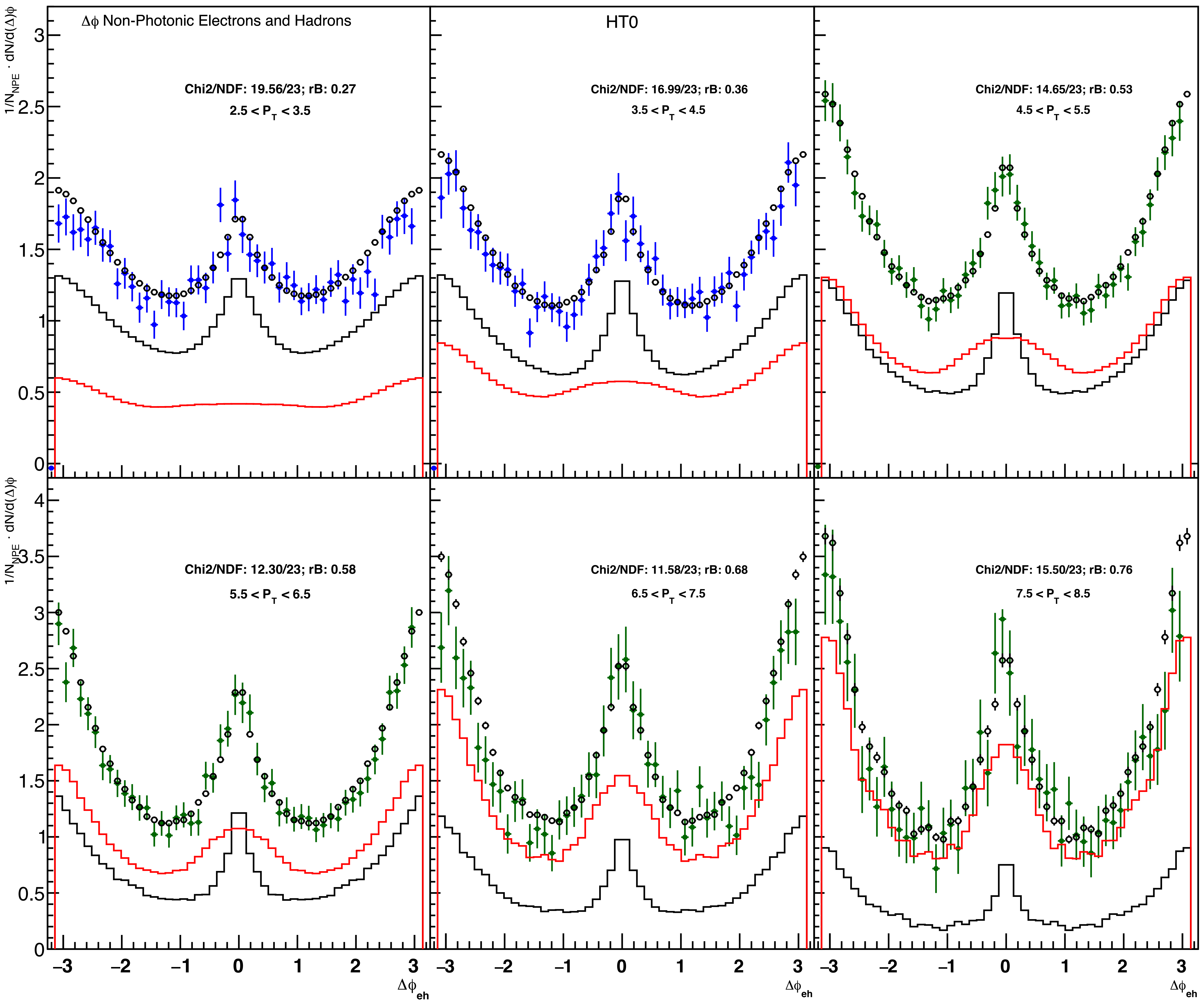
7.5 < P_T < 8.5
1/N_NPE · dN/d(Δ)φ
Δφ_eh

add split cut





origin



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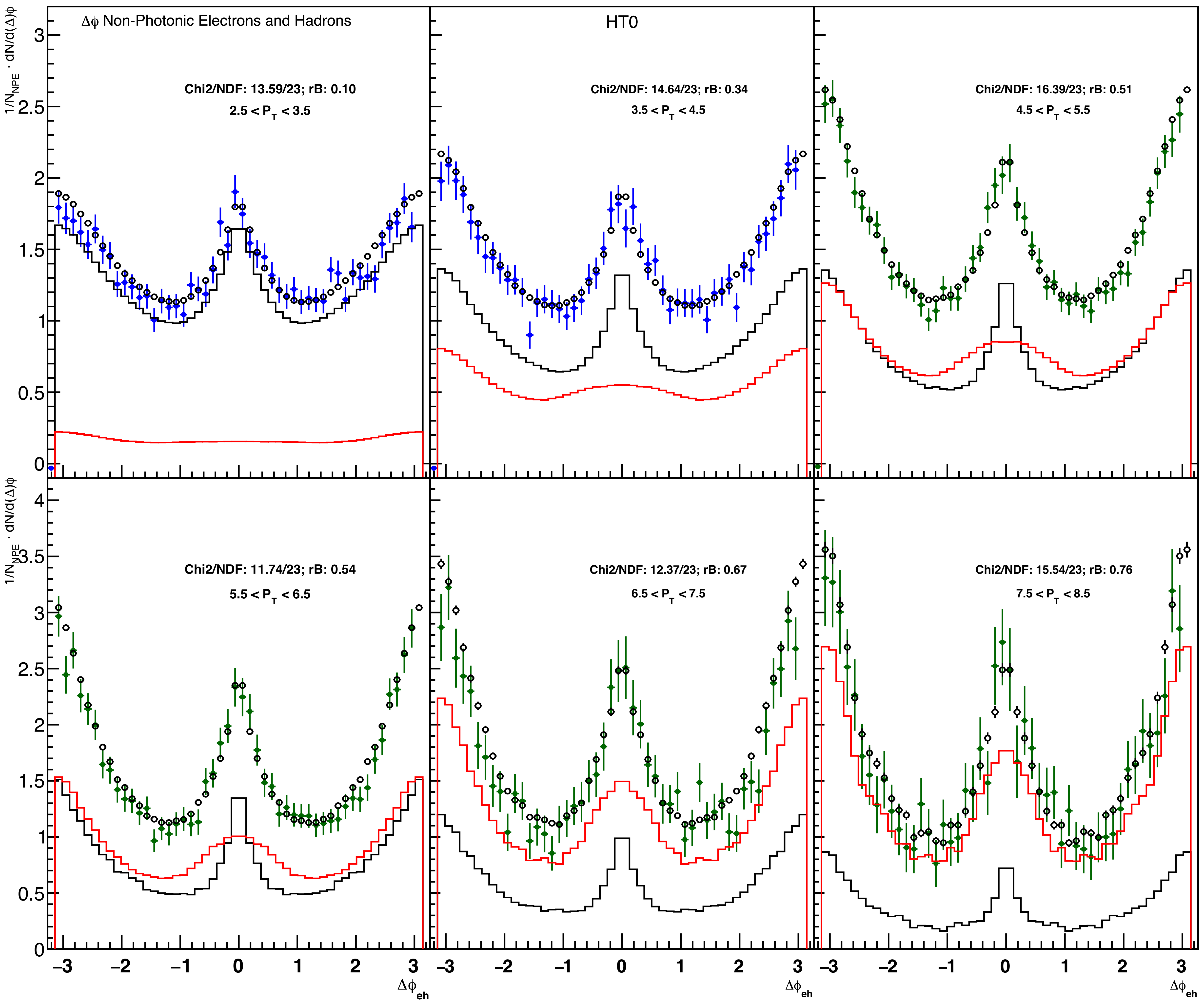

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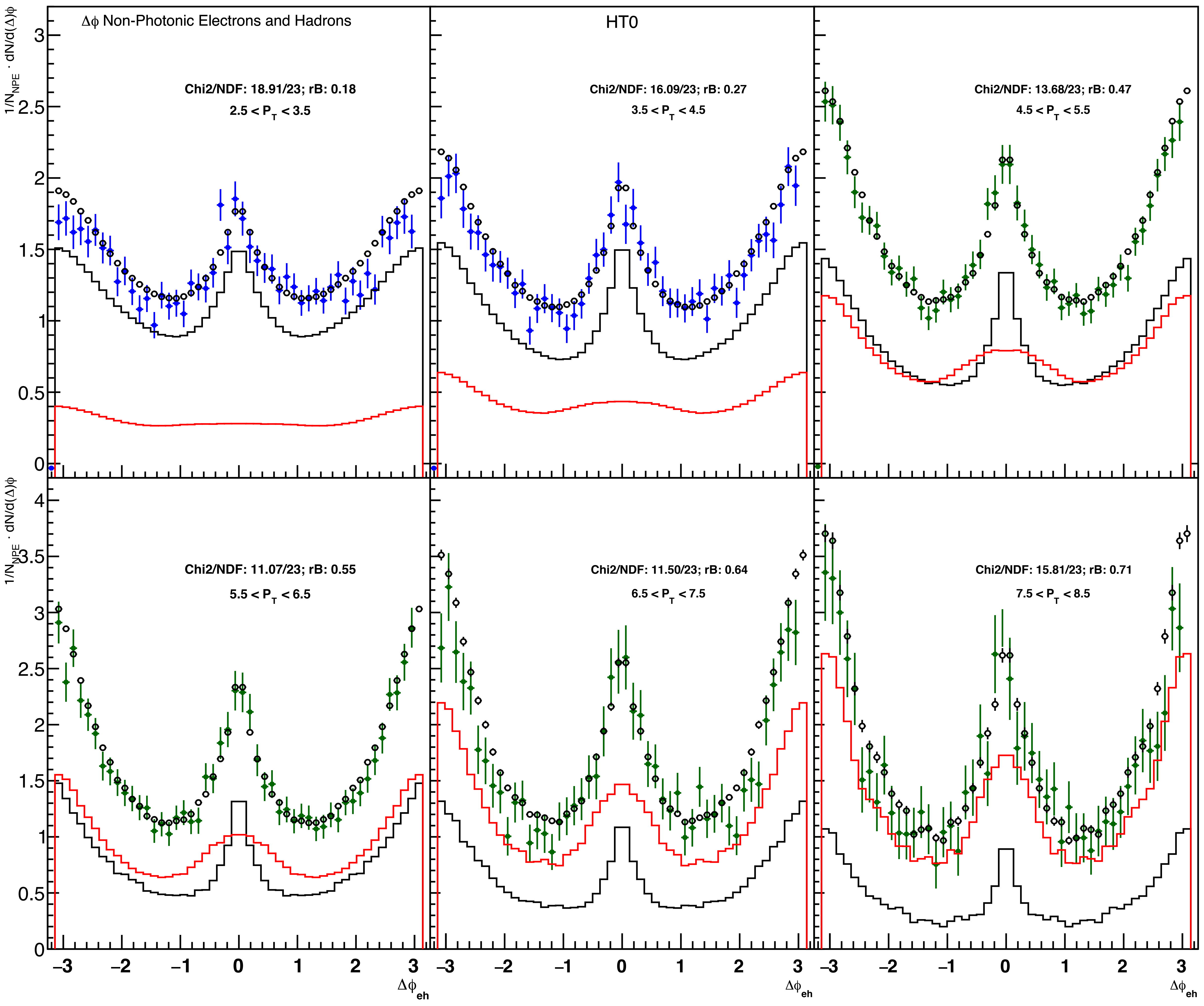
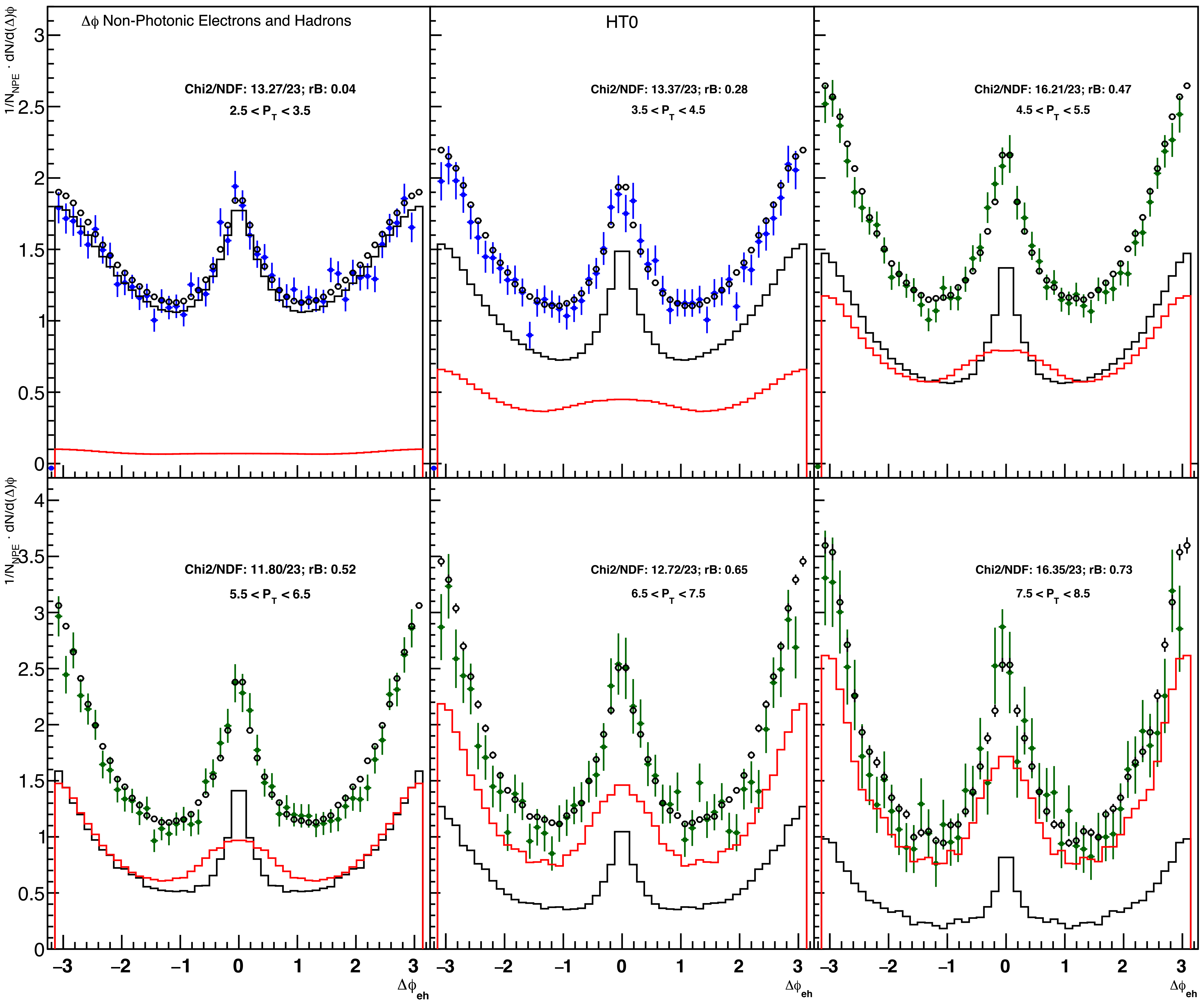
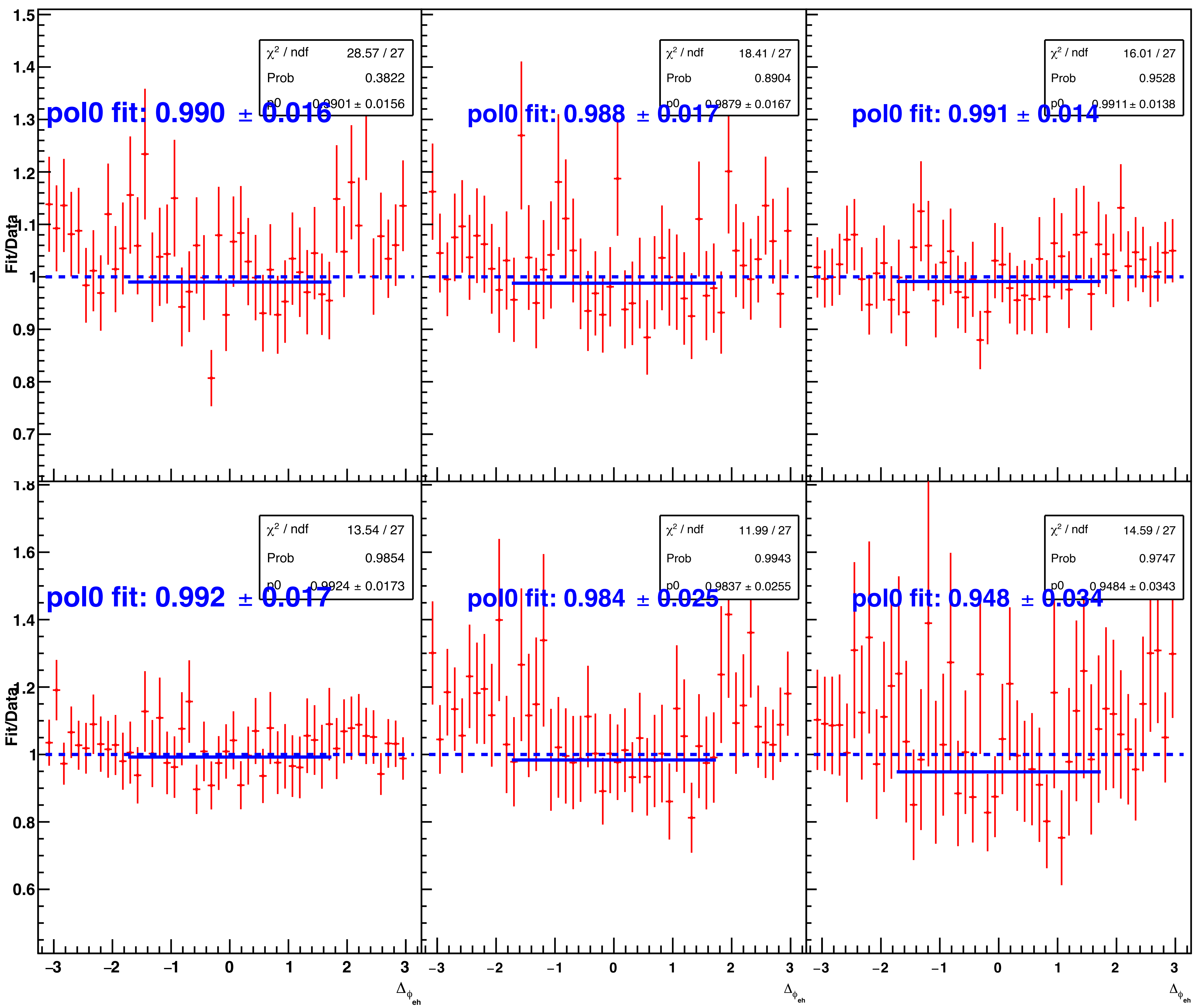
1/N_NPE · dN/d(Δ)φ
Δφ_eh

add split cut, use like sign partner e

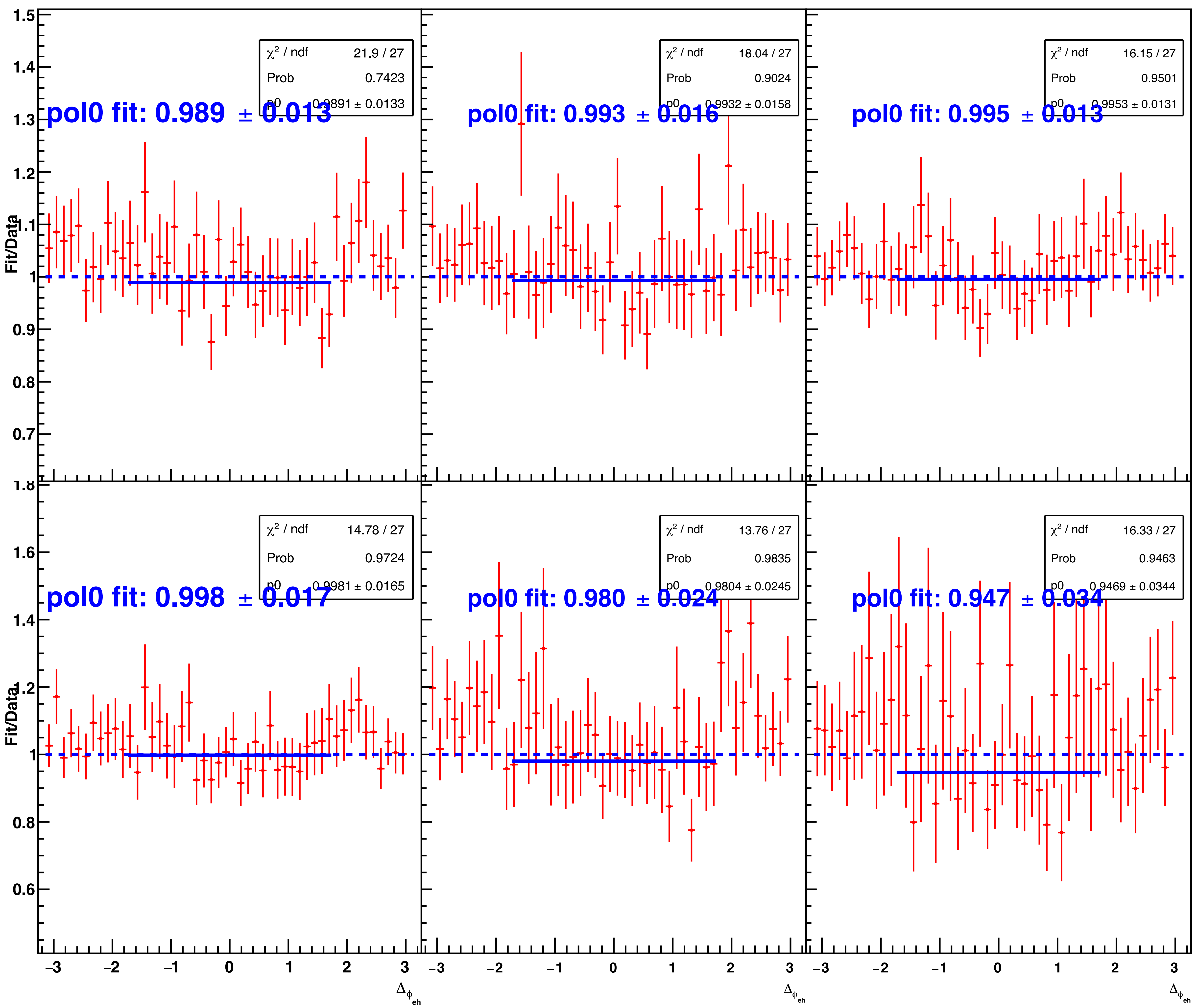




origin

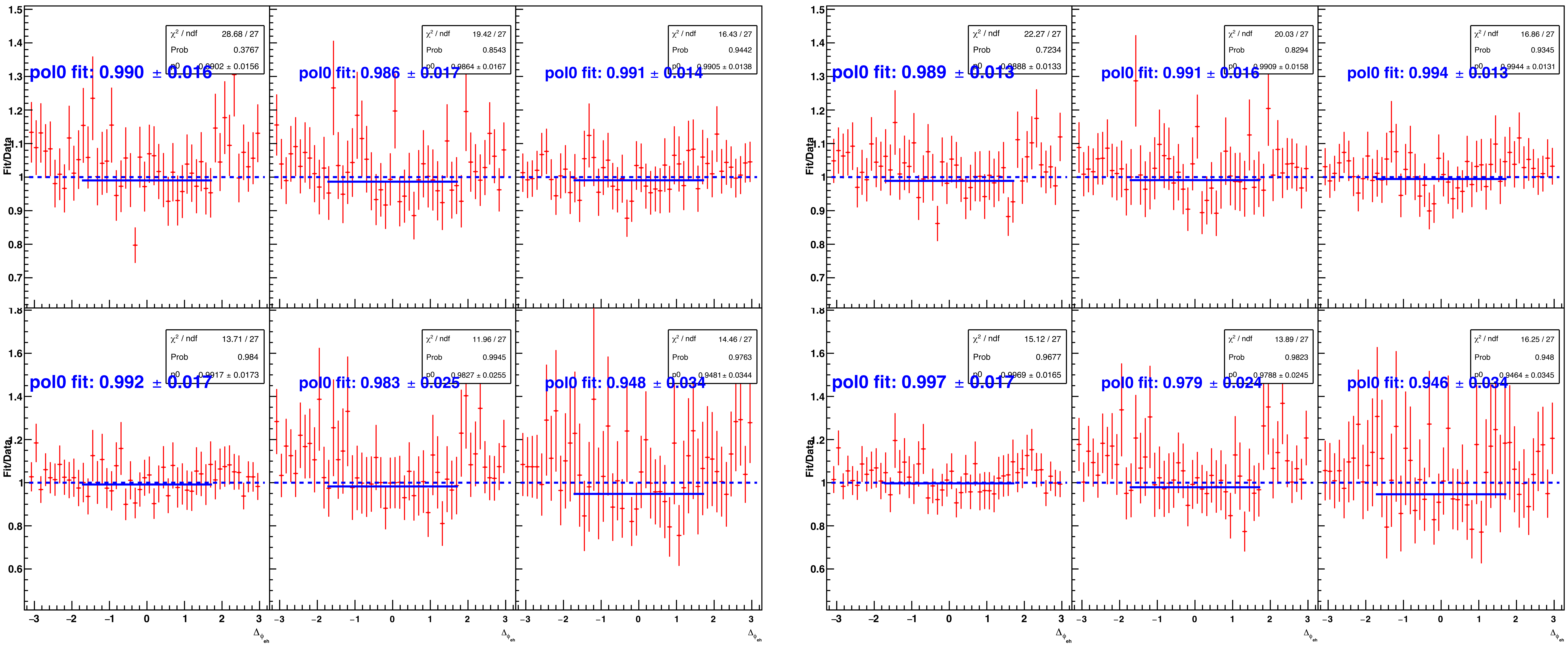


pol0 fit: 0.990 ± 0.016
pol0 fit: 0.988 ± 0.017
pol0 fit: 0.991 ± 0.014
pol0 fit: 0.992 ± 0.017
pol0 fit: 0.984 ± 0.025
pol0 fit: 0.948 ± 0.034
Fit/Data
$\Delta_{\phi_{eh}}$

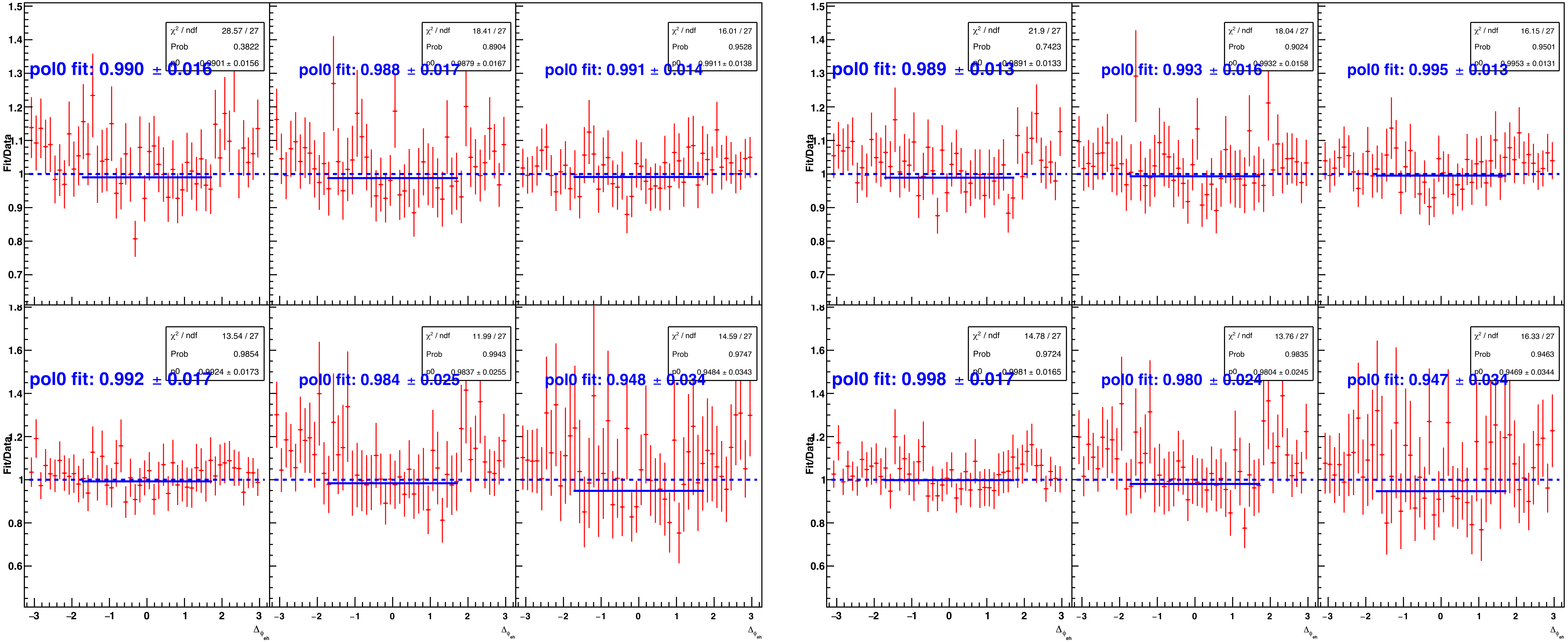


pol0 fit: 0.989 ± 0.013
pol0 fit: 0.993 ± 0.016
pol0 fit: 0.995 ± 0.013
pol0 fit: 0.998 ± 0.017
pol0 fit: 0.980 ± 0.024
pol0 fit: 0.947 ± 0.034
Fit/Data
$\Delta_{\phi_{eh}}$

add split cut



origin



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Fit/Data

add split cut, use like sign partner e