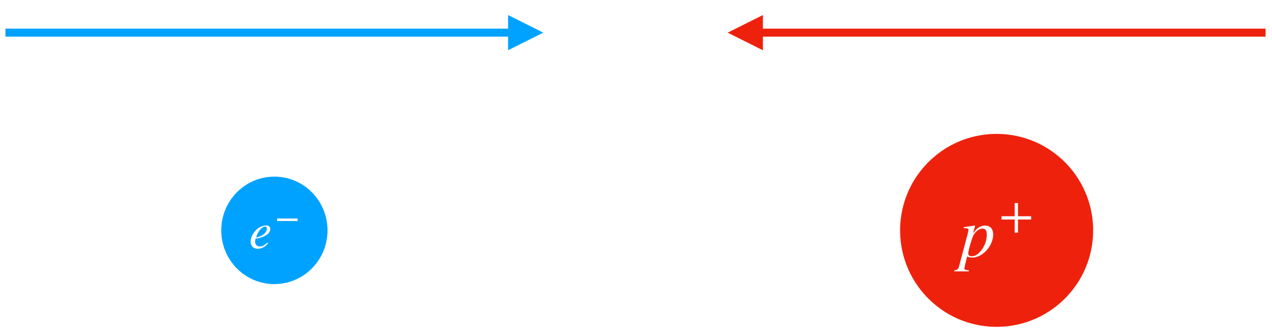
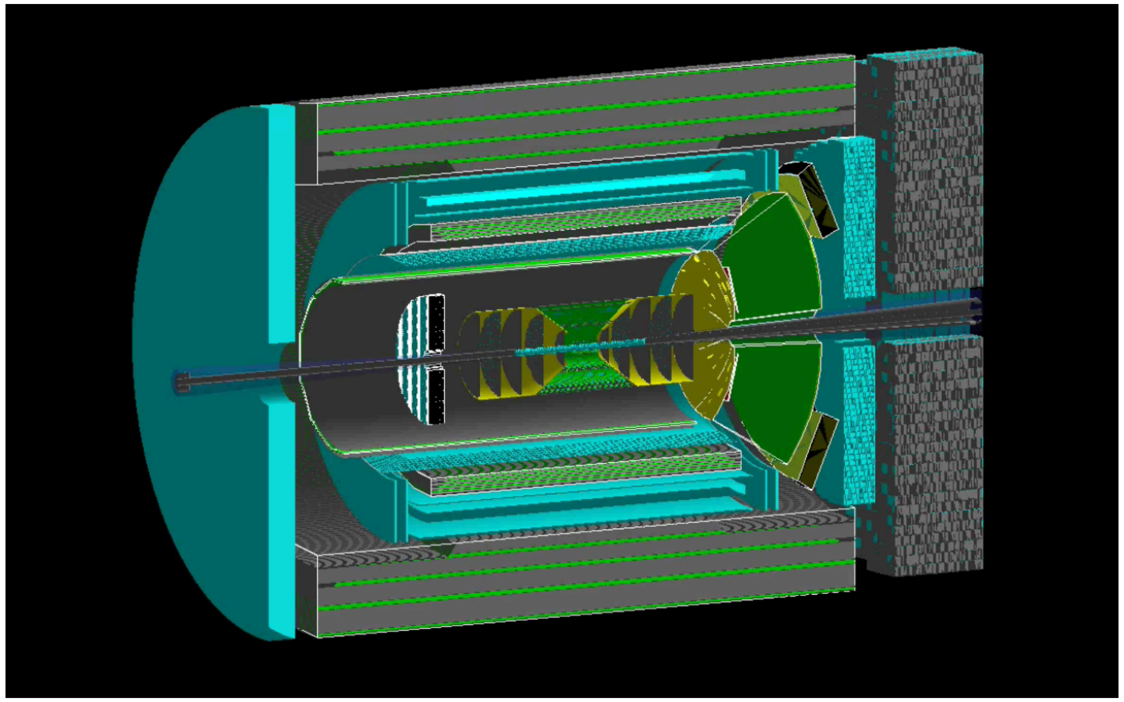
# All Silicon Tracker Jets

# Jets in e+P PYTHIA Simulation



- PYTHIA 8
  - $Q^2_{\min} \geq 16$ (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-$k_{\text{T}}$ $R$ = 1.0
  - $\Delta R$ (jet-electron) > 0.5
    - “Electron Veto”

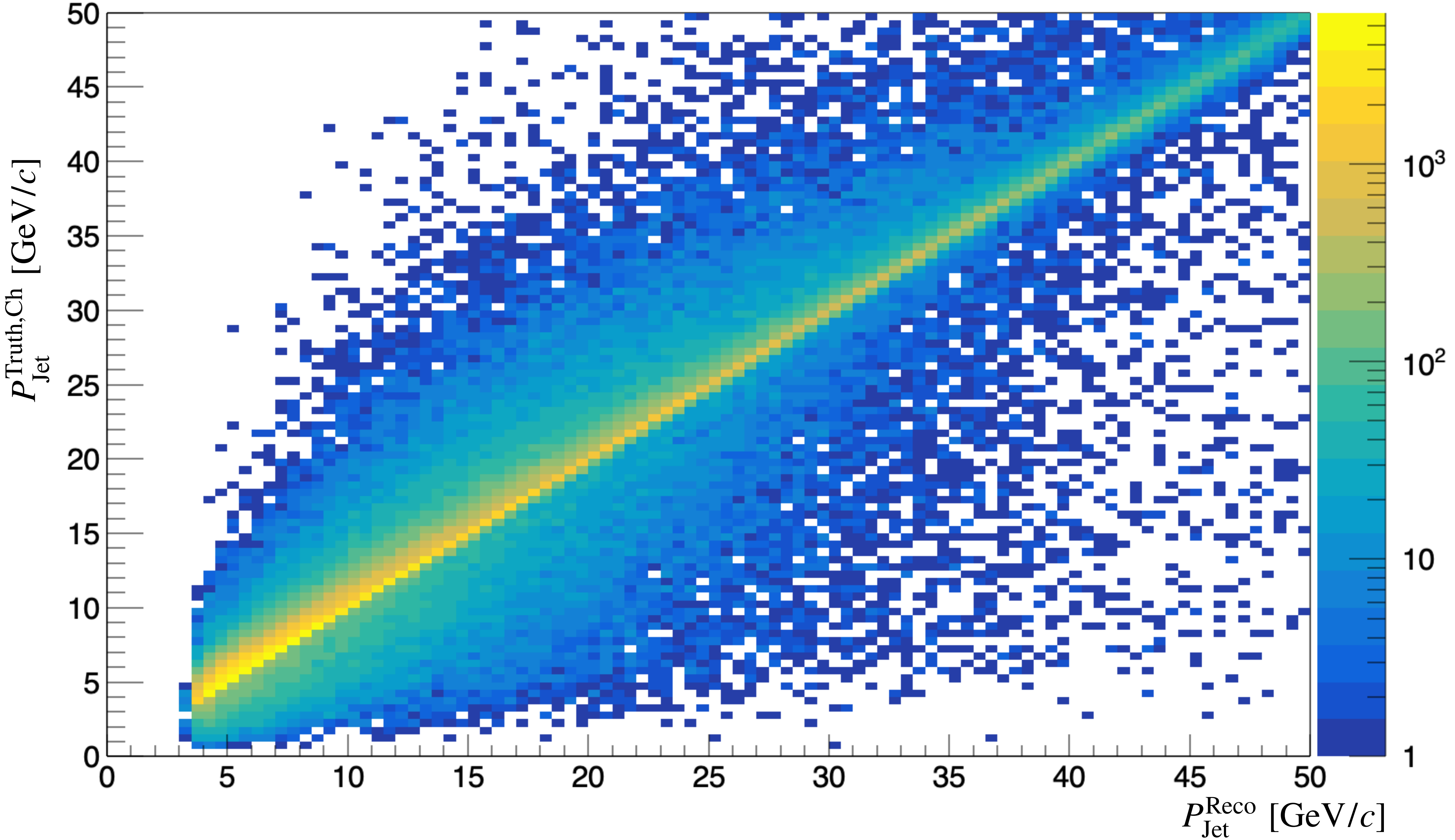
- Jet Constituents
  - $N_{\text{constituents}} \geq 4$
  - $p_{\text{T}}^{\text{constituent}} \geq 60\ \text{MeV}/c$
  - $|\eta^{\text{constituent}}| \neq 1.1$
    - Central barrel meets forward layers
    - Update: $1.06 < |\eta| < 1.13$

# Overview

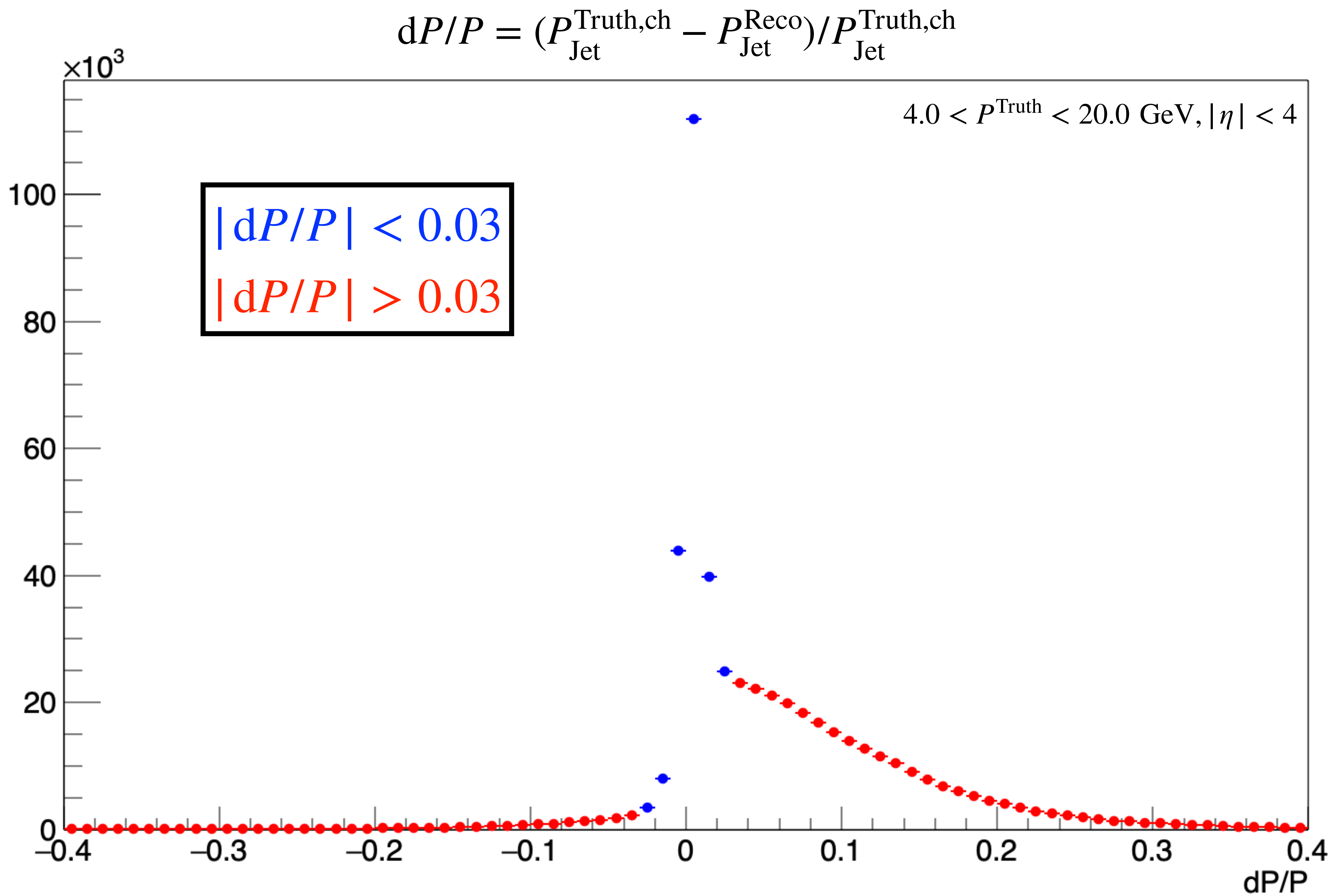
- Response Matrix
  - $P_{\mathrm{Jet}}^{\mathrm{Truth,ch}}$ vs . $P_{\mathrm{Jet}}^{\mathrm{Reco}}$
- Momentum Resolution
  - $(P_{\mathrm{Jet}}^{\mathrm{Truth,ch}} - P_{\mathrm{Jet}}^{\mathrm{Reco}})/P_{\mathrm{Jet}}^{\mathrm{Truth,ch}}$
  - Sensitive to $N_{\mathrm{Missed}}$ Constituents
- Angular Resolutions
  - $\mathrm{d}\theta$, $\mathrm{d}\varphi$

$$p^{jet,\,\mu}_{\mathrm{charged}} = p^{jet,\,\mu}_{\mathrm{total}} - p^{jet,\,\mu}_{\mathrm{neutral}}$$

# $P^{\mathrm{Truth,ch}}_{\mathrm{Jet}}$ vs . $P^{\mathrm{Reco}}_{\mathrm{Jet}}$



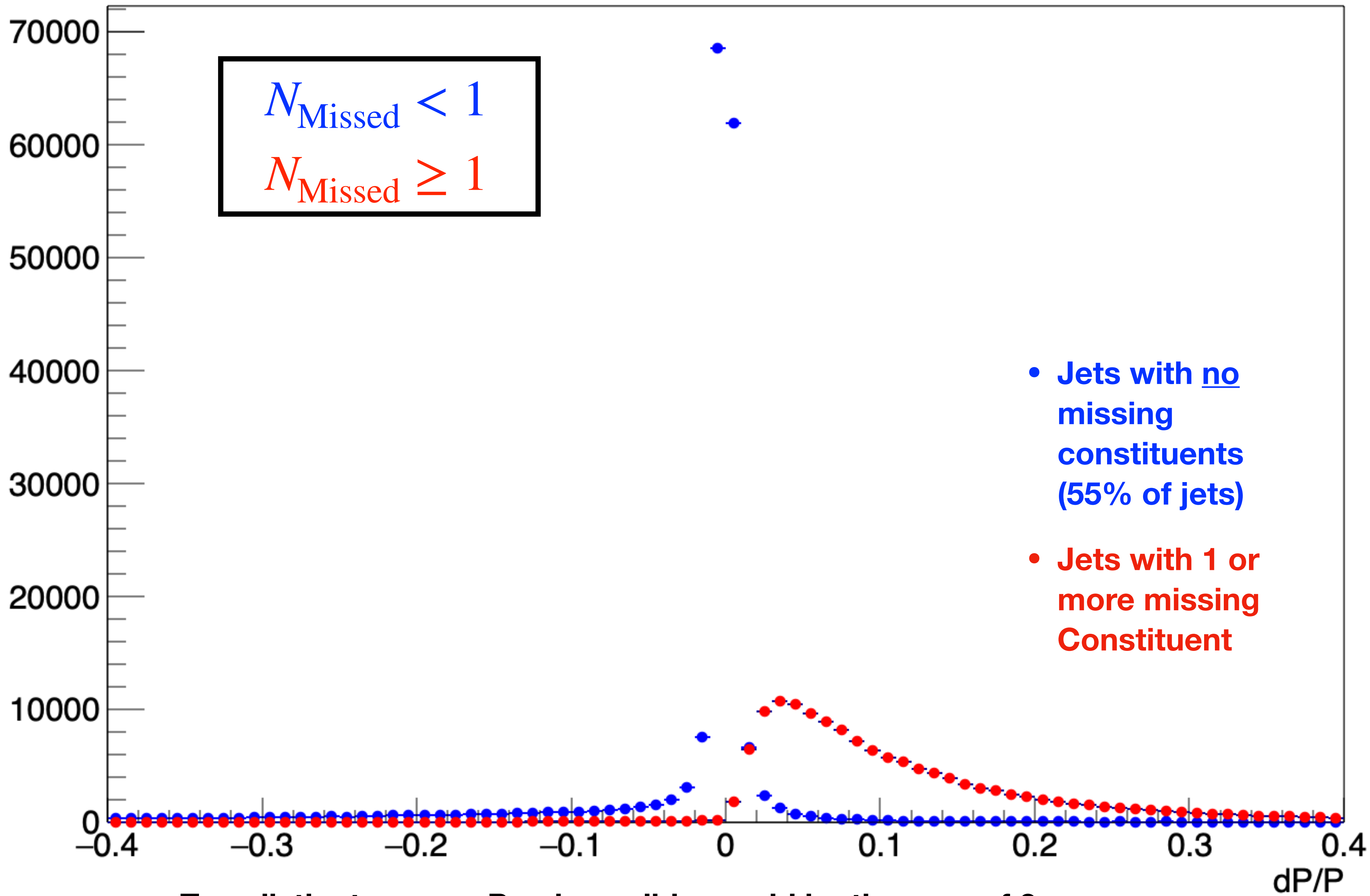
# Non-Gaus Momentum Resolution




**What kind of jets make up that wider distribution?**

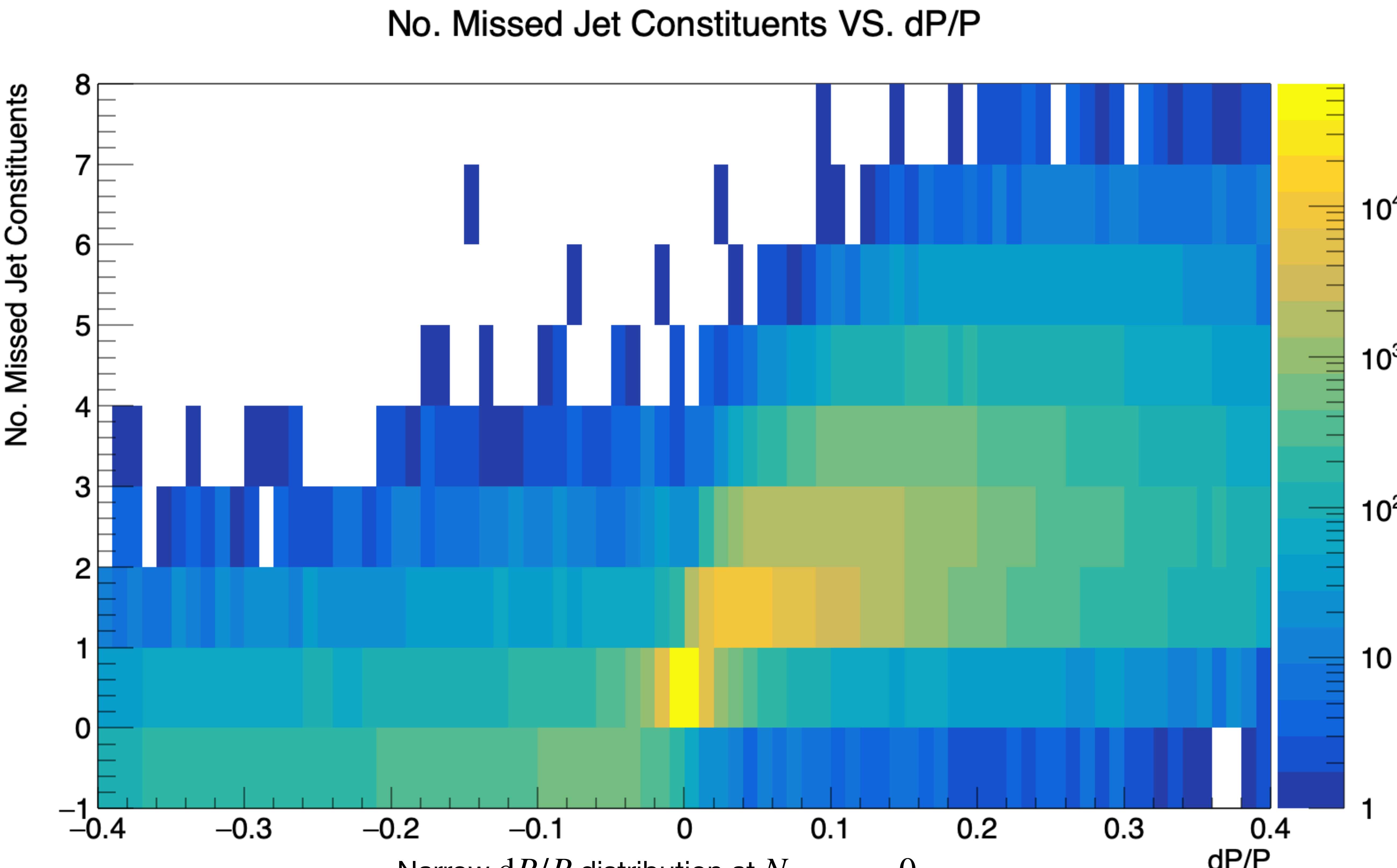
$$N_{\text{missed}} = N^{\text{truth}}_{\text{constituents}} - N^{\text{reco}}_{\text{constituents}} - N^{\text{truth}}_{\text{neutral}}$$

$$dP/P = (P^{\text{Truth,ch}}_{\text{Jet}} - P^{\text{Reco}}_{\text{Jet}})/P^{\text{Truth,ch}}_{\text{Jet}}$$




- Jets with no missing constituents (55% of jets)
- Jets with 1 or more missing Constituent

- **Two distinct curves: Previous slide would be the sum of 2 curves**
- **Blue narrow peak: charged jets with no missing *charged* constituents**
- **Red shoulder: charged jets with 1 or missing *charged* constituent**

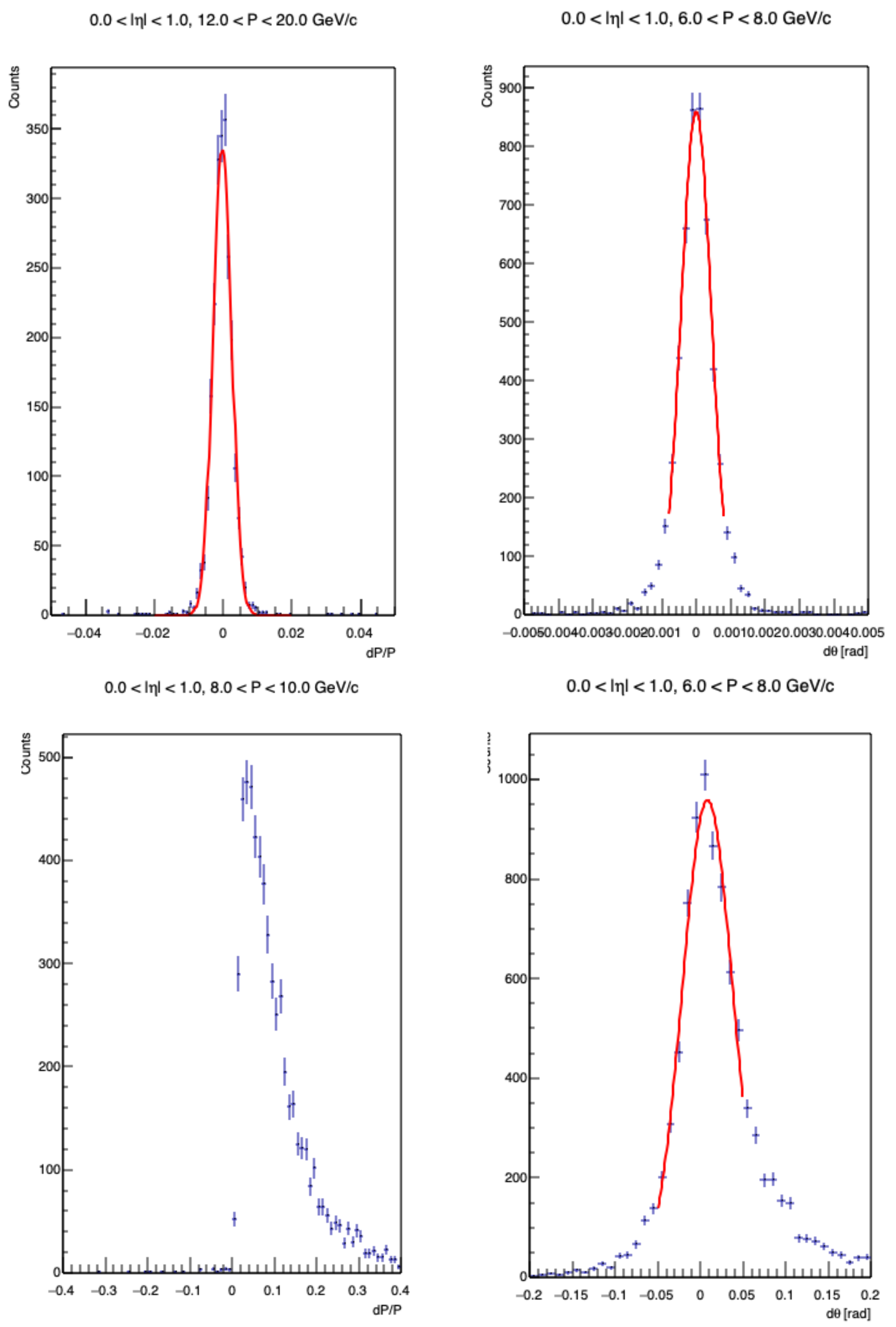



- Narrow $\mathrm{d}P/P$ distribution at $N_{\mathrm{Missed}} = 0$
- $\mathrm{d}P/P$ broadens more as $N_{\mathrm{Missed}}$ increases
- (Track-hit efficiency set at 100%)

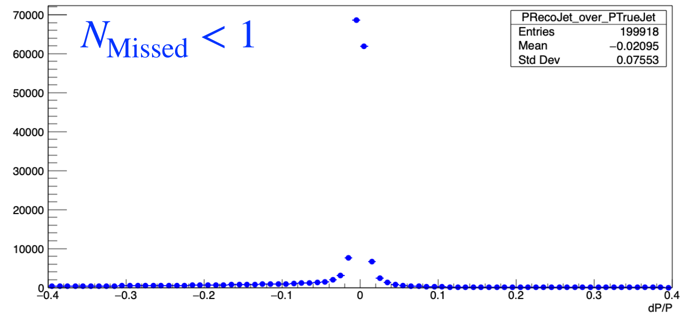
# Jet Resolutions

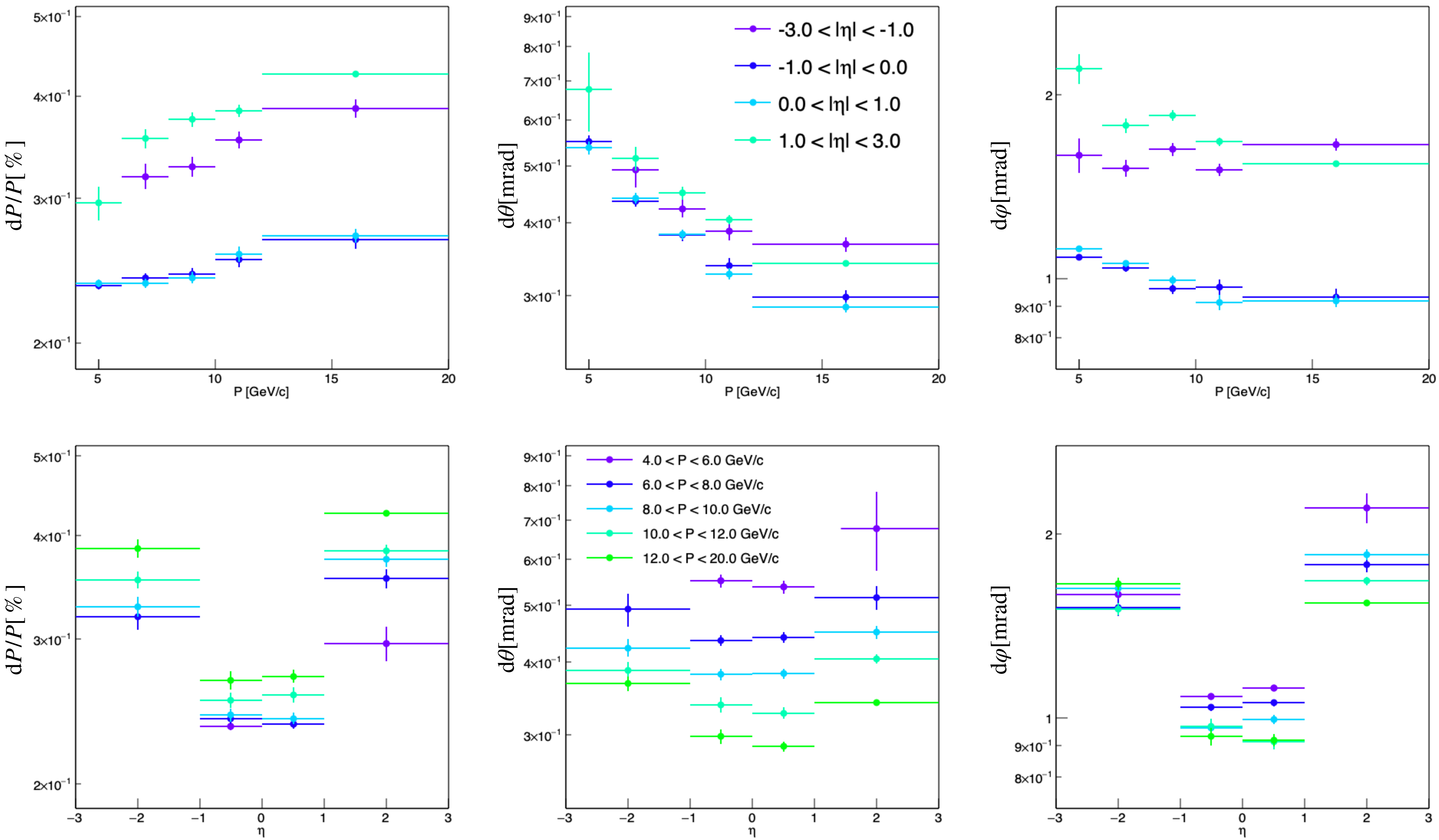
- $N_{\mathrm{Missed}} < 1$
  - $\mathrm{d}P/P$, $\mathrm{d}\theta$, and $\mathrm{d}\varphi$ distributions are fit to gaus
  - $\sigma$ and its error are extracted from the fits
- $N_{\mathrm{Missed}} \geq 1$
  - The simple standard deviation of the $\mathrm{d}P/P$ is taken
  - $\mathrm{d}\theta$ and $\mathrm{d}\varphi$ widths ($\sigma$) are still extracted from gaus fits

Example Gaus Fits

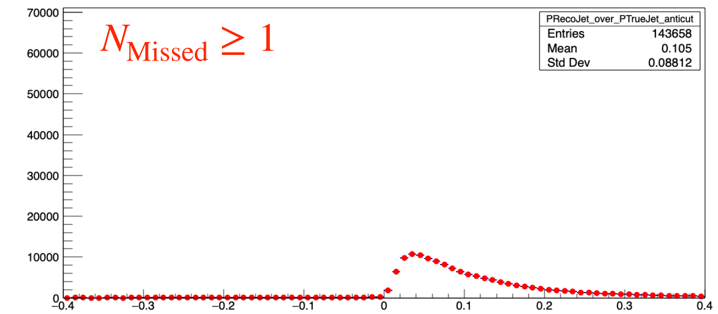


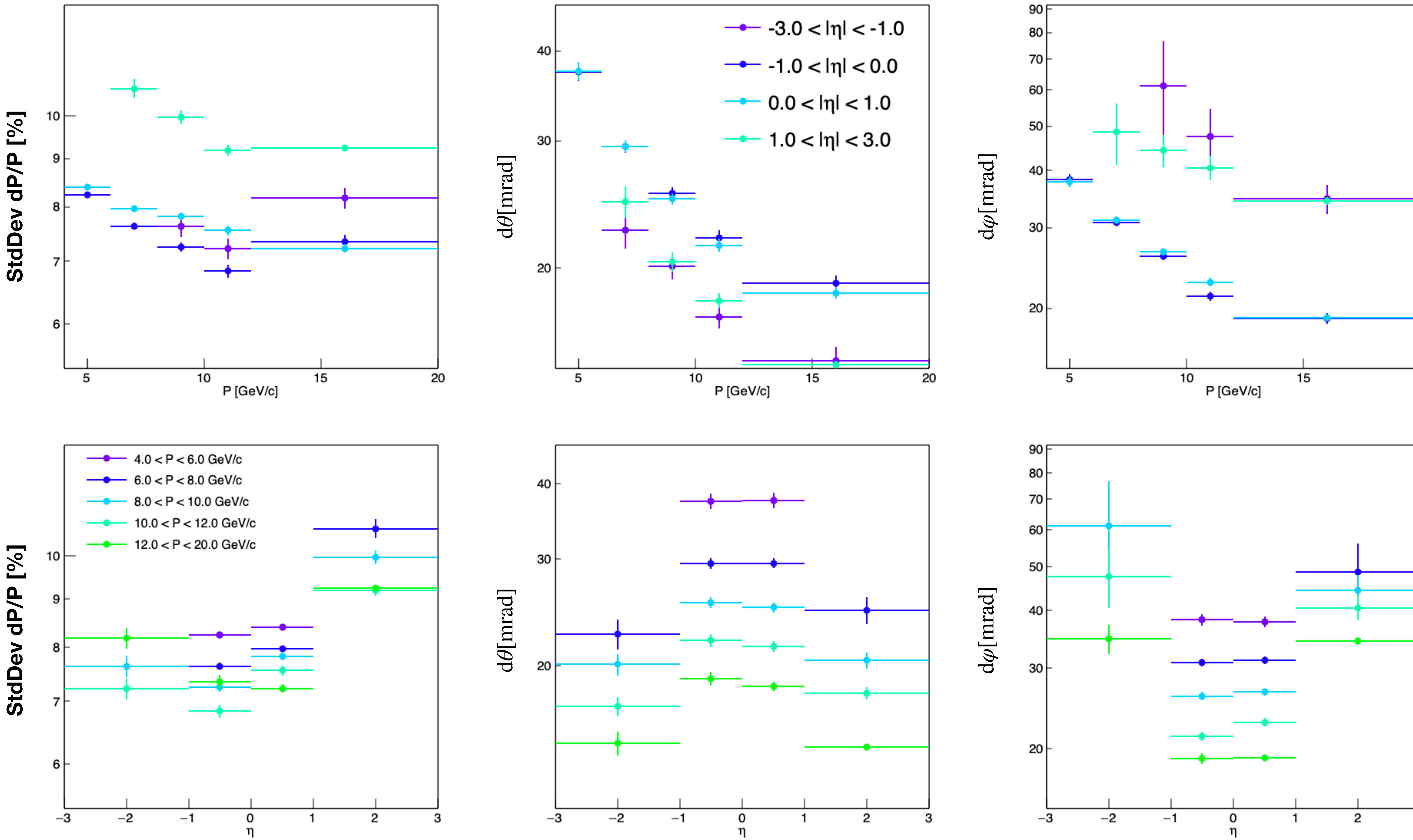
# Jet Resolutions for $N_{\mathrm{Missed}} < 1$



# Jet Resolutions for $N_{\mathrm{Missed}} \geq 1$



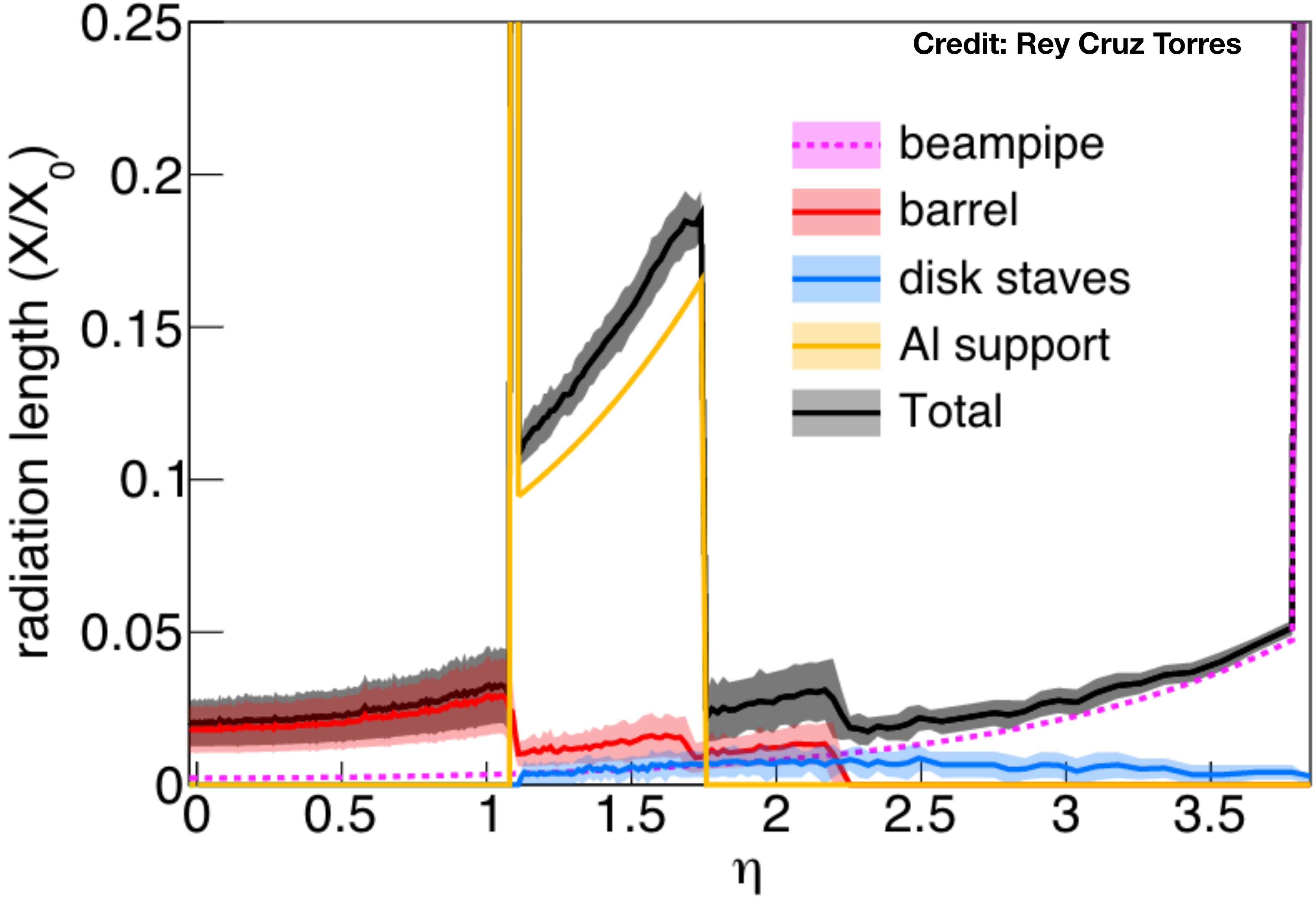
# Potential Next Steps

- Finesse better poisson or landau fits to $N_{\mathrm{Missed}} \geq 1$ $\mathrm{d}P/P$ distributions
- Re-run simulation
  - Save more reconstructed constituent information to branches
  - Understand cause missing constituents
  - More statistics for higher momentum jets

# Response to EIC UG Feedback 12/21

# More Informed $\eta$ cut

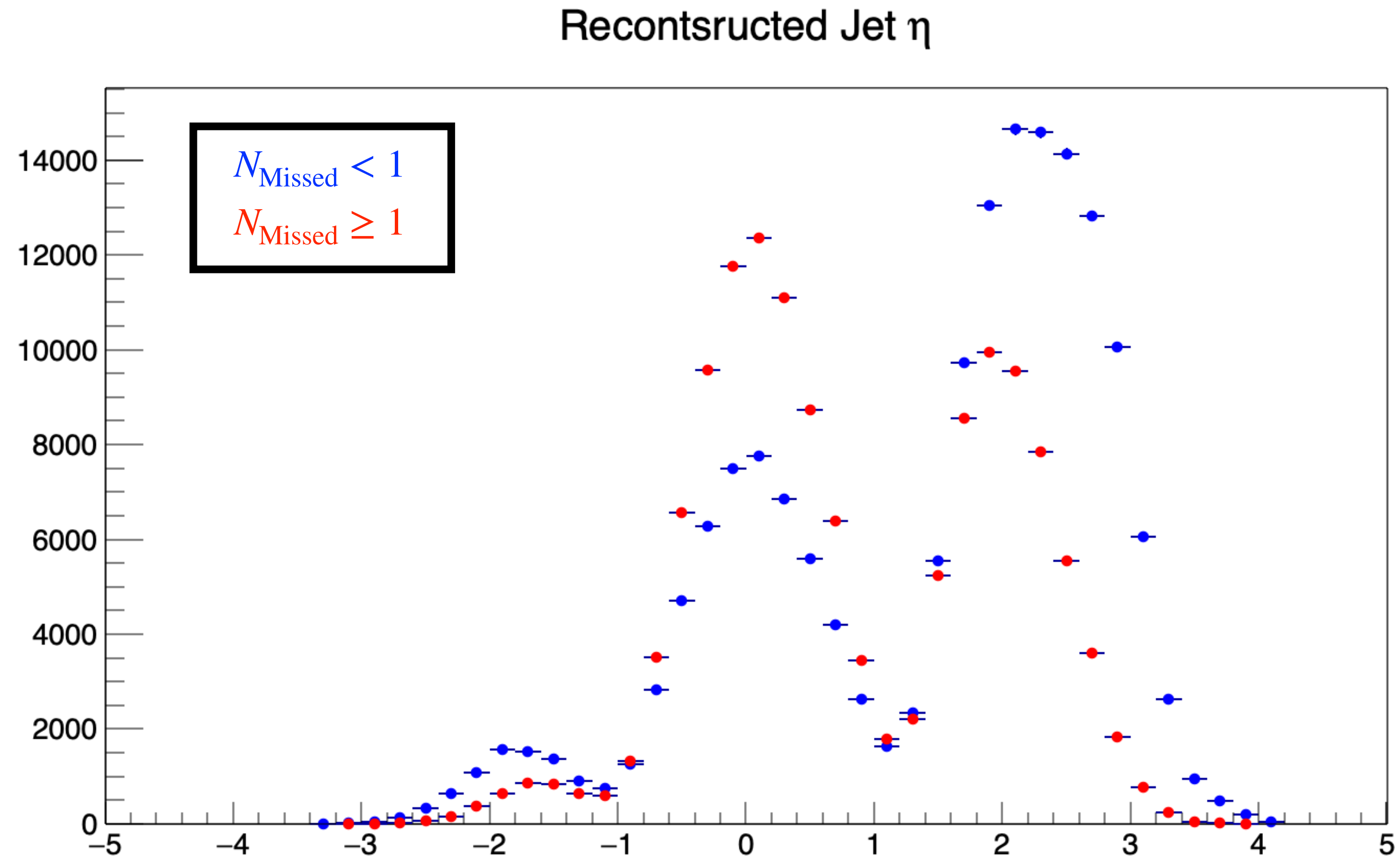
**Material Scan of All Silicon Tracker**




New Cut: $1.06 < |\eta_{\mathrm{const.}}| < 1.13$

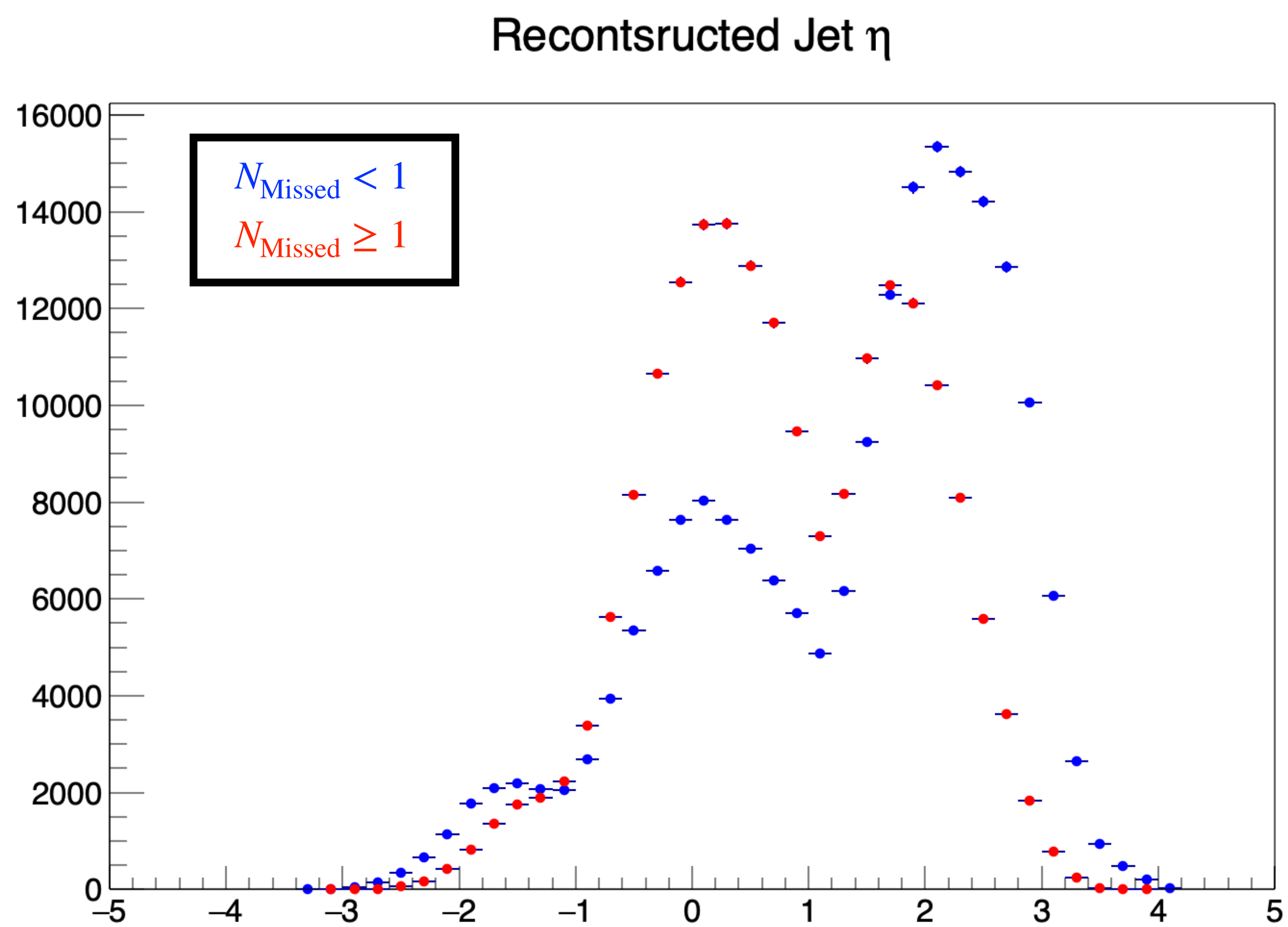
**Old:**

$1.0 < |\eta_{\text{const.}}| < 1.1$



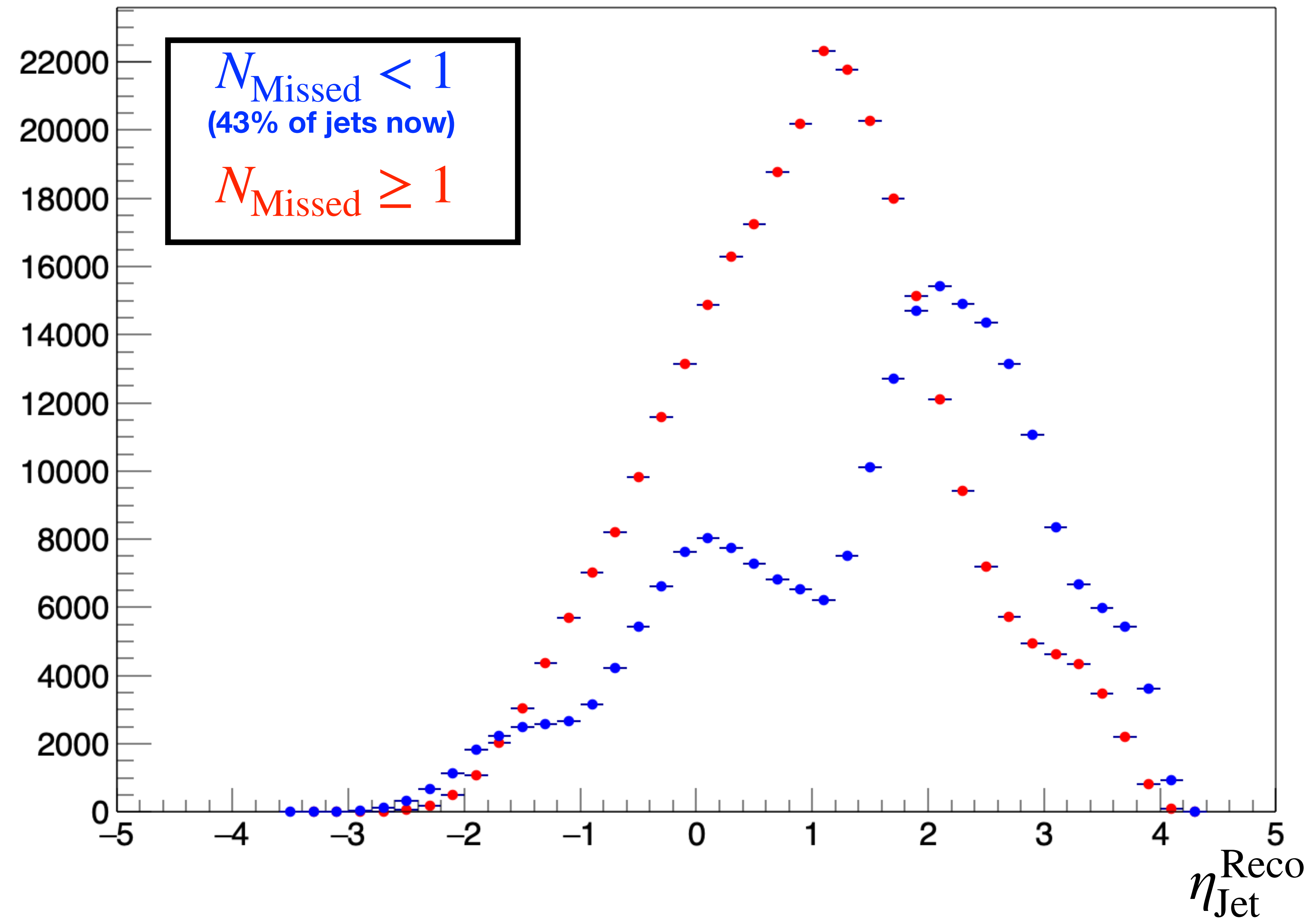

**New:**

**(**$1.06 < |\eta_{\text{const.}}| < 1.13$**)**




Keep in mind: $R_{\text{Jet}} = 1.0$

# Jet $\eta_{\text{Jet}}^{\text{Reco}}$ with ***NO*** $\eta_{\text{const.}}$ cut

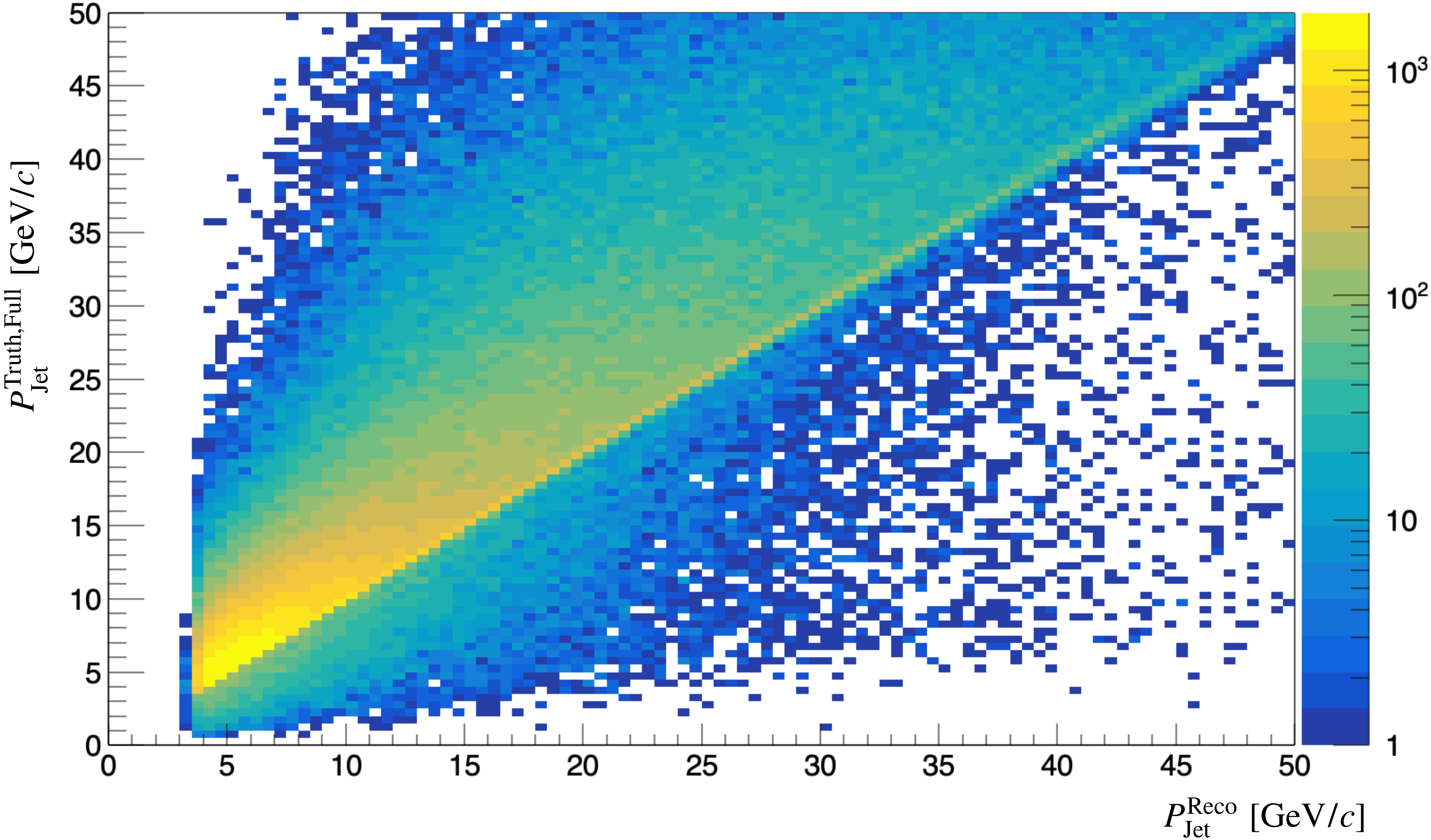



**The red curve has a large peak in the region where the barrel meets the forward layers**

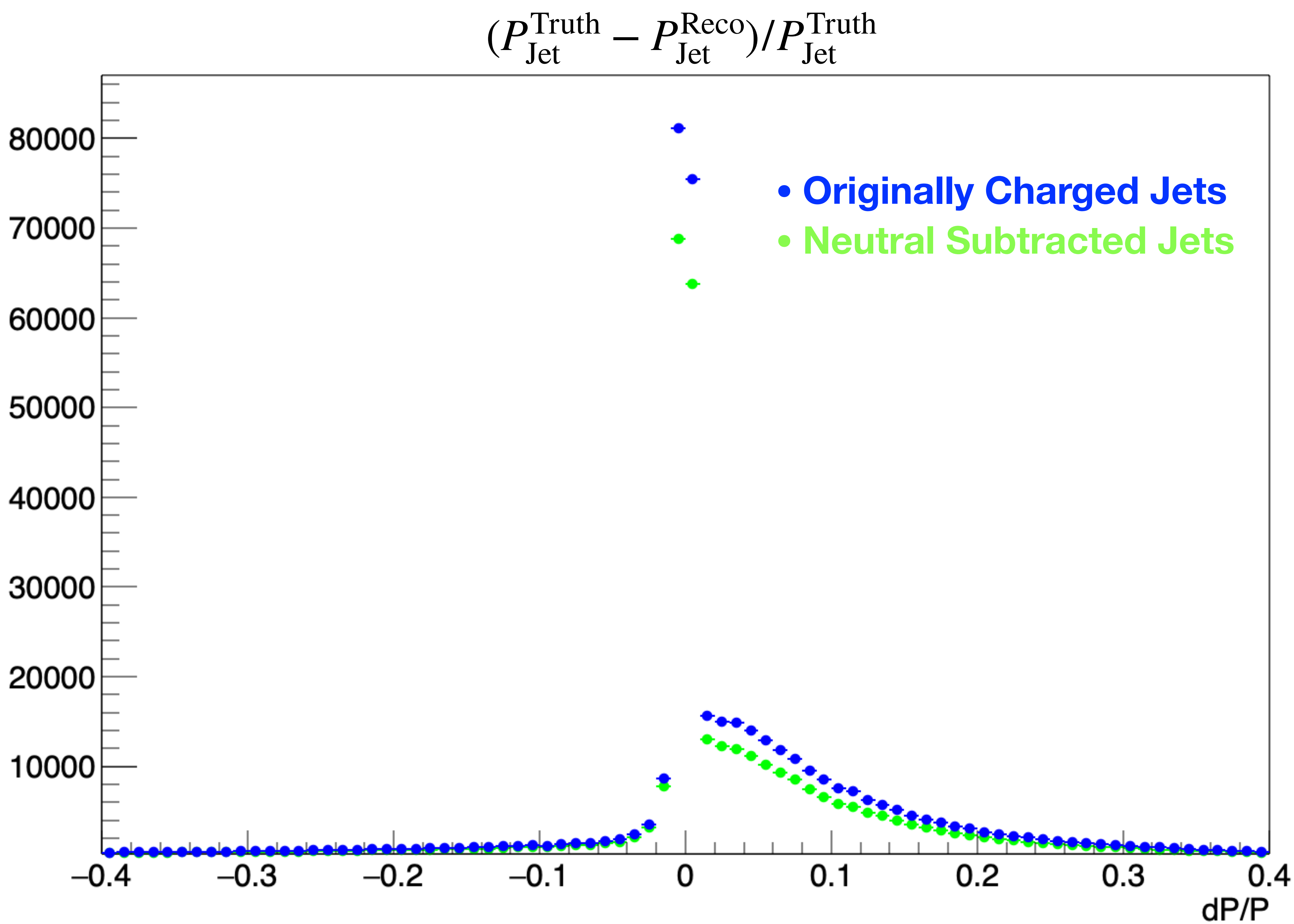
# More informed $p_{\mathrm{T}}^{\mathrm{const.}}$ cut in progress

# Backup

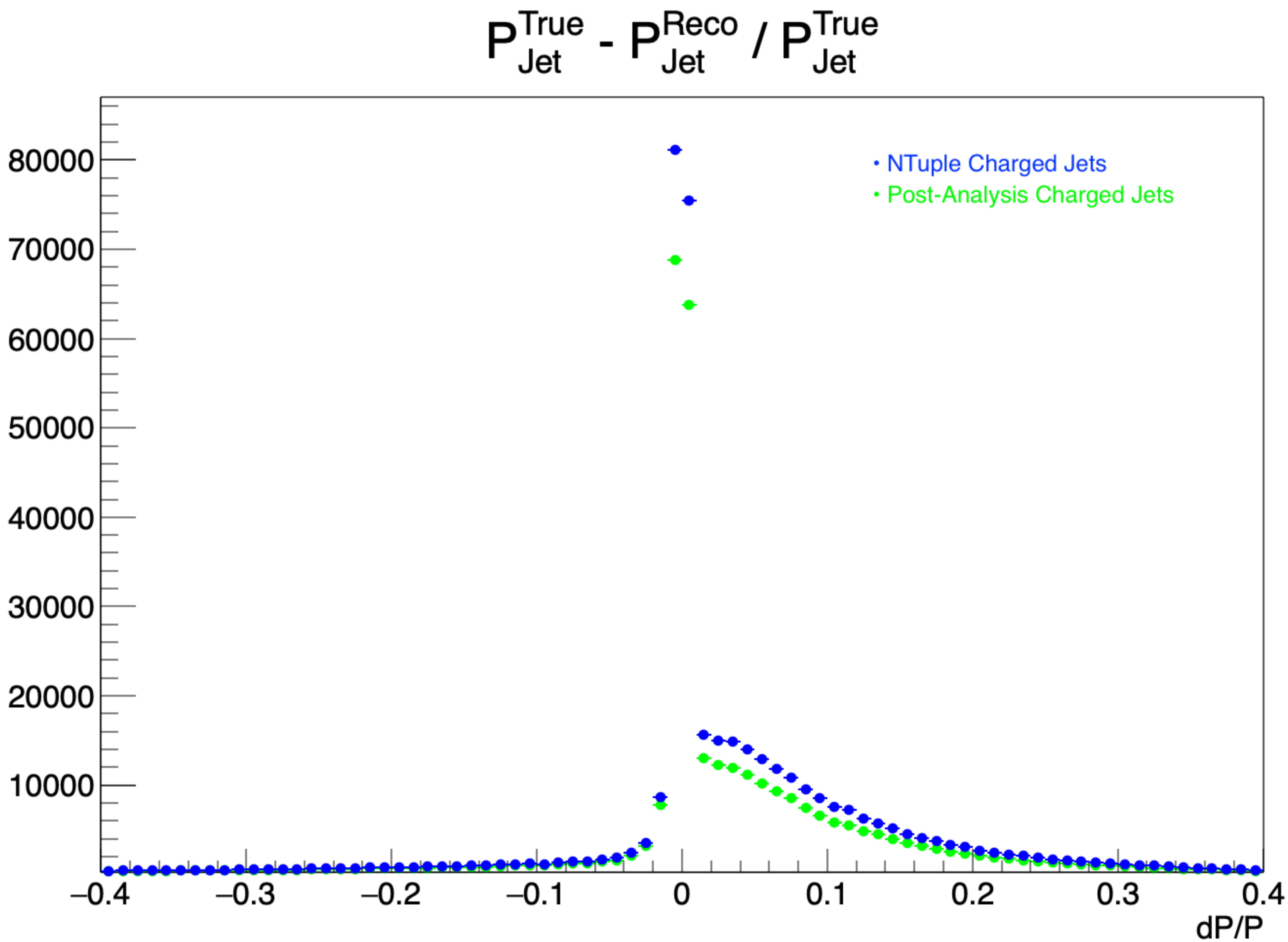
# Full Jet Momentum Response



# Full Truth vs. Charged Truth

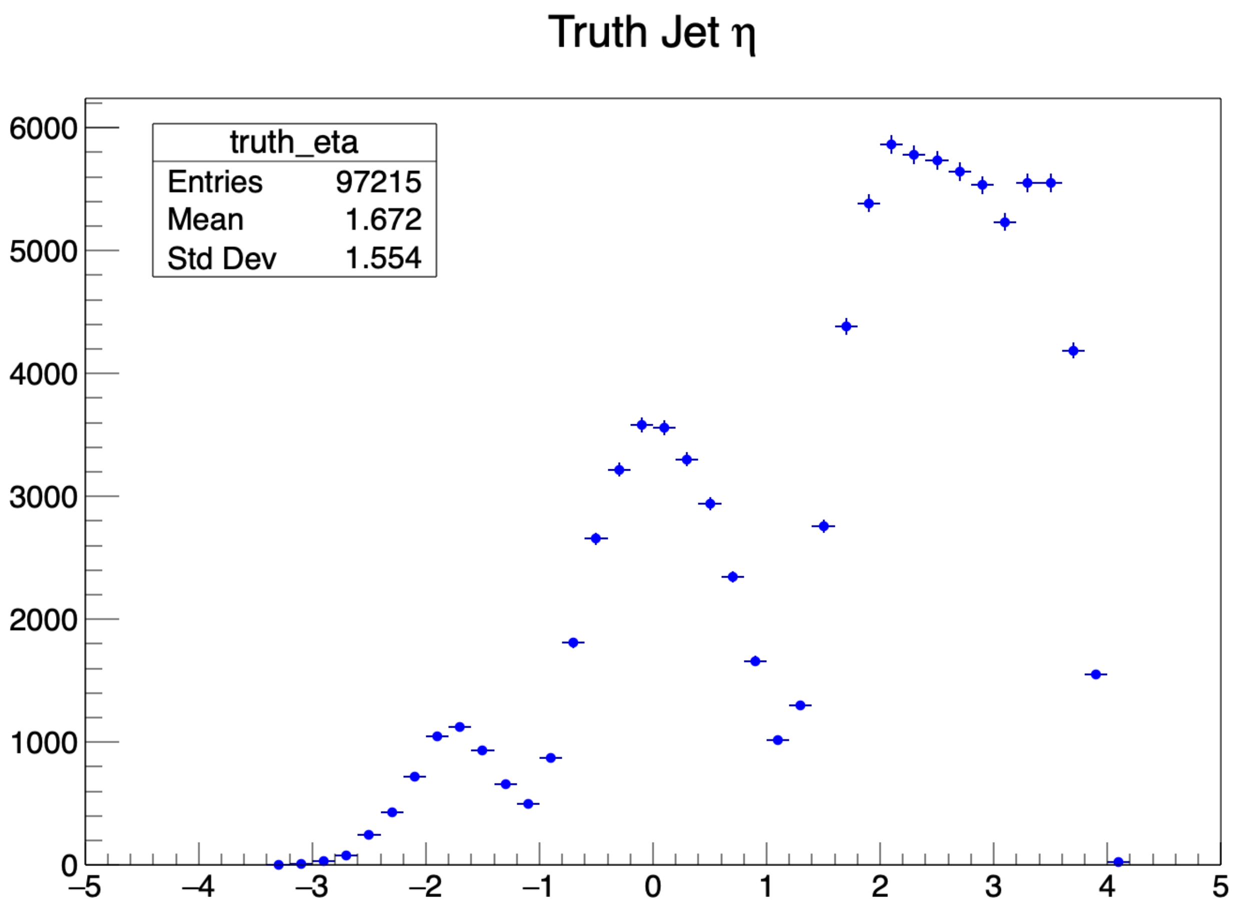


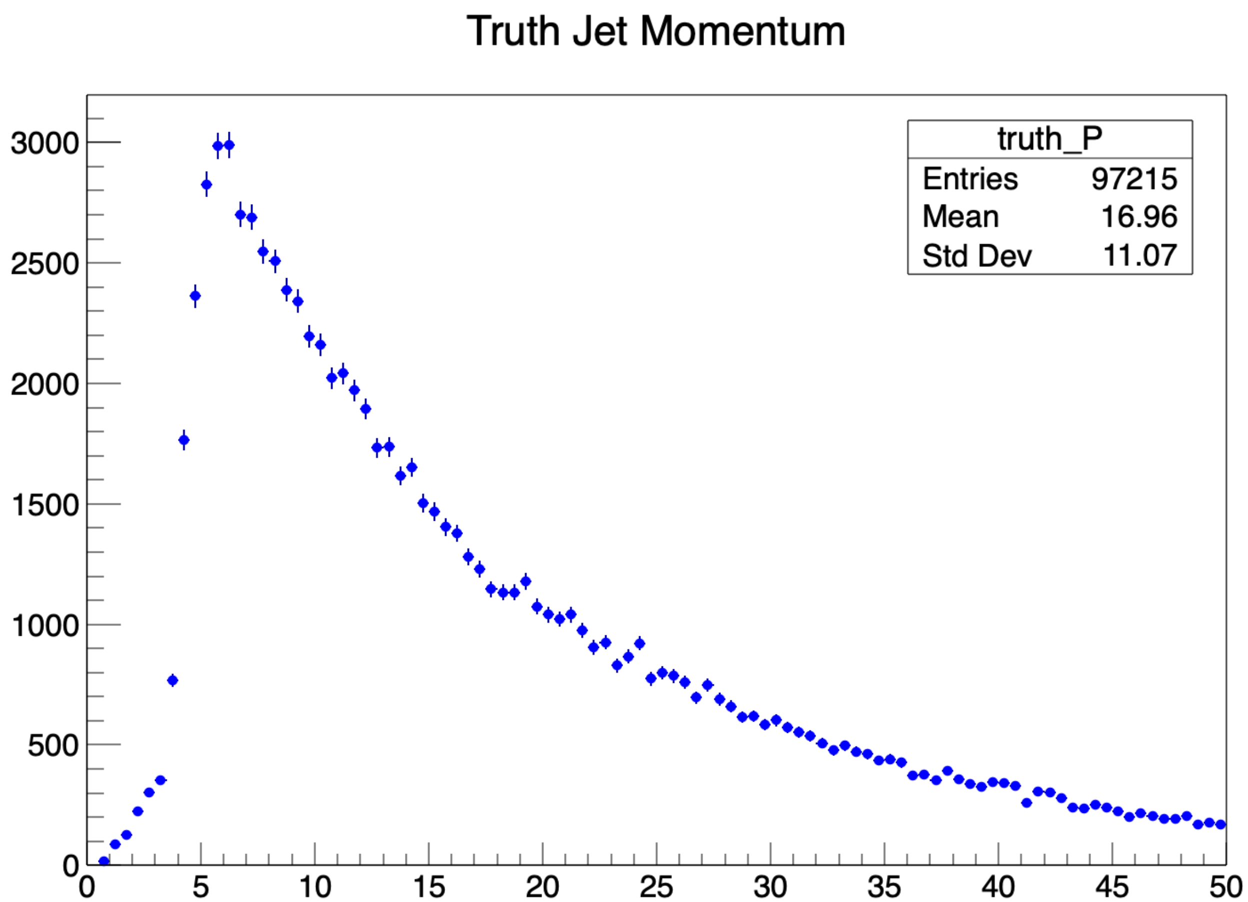

- **Small Difference in $\mathrm{d}P/P$, most likely due to different cut flows (min pT, constituent $\eta$, etc.)**



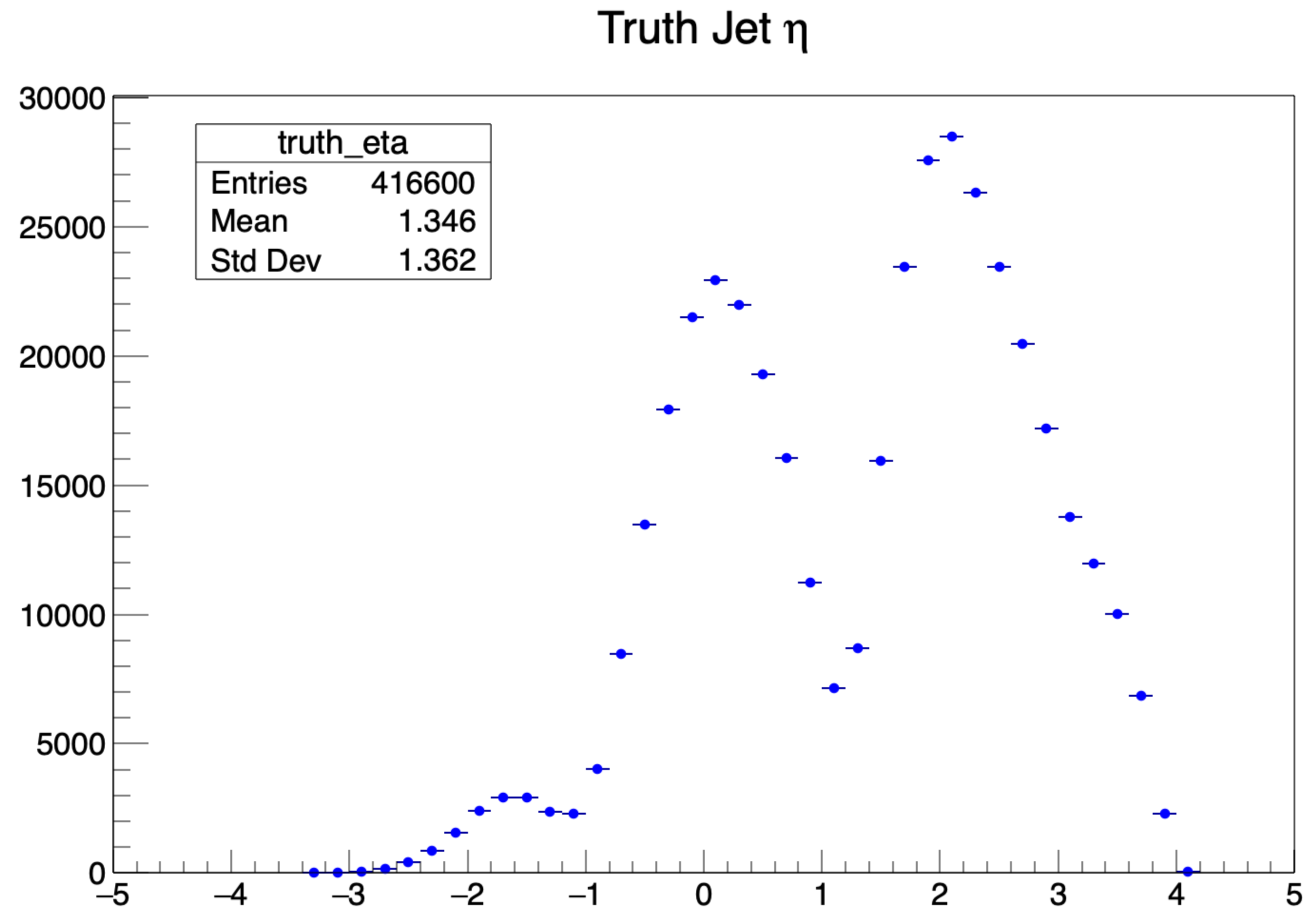

**While not complete agreement, the difference is small and almost certainly due to a different in cut-flows.**

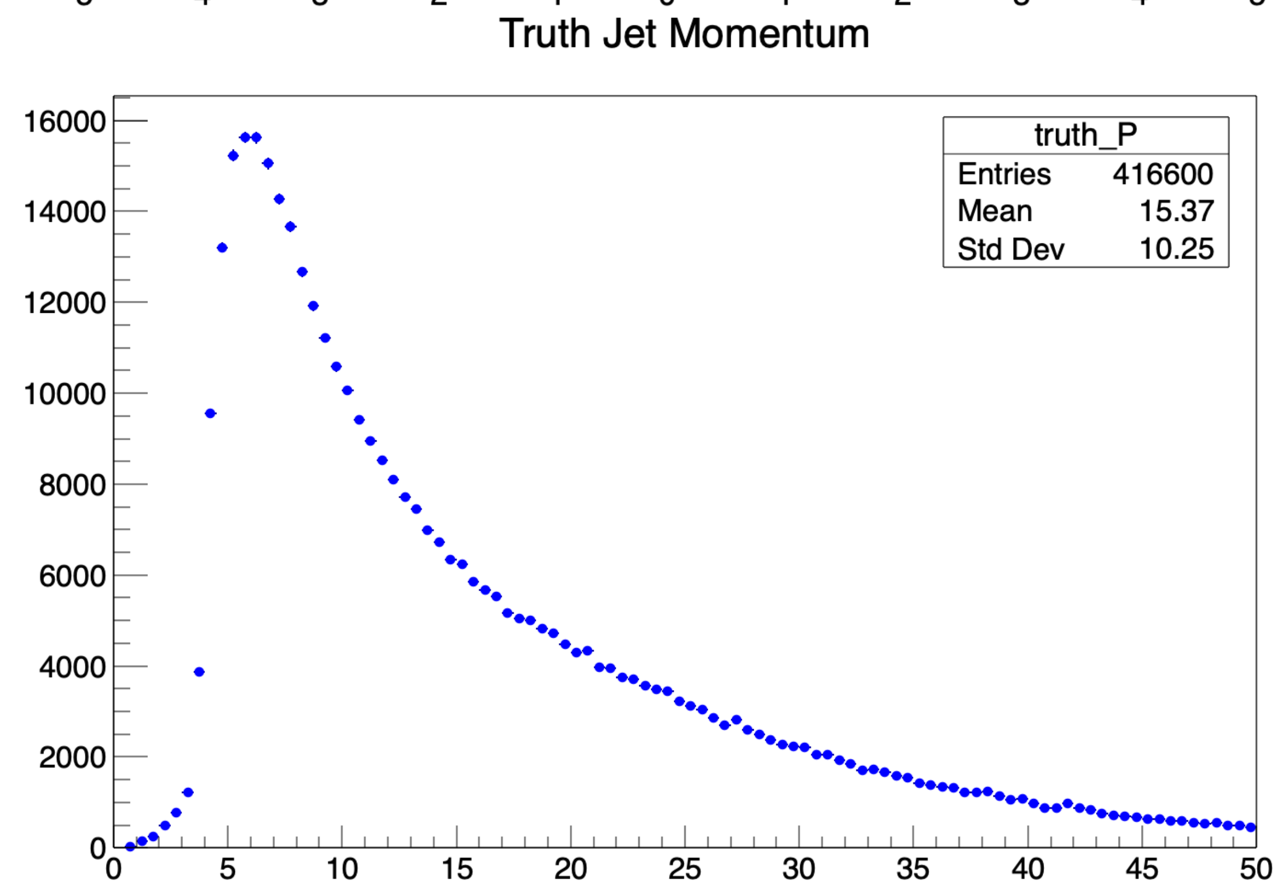
## Full Truth Jets with $N_{\text{neutral}}$ = 0 originally




## Neutral subtracted Jets used in dP/P



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

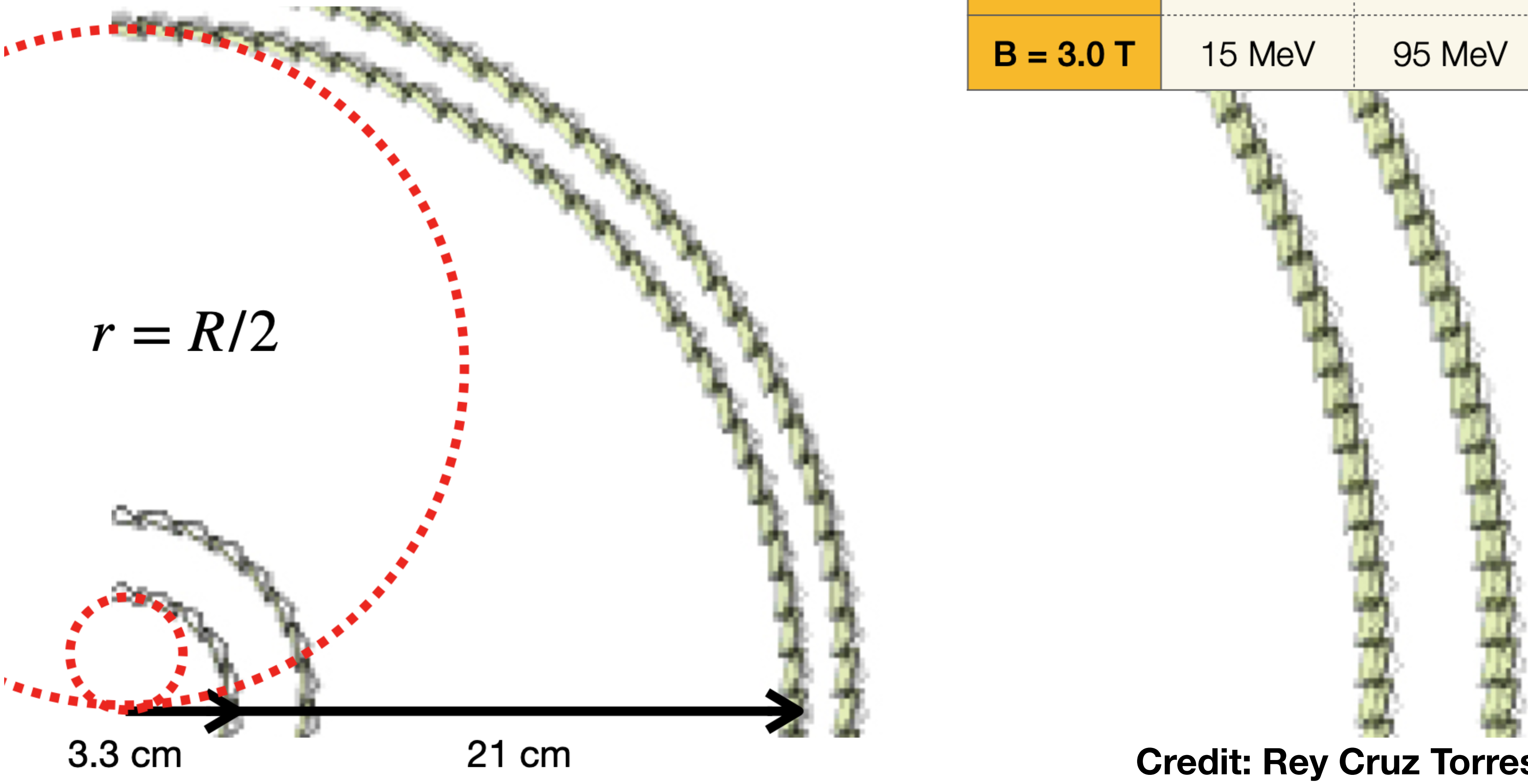
$$m\frac{v^2}{r} = qvB$$

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

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

**$p_T$ thresholds**

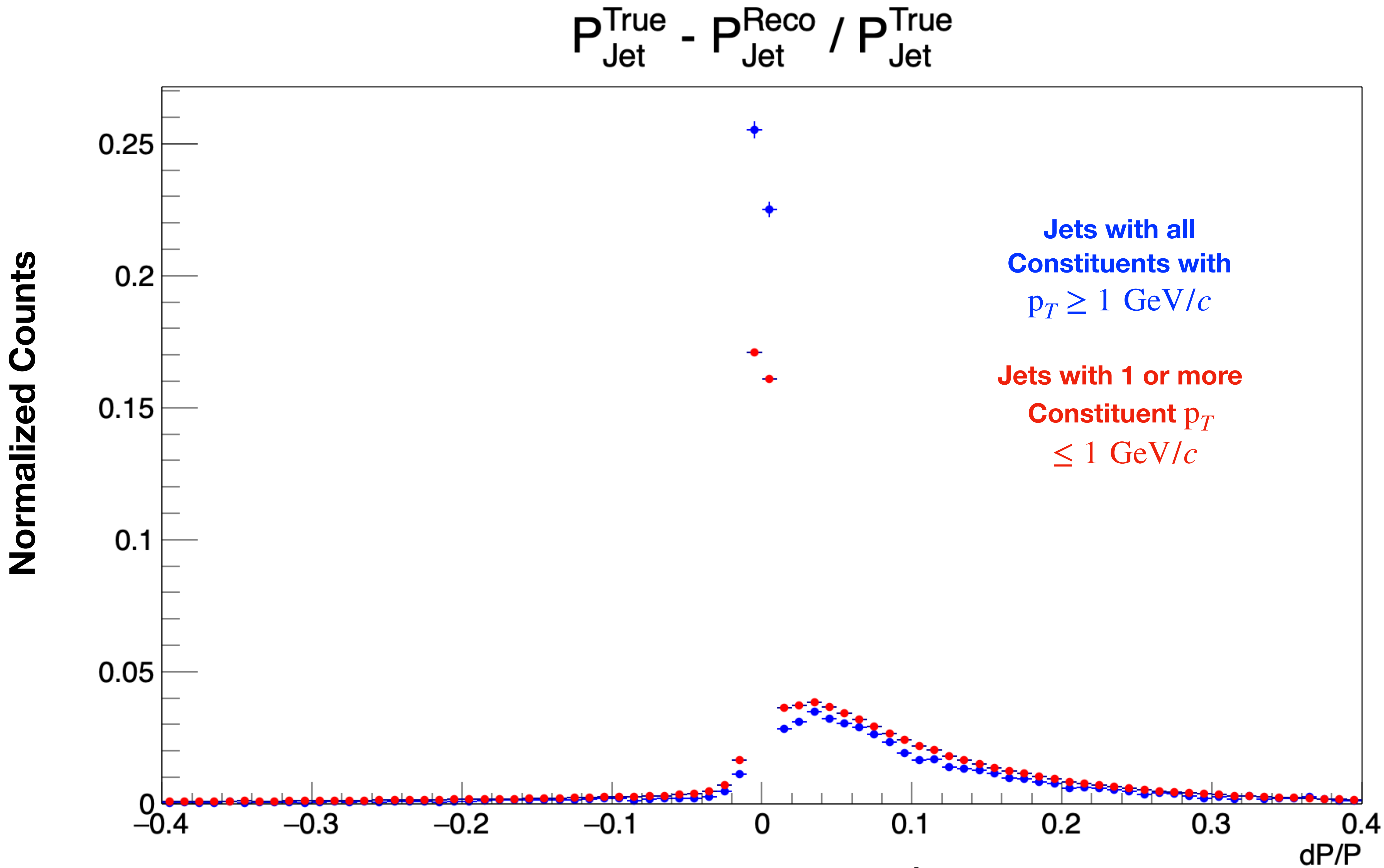
| | R = 3.3 cm | R = 21 cm |
|---|---|---|
| **B = 1.4 T** | 7 MeV | 44 MeV |
| **B = 3.0 T** | 15 MeV | 95 MeV |



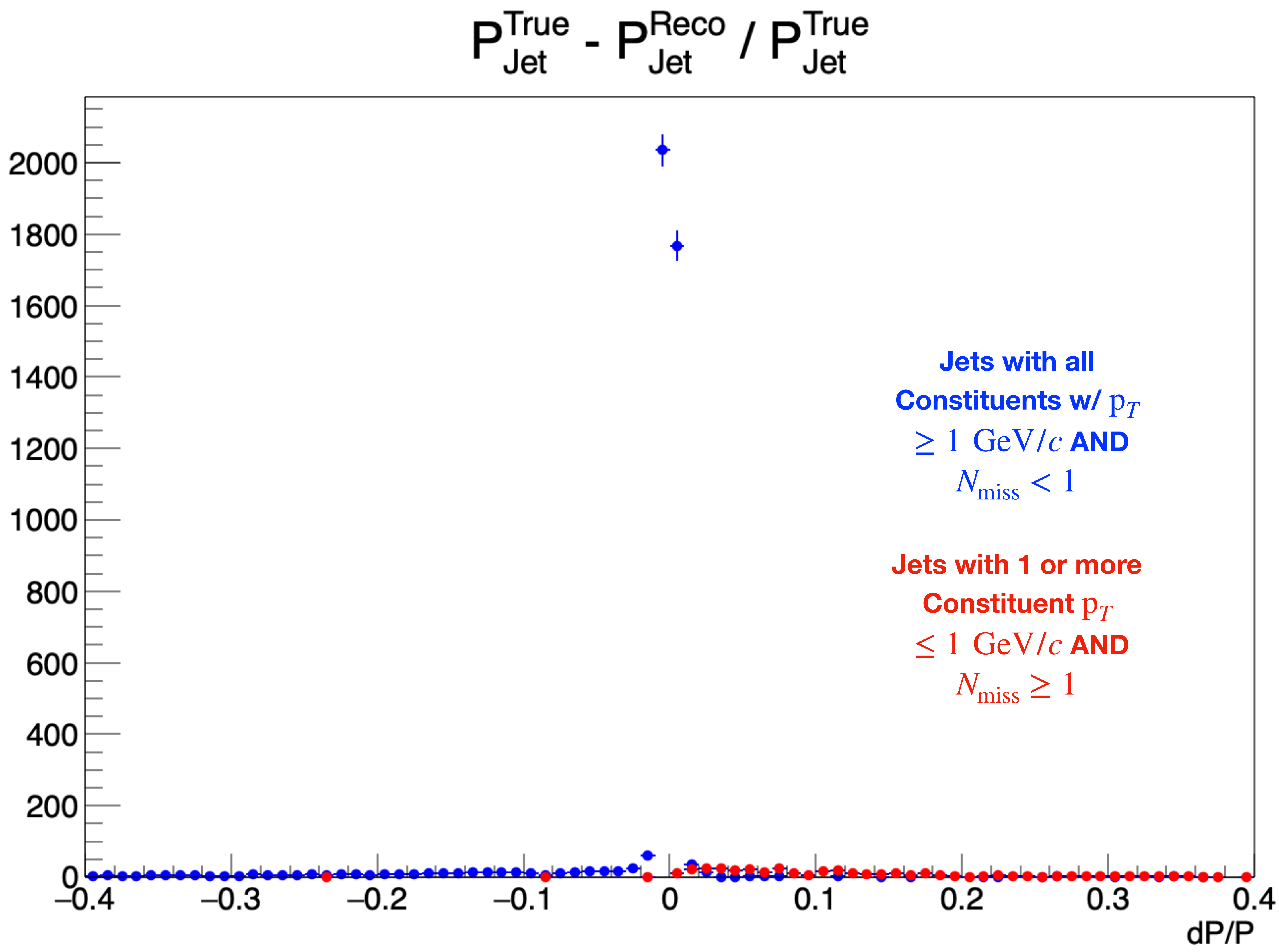

**Credit: Rey Cruz Torres** 6

# Answer: Probably Not

## Momentum Resolution enforcing Constituent $p_T$ cut of 1.0 GeV/$c$

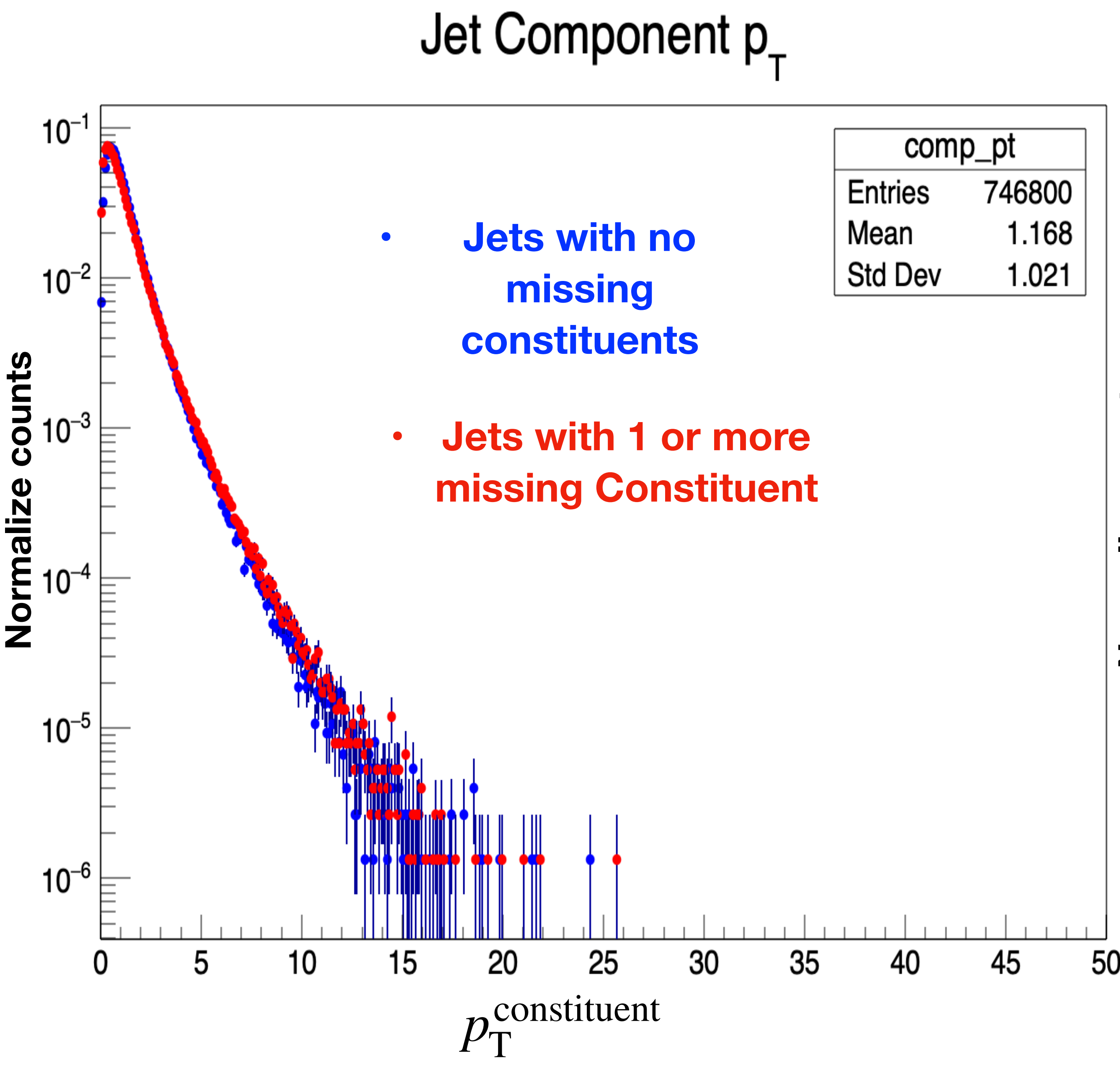


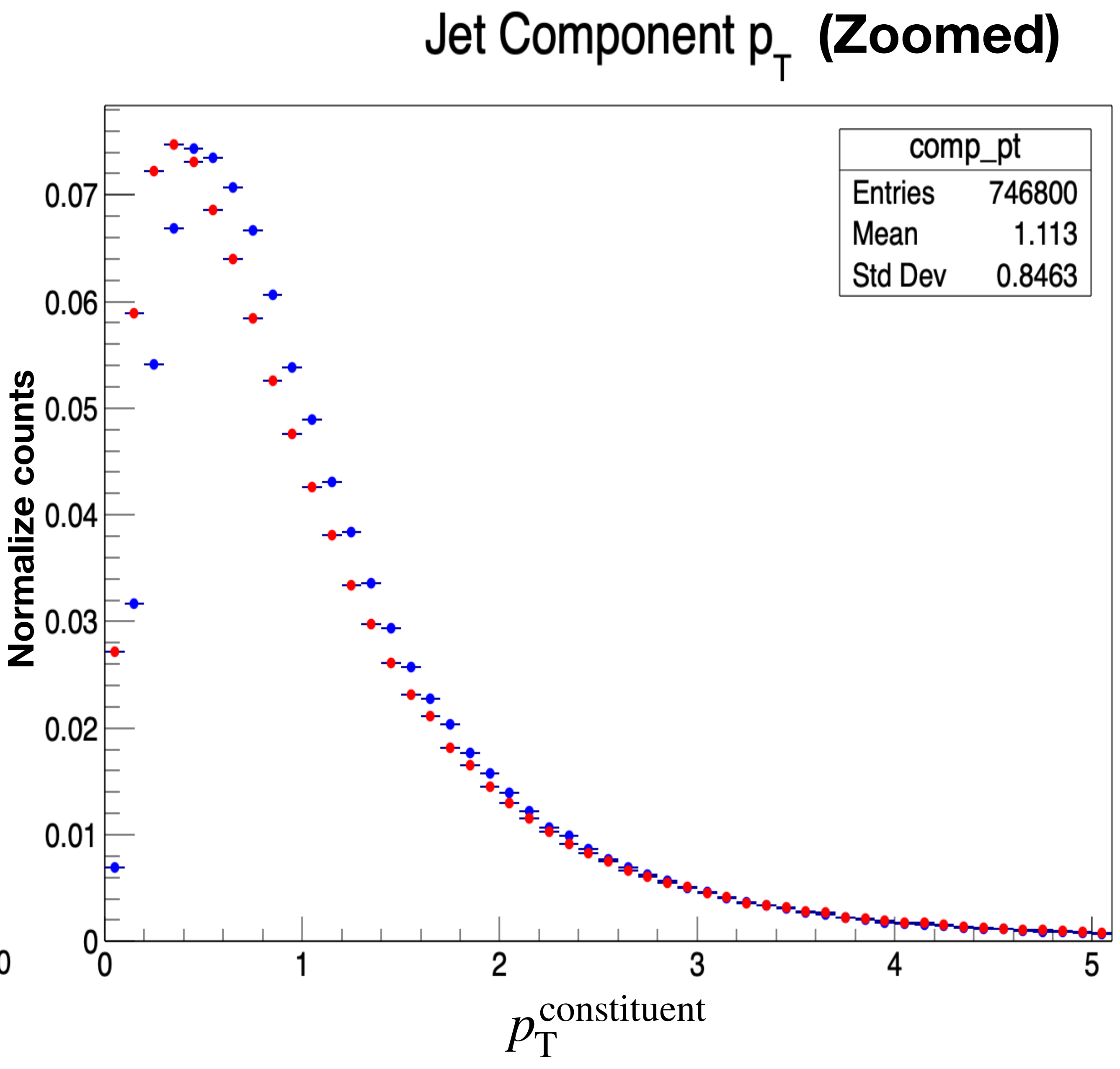

**A strict constituent cut does alter the dP/P Distribution, but not as much as the direct missing constituent comparison**



$P_{Jet}^{True}$ - $P_{Jet}^{Reco}$ / $P_{Jet}^{True}$
2000
1800
1600
1400
1200
1000
800
600
400
200
0
−0.4
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
dP/P
**Jets with all Constituents w/** $p_T \geq 1$ GeV/$c$ **AND** $N_{miss} < 1$
**Jets with 1 or more Constituent** $p_T \leq 1$ GeV/$c$ **AND** $N_{miss} \geq 1$

# Jet Component pT distributions

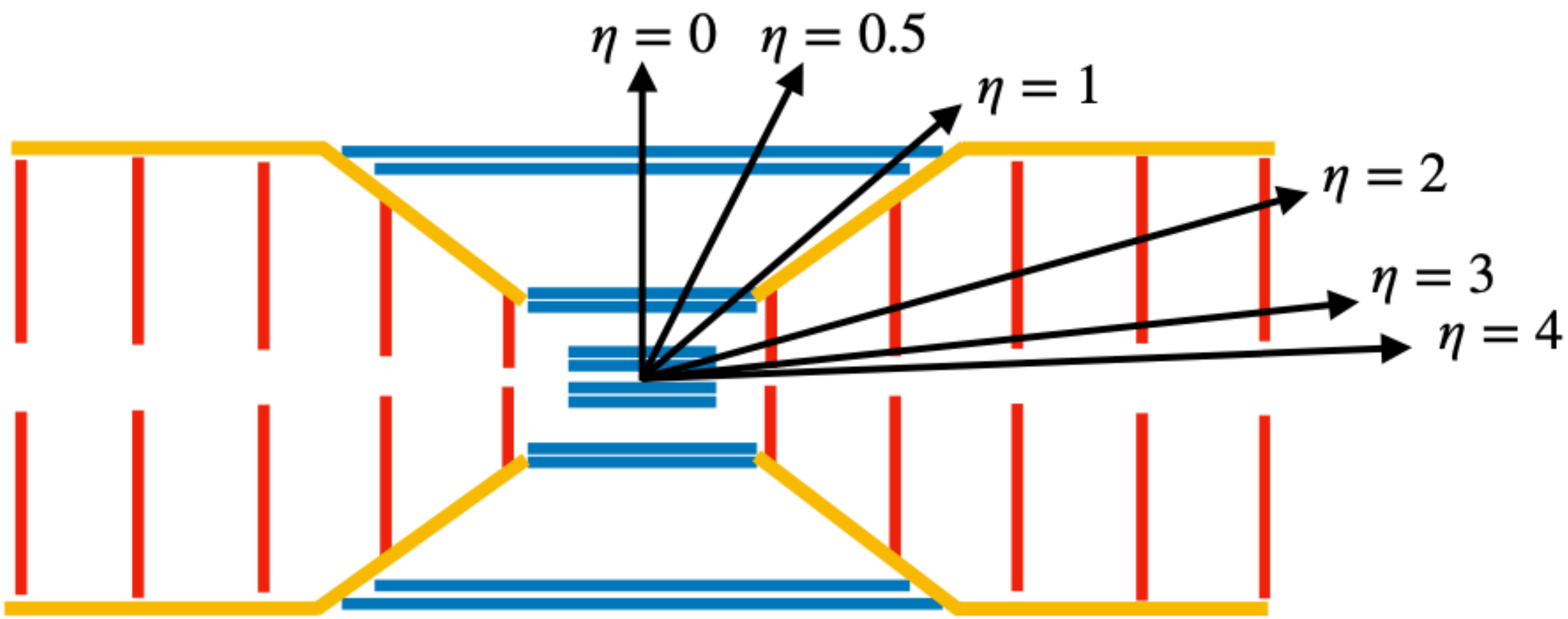


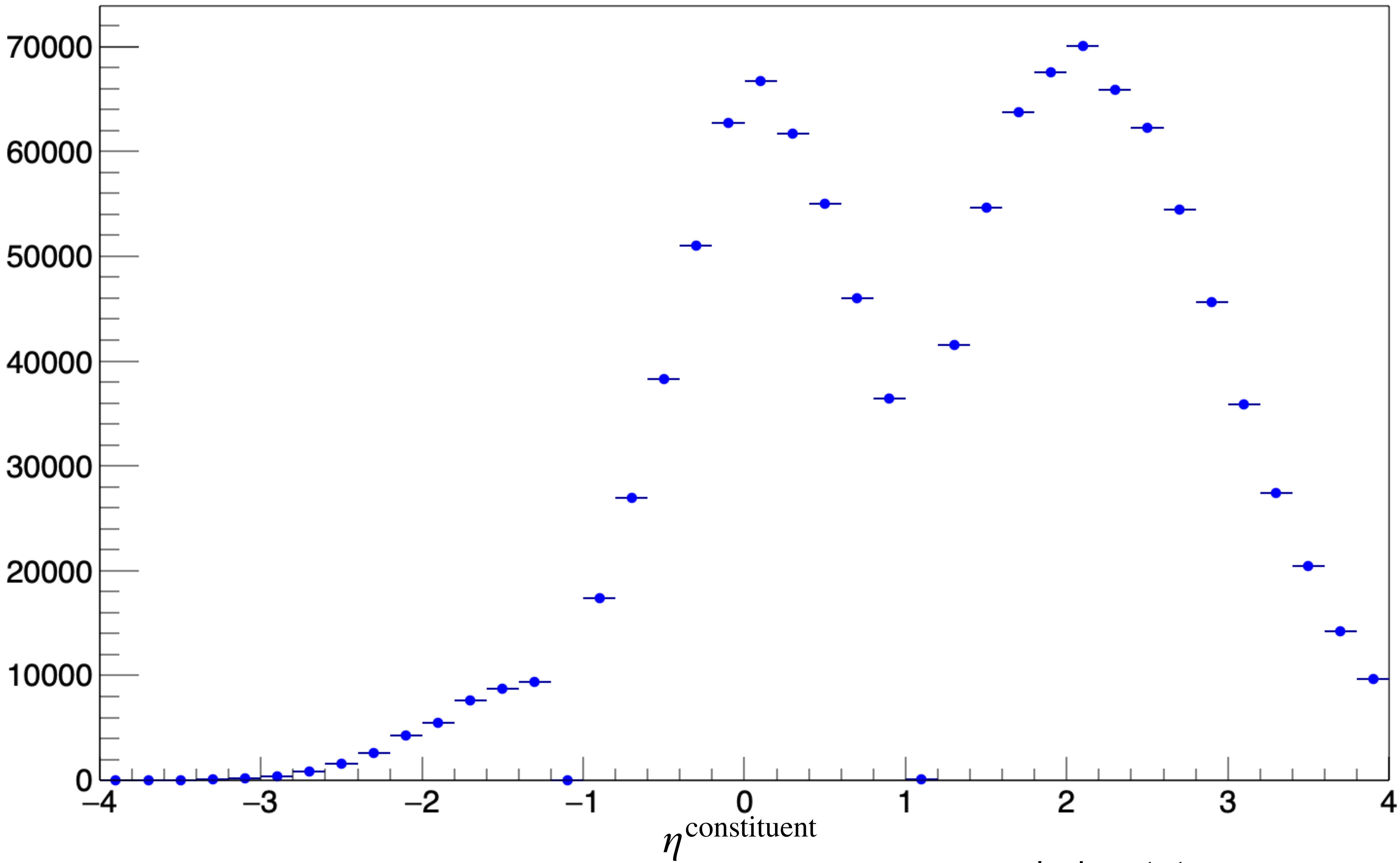

**Jets with a missing constituent tend to have constituents with slightly lower pT**

# Barrel/Endcap Constituent Cut

- Cut on jets with any constituent within $1.0 < |\eta| < 1.2$
- The central barrel meets the forward-layers at $|\eta| \approx 1.1$

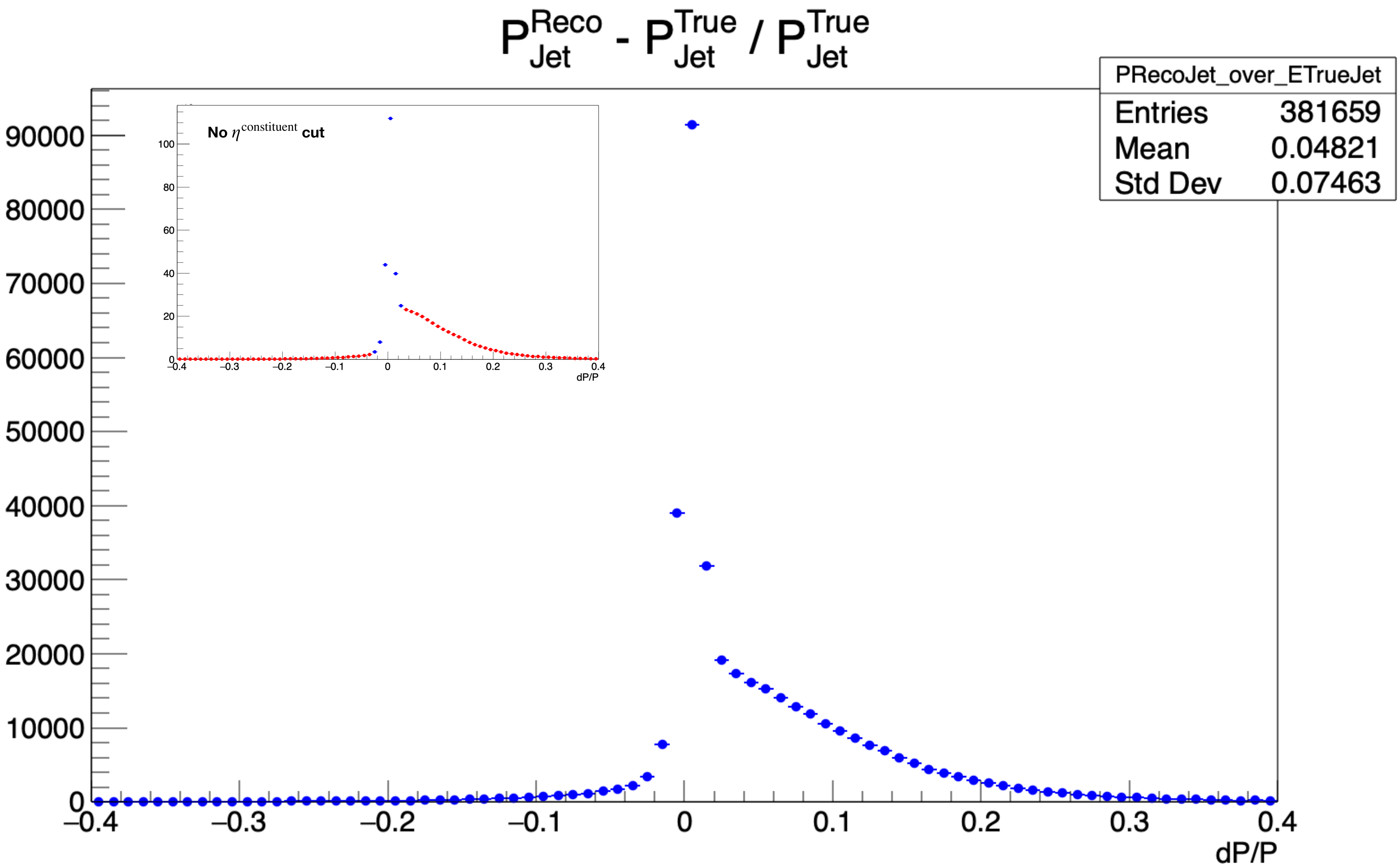


# Jet Component η




**Displaying cut on jets with any constituents near** $|\eta| \approx 1.1$

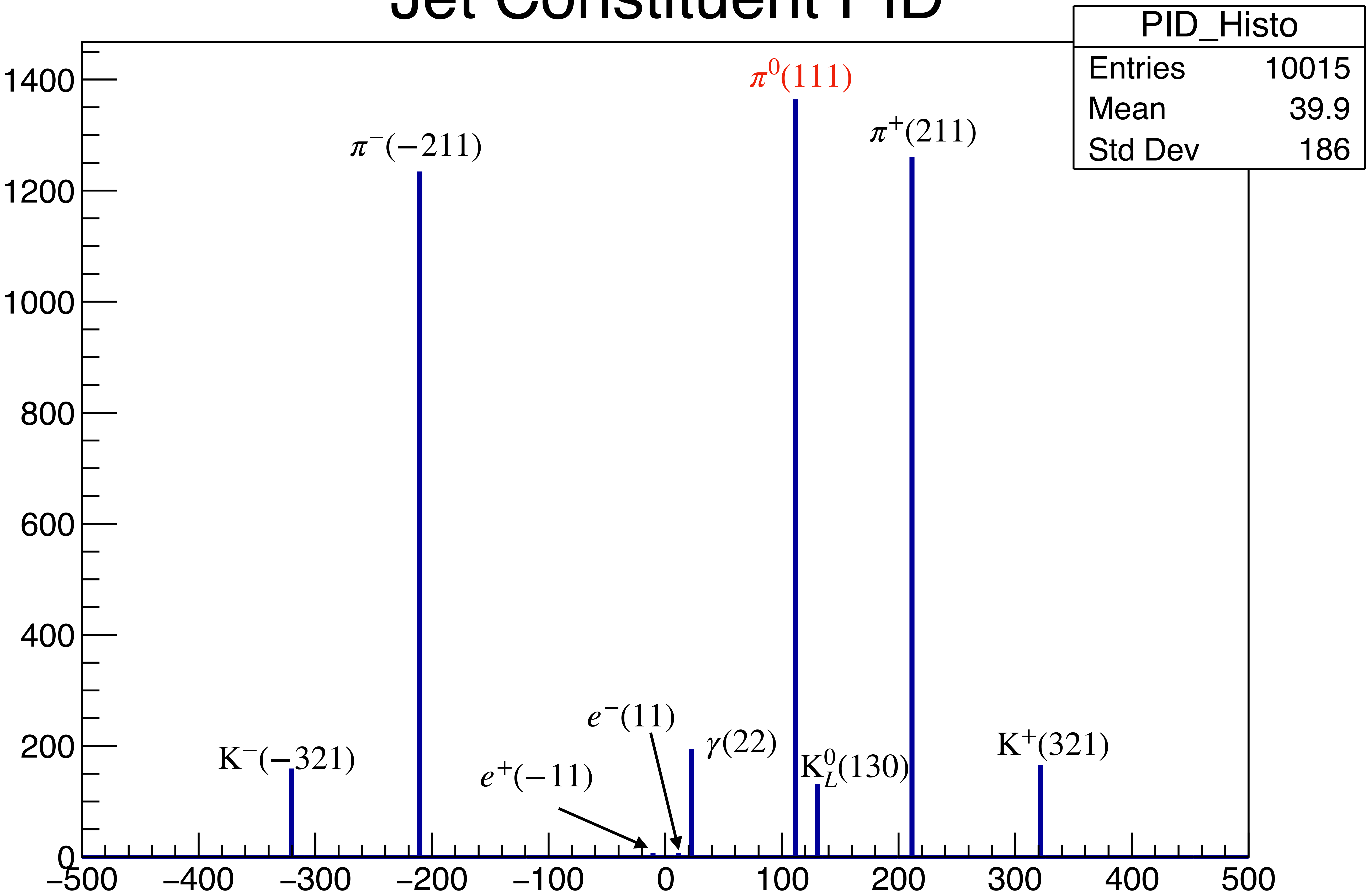
# Applying $\eta^{\text{constituent}}$ cut




**No significant Effect (See comparison to small plot with no such cut)**

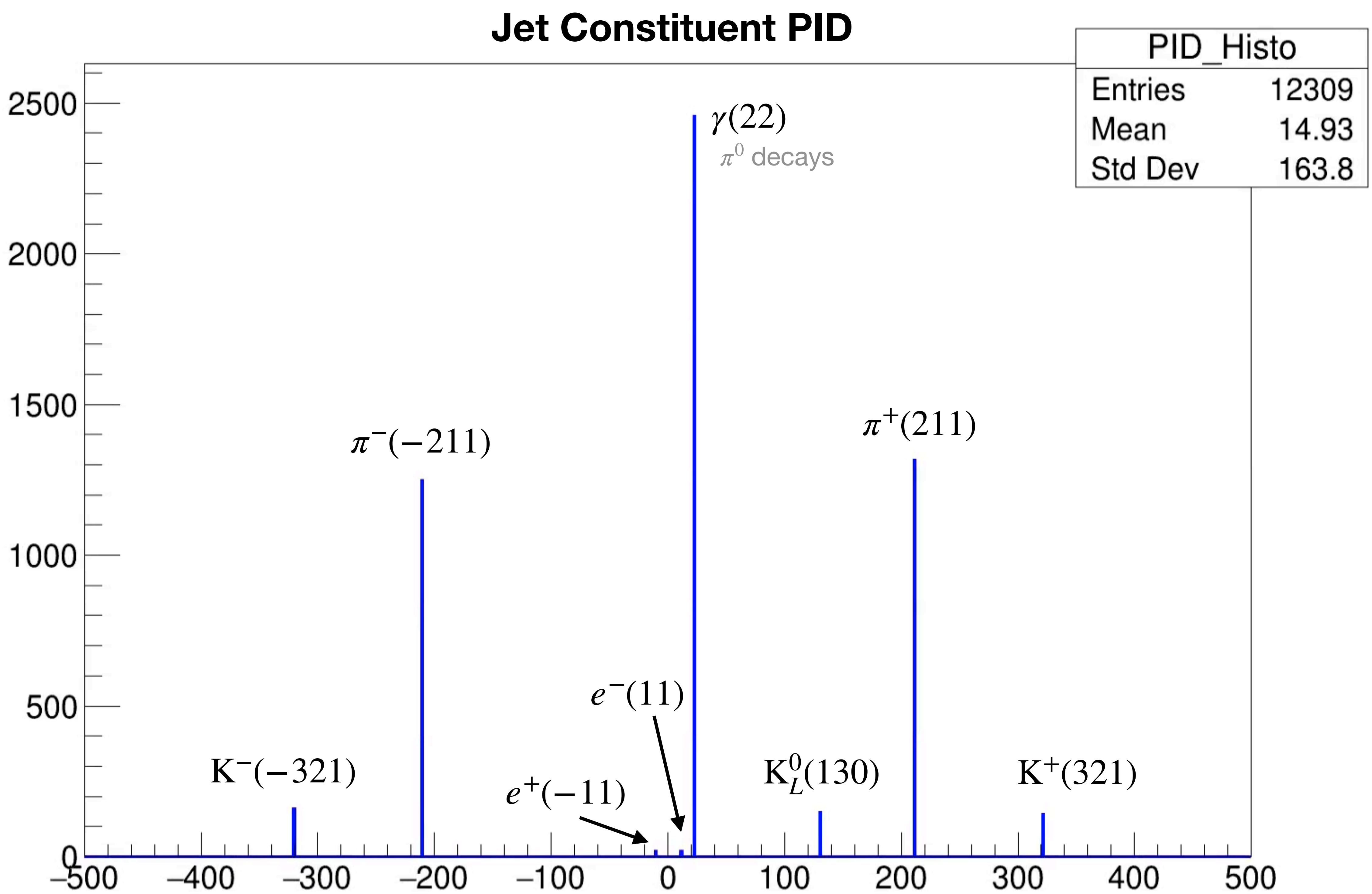
111:mayDecay = false

# Jet Constituent PID

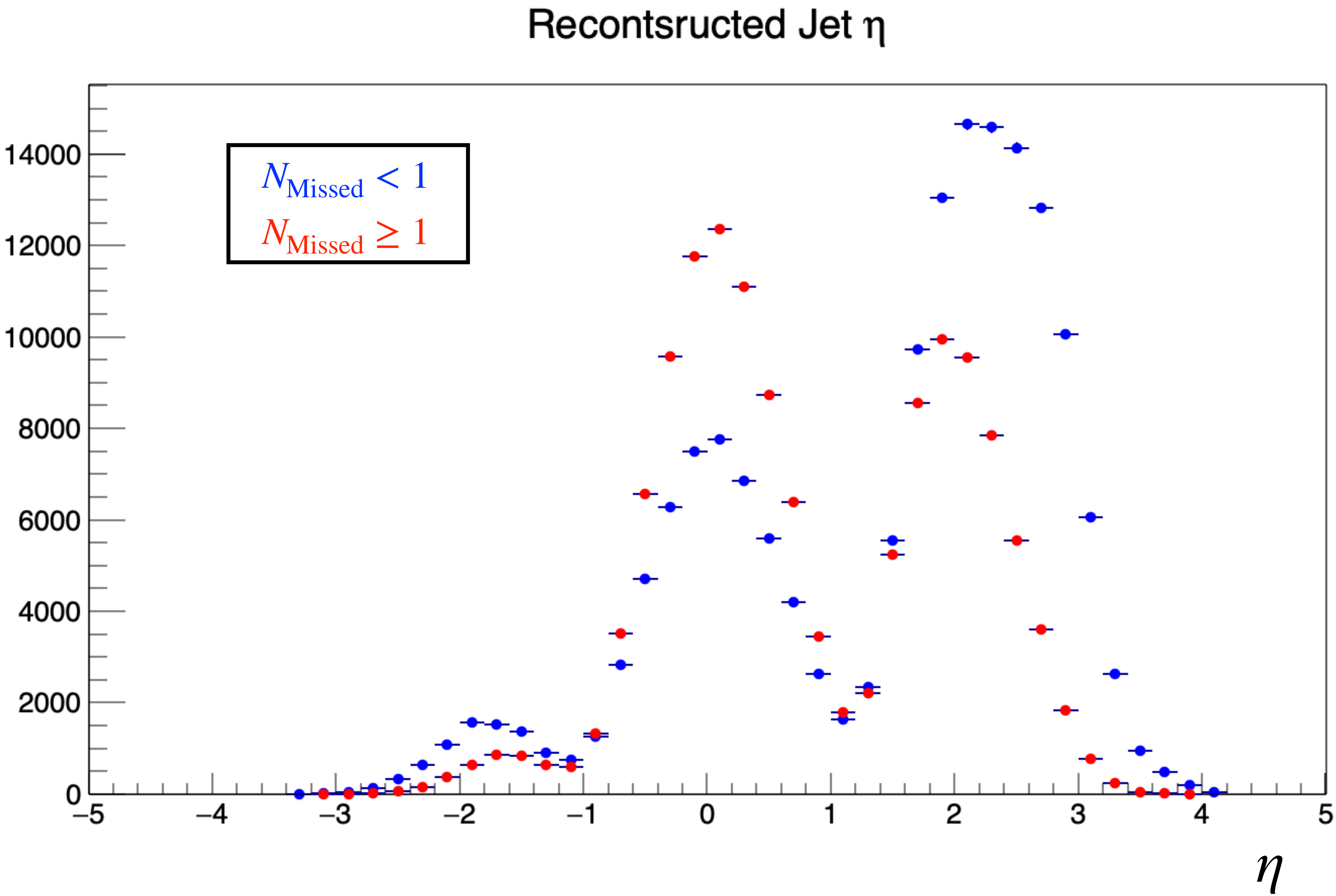


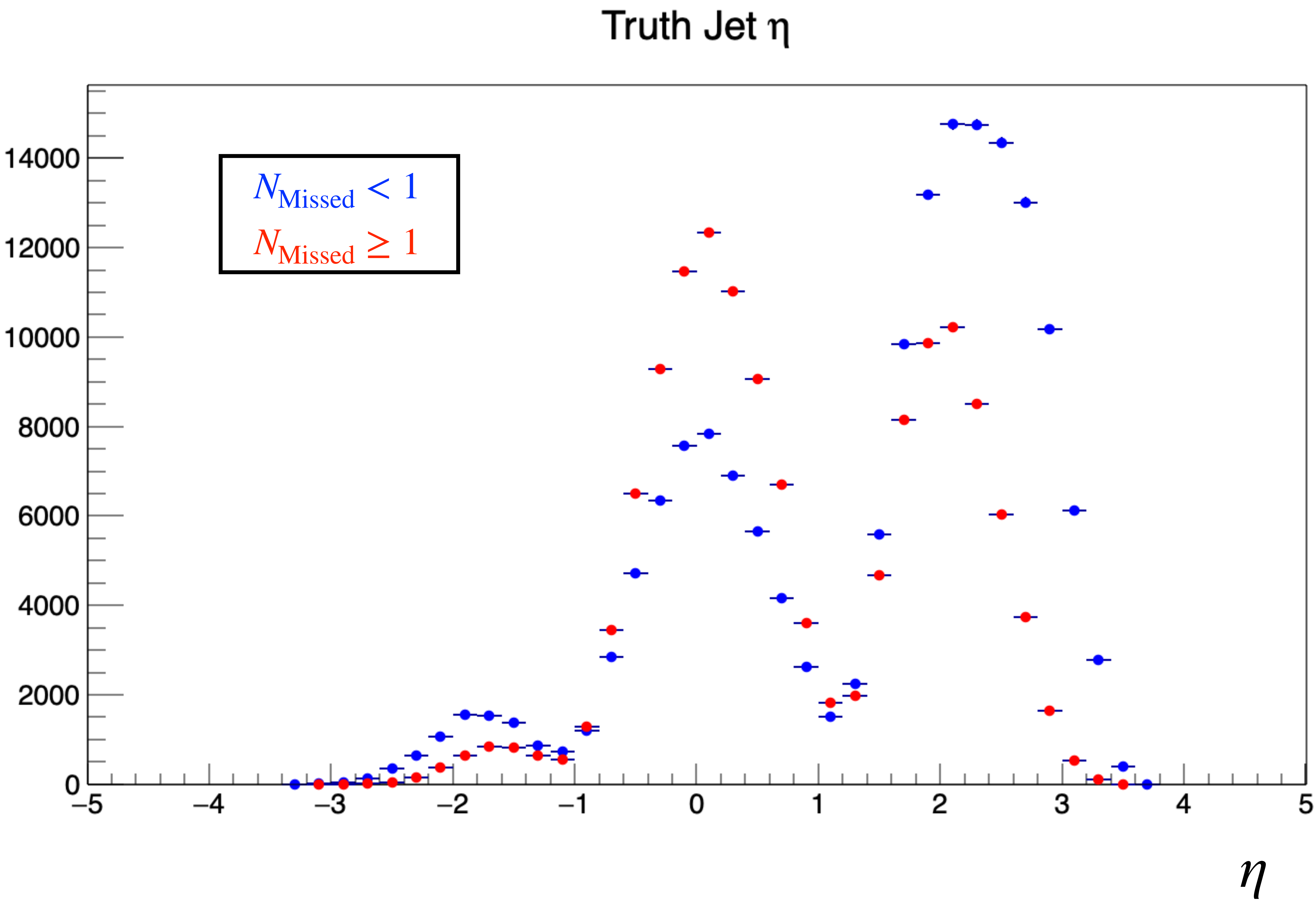
# Charged Truth Jets

$$p^{jet,\,\mu}_{\text{charged}} = p^{jet,\,\mu}_{\text{total}} - p^{jet,\,\mu}_{\text{neutral}}$$



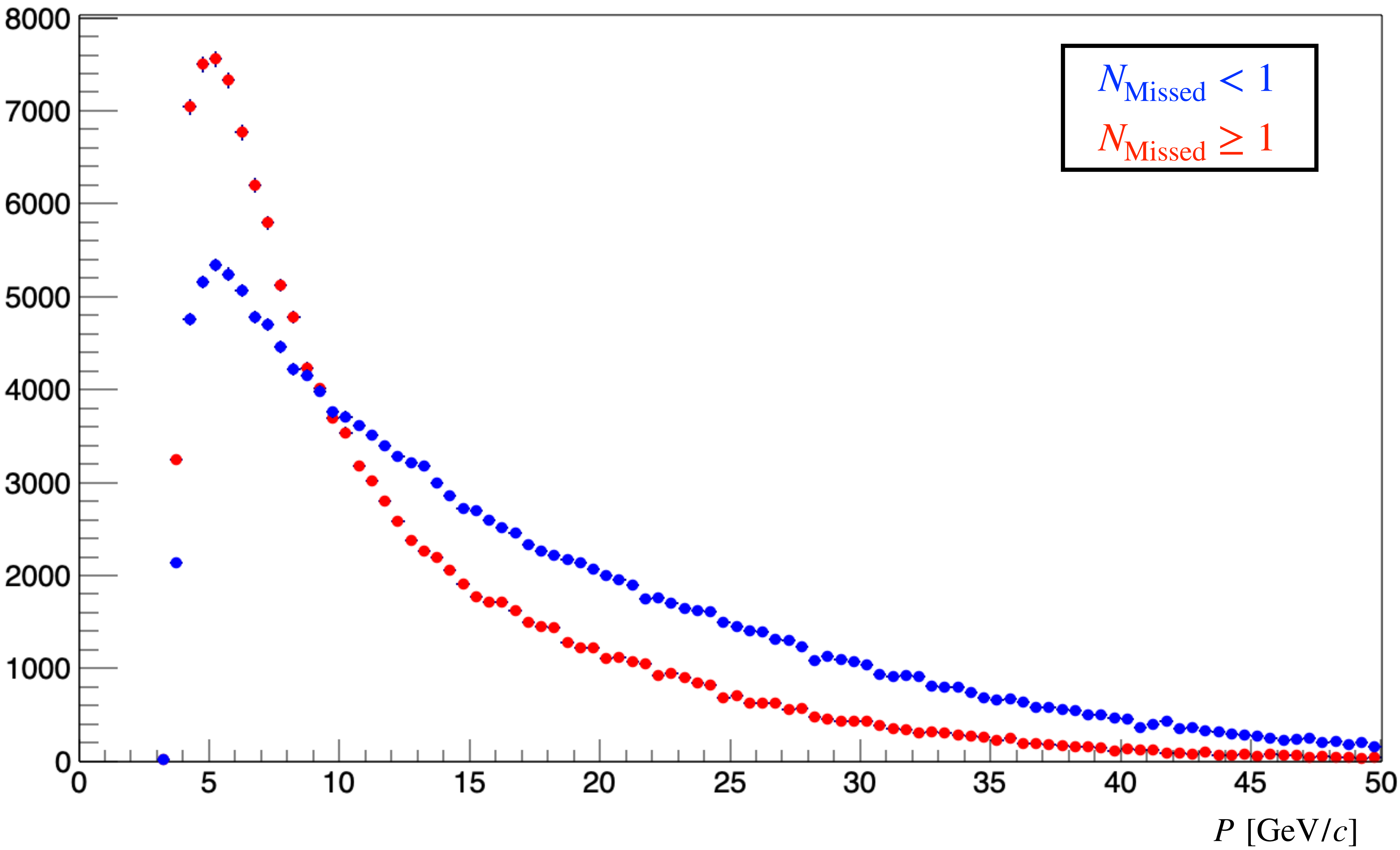
# Comparing Jets


Recontsructed Jet η
$N_{\mathrm{Missed}} < 1$
$N_{\mathrm{Missed}} \geq 1$
14000
12000
10000
8000
6000
4000
2000
0
−5
−4
−3
−2
−1
0
1
2
3
4
5
η

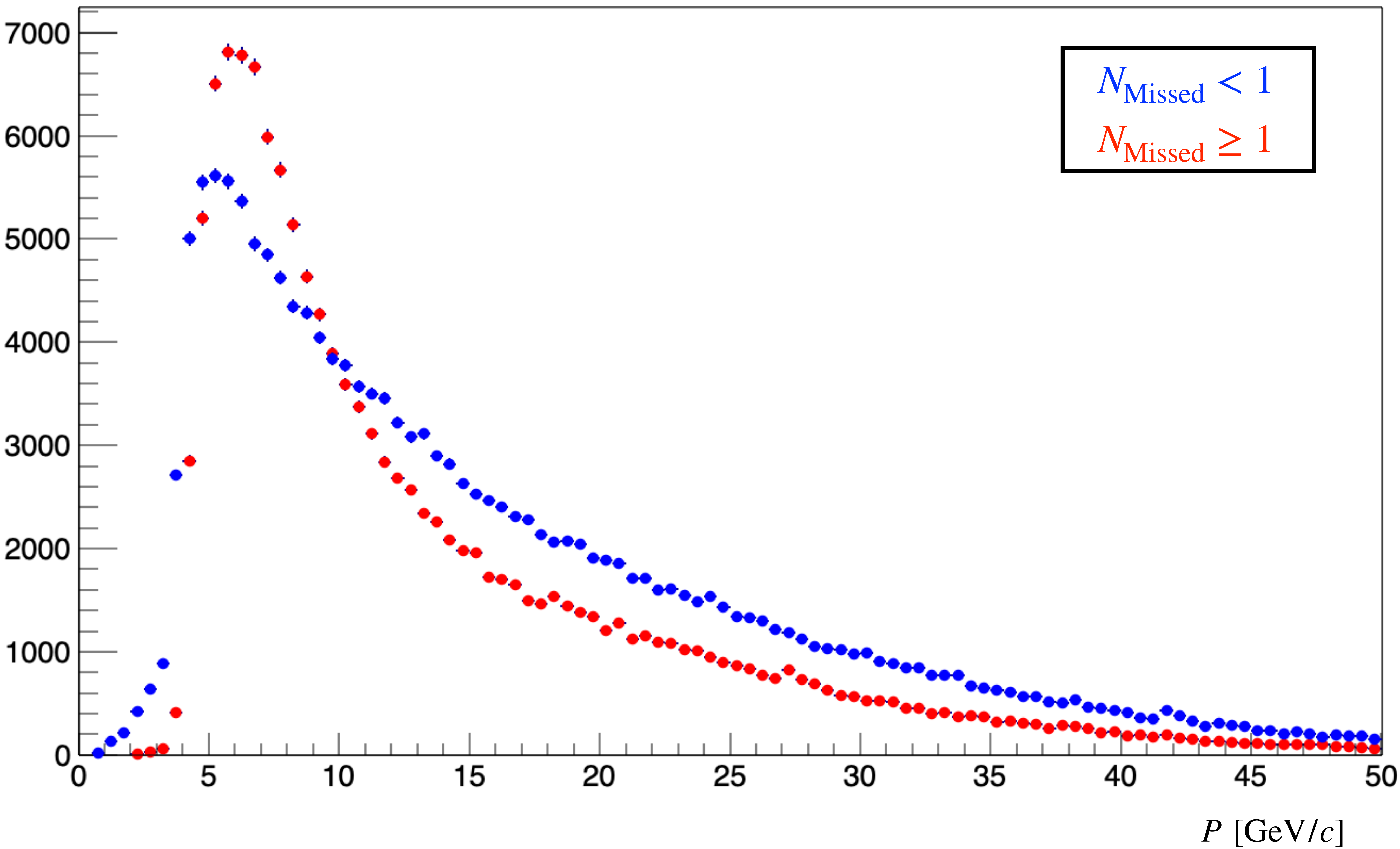


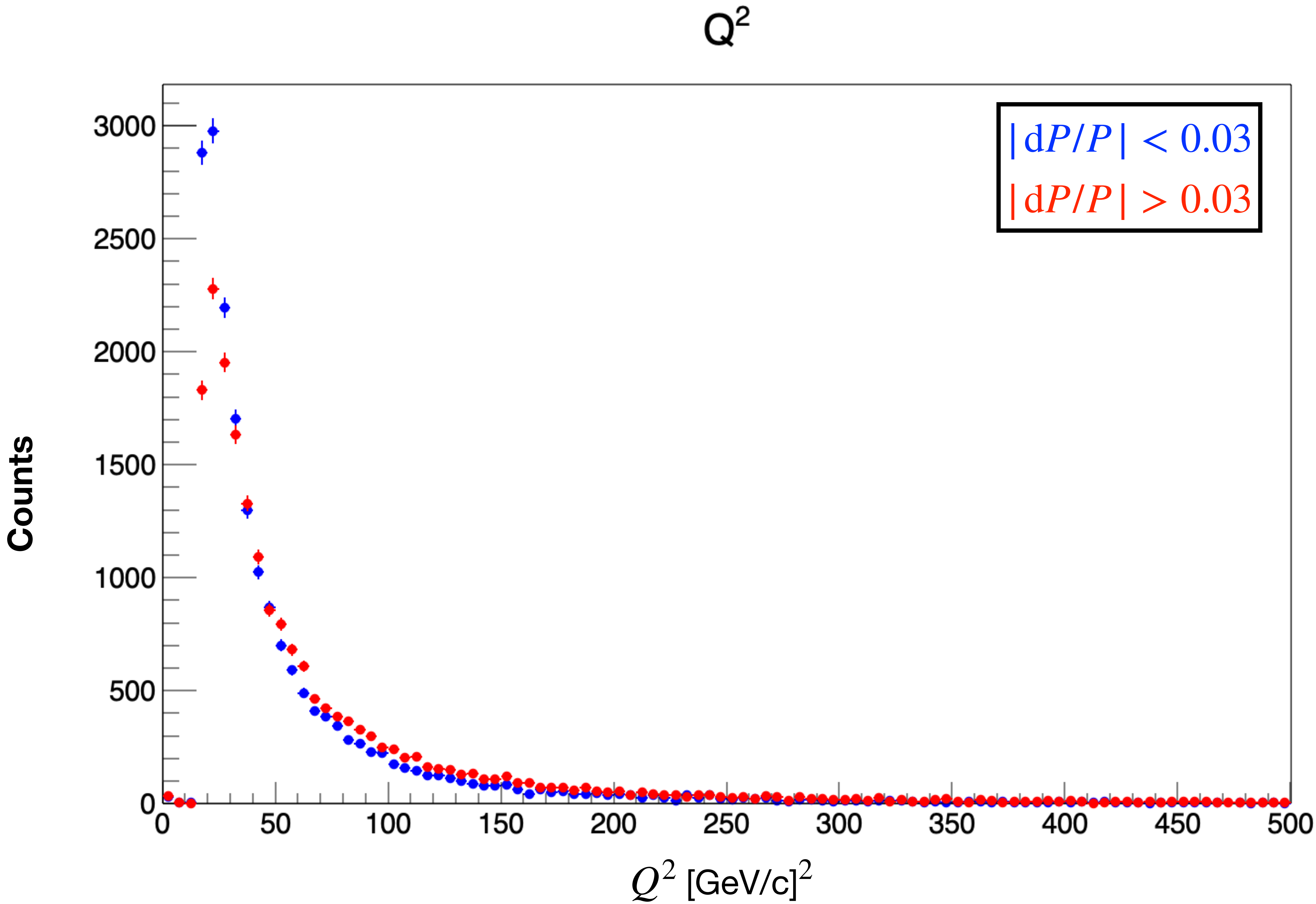
Truth Jet η
$N_{\mathrm{Missed}} < 1$
$N_{\mathrm{Missed}} \geq 1$
14000
12000
10000
8000
6000
4000
2000
0
−5
−4
−3
−2
−1
0
1
2
3
4
5
η

# Reconstructed Jet Momentum Comparison



# Truth Jet Momentum Comparison






**Seems to be independent of "Hardness" of scattering**

**If anything, the lower $Q^2$ Jets tend to be better…**