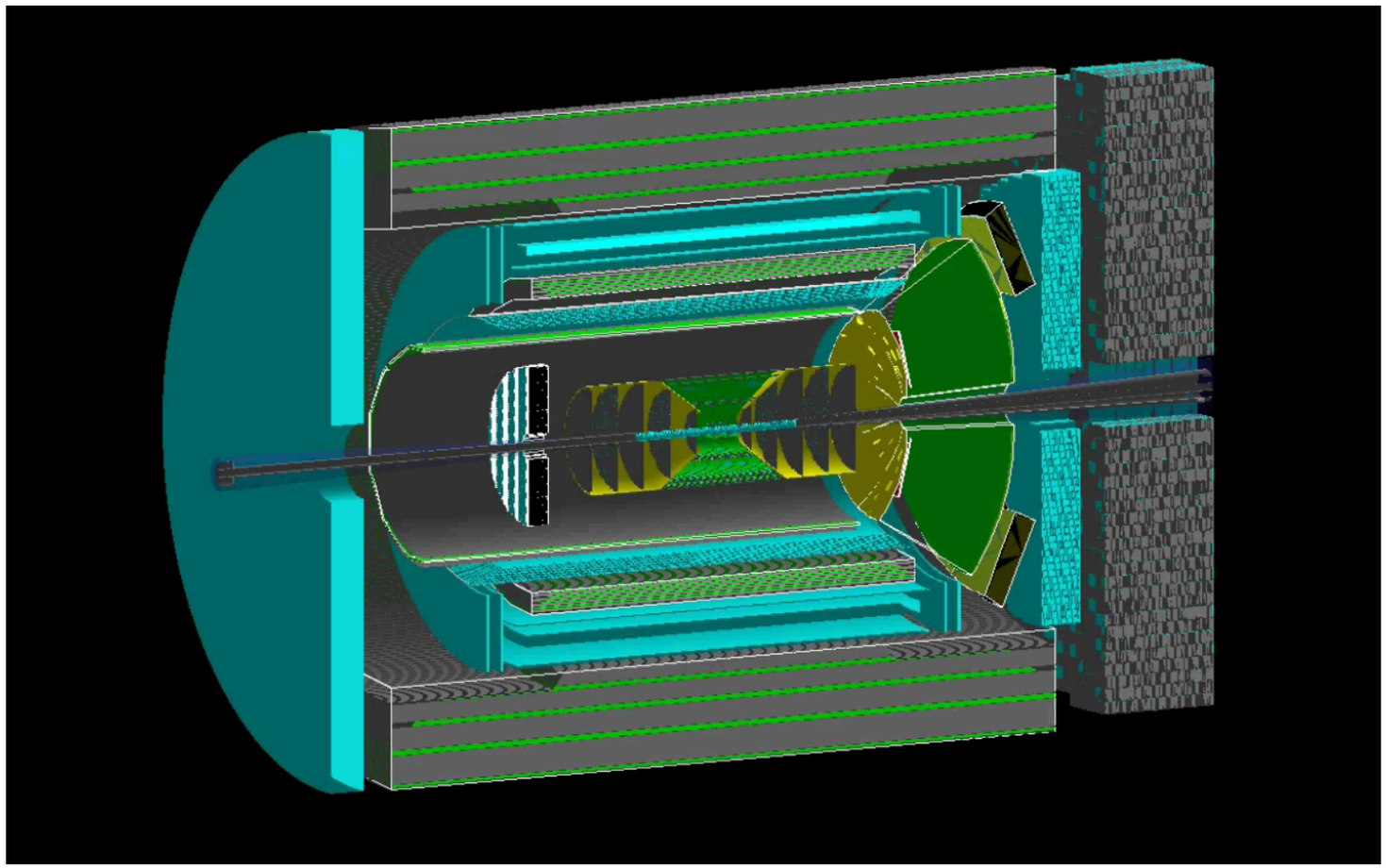
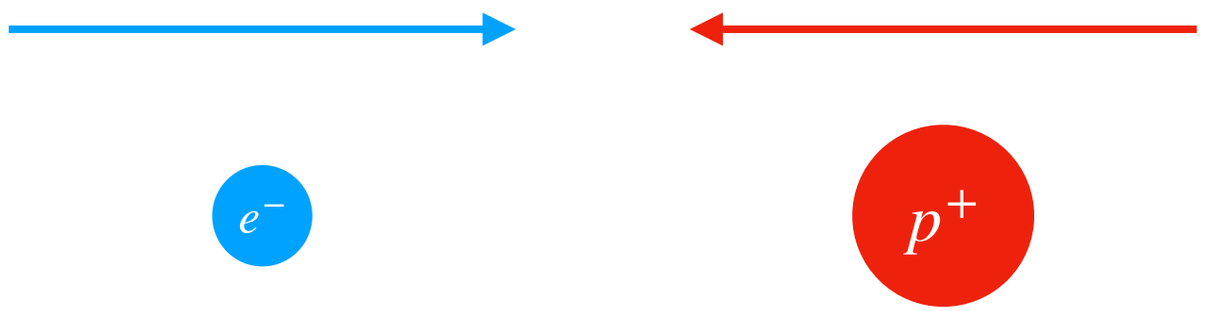
Charged Jet Reconstruction with an All-Silicon Tracker



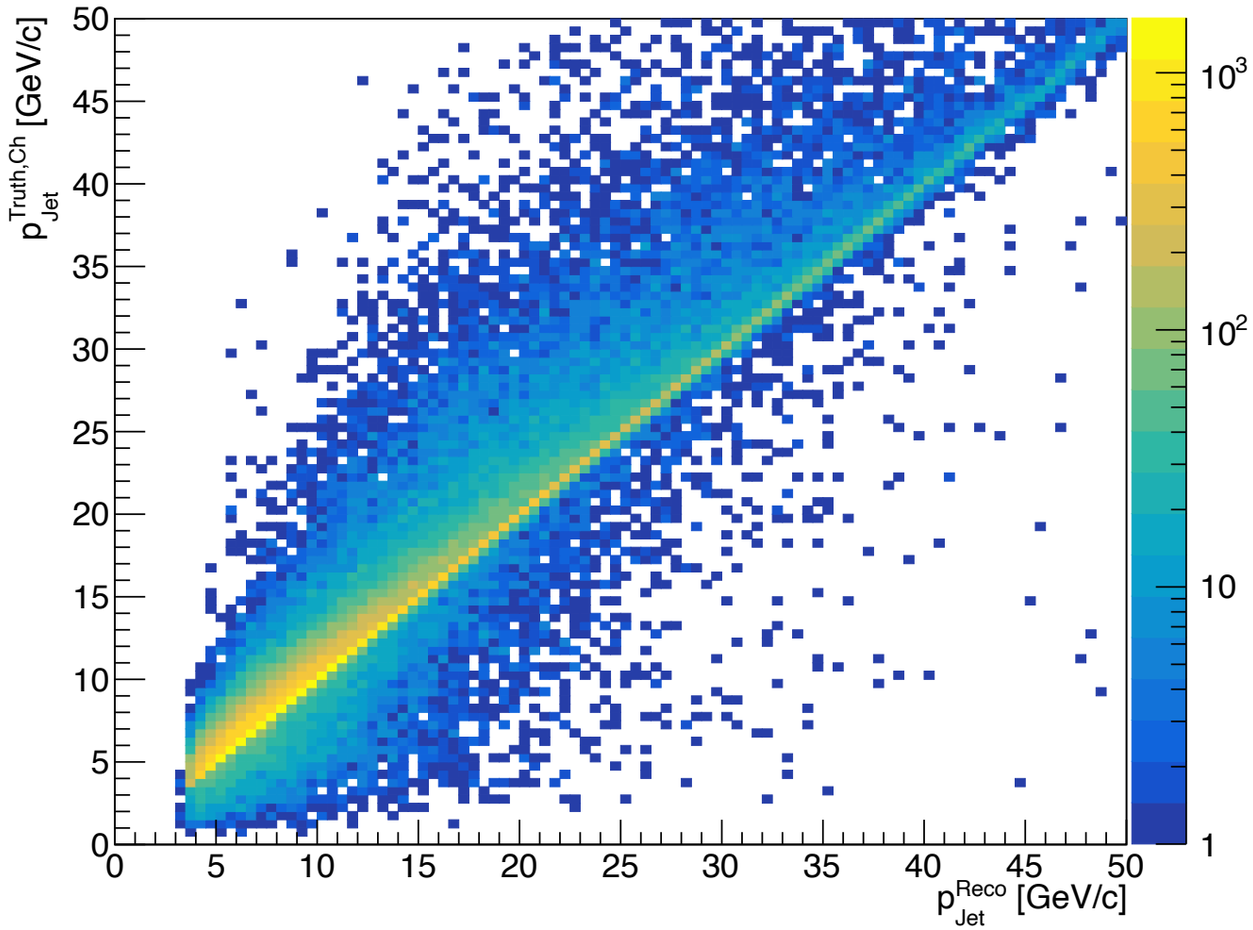
Jets in e+P PYTHIA Simulation



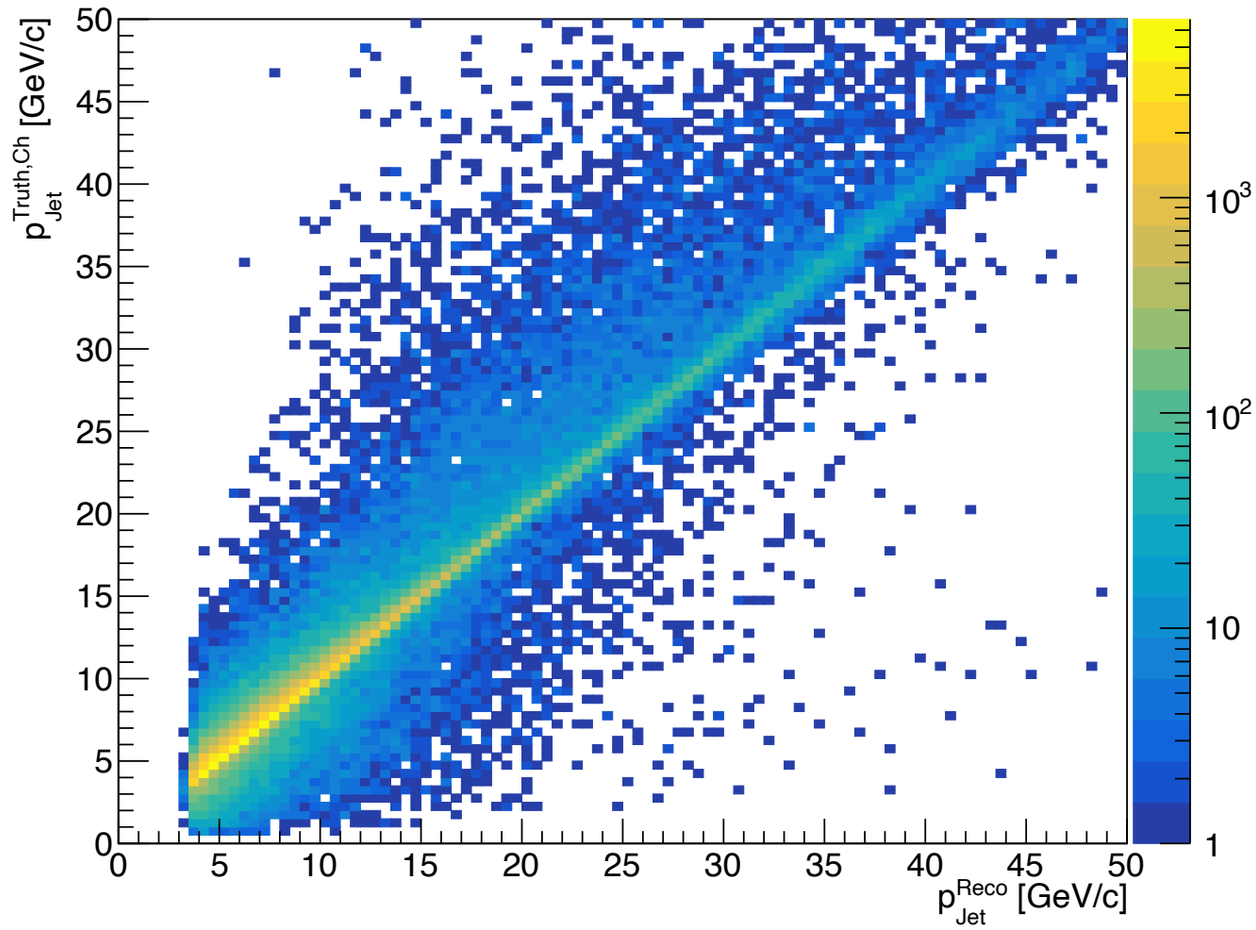
- PYTHIA 8:
  - PYTHIA 8
  - $Q^2_{\min} \geq 16$ (GeV/c^2)^2
  - $\sqrt{s} = 89$
  - Electron beam: 20 GeV
  - Proton beam: 100 GeV
  - B = 1.4 and 3.0 T > 4 GeV
- Jets:
  - $E^{\text{Jet}}_{\text{Reco}} > 4$ GeV
  - Anti-k_{T} R = 1.0
  - # of Jet Constituents ≥ 4
  - $\Delta R < 0.1$ between Reco and Truth axis
  - ΔR (jet-electron) > 0.5
    - “Electron Veto”
- Tracking
  - Truth Seeded Tracking
  - 100% *hit* efficiency
  - η-dependent minimum p_{T} threshold for constituents

Charged Jet Momentum Response

$B = 3.0$ T

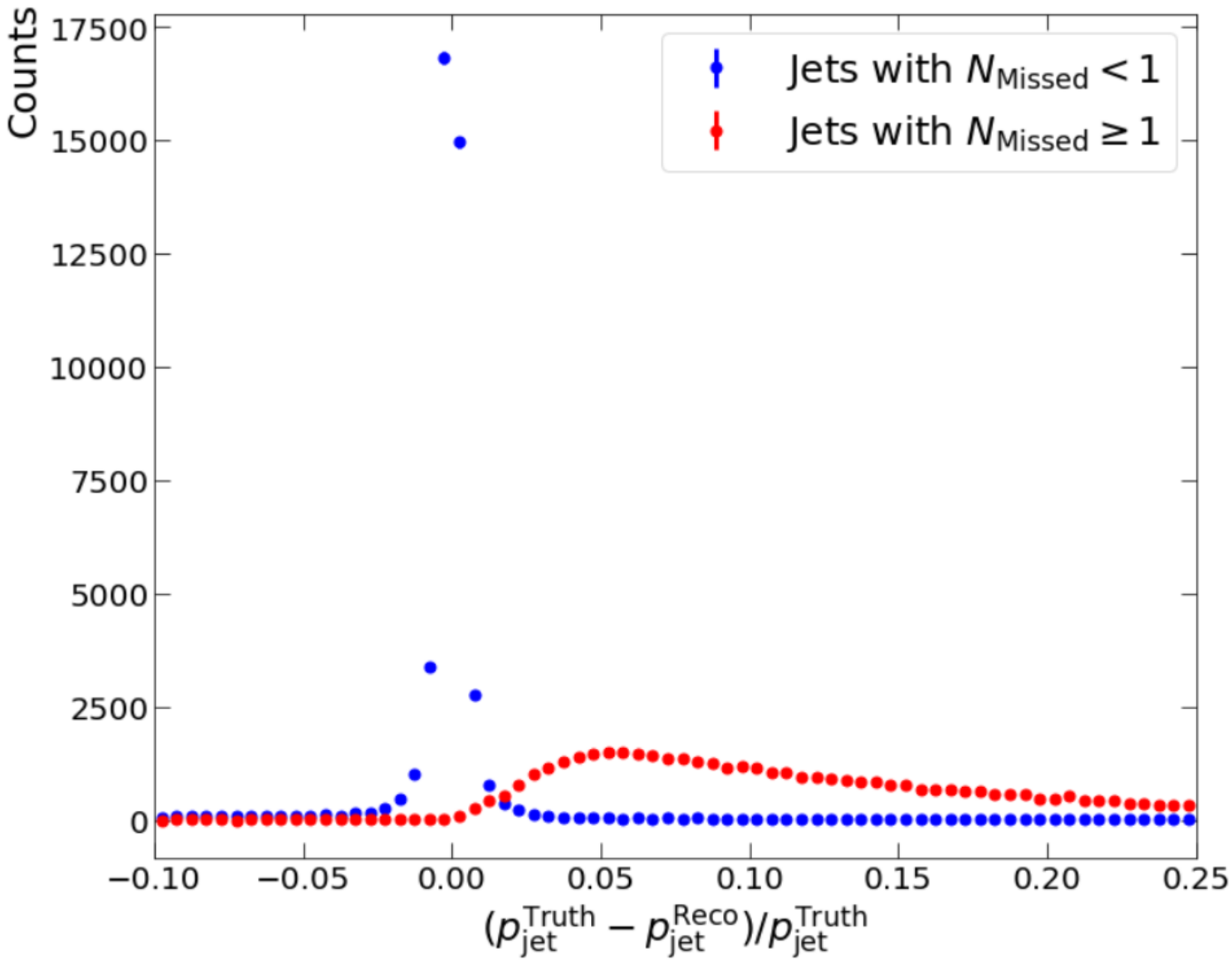


$B = 1.4$ T



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

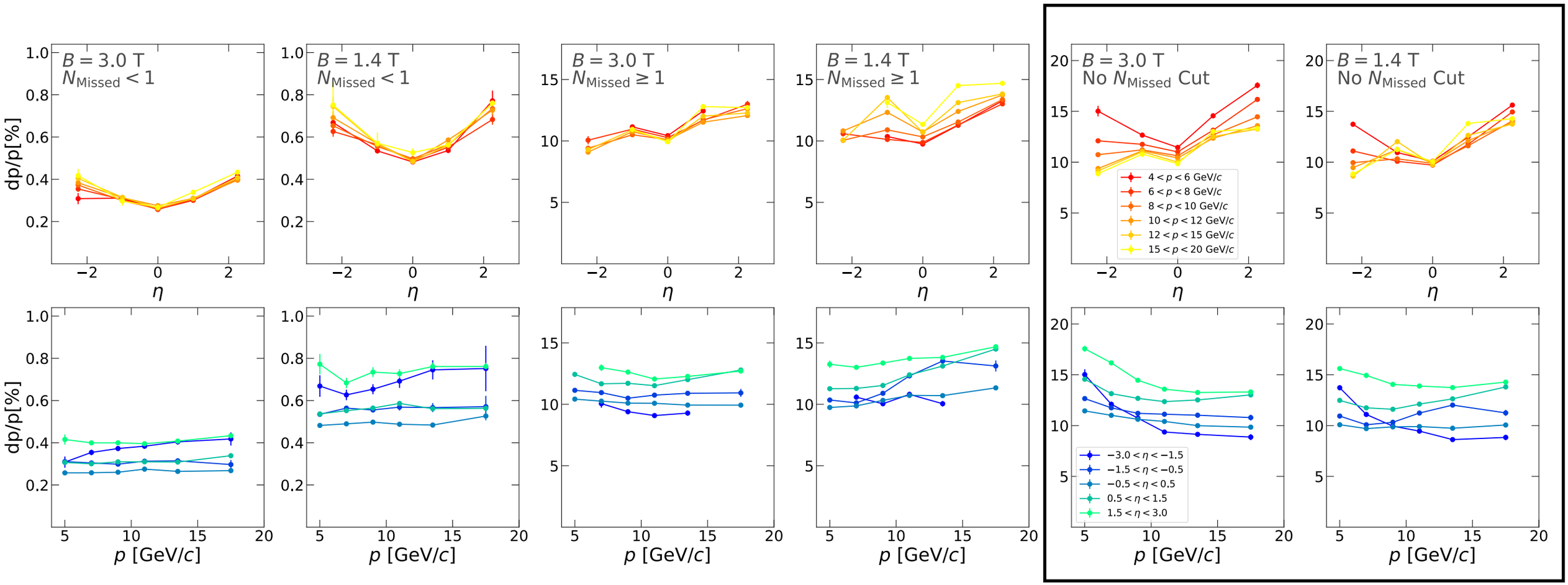
Two Populations of Jets



Number of Missed Charged Constituents:

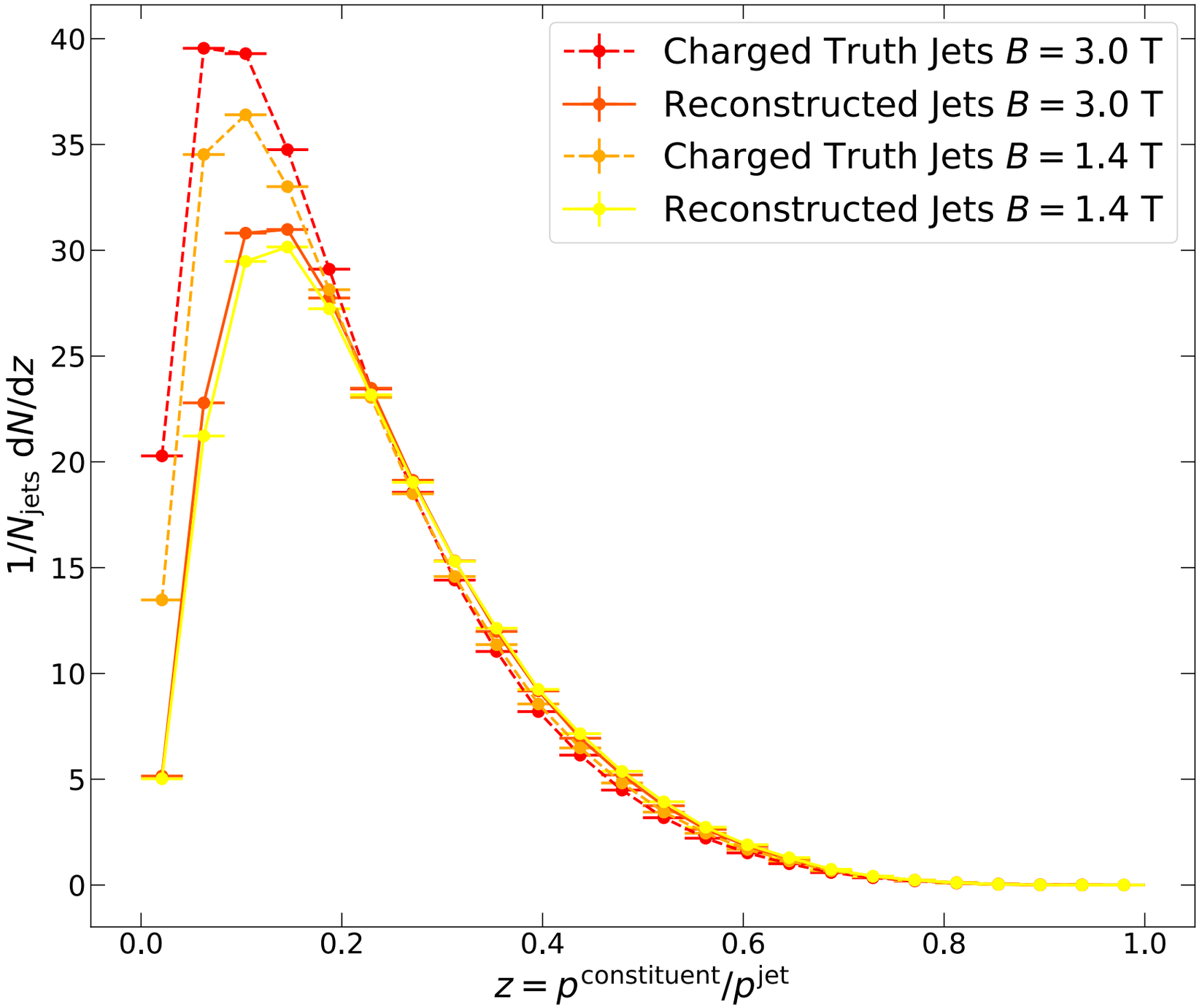
$$N_{\text{missed}} = N_{\text{constituents}}^{\text{truth}} - N_{\text{constituents}}^{\text{reco}} - N_{\text{neutral}}^{\text{truth}}$$

Momentum Resolution (σ_p or StdDev)



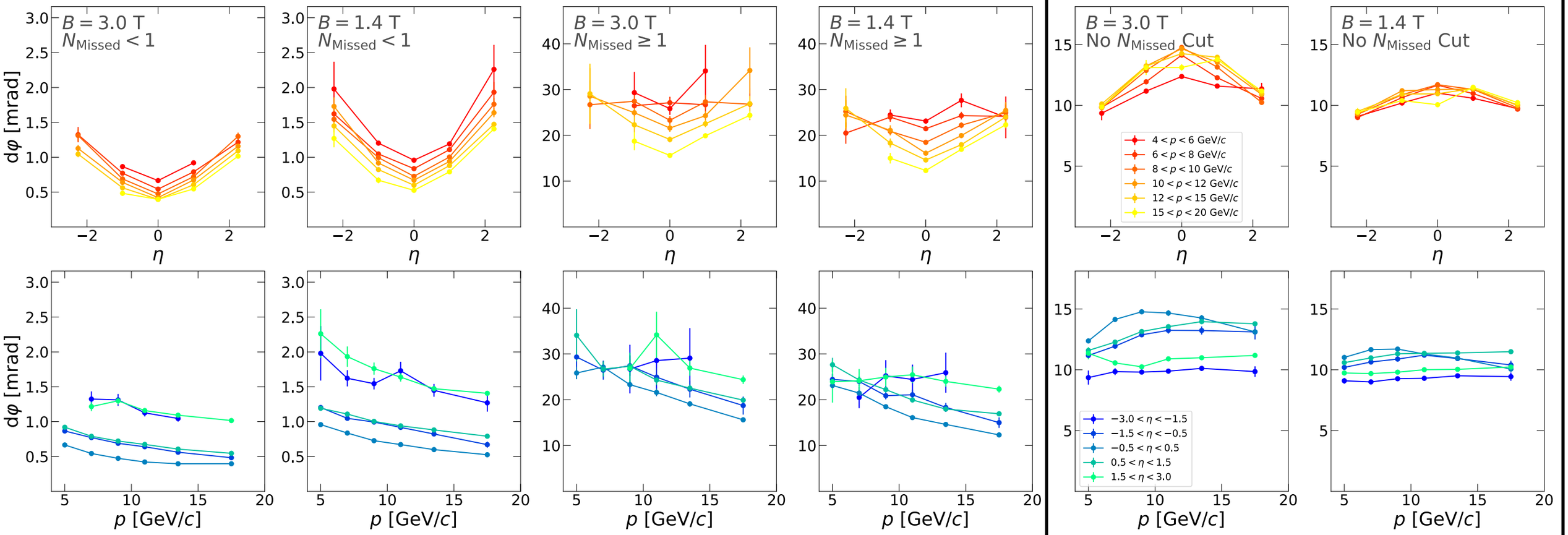
Jets with no missing constituents have better momentum resolution
Jets at central rapidities generally have better resolution as well

Charged Jet Fragmentation Function



Fragmentation Function in both magnetic fields are similar

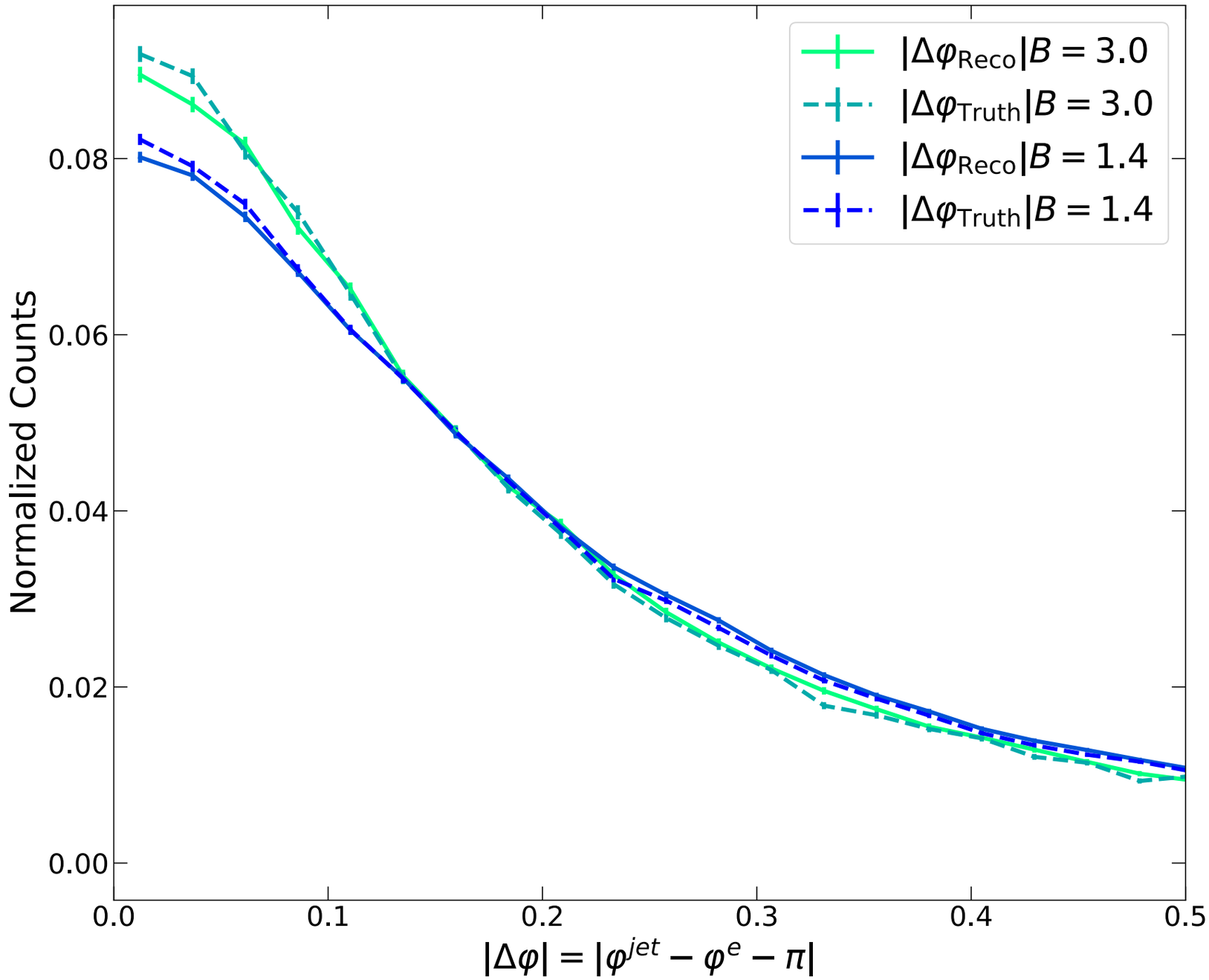
φ Resolutions



Resolutions show dependance on η, better at central

Jets without any missing constituents have better pointing resolution, as expected

Electron-Jet Correlation



Observable difference between B fields at low $\Delta\varphi$

To be fit with gaussian, extract width

Observable can probe TMD distributions[1]

[1] arXiv:1812.08077

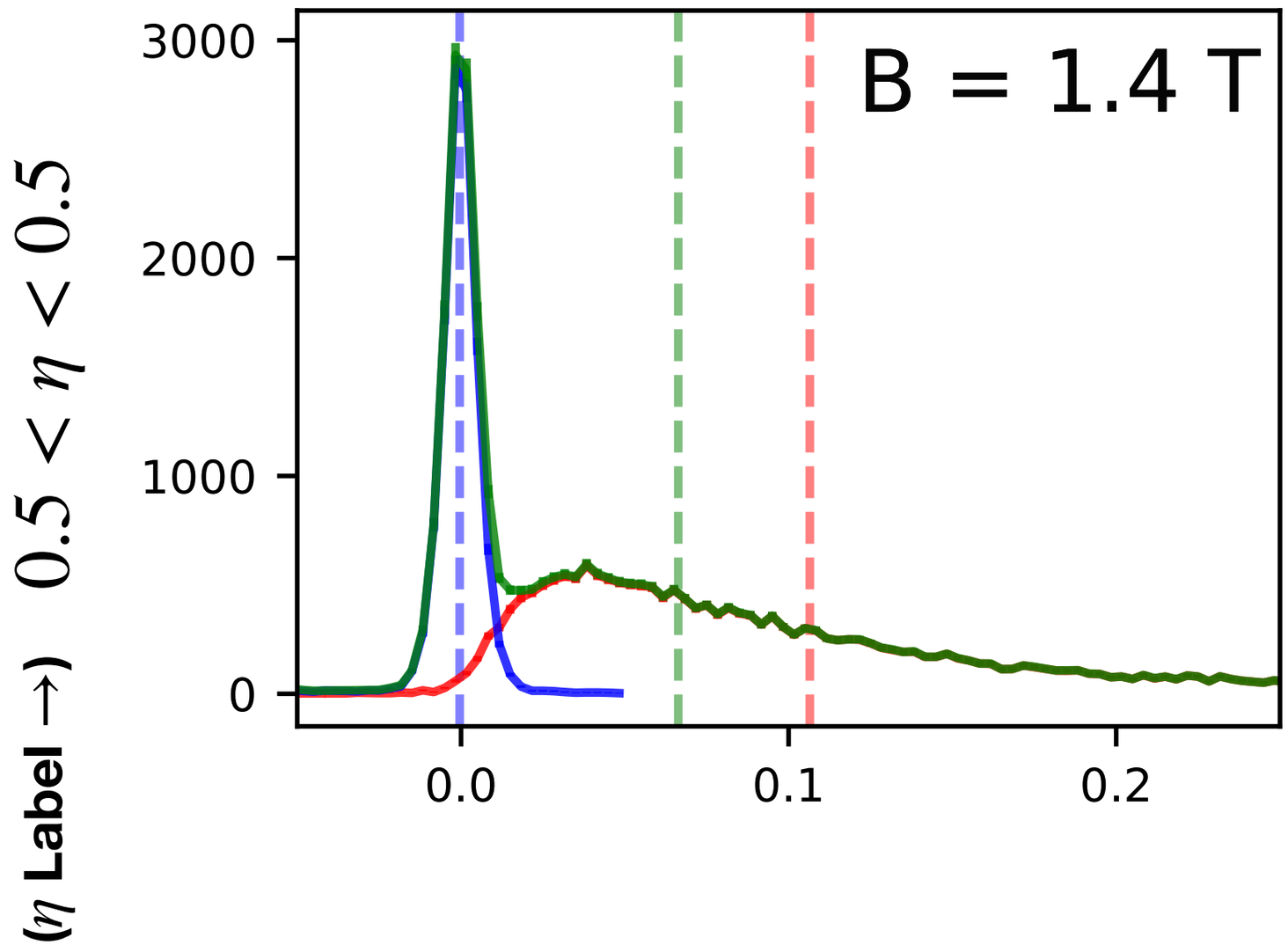
Next Steps

- Luminosity X Cross Section for Observables
  - e+P collisions, $Q^2 \geq 20\ \mathrm{GeV/c}$
- Smear Electron Truth information and apply E/p cluster selection
  - Current observables do not depend on E_{Reco}
  - This selection ensures correct number of events for electron-jet correlation plot
- Study Low p_{T} Threshold for Jet Constituents

End.

Example of Distribution

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



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

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

No N_{Missed} Cut

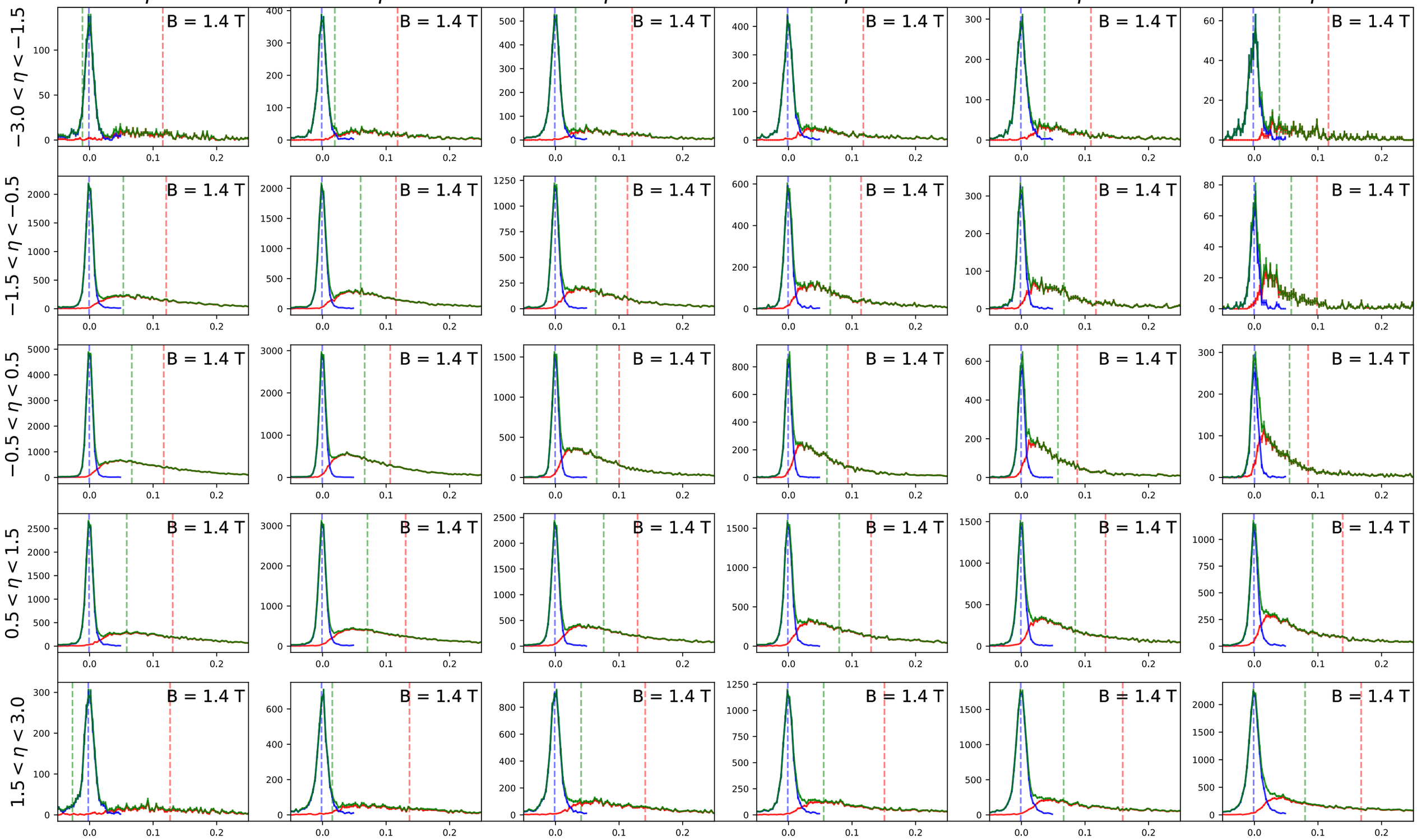
$$\sigma = \sqrt{\frac{\sum (X - \mu)^2}{N}}$$

- **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

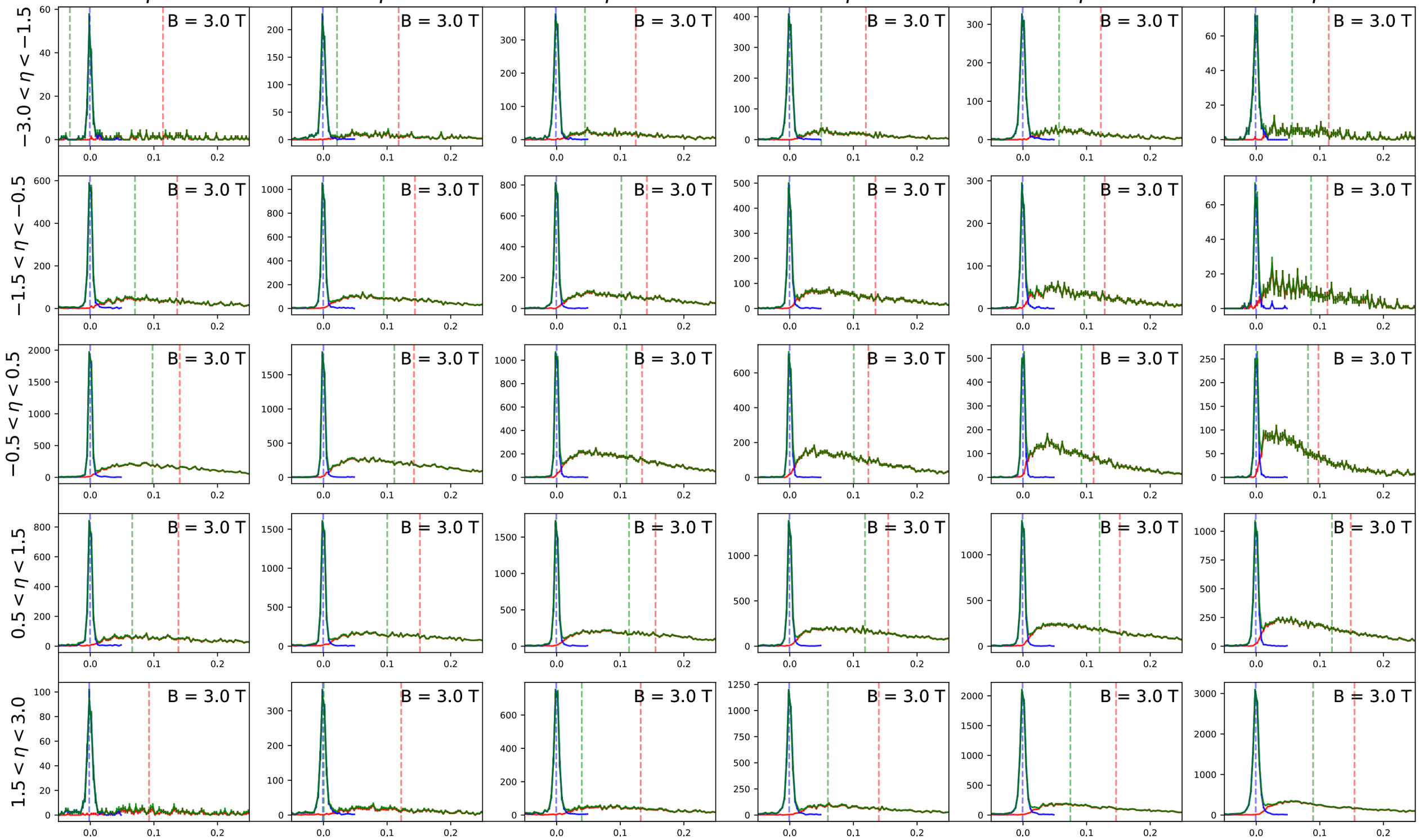
dp/p[%]



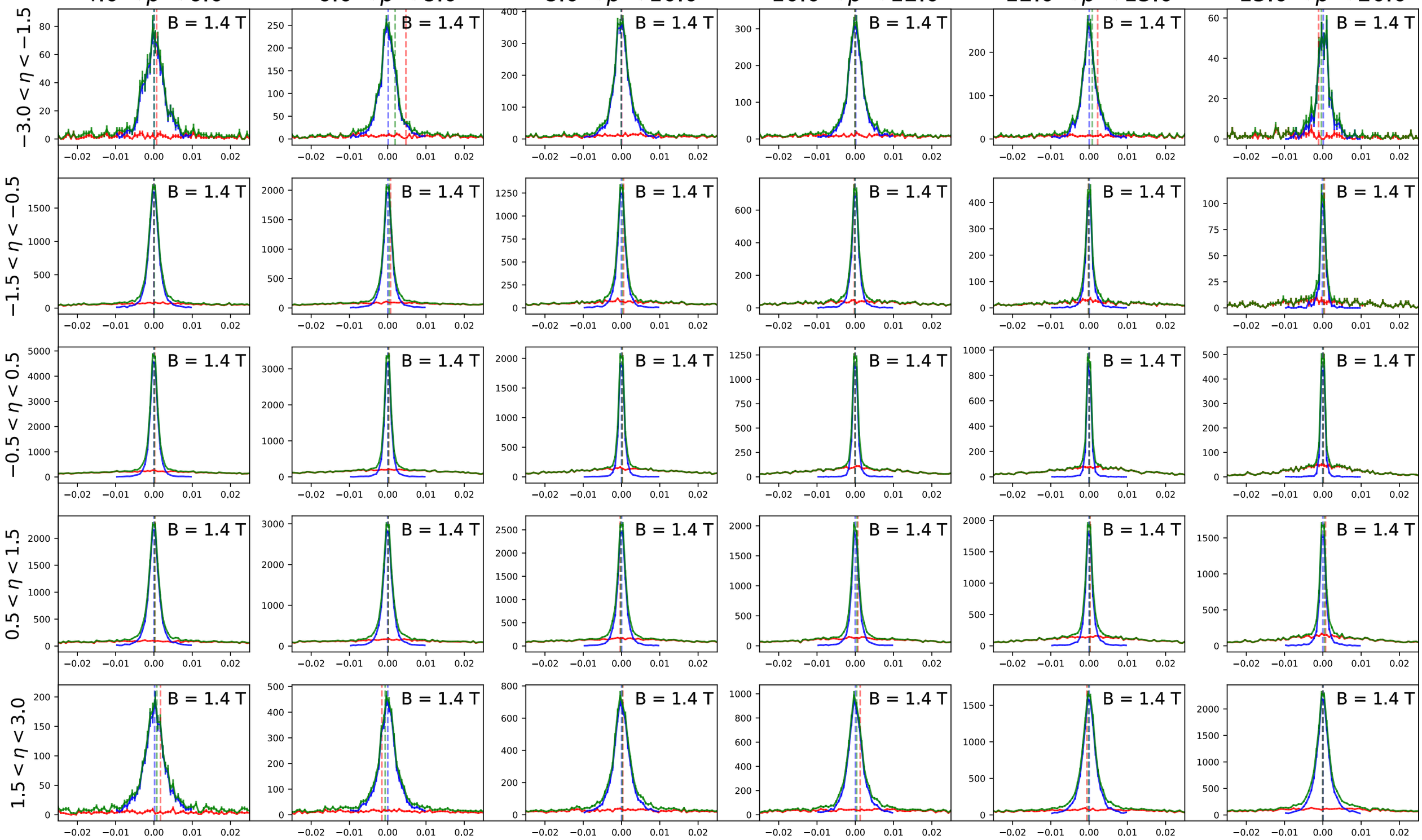
$N_{\text{Missed}} < 1$ $N_{\text{Missed}} \geq 1$ No N_{Missed} Cut

B = 3.0 T

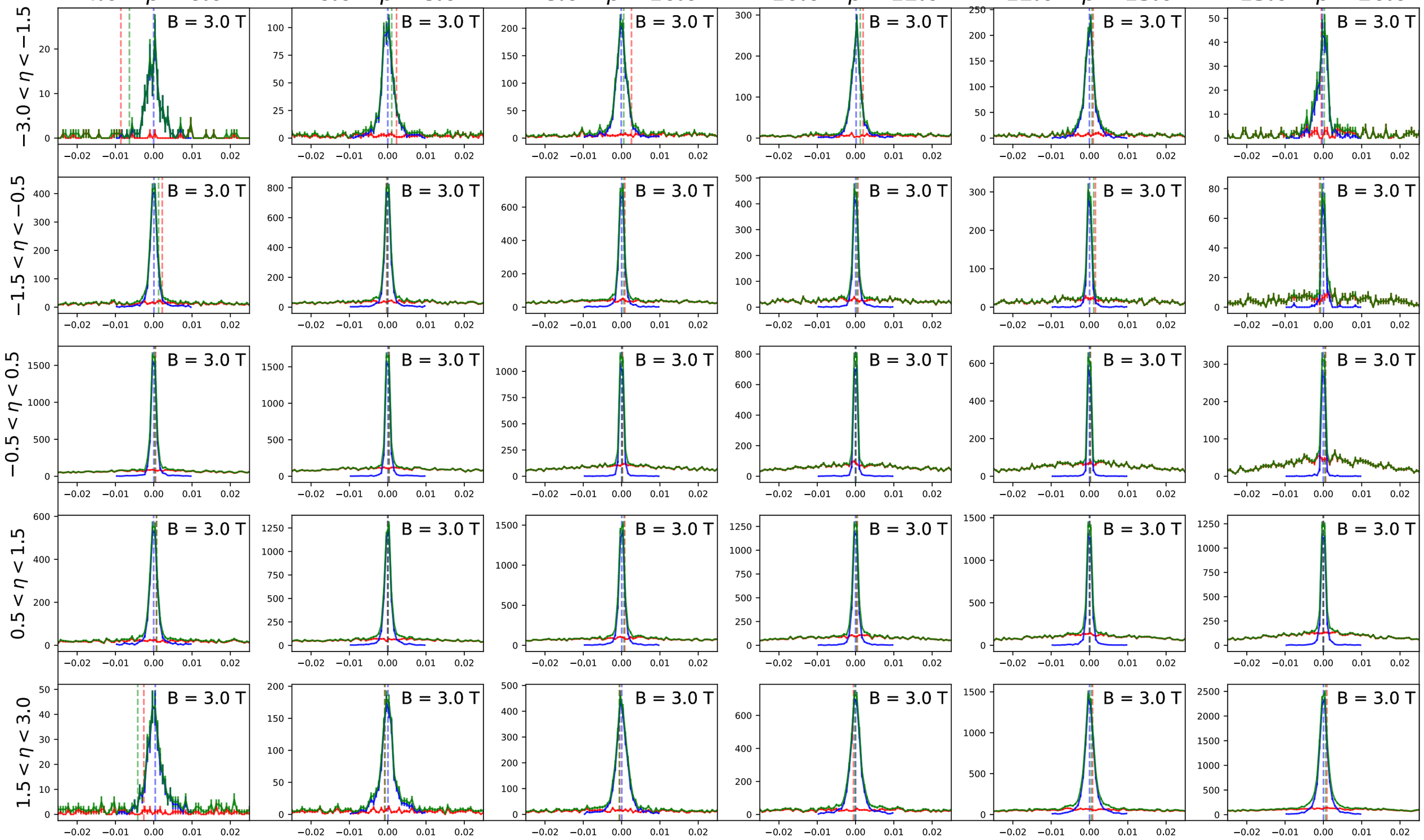
dp/p[%]



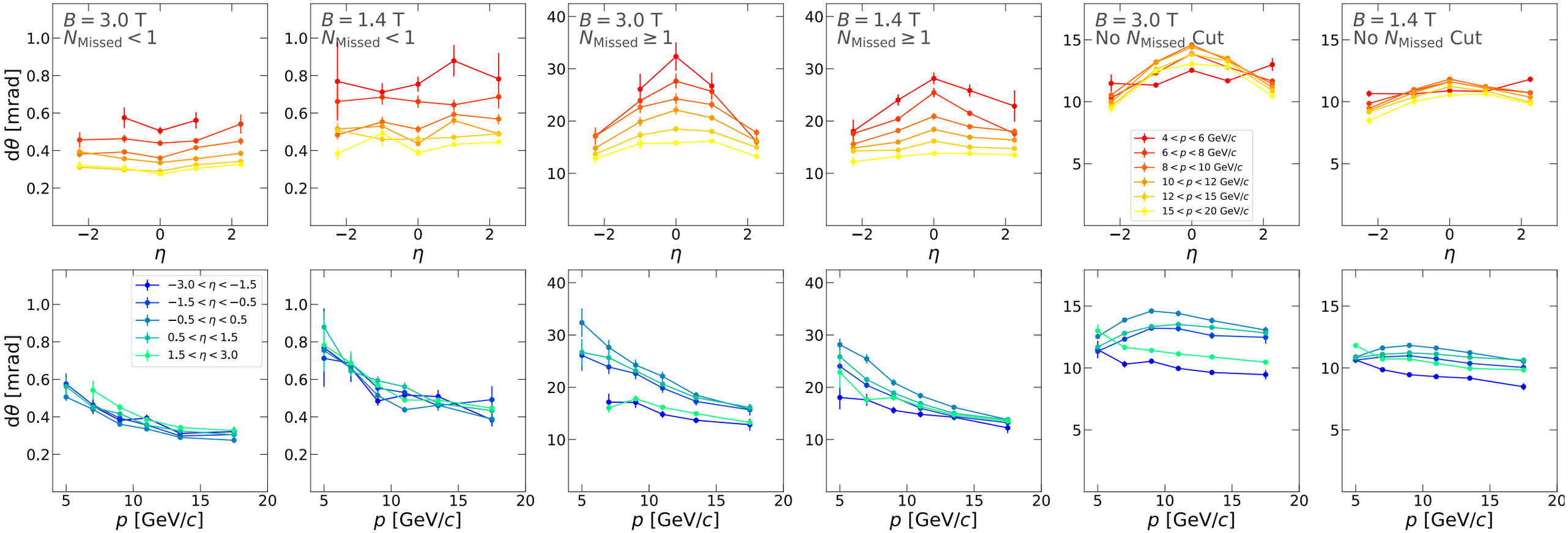
dφ [mrad]



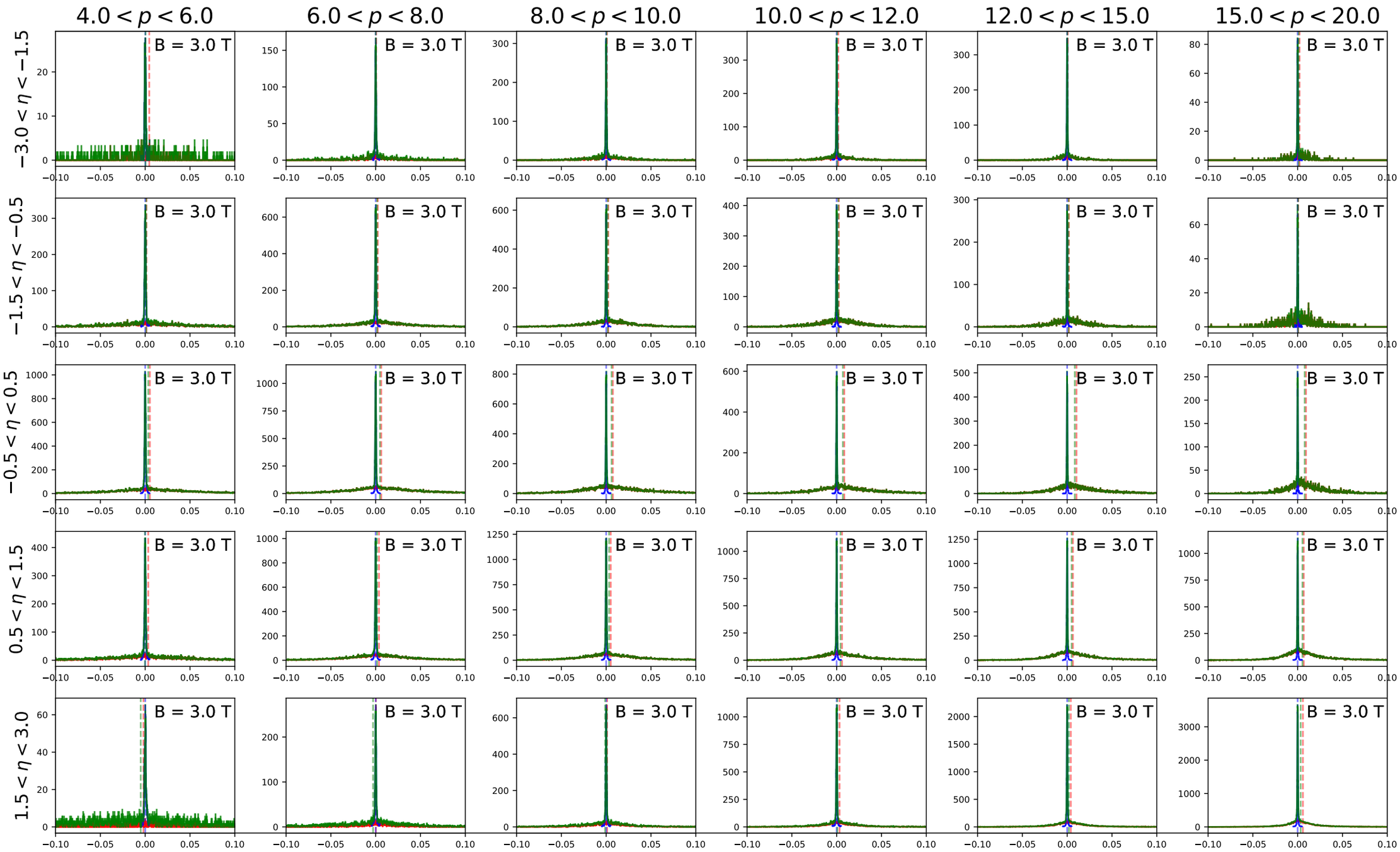
dφ [mrad]

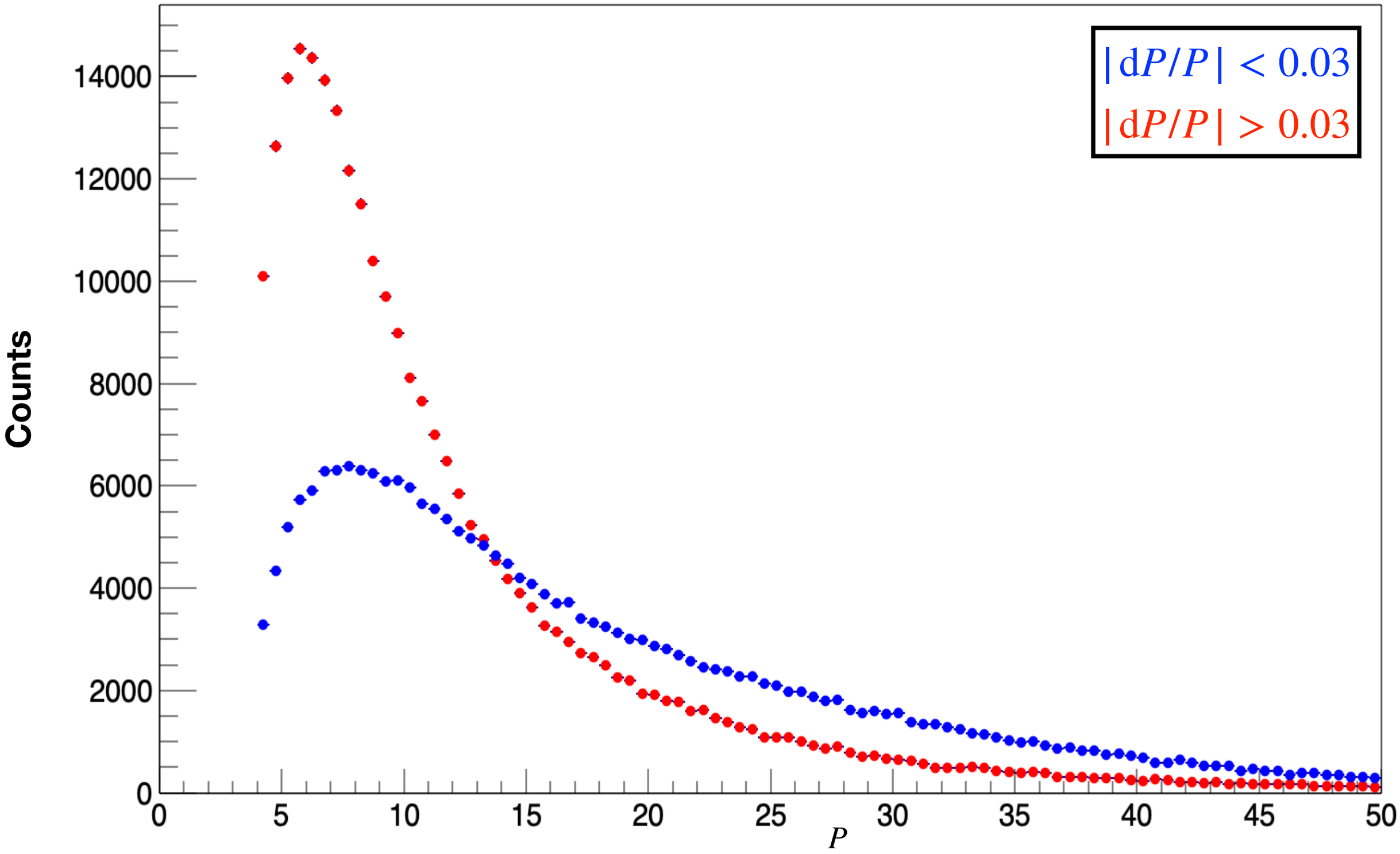

4.0 < p < 6.0
6.0 < p < 8.0
8.0 < p < 10.0
10.0 < p < 12.0
12.0 < p < 15.0
15.0 < p < 20.0
−3.0 < η < −1.5
−1.5 < η < −0.5
−0.5 < η < 0.5
0.5 < η < 1.5
1.5 < η < 3.0
B = 3.0 T

θ Resolutions

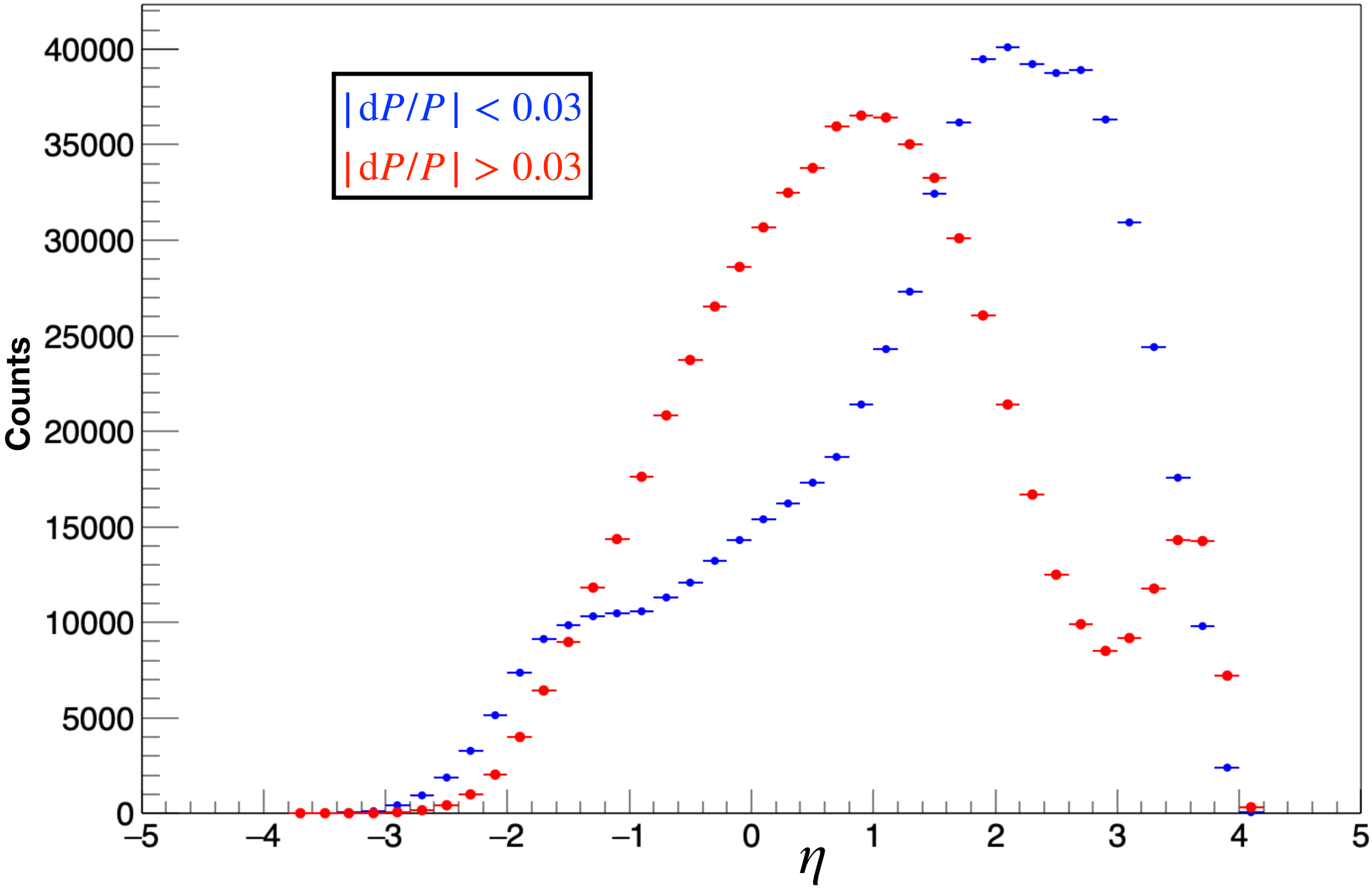


dθ [mrad]


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

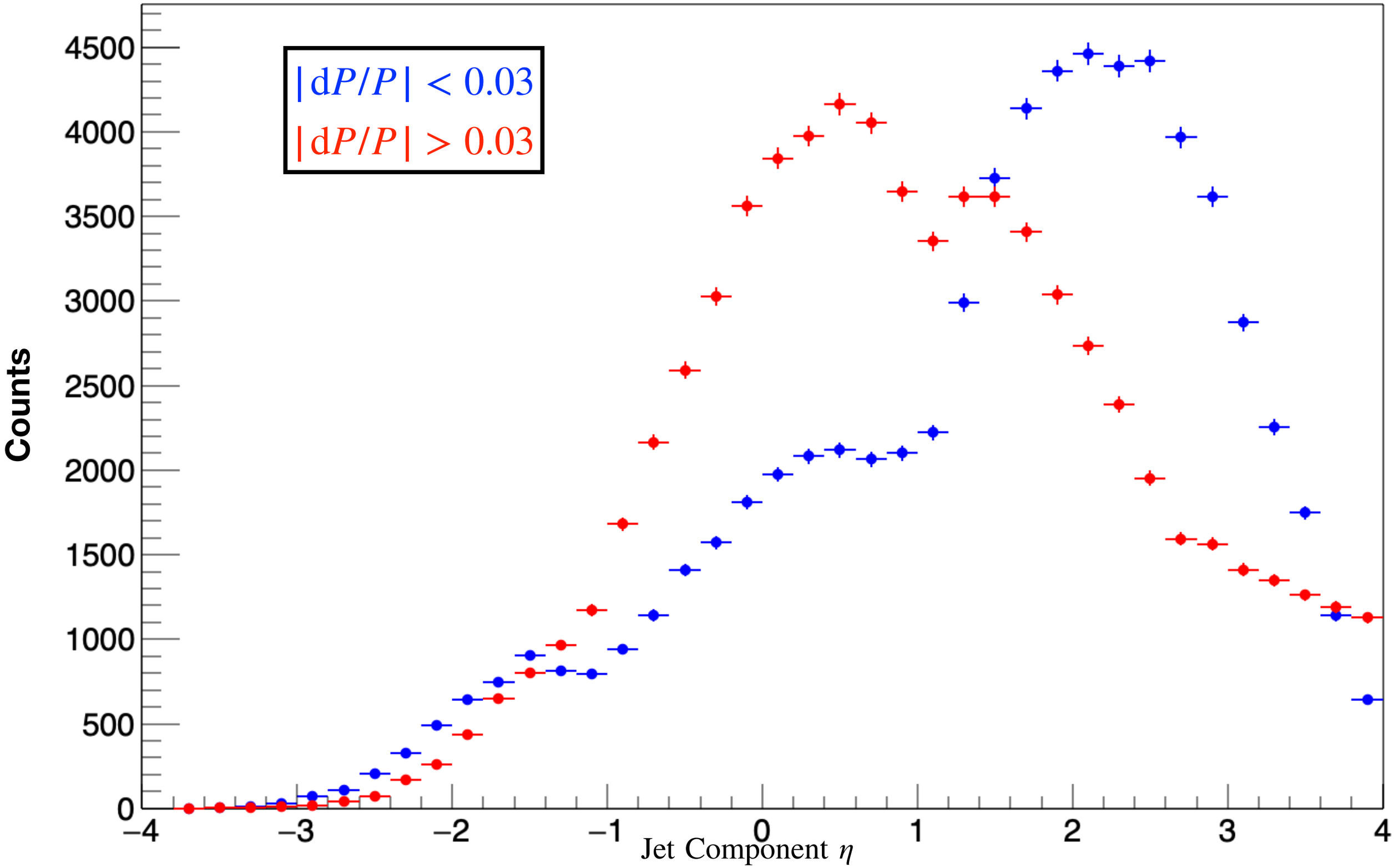

$|dP/P| < 0.03$
$|dP/P| > 0.03$
Counts
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
30
35
40
45
50
P

Recontsructed Jet η



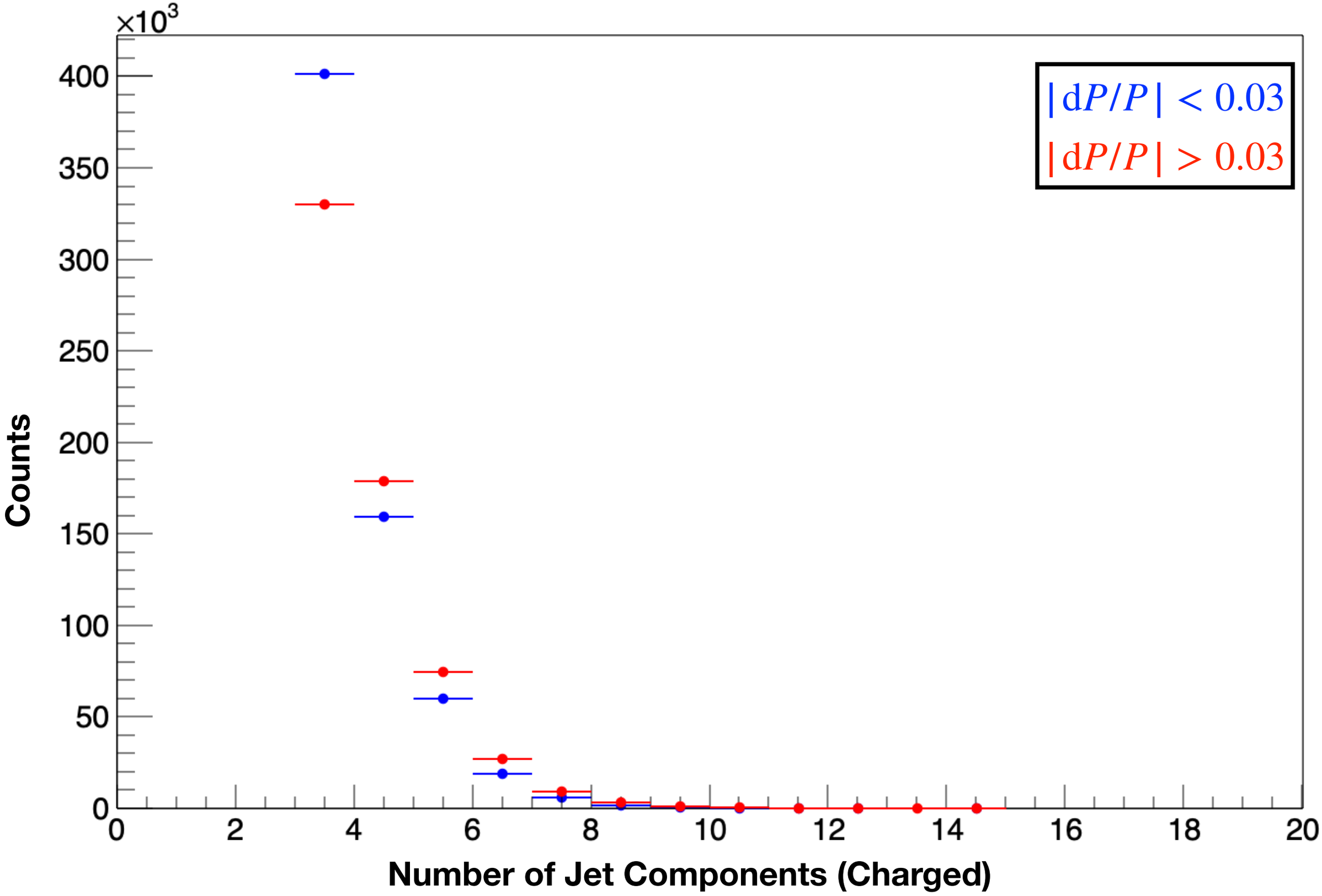
Jet Component Distributions

Jet Component η

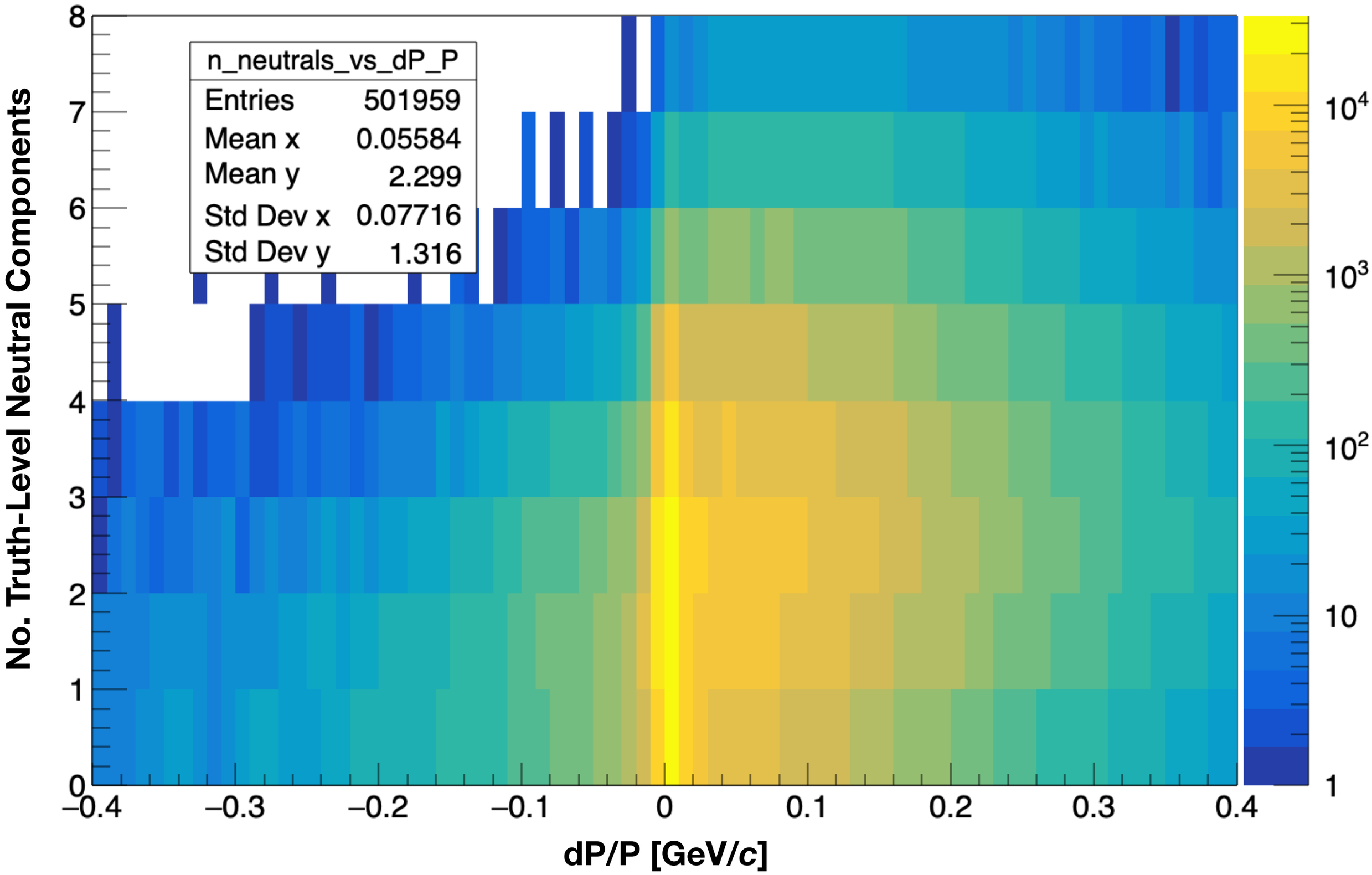


The central barrel layers meet the endcap of the all-sillicon tracker at $\eta \approx 1.1$, jets near this region are omitted in the resolution calculation

Reconstructed Jet N Component

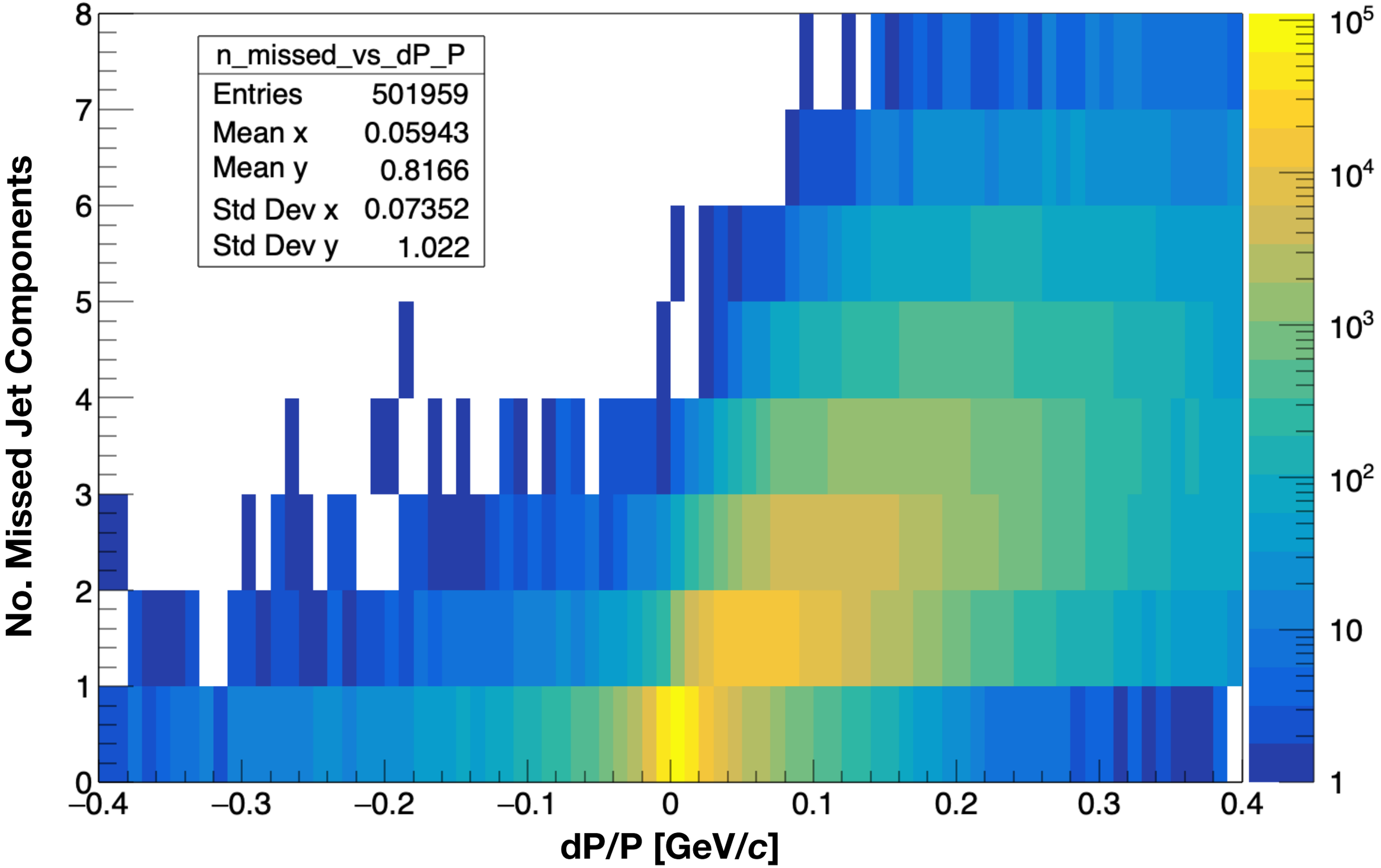


No. Neutral Components in Original Truth Jet VS. dP/P



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

No. Missed Jet Components VS. dP/P

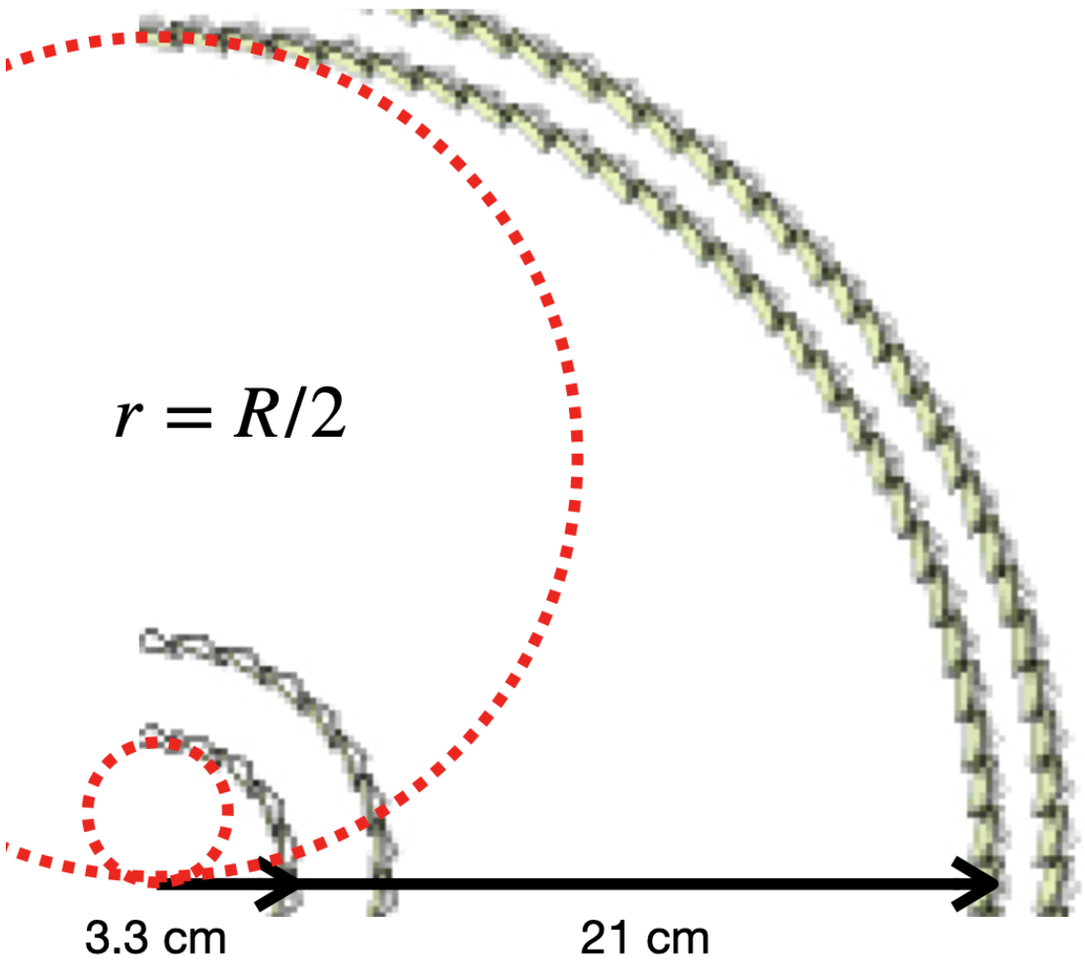


Are lost constituents and poor dP/P due to low pT constituents?

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

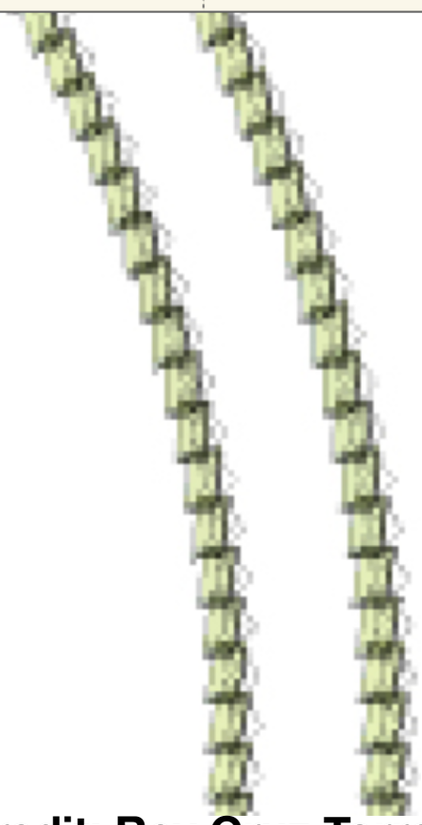
*** Need at least three points for a momentum measurement**

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



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

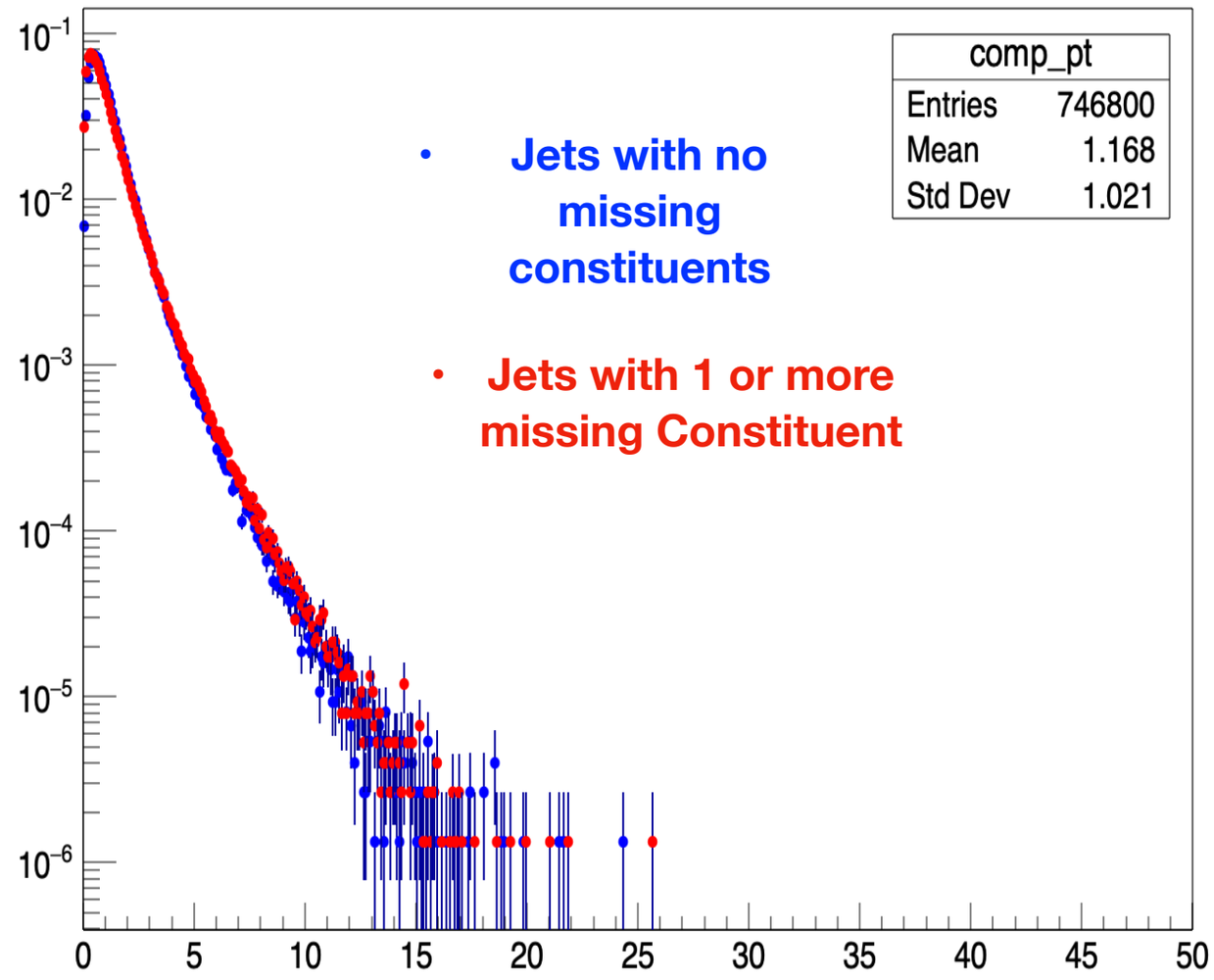
Notes:

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

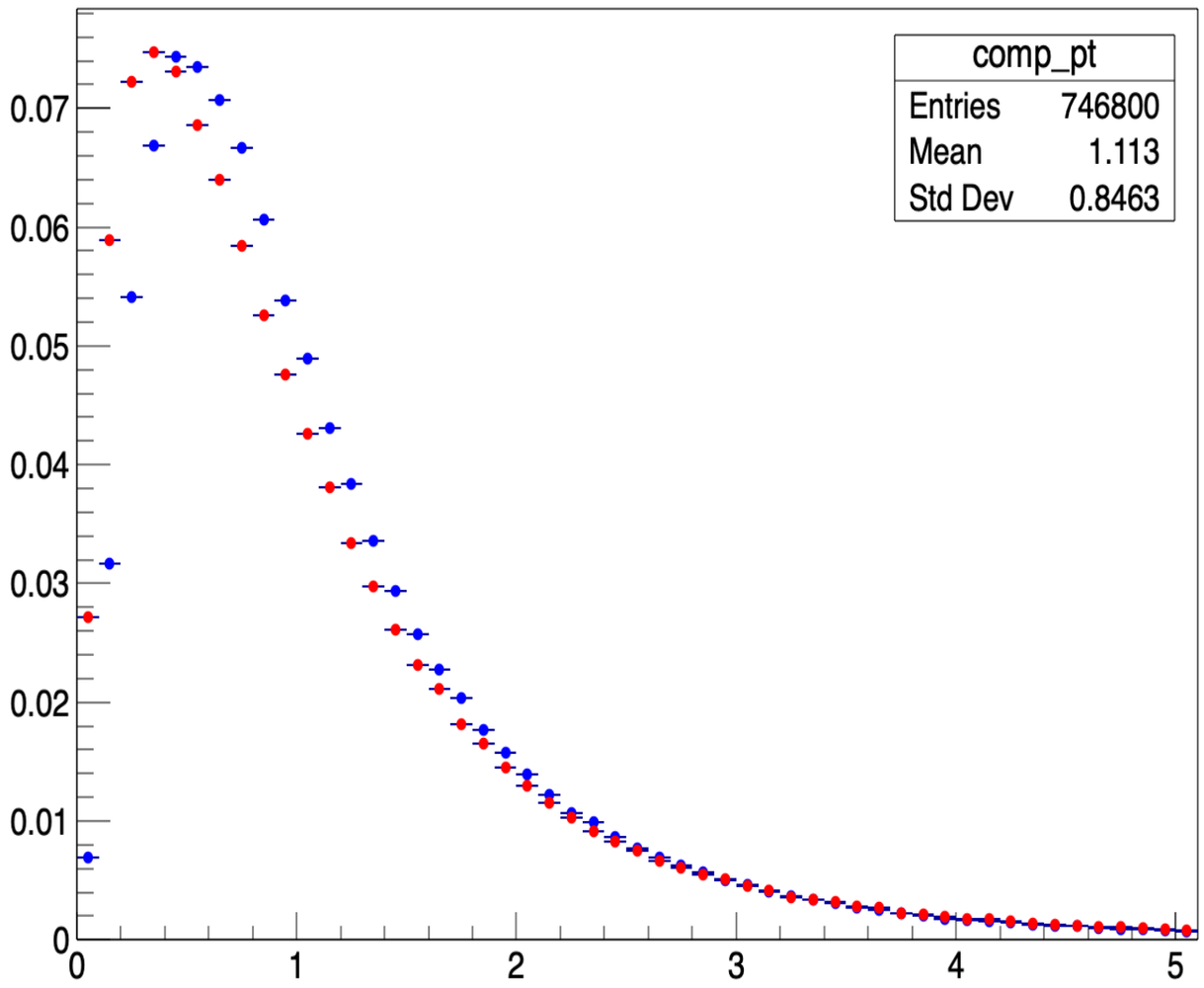
https://physdiv.jlab.org/DetectorMatrix/

Jet Component p_T



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

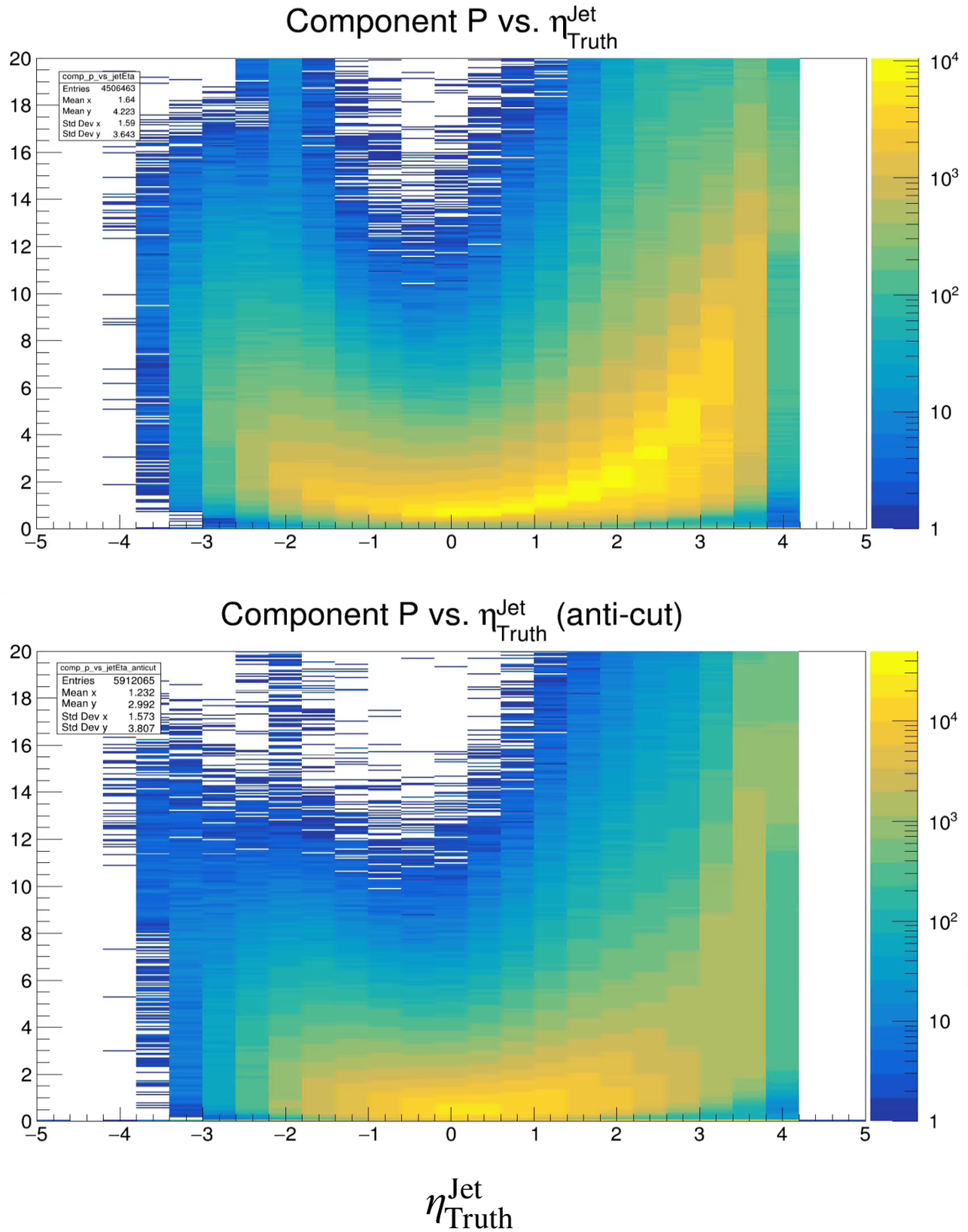
Jet Component p_T



Jet Component p vs Jet η

$|dP/P| < 0.03$

Constituent p [Gev/c]

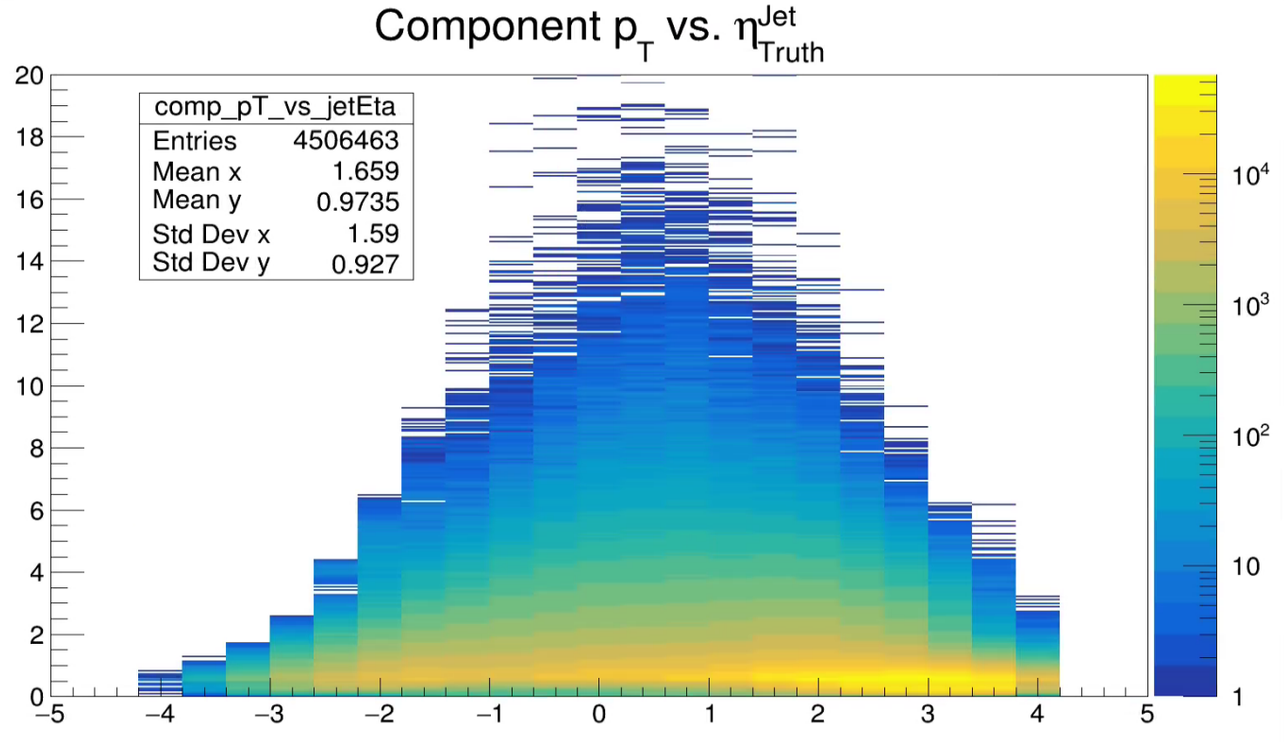


$|dP/P| > 0.03$

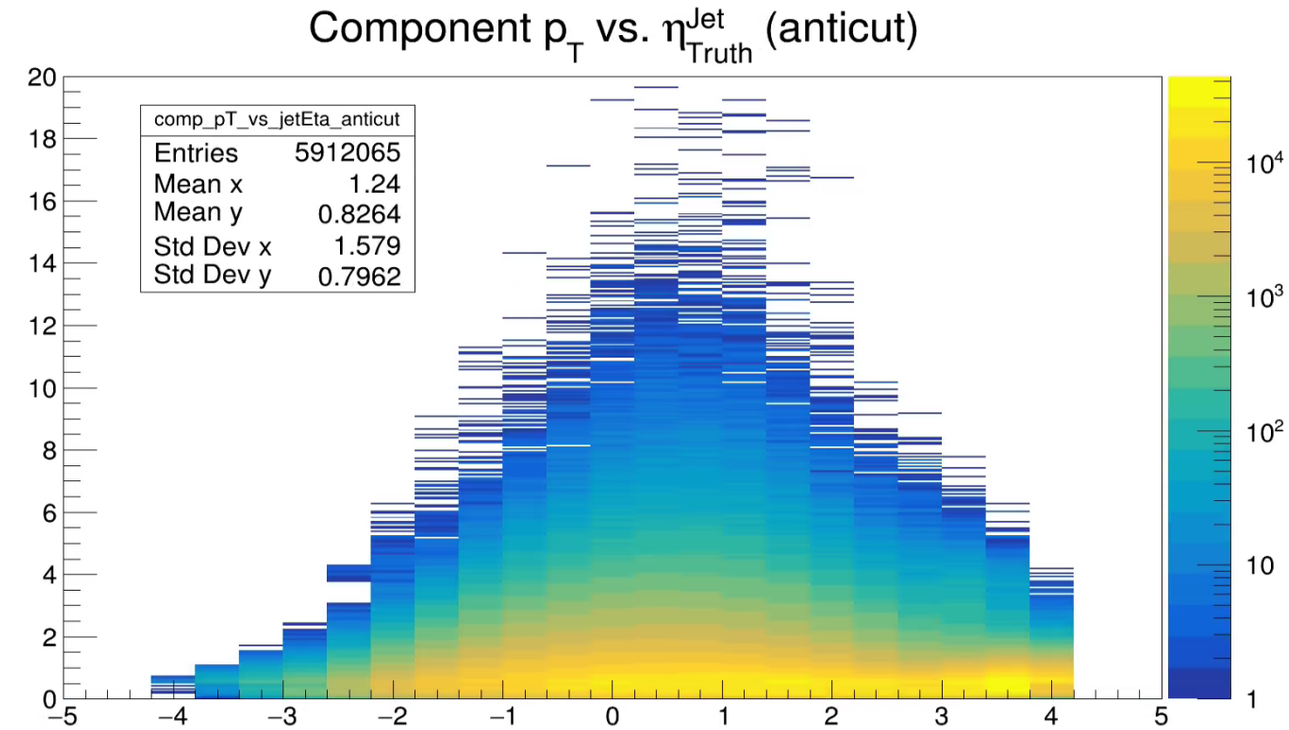
An η dependent p cut does not seem to be a likely solution

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