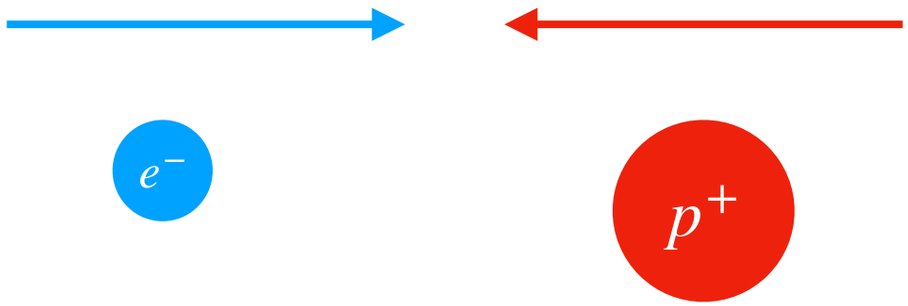
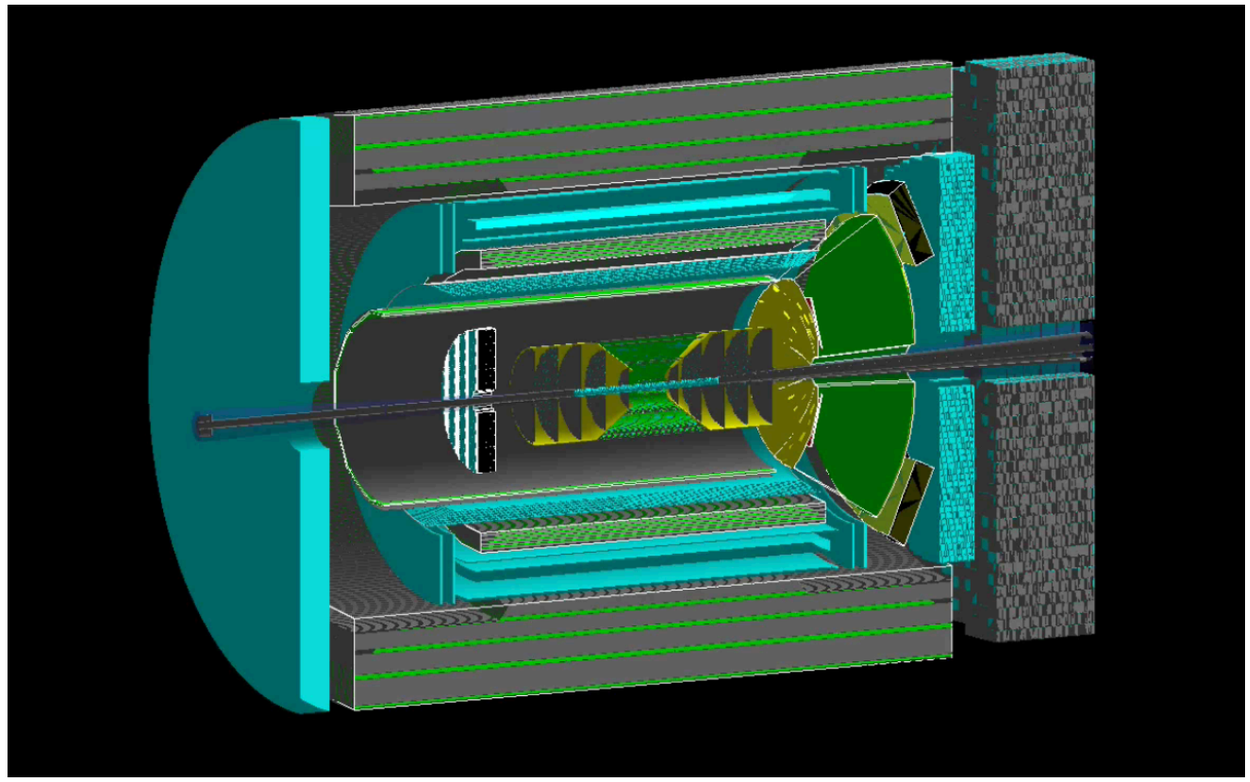
EIC All-Silicon Jets

Jets in e+P PYTHIA Simulation

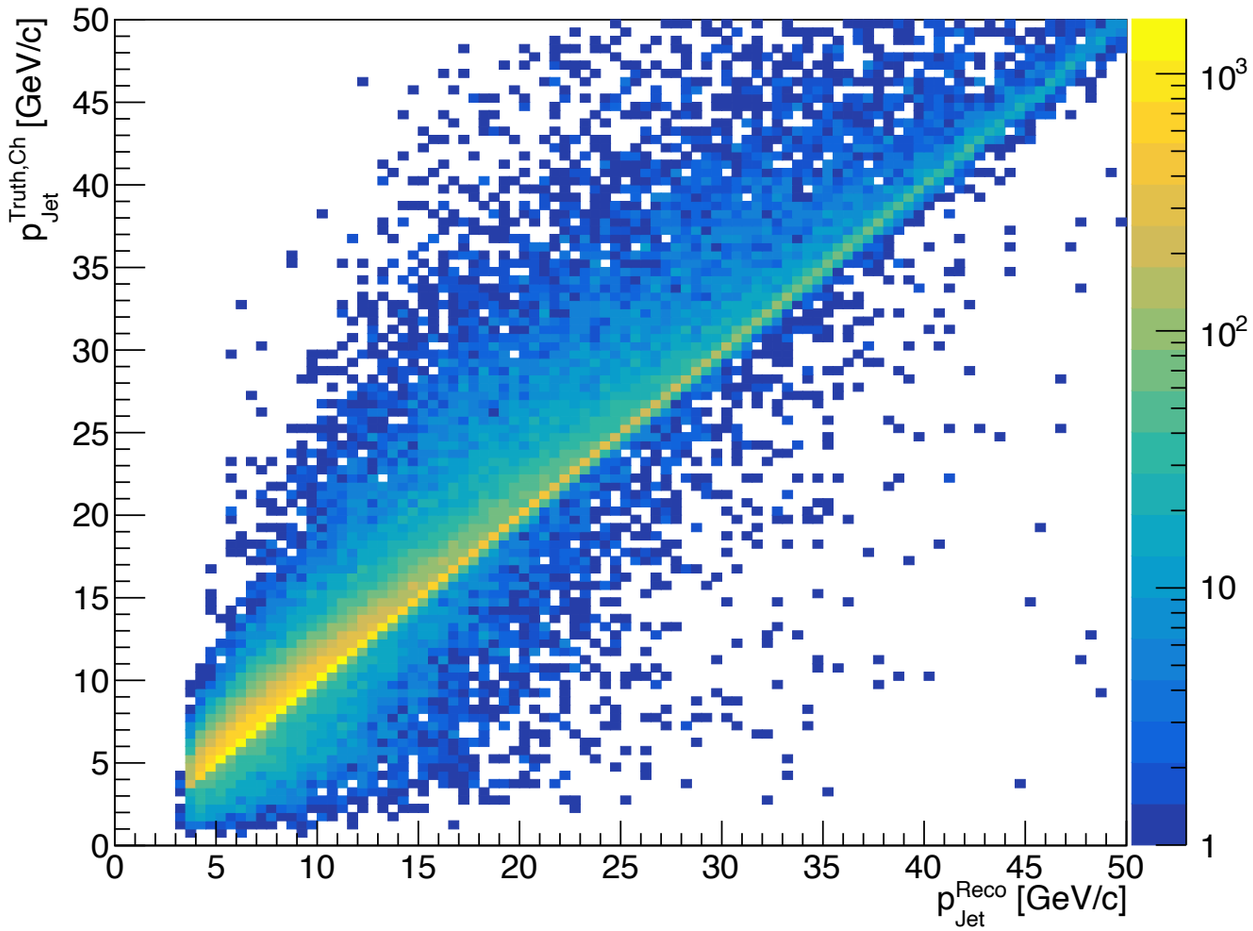




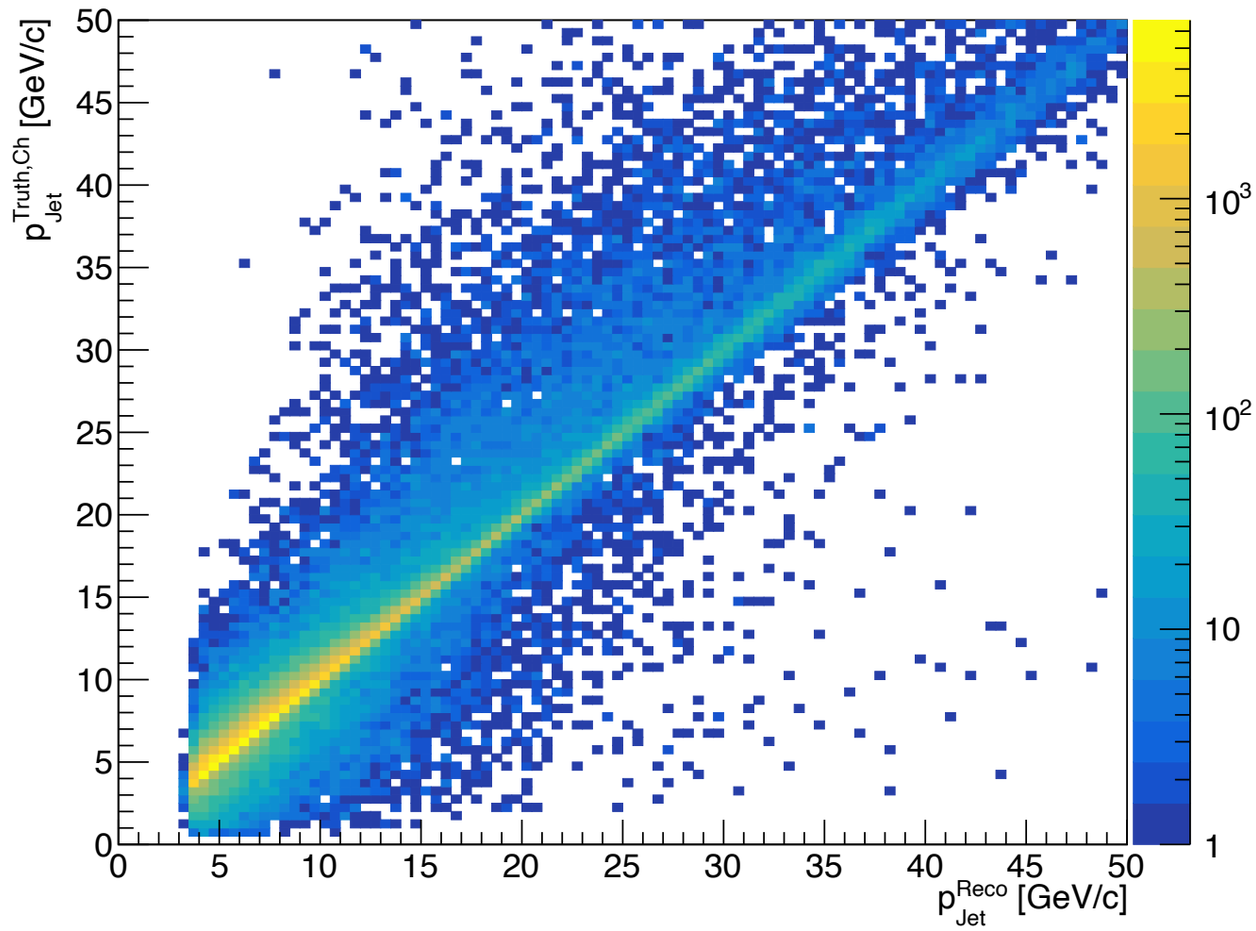
- PYTHIA 8
  - $Q^2_{\text{min}} \geq 16$ (GeV/c^2)^2
  - $\sqrt{s} = 89$ GeV
  - Electron beam: 20 GeV
  - Proton beam: 100 GeV
- Jets
  - Charged Jets
  - $E^{\text{Jet}}_{\text{Reco}} > 4.0$ GeV
  - Anti-k_{T} $R = 1.0$
  - ΔR (jet-electron) > 0.5
    - “Electron Veto”
- Jet Constituents
  - $N_{\text{constituents}} \geq 4$
  - $p^{\text{constituent}} \geq 60$ MeV/c
  - η-dependent $p_{\text{T}}^{\text{constituent}}$ cut
  - Cut $1.06 < |\eta| < 1.13$
    - Central barrel meets forward layers

Charged Jet Momentum Response

$B = 3.0$ T

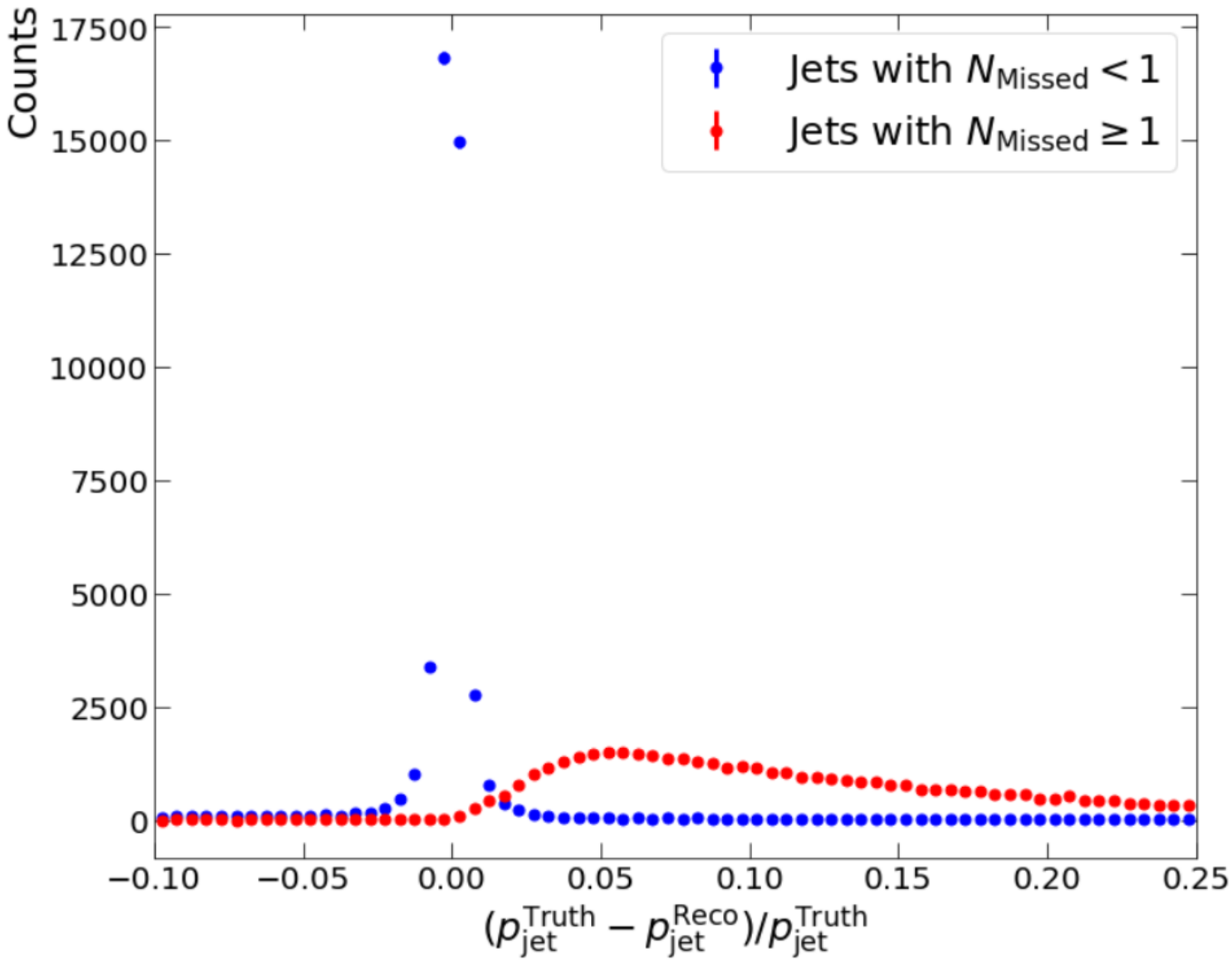


$B = 1.4$ T



Clear truth-reco correlation, but with significant number of off-diagonal hits

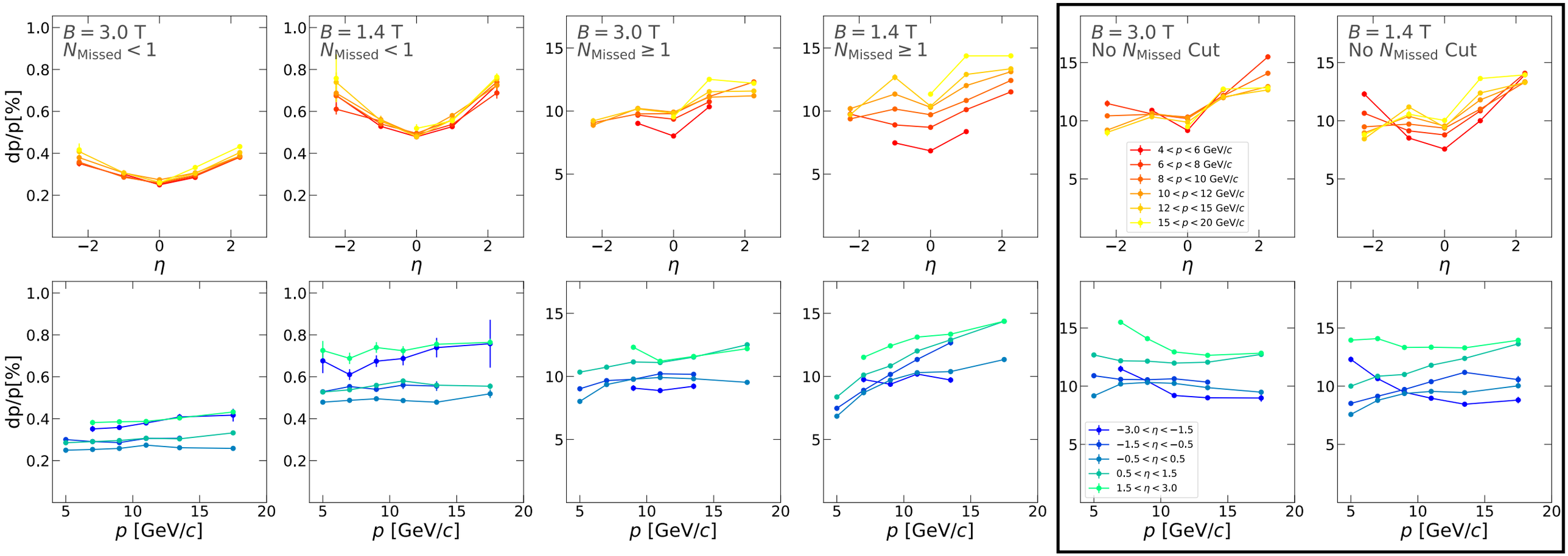
Two Populations of Jets



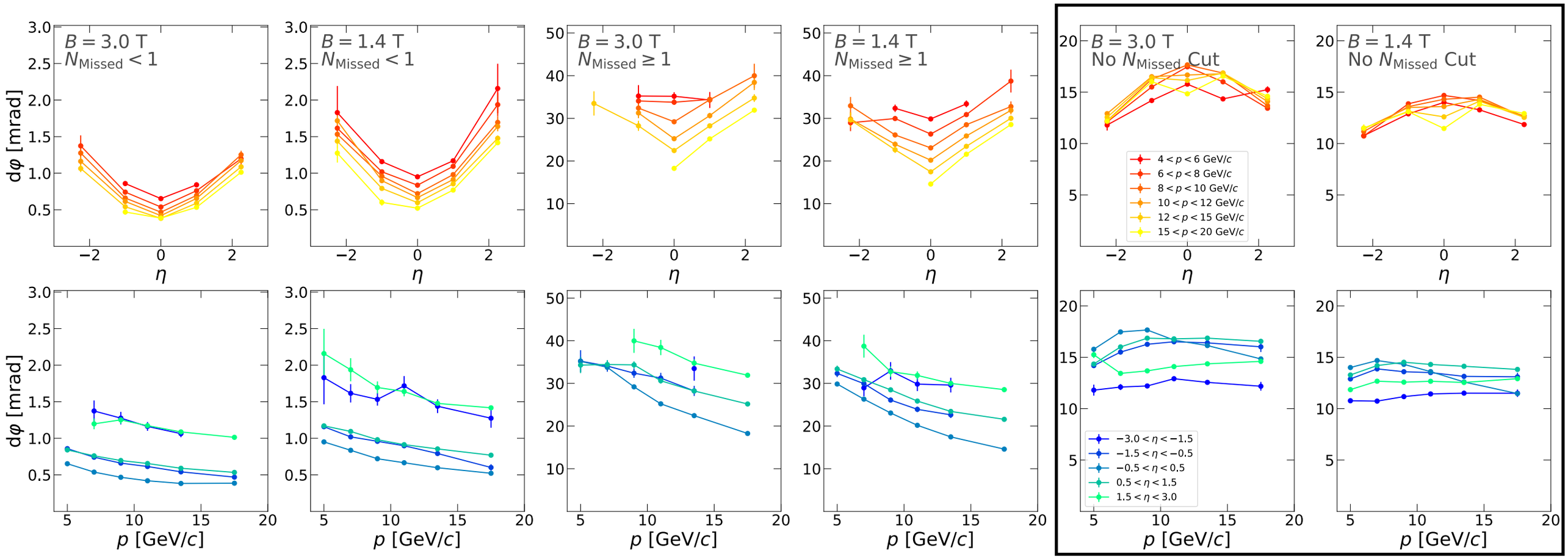
Number of Missed Charged Constituents:

$$N_{\text{missed}} = N_{\text{constituents}}^{\text{truth}} - N_{\text{constituents}}^{\text{reco}} - N_{\text{neutral}}^{\text{truth}}$$

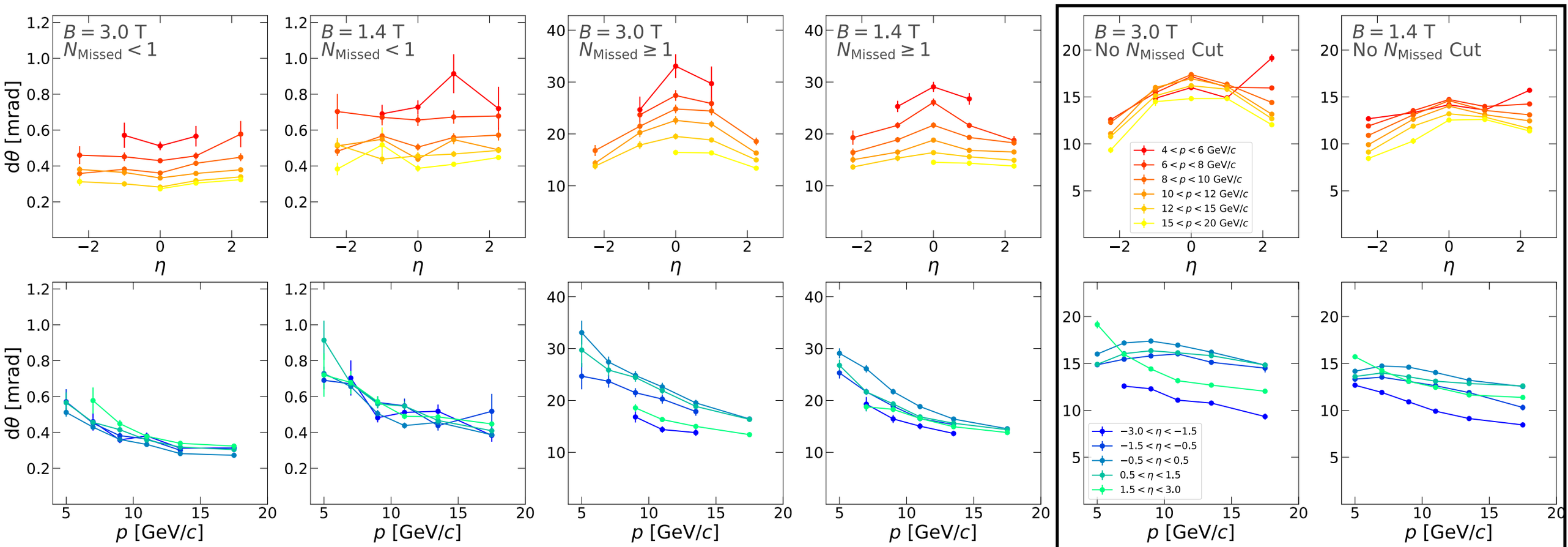
$\mathrm{d}P/P$


$B = 3.0$ T
$N_{\mathrm{Missed}} < 1$
$B = 1.4$ T
$N_{\mathrm{Missed}} < 1$
$B = 3.0$ T
$N_{\mathrm{Missed}} \geq 1$
$B = 1.4$ T
$N_{\mathrm{Missed}} \geq 1$
$B = 3.0$ T
No N_{Missed} Cut
$B = 1.4$ T
No N_{Missed} Cut
dp/p[%]
η
p [GeV/c]
$4 < p < 6$ GeV/c
$6 < p < 8$ GeV/c
$8 < p < 10$ GeV/c
$10 < p < 12$ GeV/c
$12 < p < 15$ GeV/c
$15 < p < 20$ GeV/c
$-3.0 < \eta < -1.5$
$-1.5 < \eta < -0.5$
$-0.5 < \eta < 0.5$
$0.5 < \eta < 1.5$
$1.5 < \eta < 3.0$

φ Resolution



θ Resolutions



Charged Jet EIC Observables

1. Electron-Jet Correlations
   - Sensitive to p_{T} broadening effects in e+A
   - Can constrain $\hat{q}L$, and TMD of nucleus

2. Charged Jet Fragmentation Function

Luminosity Scaling

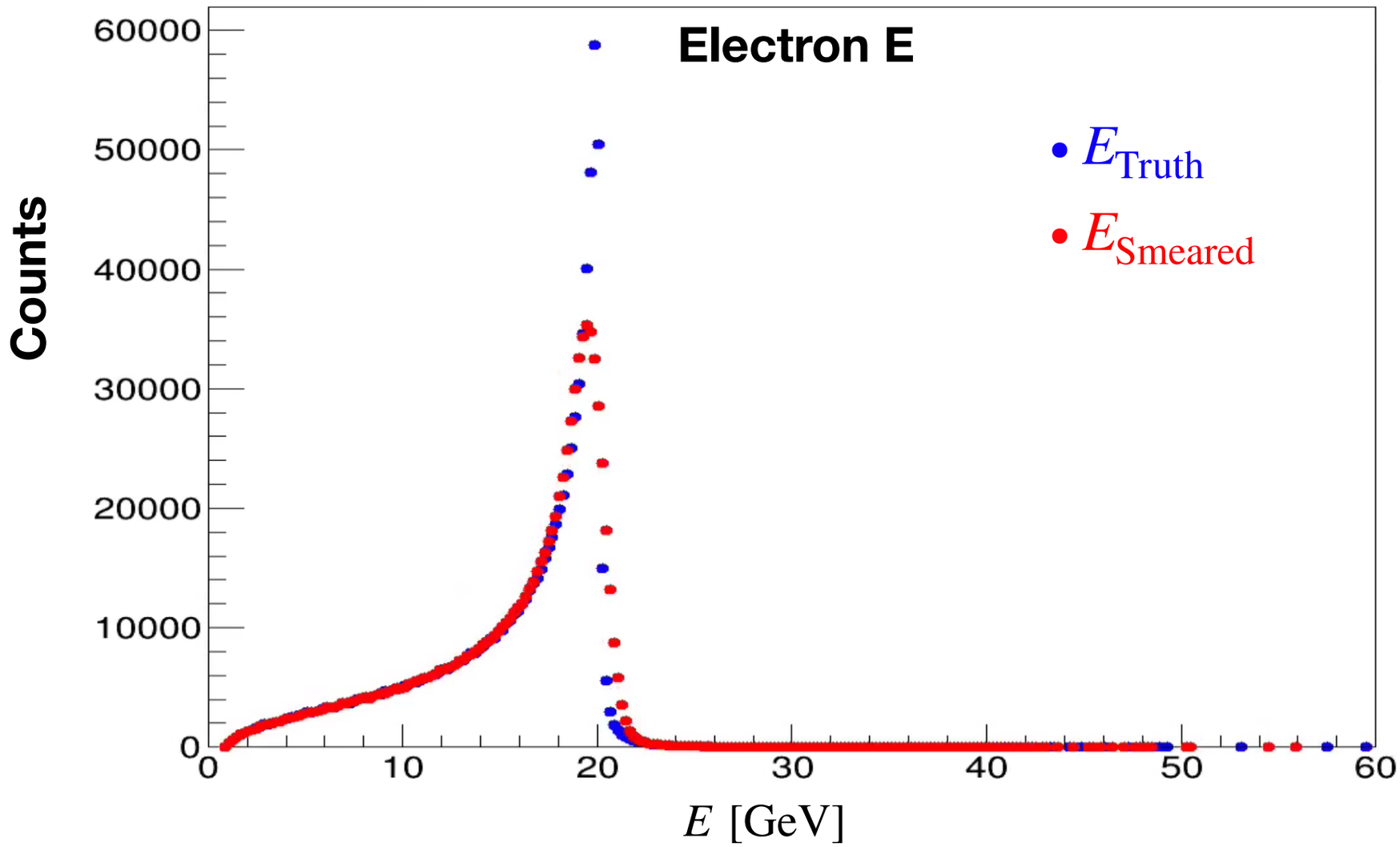
- $L_{\text{EIC}} = 10\ \text{fb}^{-1}$
- $L_{\text{gen}} = N_{\text{events}}/\sigma_{e+p}$ ⟶
- Scale = $L_{\text{EIC}}/L_{\text{gen}}$

- $\sigma_{e+p} = 9.27 \times 10^{-5}\text{mb}$
- $N_{\text{events}} \approx 2{,}000{,}000$
- $L_{\text{gen}} = 2.49\ \text{fb}^{-1}$

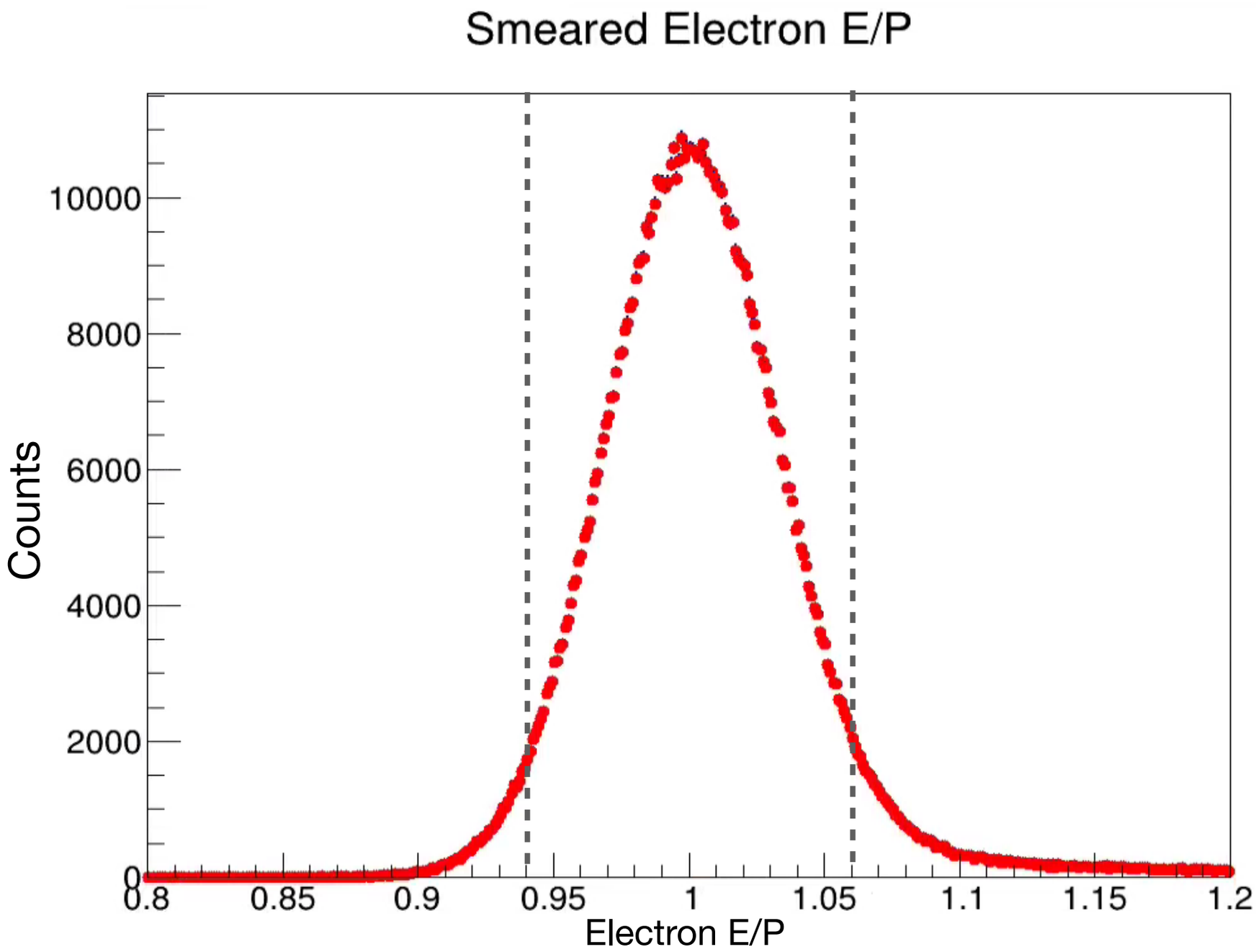
Scale = 0.401

Electron Smearing + E/P cut

- Smear electron energy in order to simulate an E/P selection
- From YR, backwards EMCal requirement:
  - $\sigma(E)/E \approx 2\,\%/\sqrt{E} \oplus (1-3)\,\%$
  - Obtain σ_E, and smear E according to Gaussian distribution ($\mu = E$, $\sigma = \sigma_E$)
  - Example: $E = 20.4$, $\sigma_E = 0.62$, $E_{\text{smeared}} = 20.6$



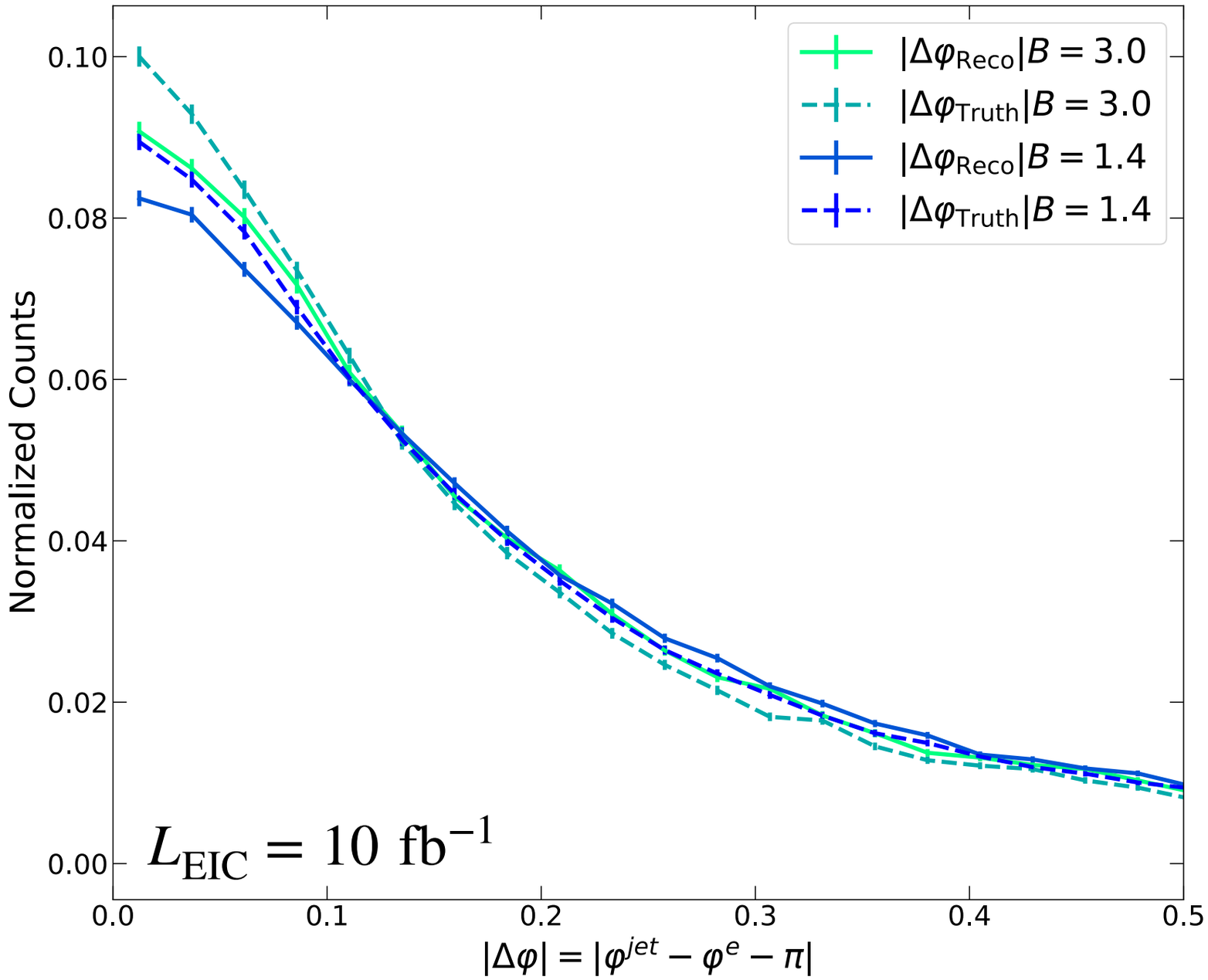
E/P Selection



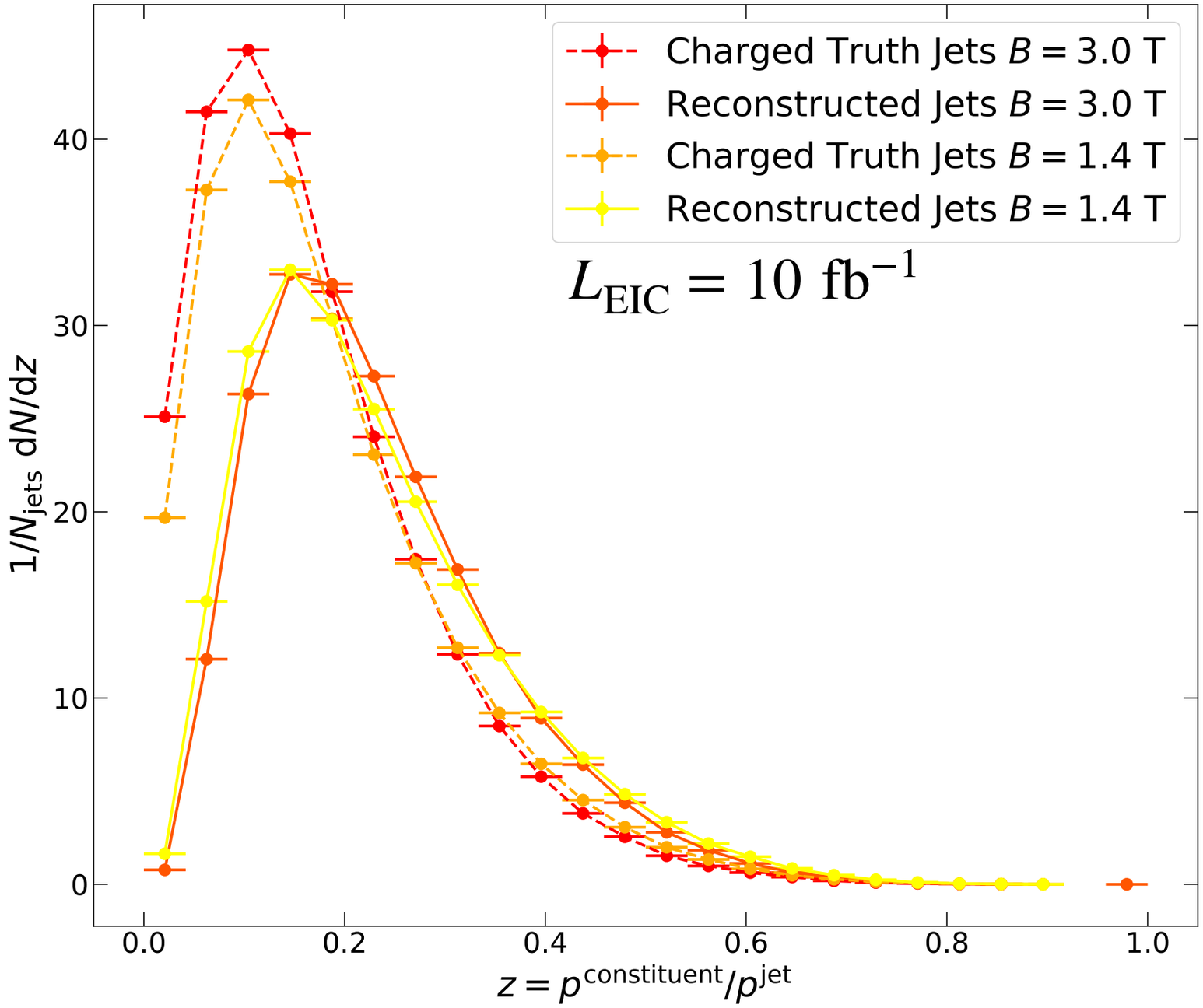
Indicates smearing working as intended (clear gaus distribution)

Applying a 2σ cut, $\sigma_{\mathrm{E/P}} = 0.03$

Electron-Jet Correlation

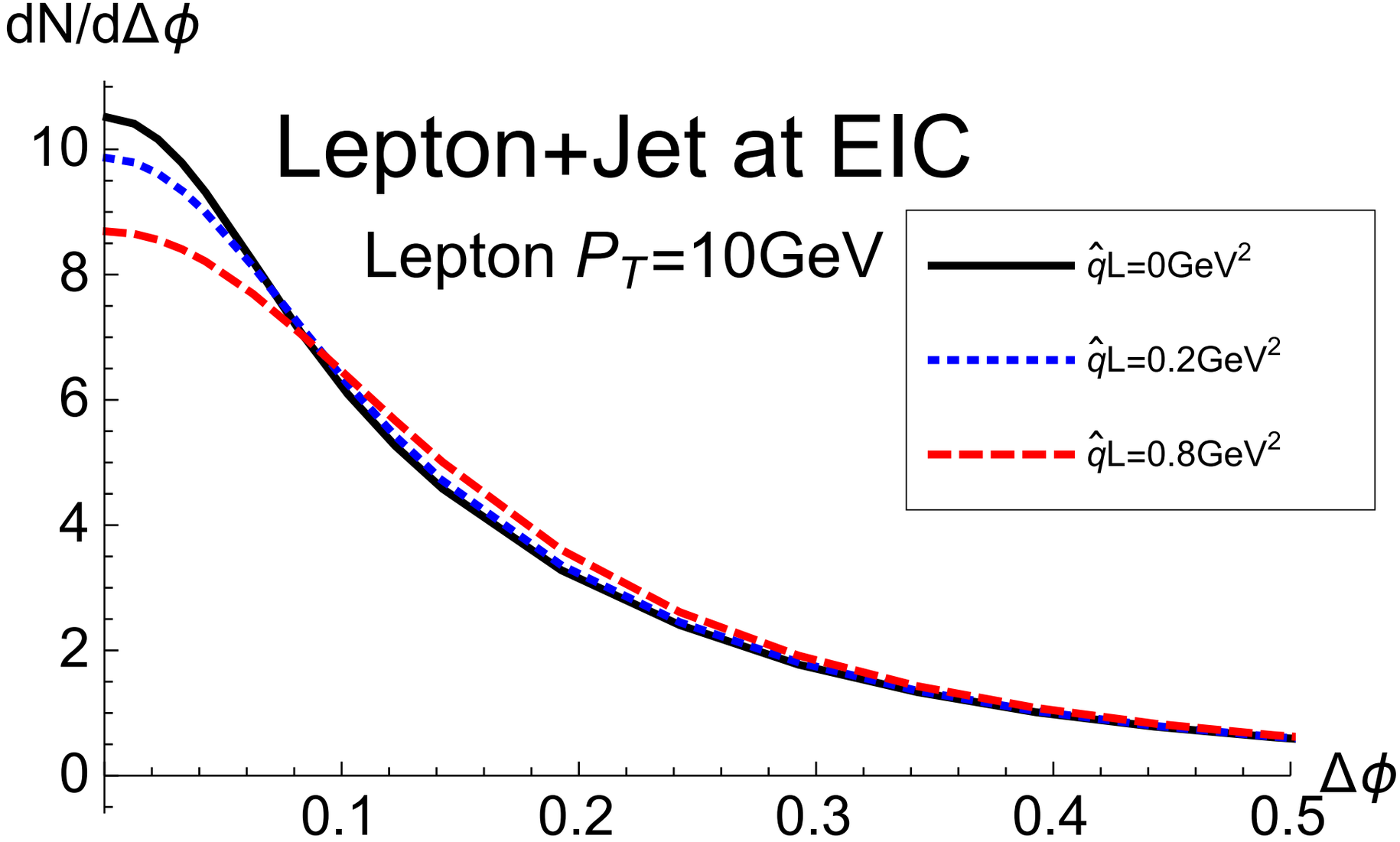


Charged Jet Fragmentation

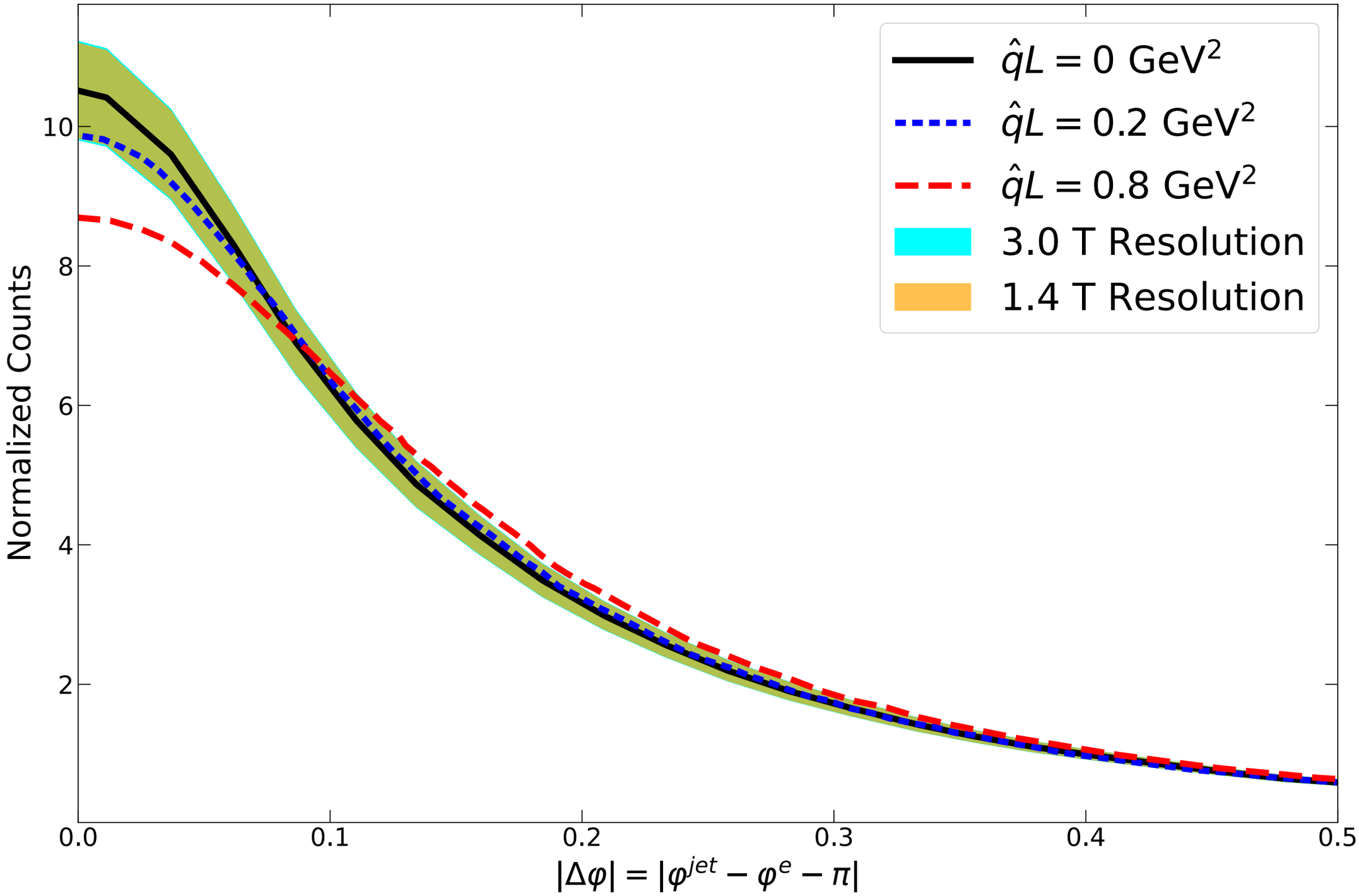


Lepton+Jet Theory

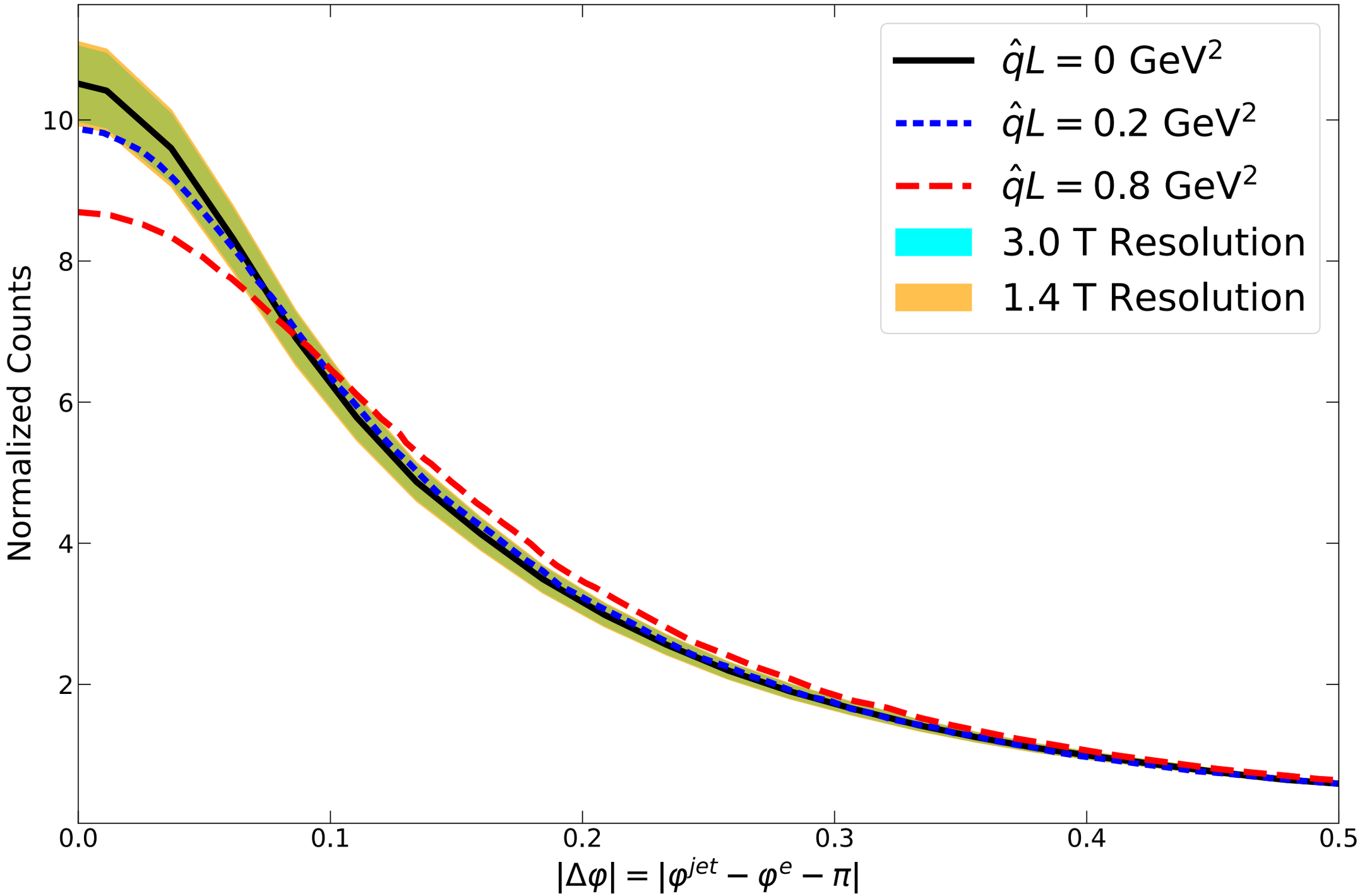
- Lepton+Jet Correlations for different $\hat{q}L$
  - https://arxiv.org/pdf/1812.08077.pdf



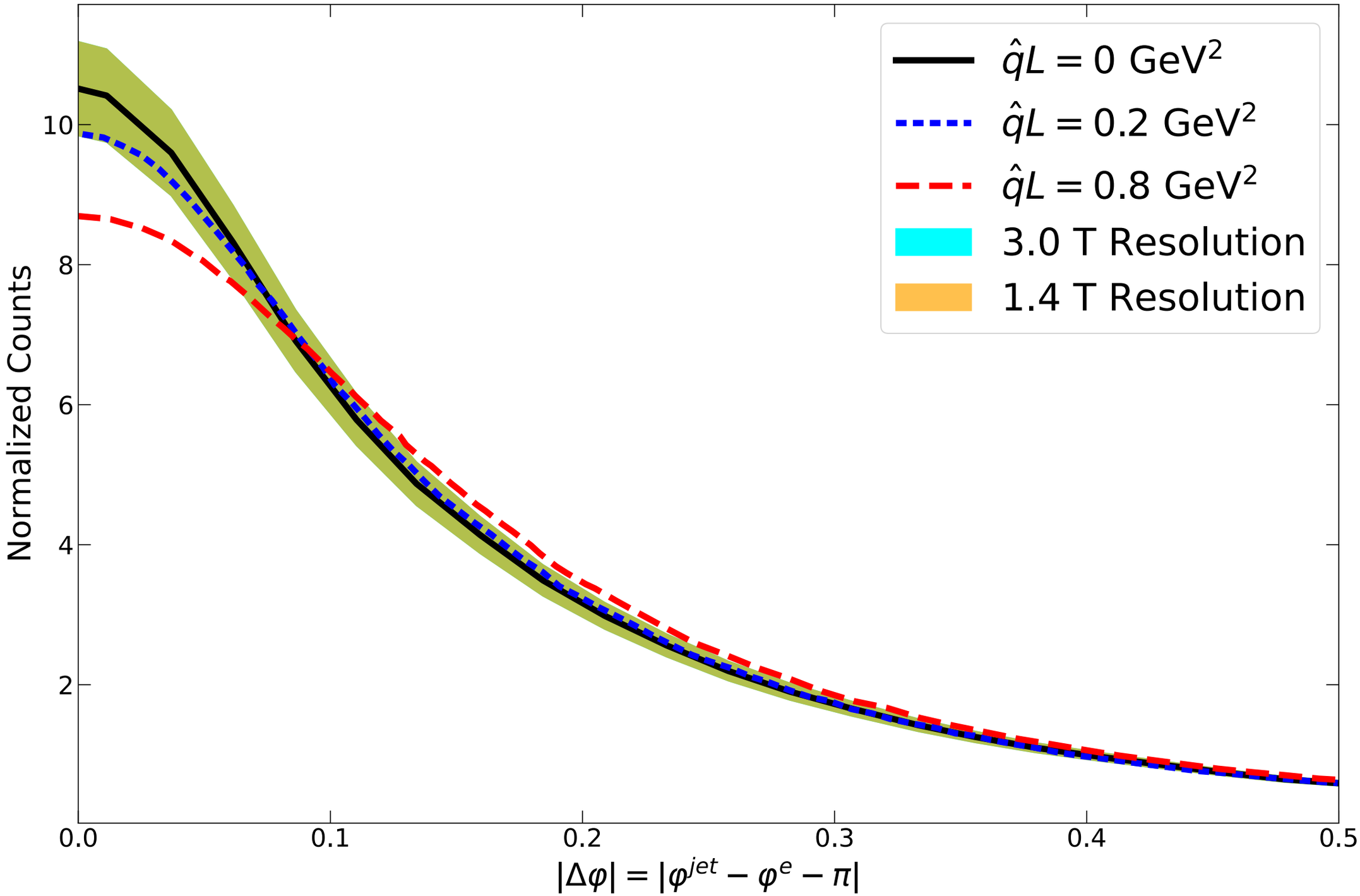
Central Barrel $|\eta| < 0.5$



Backwards Region $\eta < -0.5$



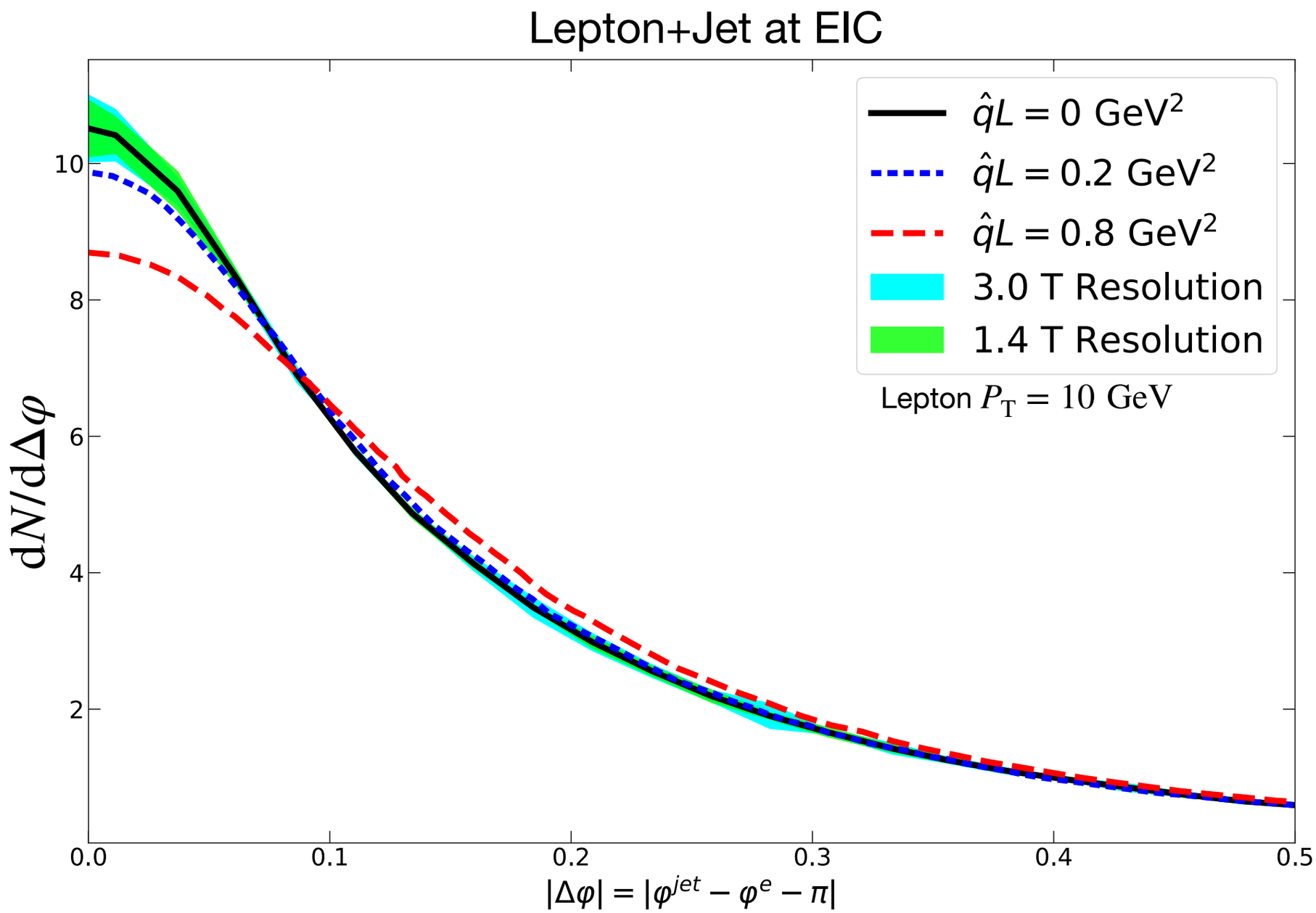
Forward Region $\eta > 0.5$



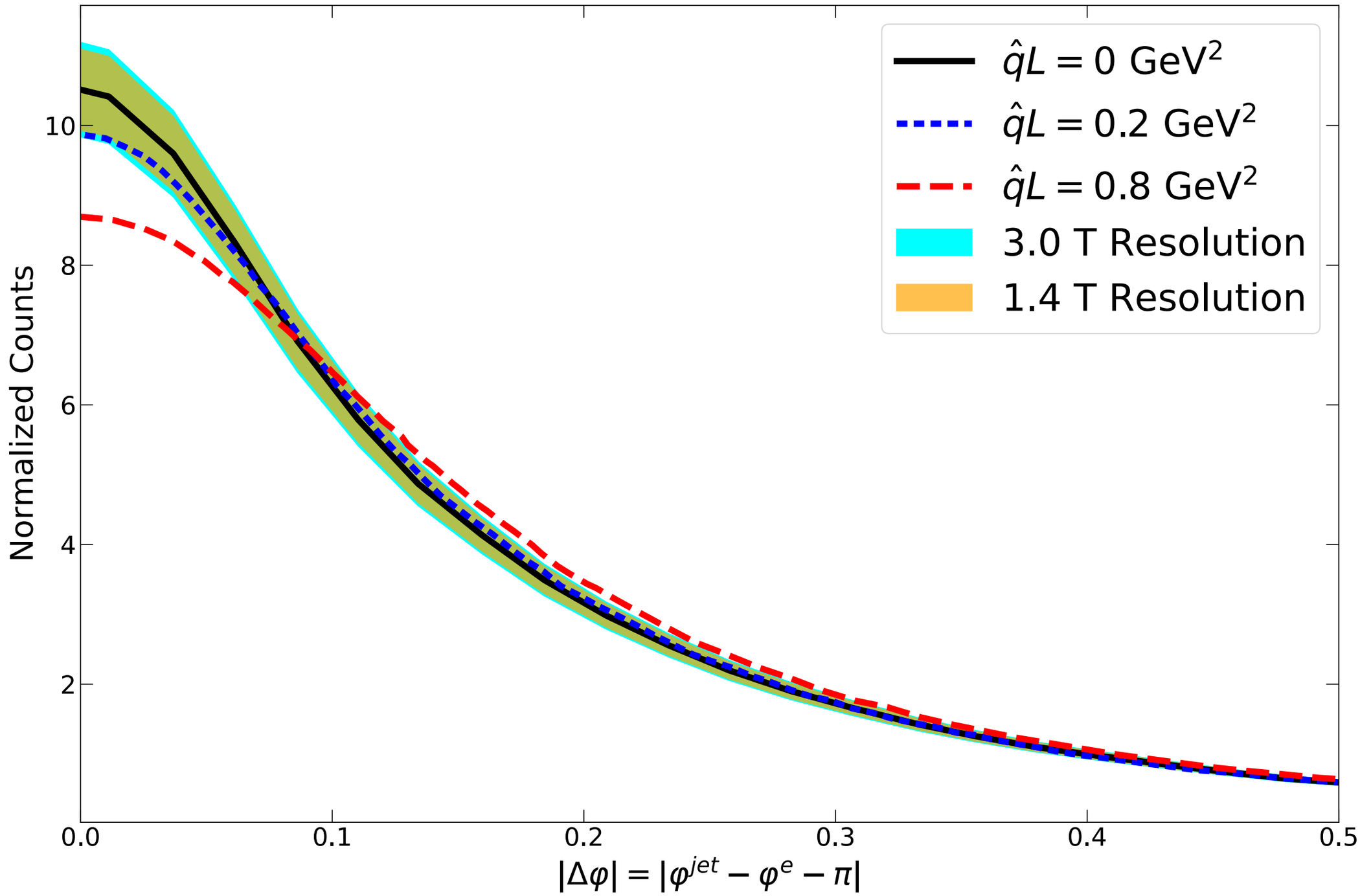
End.

Lepton+Jet Theory

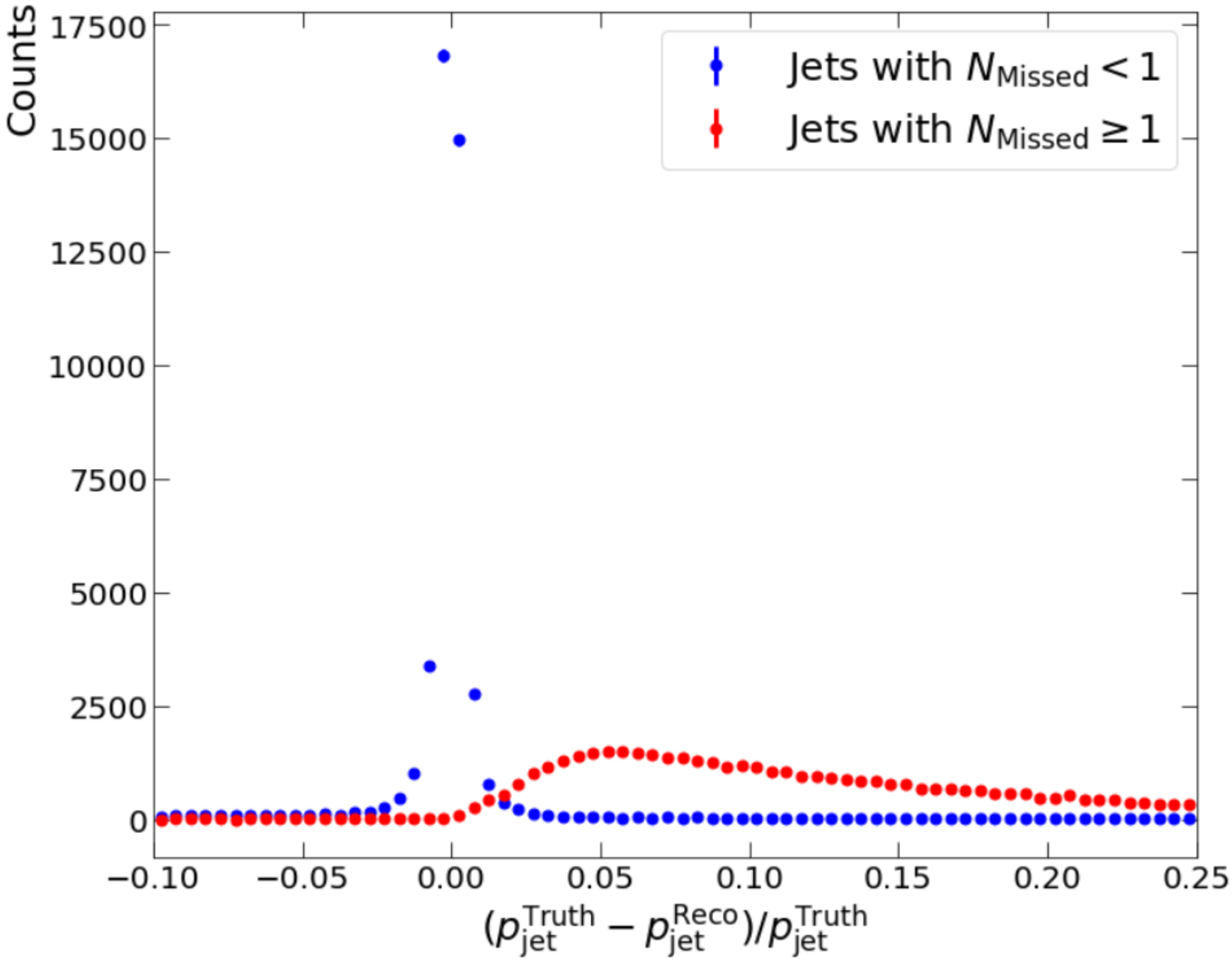
Resolution (%) = (Truth-Reco) / Truth



$|\eta| < 3.0$ (All Regions)



Two Populations of Jets

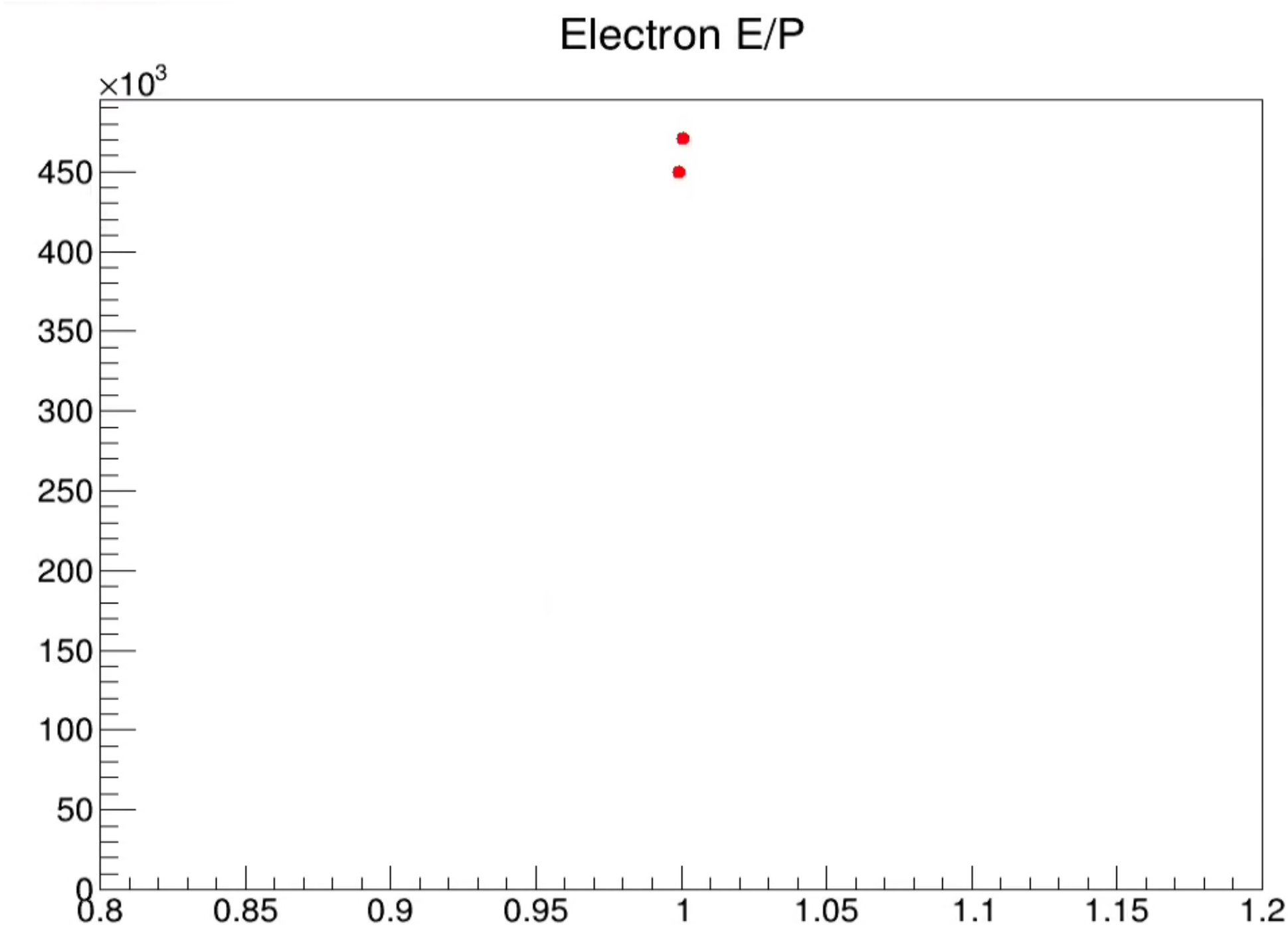


- Truth Seeded Tracking
- 100% *hit* efficiency
- Kalman filter in Fun4All
- Low p_{T} Threshold (3-hits)

Number of Missed Charged Constituents:

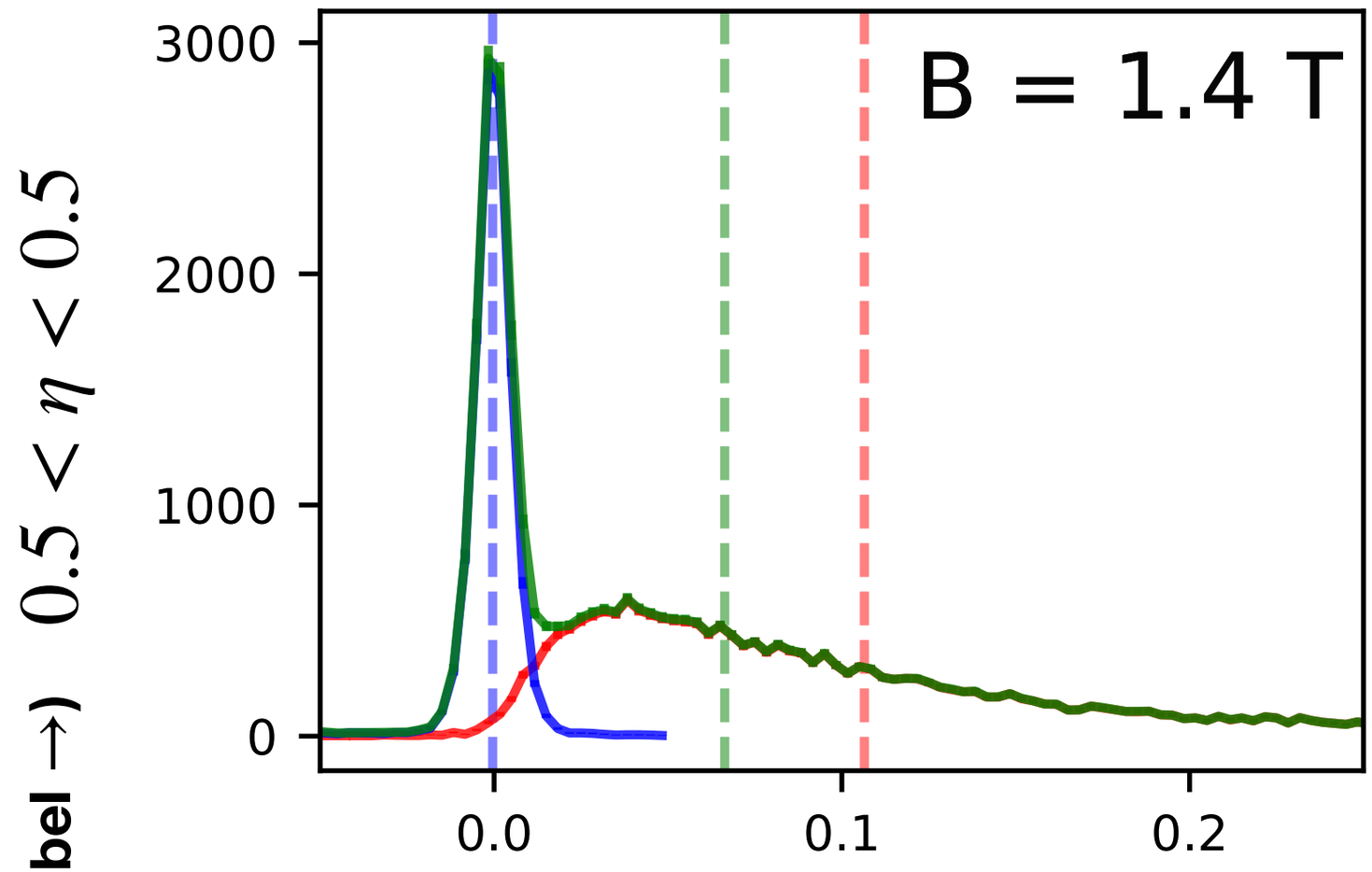
$$N_{\text{missed}} = N_{\text{constituents}}^{\text{truth}} - N_{\text{constituents}}^{\text{reco}} - N_{\text{neutral}}^{\text{truth}}$$

E/P Without Smearing



Example of Distribution

$6 < p < 8$ GeV/c **(← Momentum Label)**



$N_{\text{Missed}} < 1$

$N_{\text{Missed}} \geq 1$

No N_{Missed} Cut

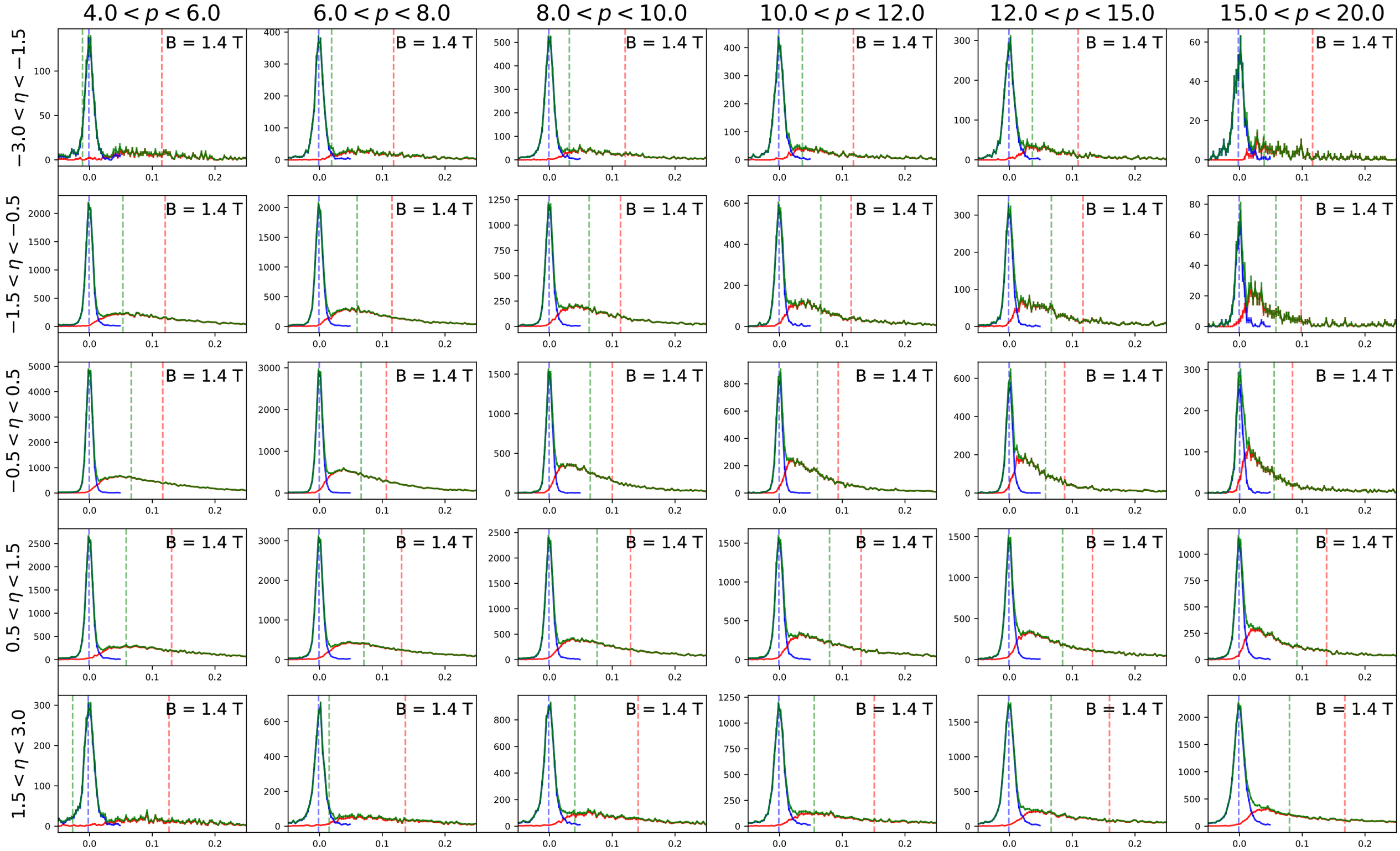
$$\sigma = \sqrt{\frac{\sum (X - \mu)^2}{N}}$$

- **Y-Axis: Simply the counts (histogram)**
- **X-axis: dp/p (%), given in title**
- **Dashed Lines: Mean of distribution**

$N_{\text{Missed}} < 1$ $N_{\text{Missed}} \geq 1$ No N_{Missed} Cut

B = 1.4 T

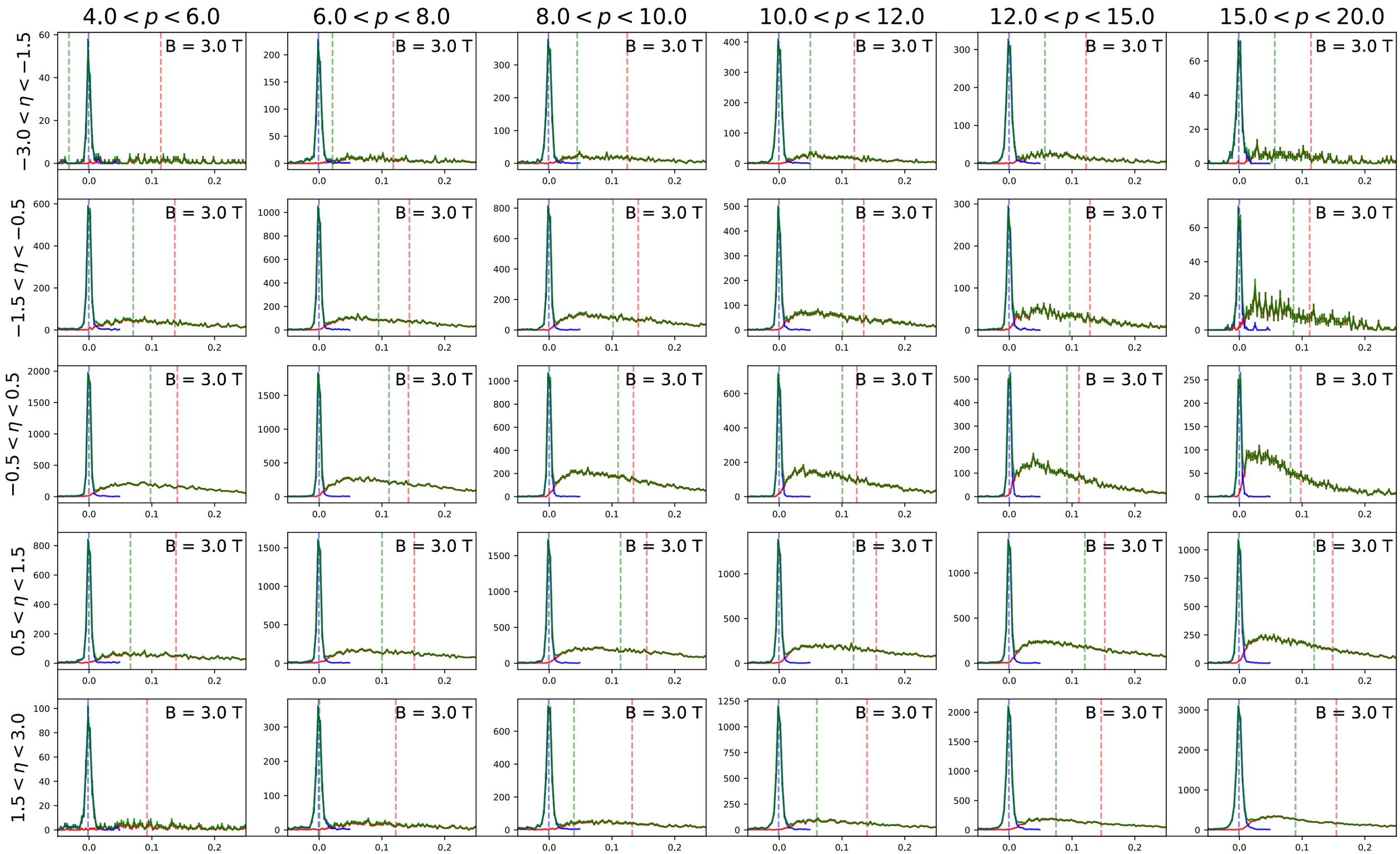
dp/p[%]



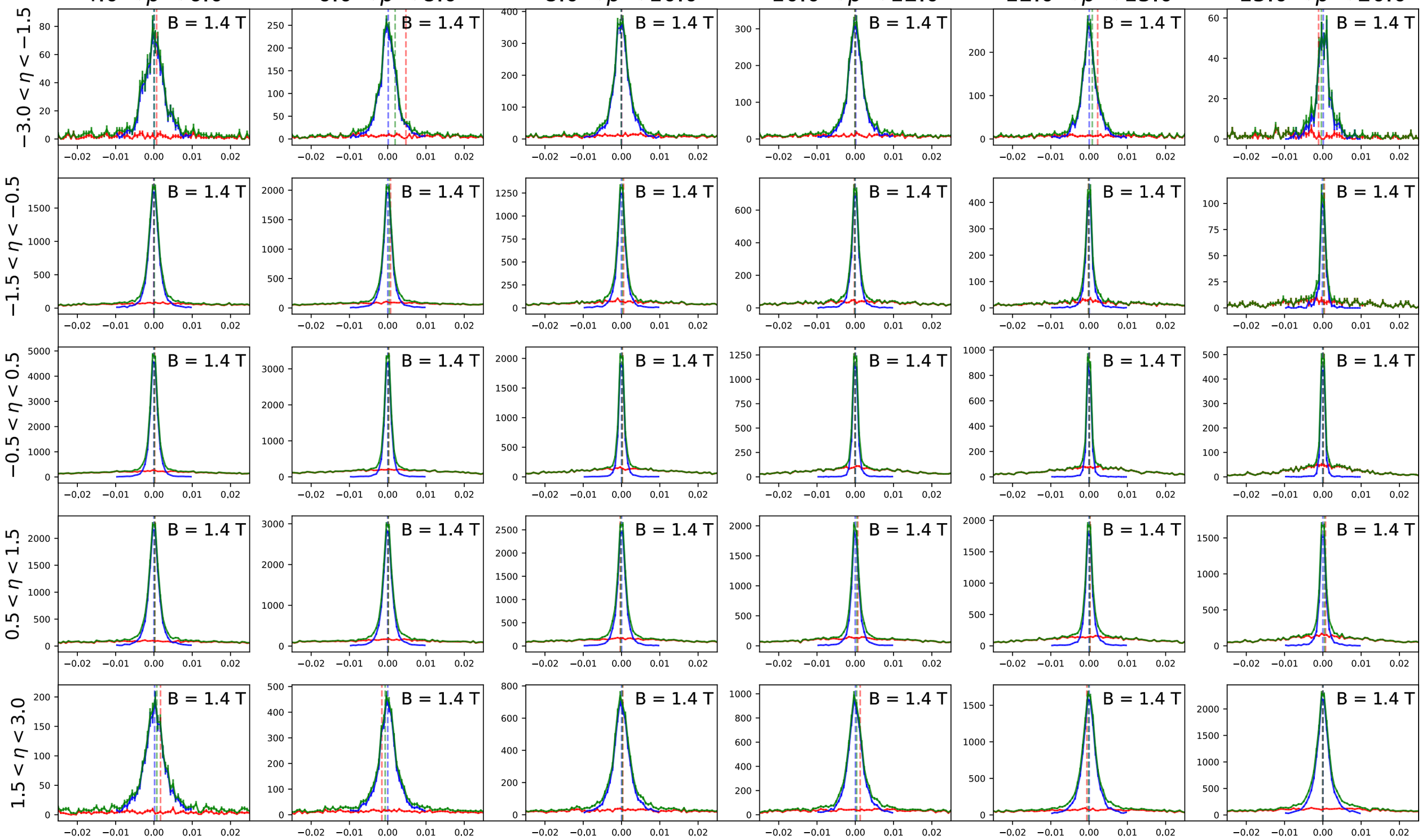
$N_{\text{Missed}} < 1$ $N_{\text{Missed}} \geq 1$ No N_{Missed} Cut

B = 3.0 T

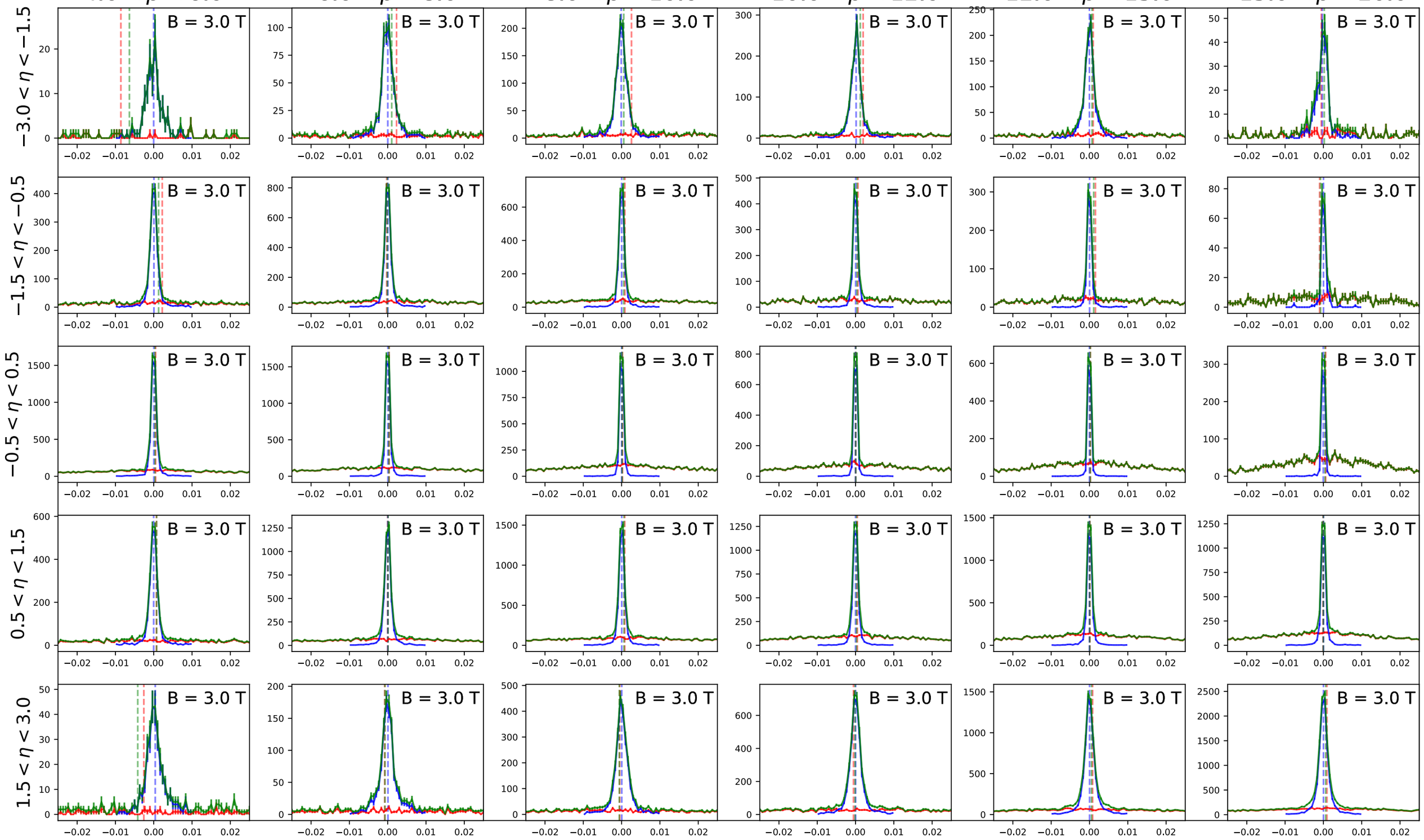
dp/p[%]



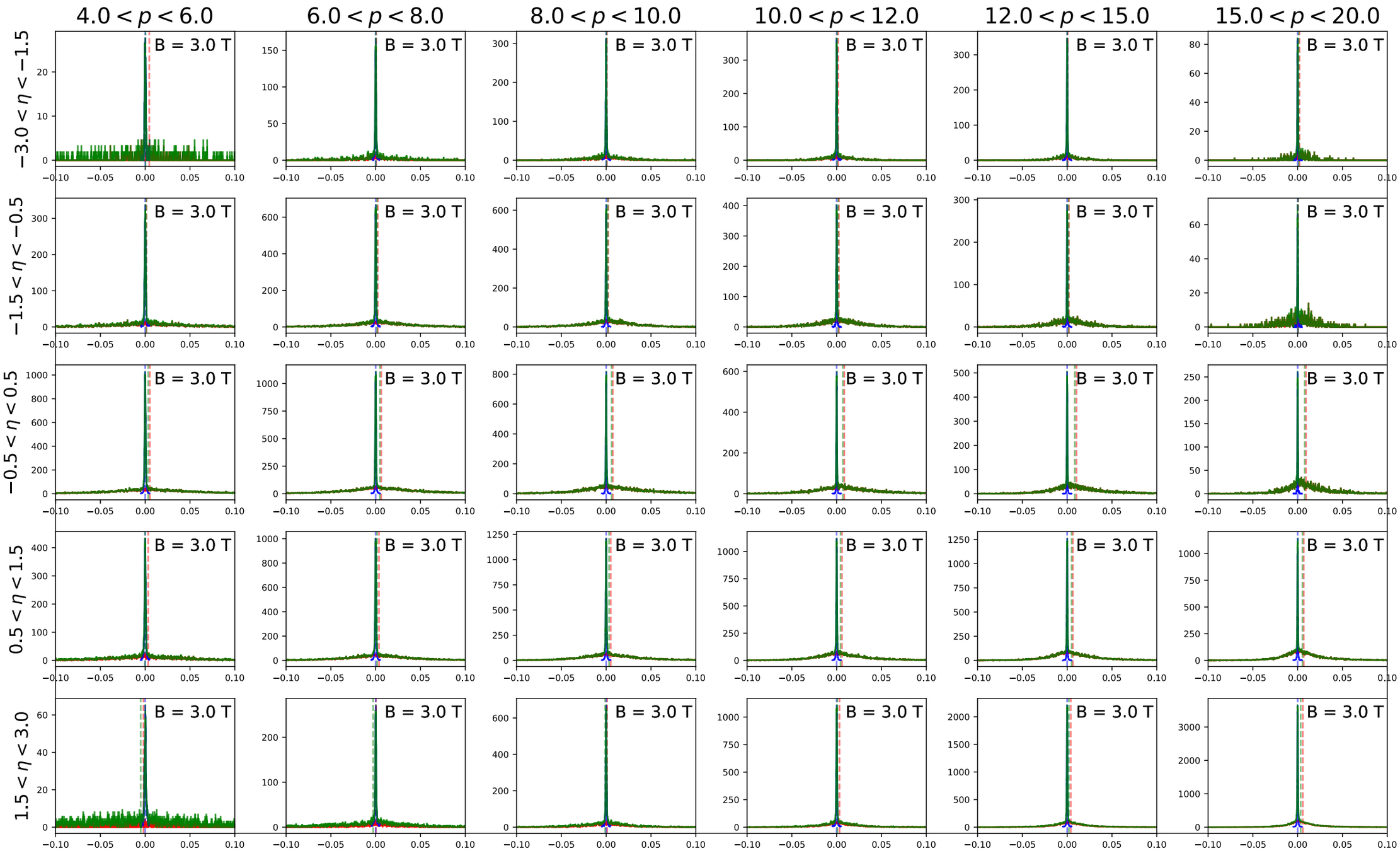
dφ [mrad]

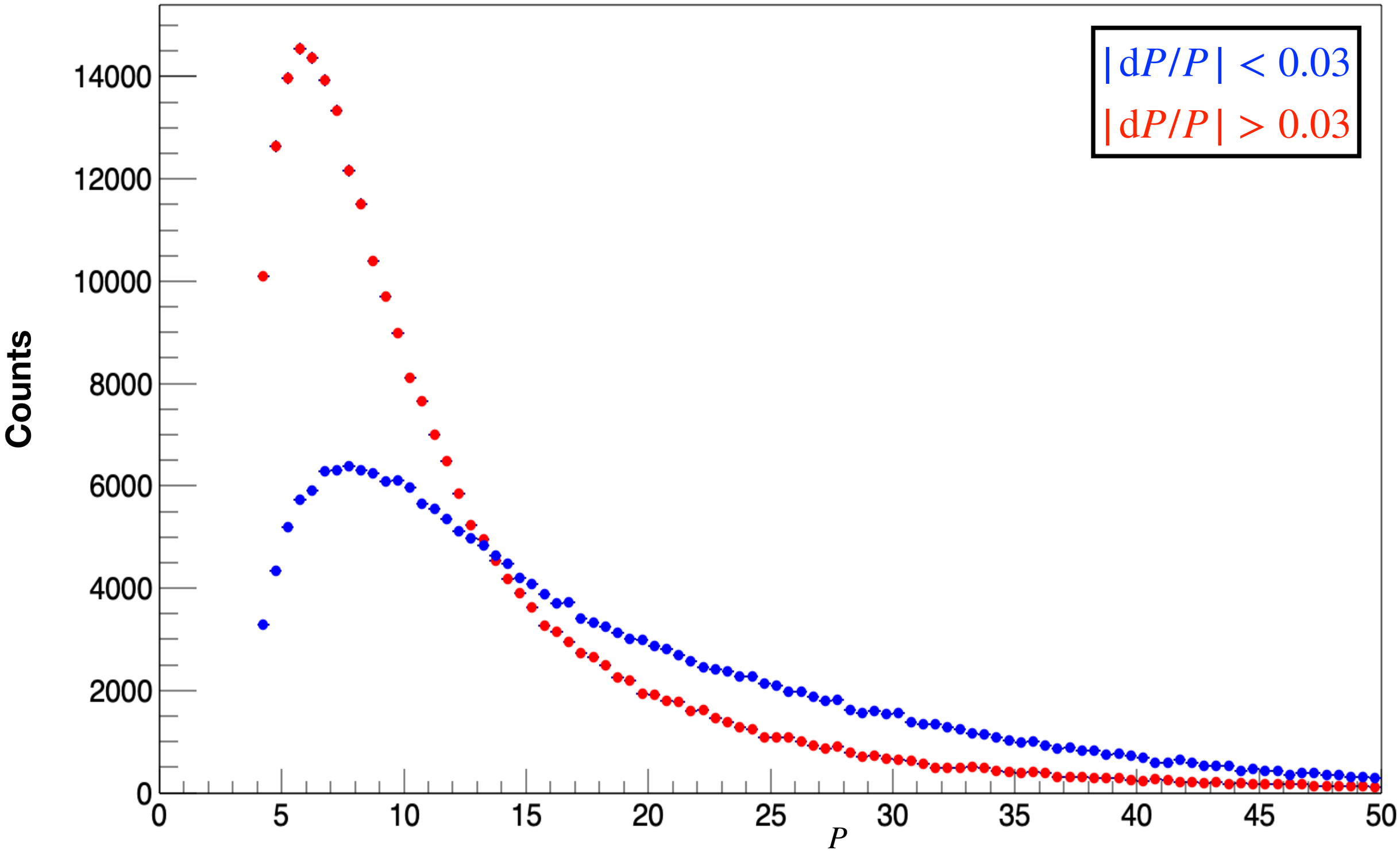


dφ [mrad]

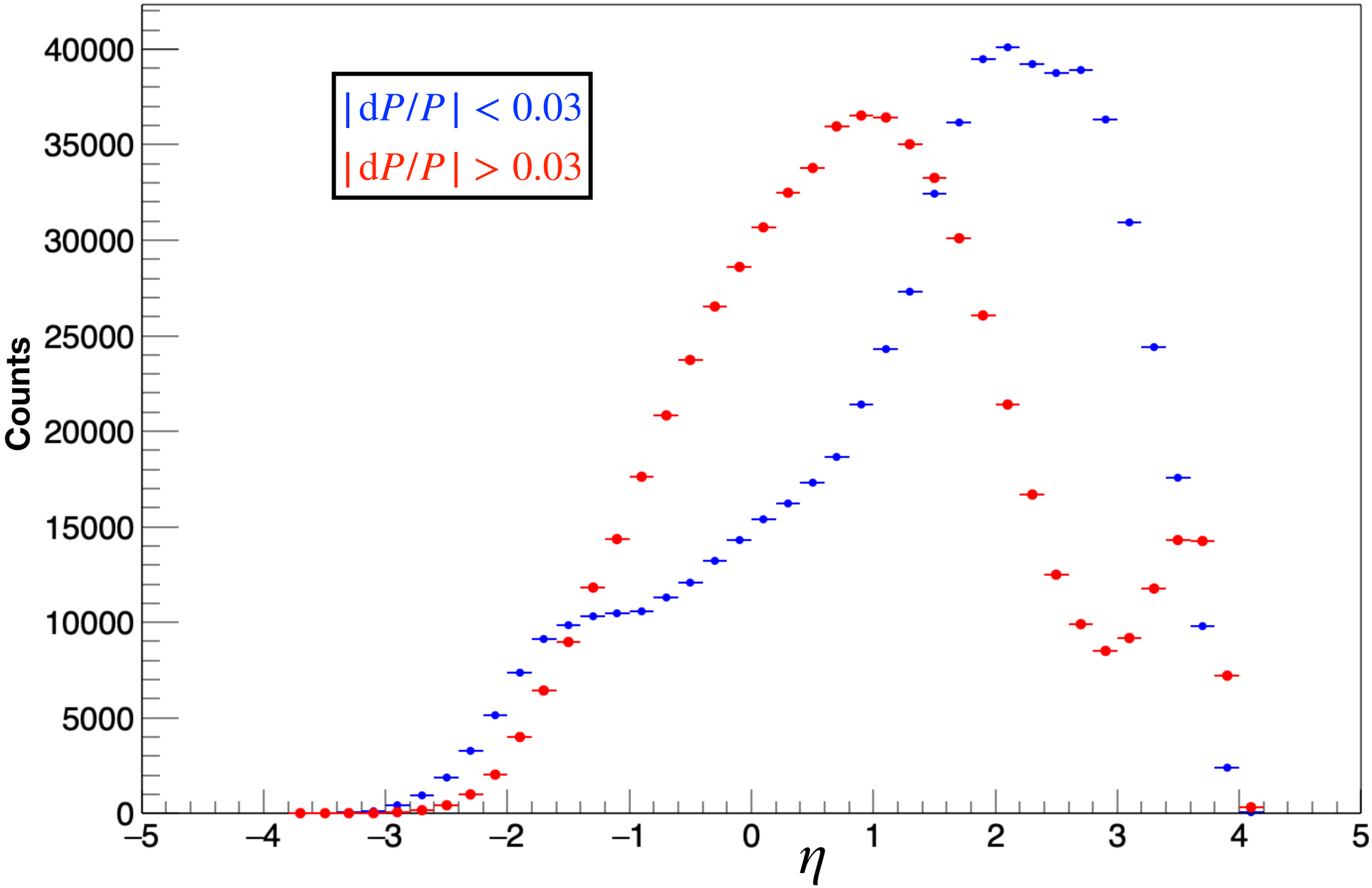


dθ [mrad]


4.0 < p < 6.0
6.0 < p < 8.0
8.0 < p < 10.0
10.0 < p < 12.0
12.0 < p < 15.0
15.0 < p < 20.0
−3.0 < η < −1.5
−1.5 < η < −0.5
−0.5 < η < 0.5
0.5 < η < 1.5
1.5 < η < 3.0
B = 3.0 T

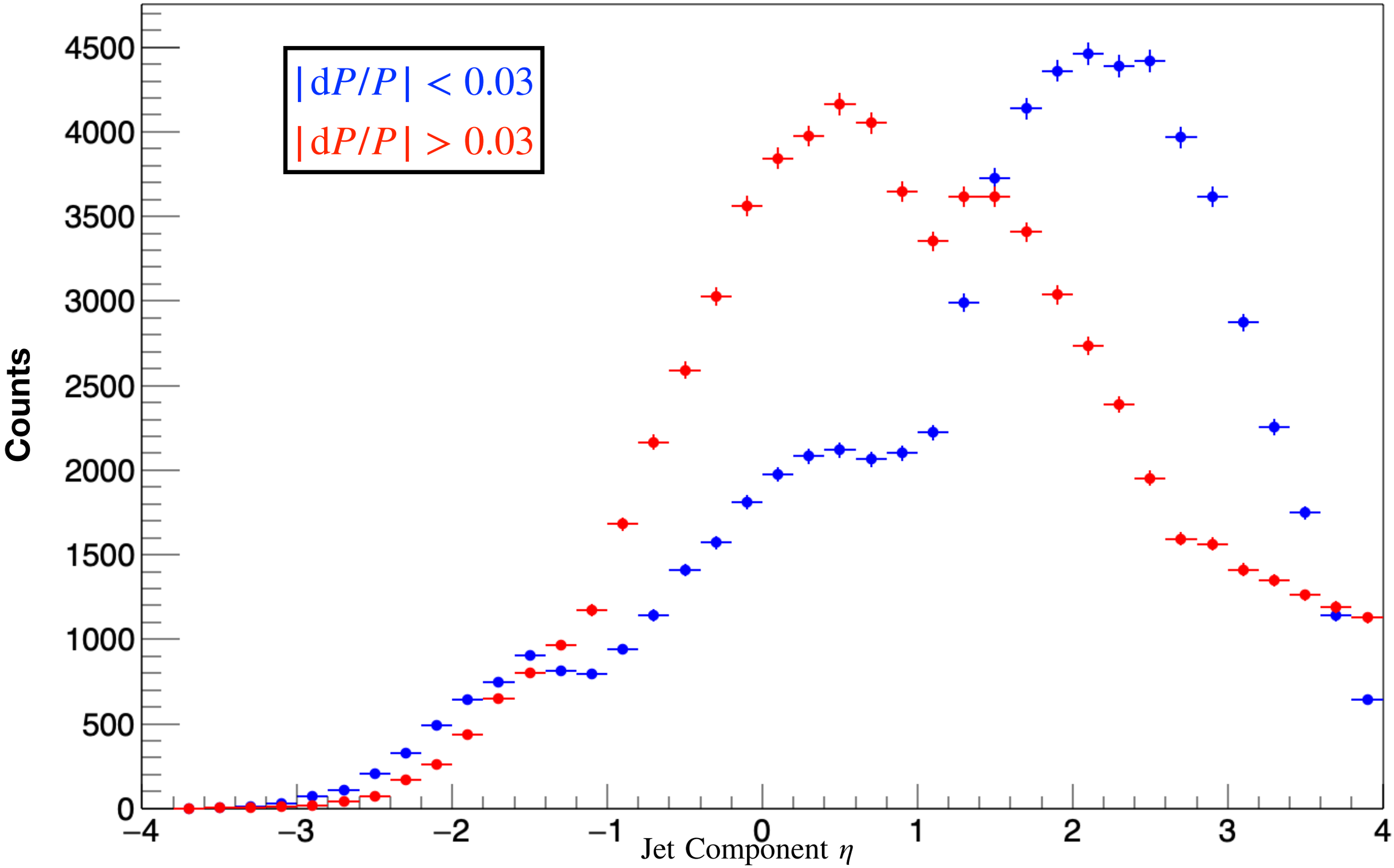

$|\mathrm{d}P/P| < 0.03$
$|\mathrm{d}P/P| > 0.03$
Counts
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
30
35
40
45
50
P

Recontsructed Jet η



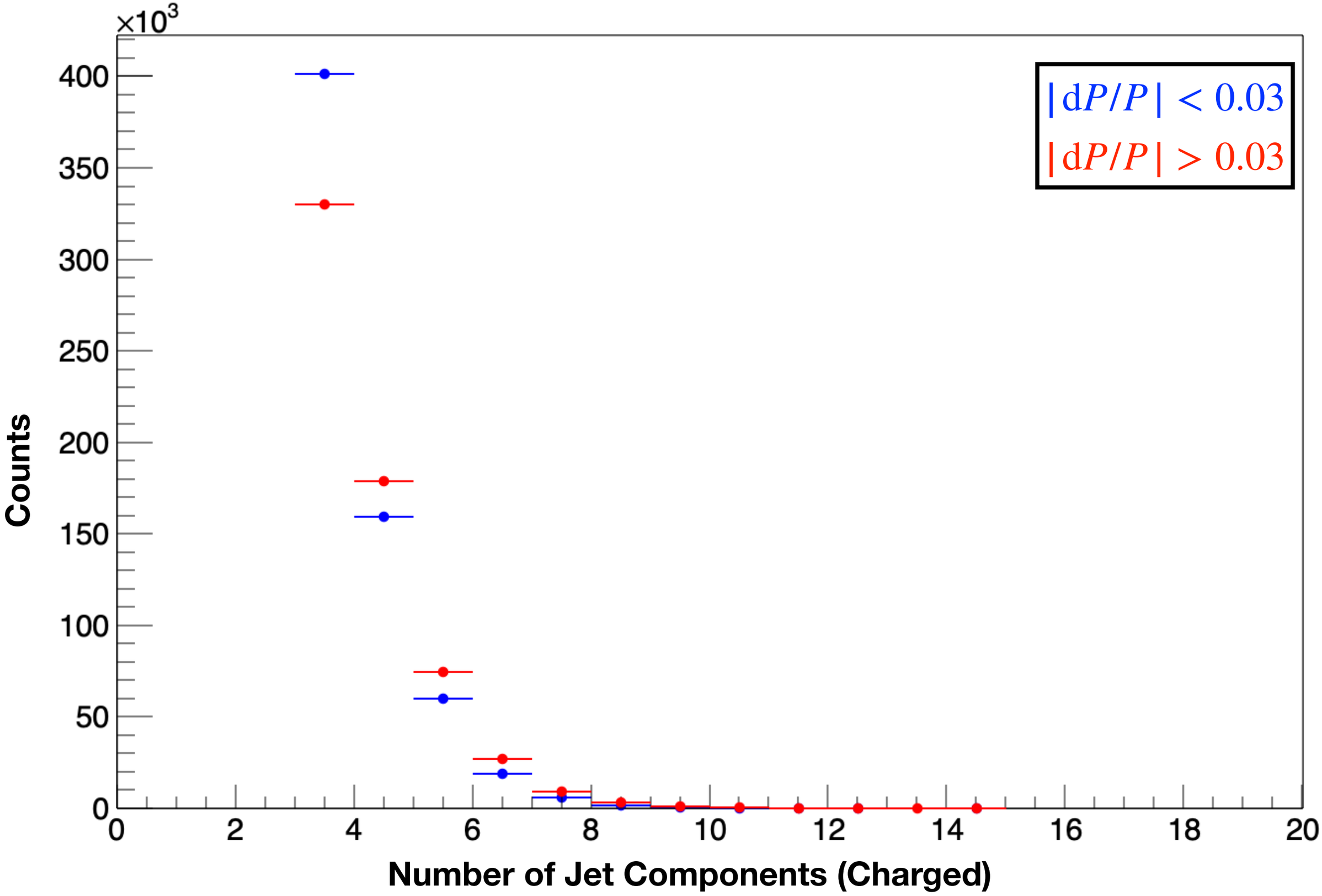
Jet Component Distributions

Jet Component η

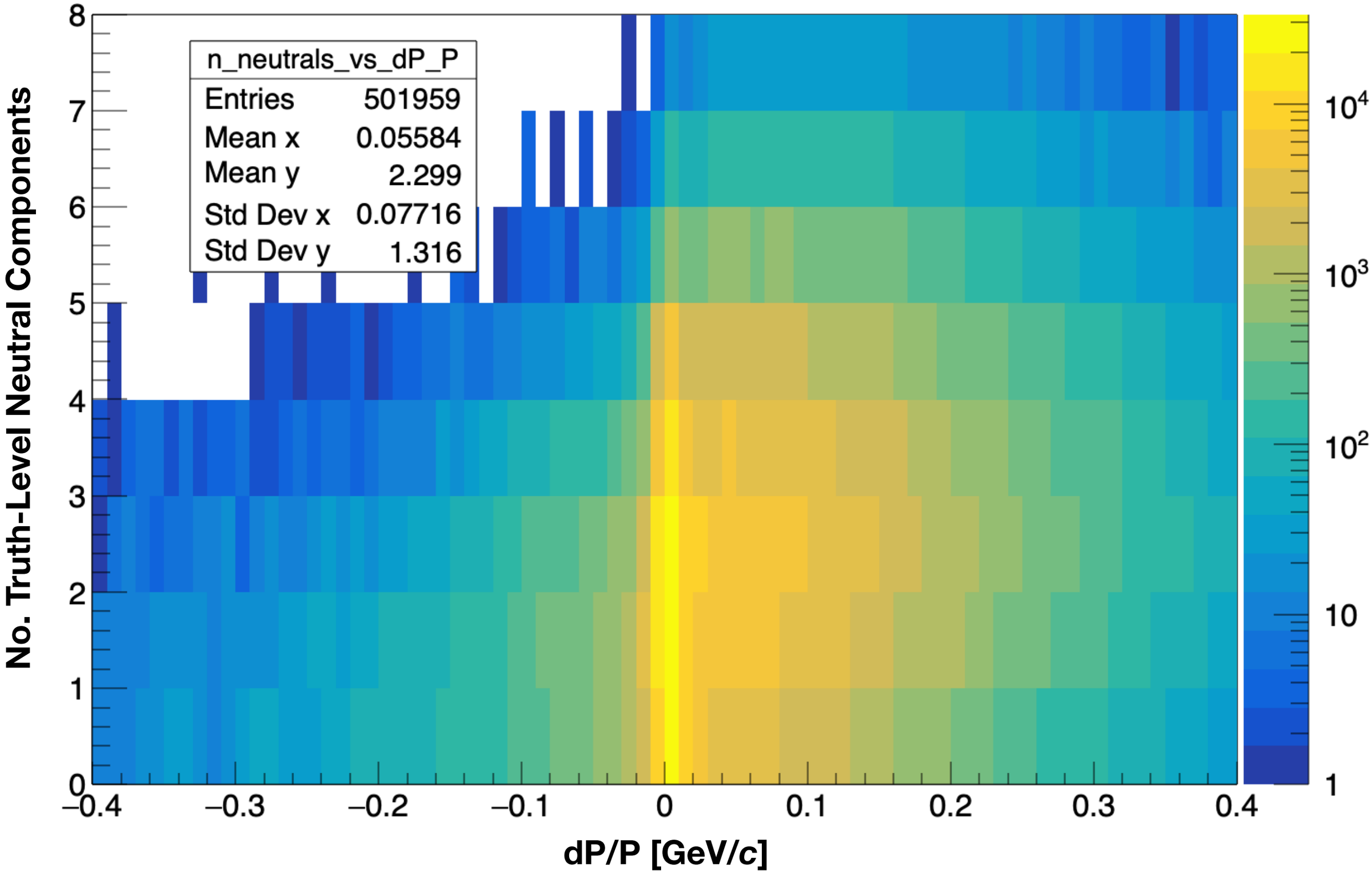


The central barrel layers meet the endcap of the all-sillicon tracker at $\eta \approx 1.1$, jets near this region are omitted in the resolution calculation

Reconstructed Jet N Component

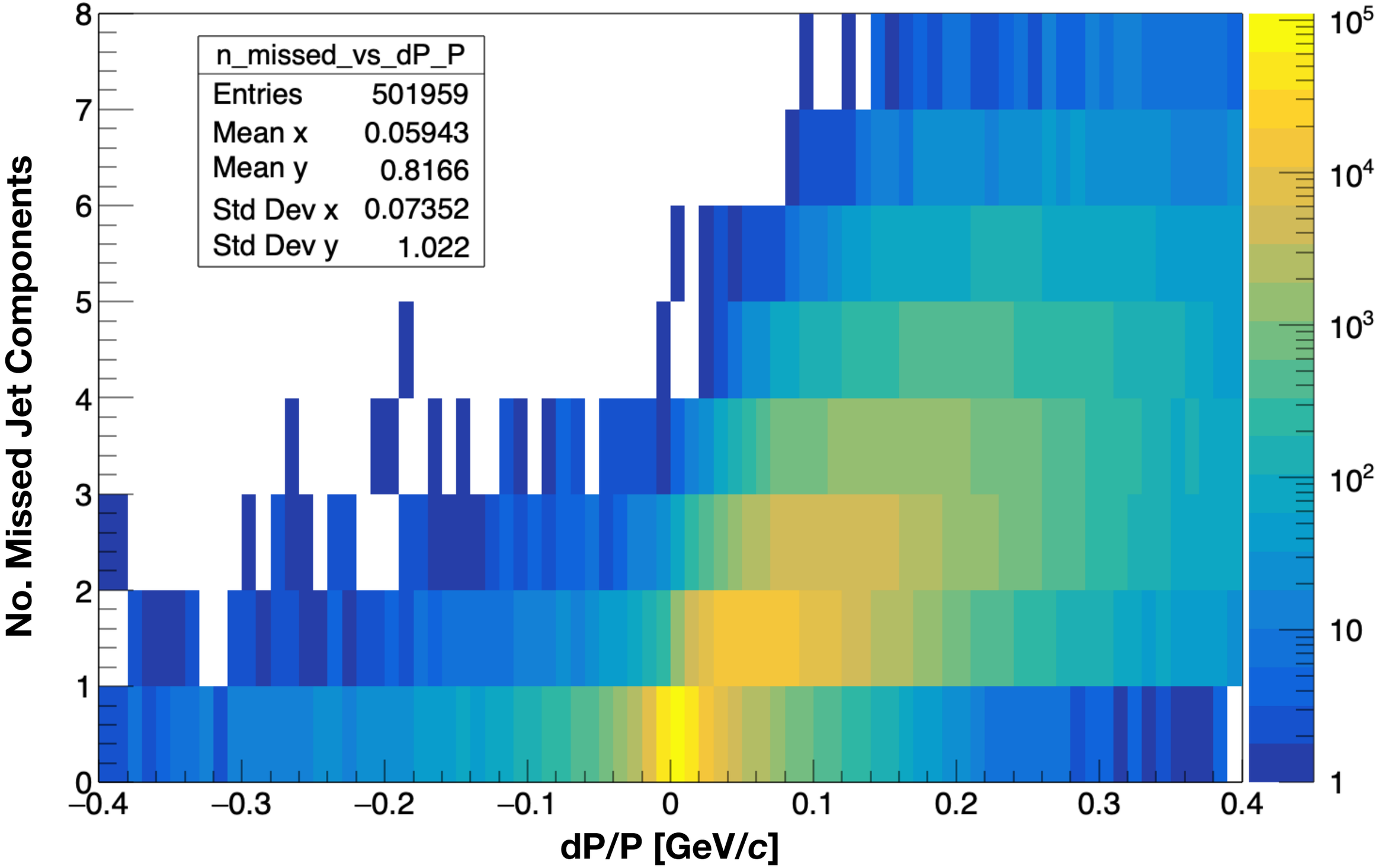


No. Neutral Components in Original Truth Jet VS. dP/P



$$N_{\text{missed}} = N^{\text{truth}}_{\text{constituents}} - N^{\text{reco}}_{\text{constituents}}$$

No. Missed Jet Components VS. dP/P

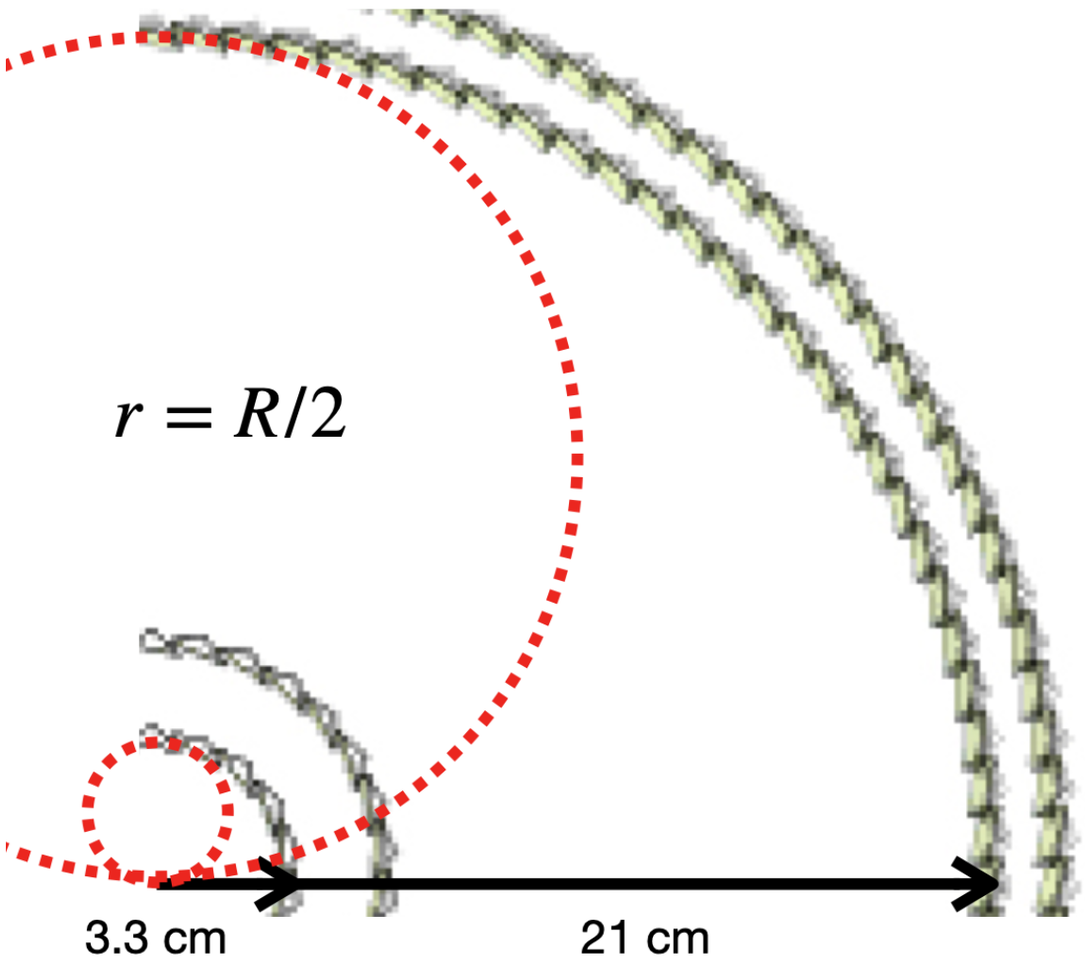


Are lost constituents and poor dP/P due to low pT constituents?

$$m\frac{v^2}{r} = qvB$$

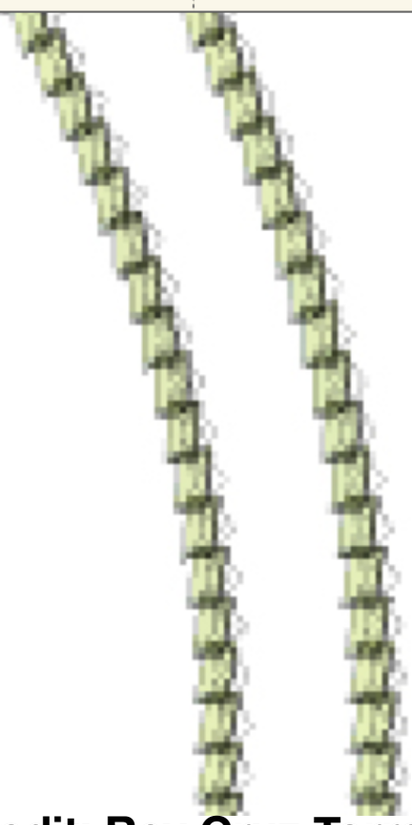
*** Need at least three points for a momentum measurement**

$$p\ [\mathrm{GeV}/c] = 0.3B\ [\mathrm{T}] \cdot r\ [\mathrm{m}]$$



p_T thresholds

	R = 3.3 cm	R = 21 cm
B = 1.4 T	7 MeV	44 MeV
B = 3.0 T	15 MeV	95 MeV



Credit: Rey Cruz Torres 6

Details for 70-150 MeV/c (B=1.5 T)

Abstract:

latest tracking performance numbers as provided recently to DWG conveners
(also circulated directly to the PWG conveners).

Referenced Files

1 Tracking characteristics
Latest version of tracking from EICUG YR Tracking WG Wiki

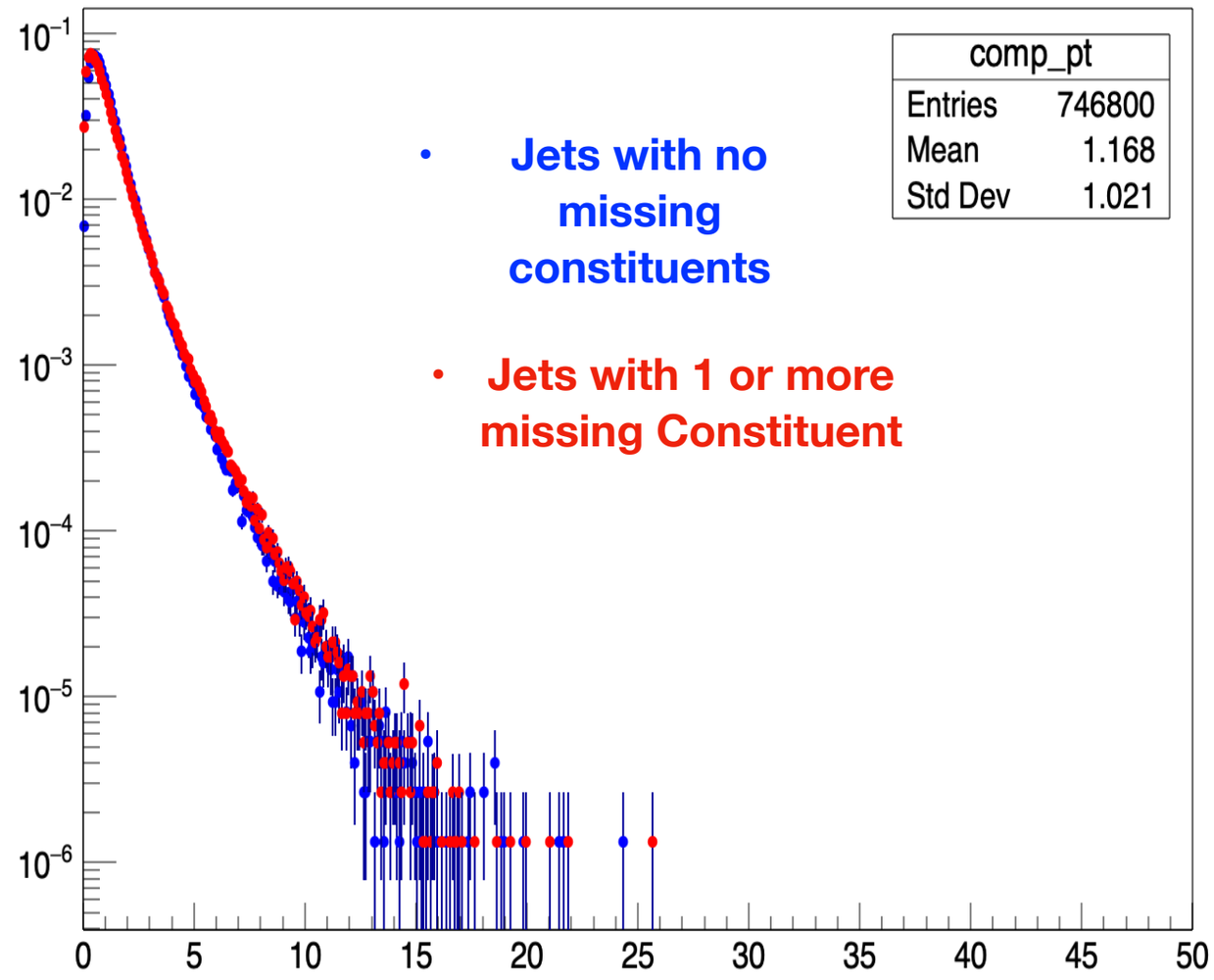
Notes:

Minimum pT for B = 1.5 T:
100 MeV/c for -3.0 < eta < -2.5
130 MeV/c for -2.5 < eta < -2.0
70 MeV/c for -2.0 < eta < -1.5
150 MeV/c for -1.5 < eta < -1.0

Minimum pT for B = 3 T:
150 MeV/c for -3.0 < eta < -2.5
220 MeV/c for -2.5 < eta < -2.0
160 MeV/c for -2.0 < eta < -1.5
300 MeV/c for -1.5 < eta < -1.0

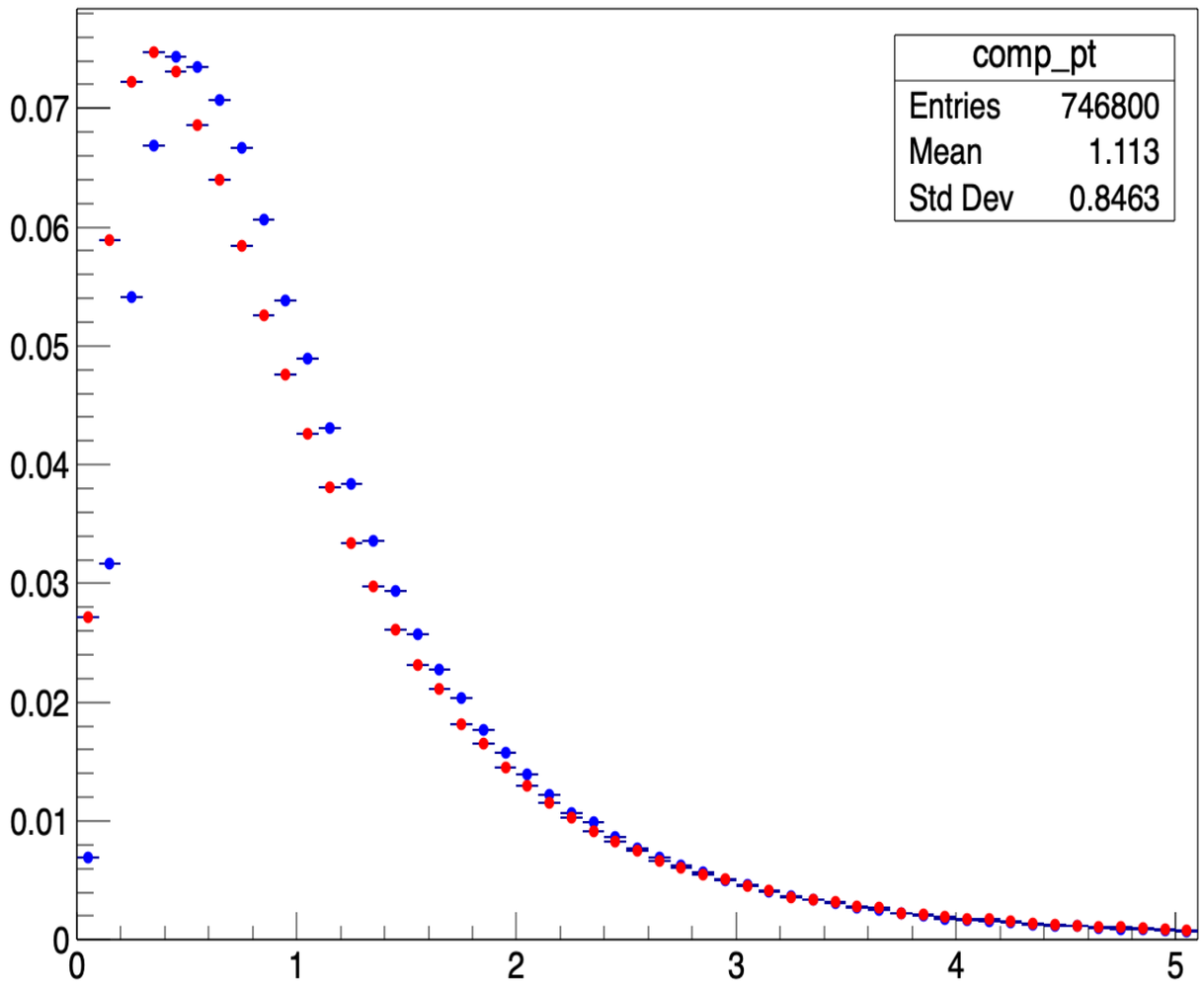
https://physdiv.jlab.org/DetectorMatrix/

Jet Component p_T



- **Jets with no missing constituents**
- **Jets with 1 or more missing Constituent**

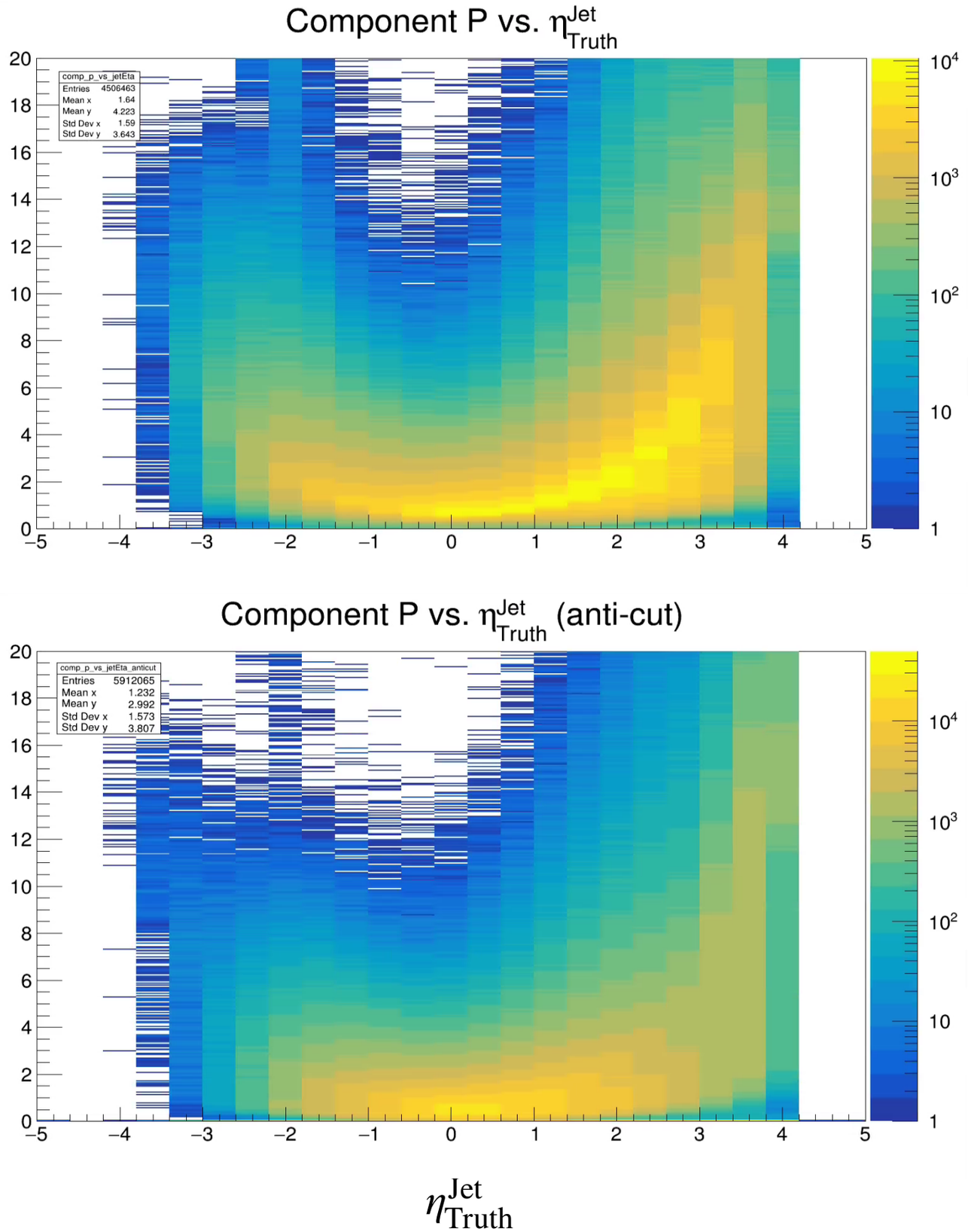
Jet Component p_T



Jet Component p vs Jet η

$|dP/P| < 0.03$

Constituent p [Gev/c]

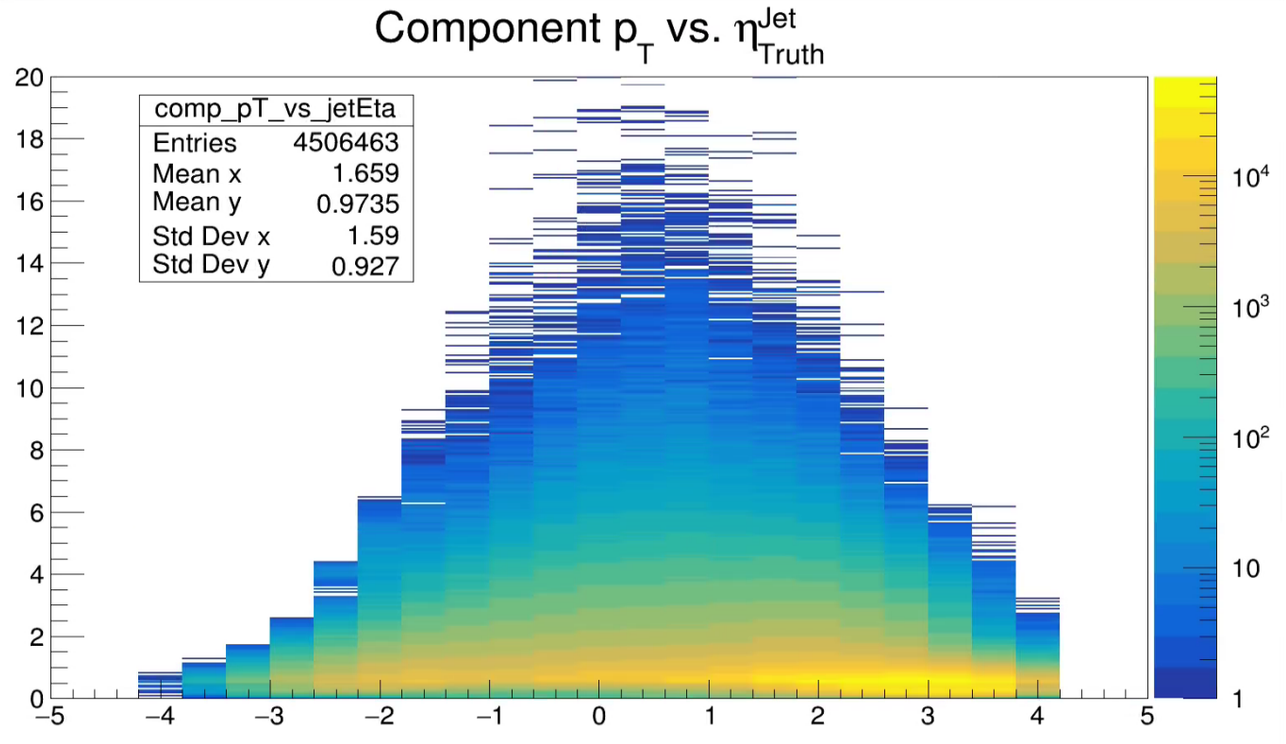


$|dP/P| > 0.03$

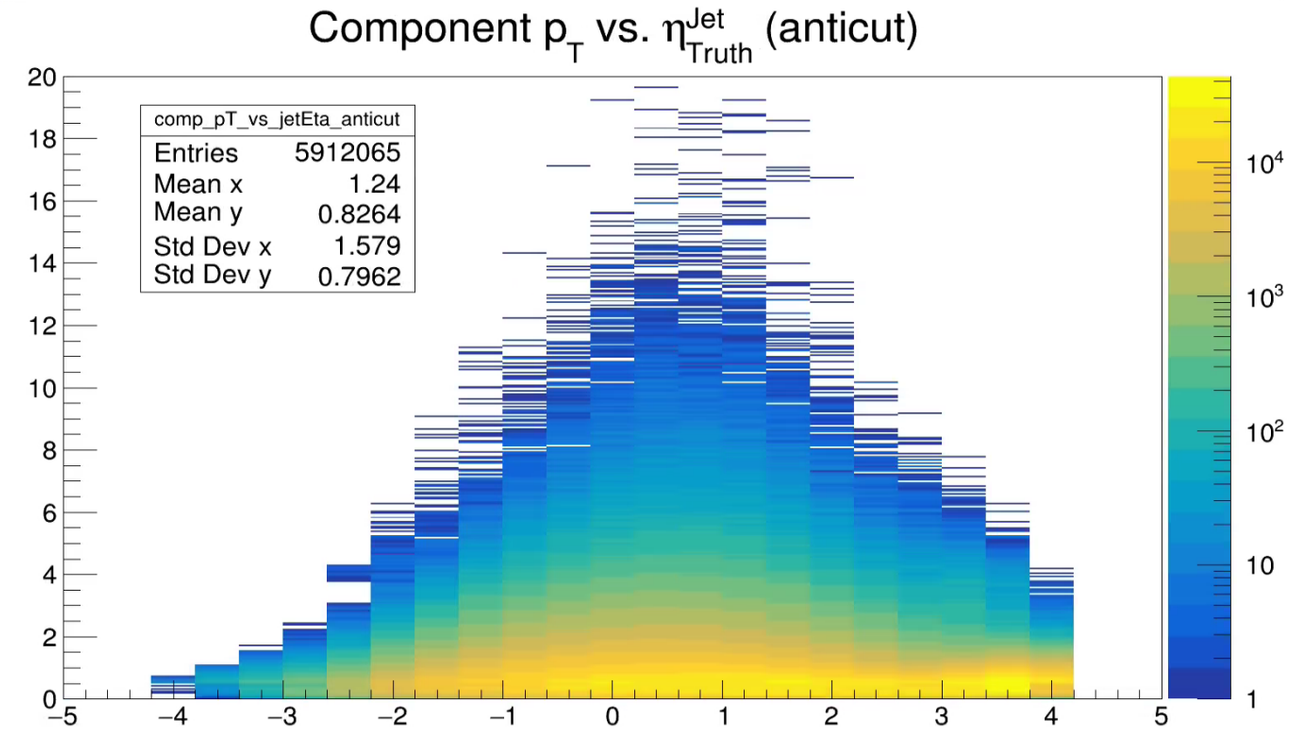
An η dependent p cut does not seem to be a likely solution

Jet Component p_{T} vs Jet η

$|dP/P| < 0.03$



$|dP/P| > 0.03$



An η dependent p_{T} cut does not seem to be a likely solution either