Crossing angle study at EIC (IP6)

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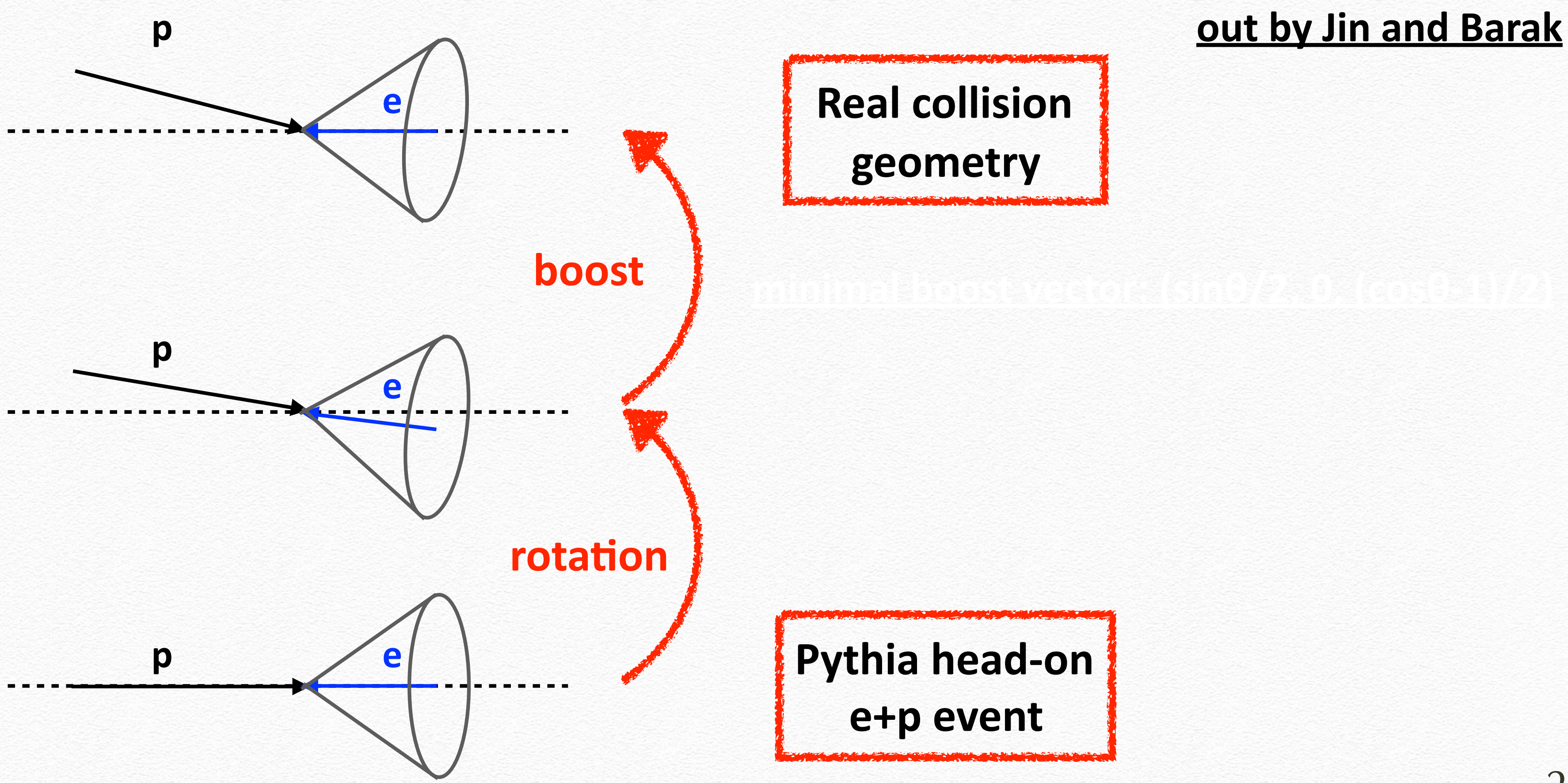
with lots of help & inputs from Jin Huang (BNL) and Barak Schmookler (SBU)

Steps to implement Xing angle

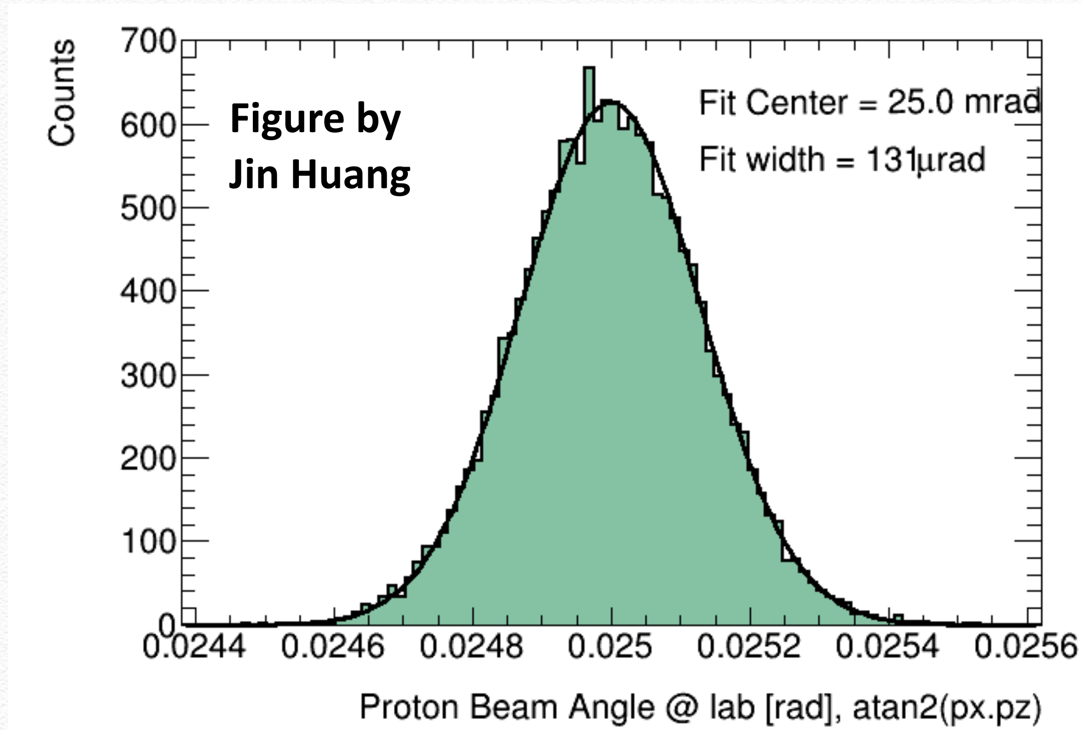
- Scenario: hadron beam has 25 mrad angle from z axis and electron beam along z
  - Detectors' centroid aligned with z (magnetic field along aligned with z)

Boost and rotation worked out by Jin and Barak



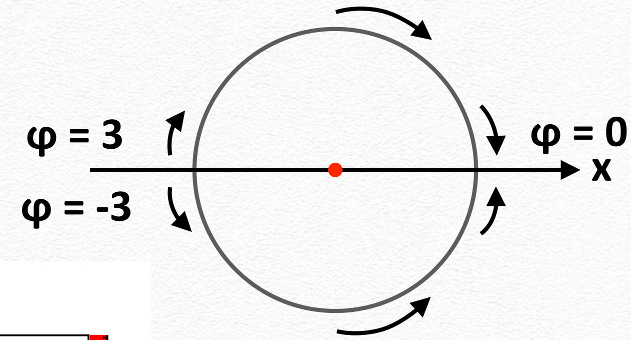
Crossing angle study in Fun4All

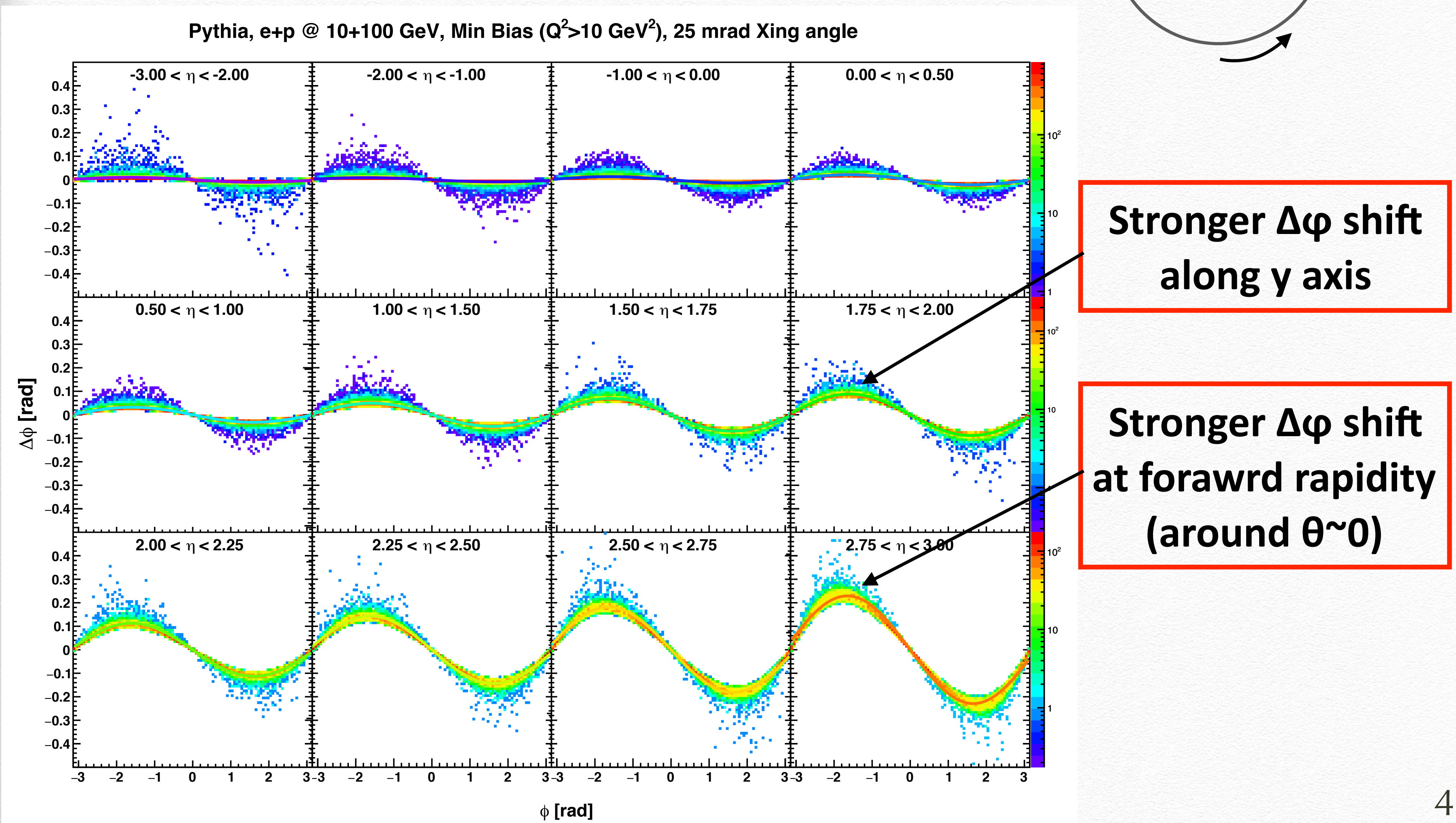
- The crossing angle now implemented in Fun4All by Jin
  - Xing angle + beam divergence: https://github.com/sPHENIX-Collaboration/coresoftware/pull/1087
  - Crab cavity kick: https://github.com/sPHENIX-Collaboration/coresoftware/pull/1113



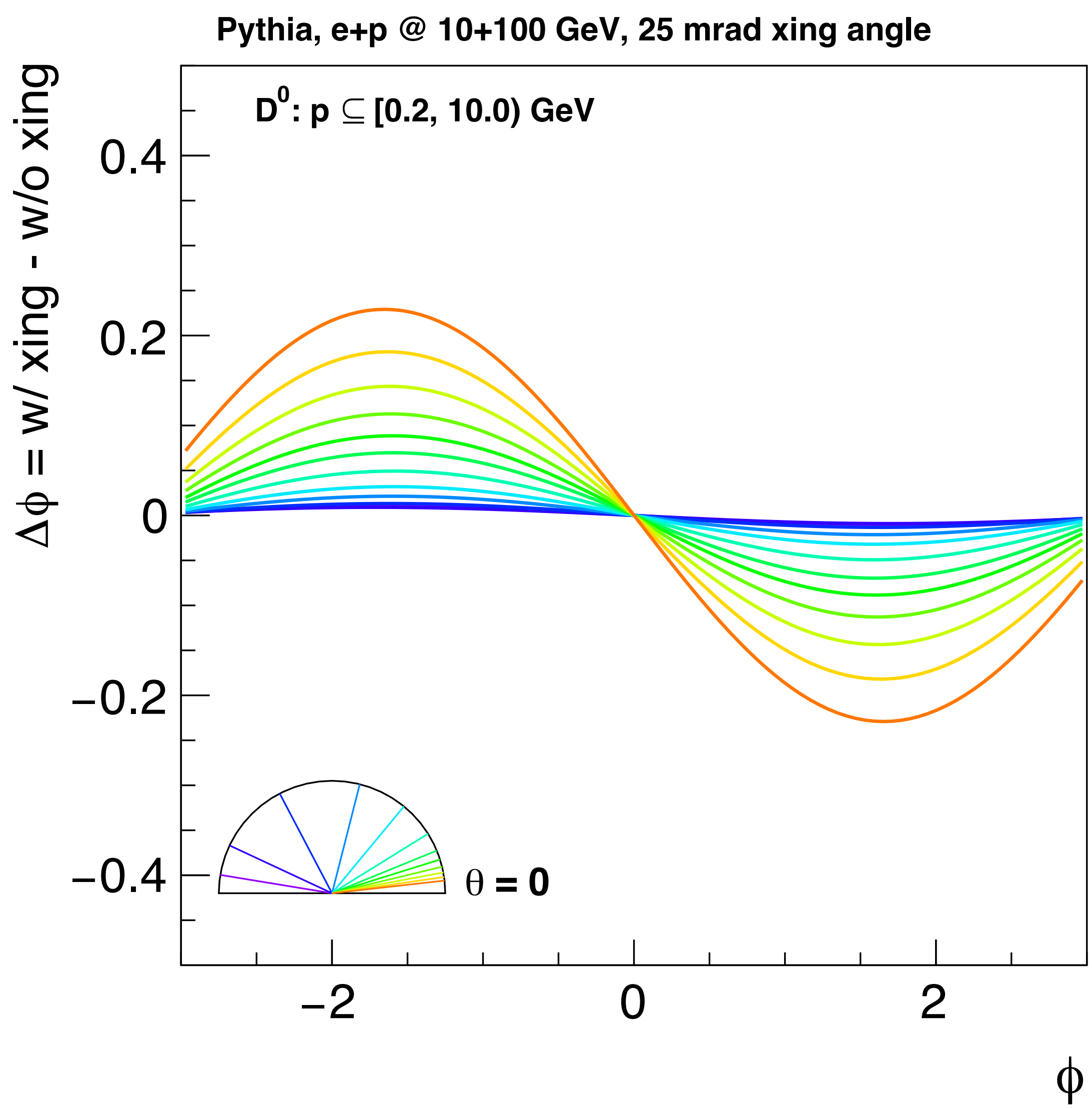
- PythiaeRHIC
  - Peal out $D^0 \to K\pi$
  - Feed to Fun4All
  - Apply beam parameters
  - Only turn on trackers (using Hybrid for this study)
  - Look at the new $D^0 \to K\pi$ (both reco and true) from track evaluator

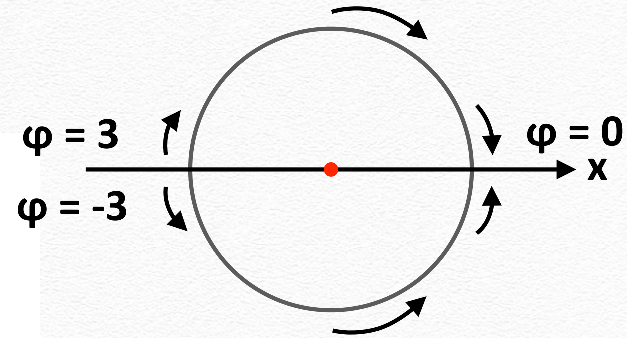
D^0 ϕ shift with Xing angle





D^0 ϕ shift with Xing angle

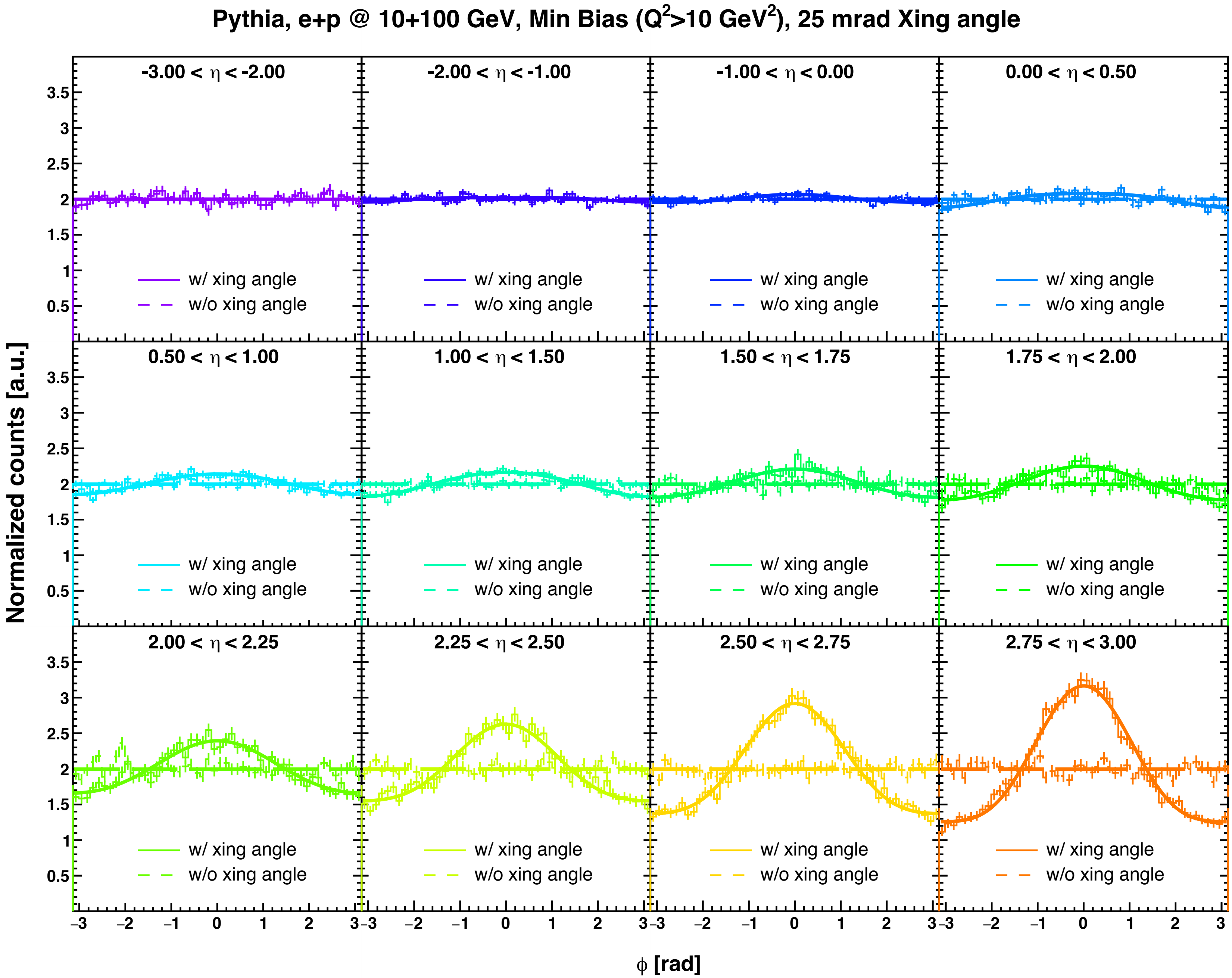




Such shift will create an "artificial" azimuthal anisotropy of the outgoing particles

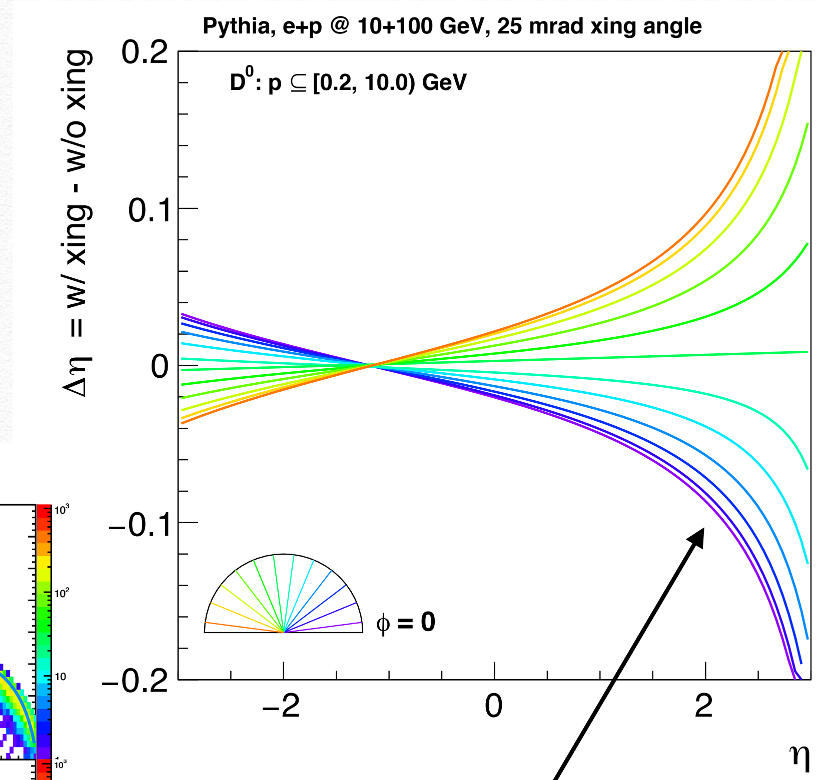
Correctable as long as one boost back to head on event by event

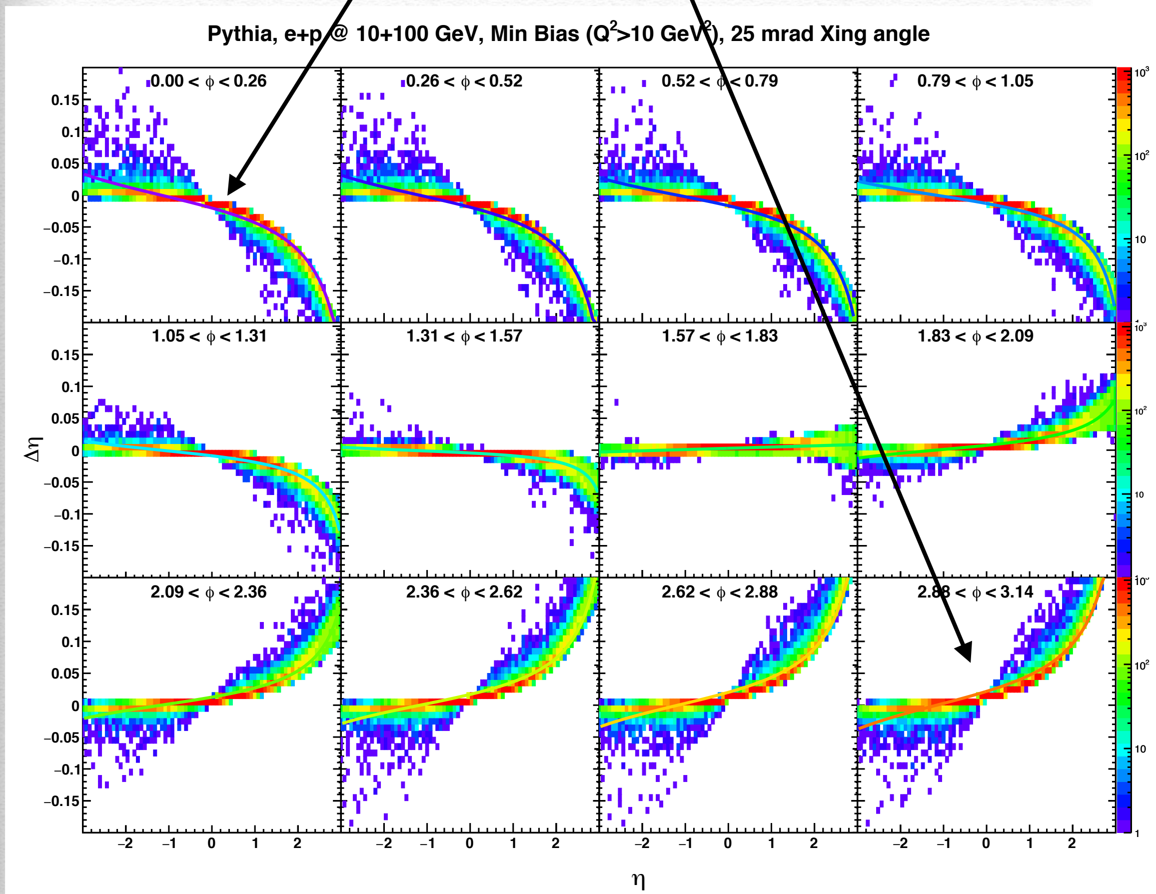
D^0 ϕ distribution w & w/o Xing angle



D^0 η shift with Xing angle

Larger effect along x axis

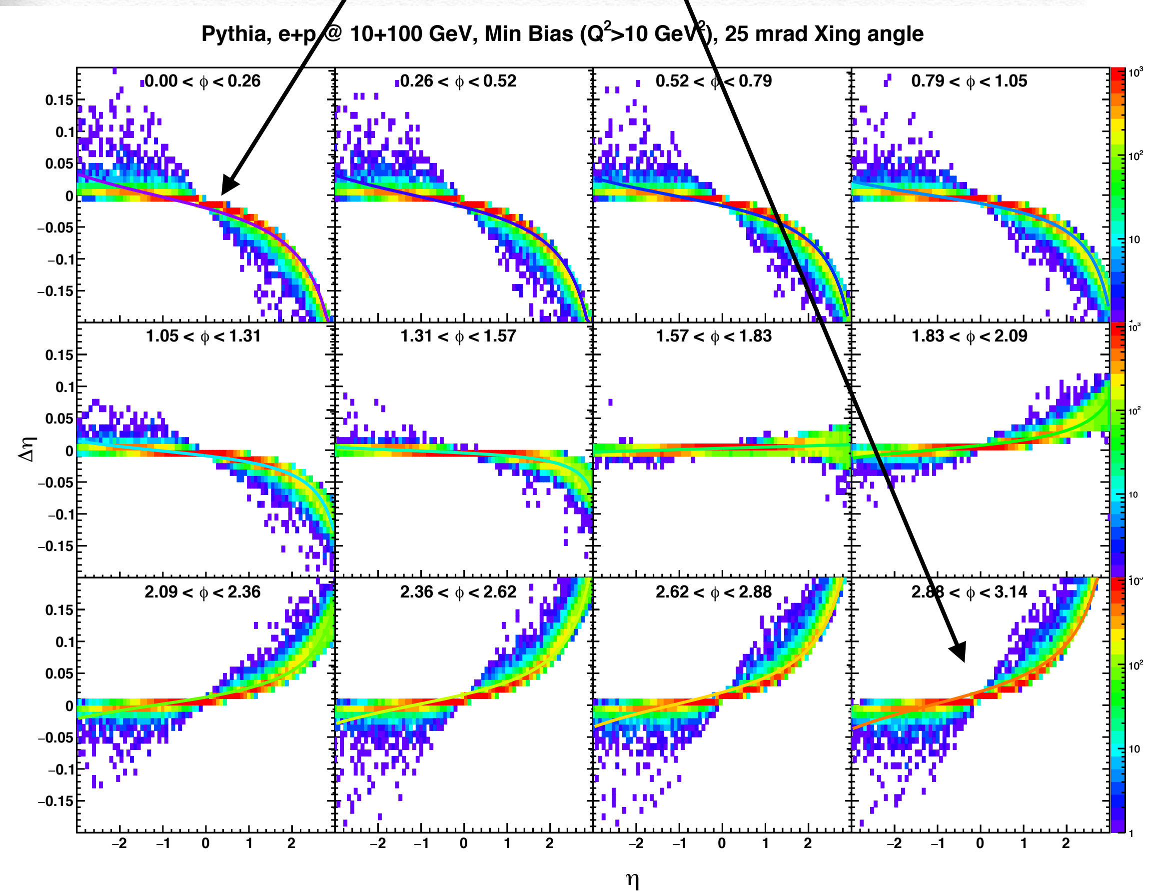


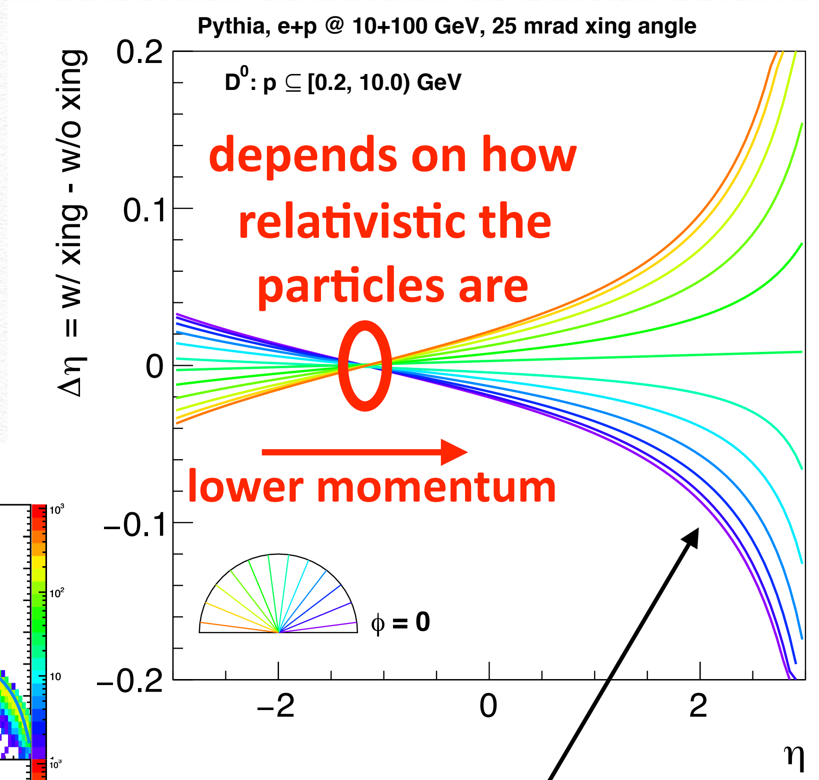


Larger effect at very forward rapidity

D^0 η shift with Xing angle

Larger effect along x axis





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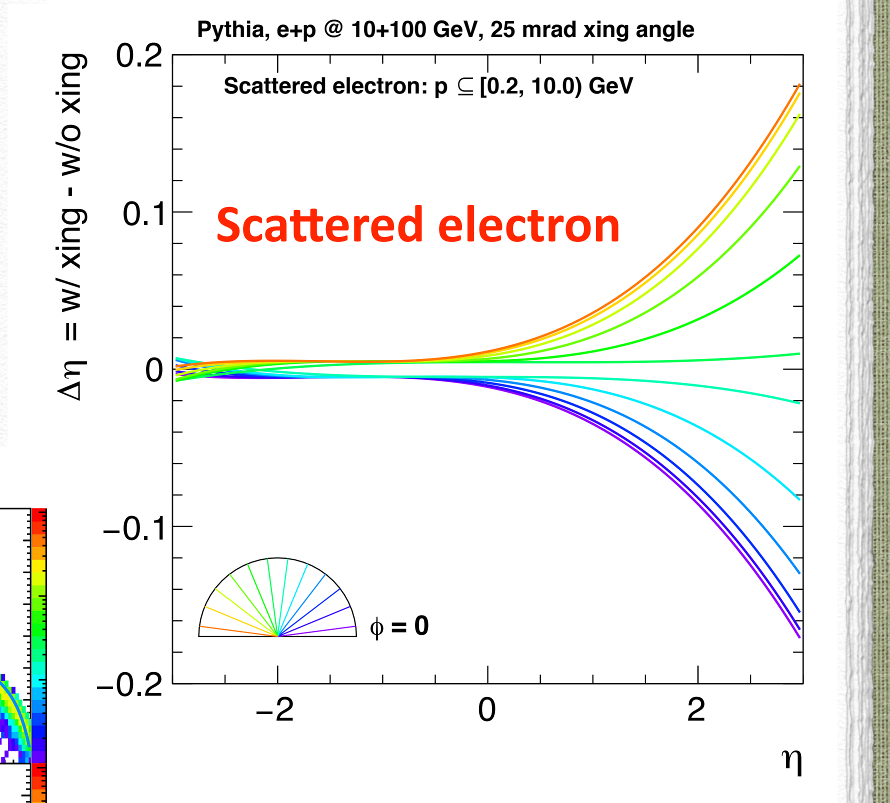
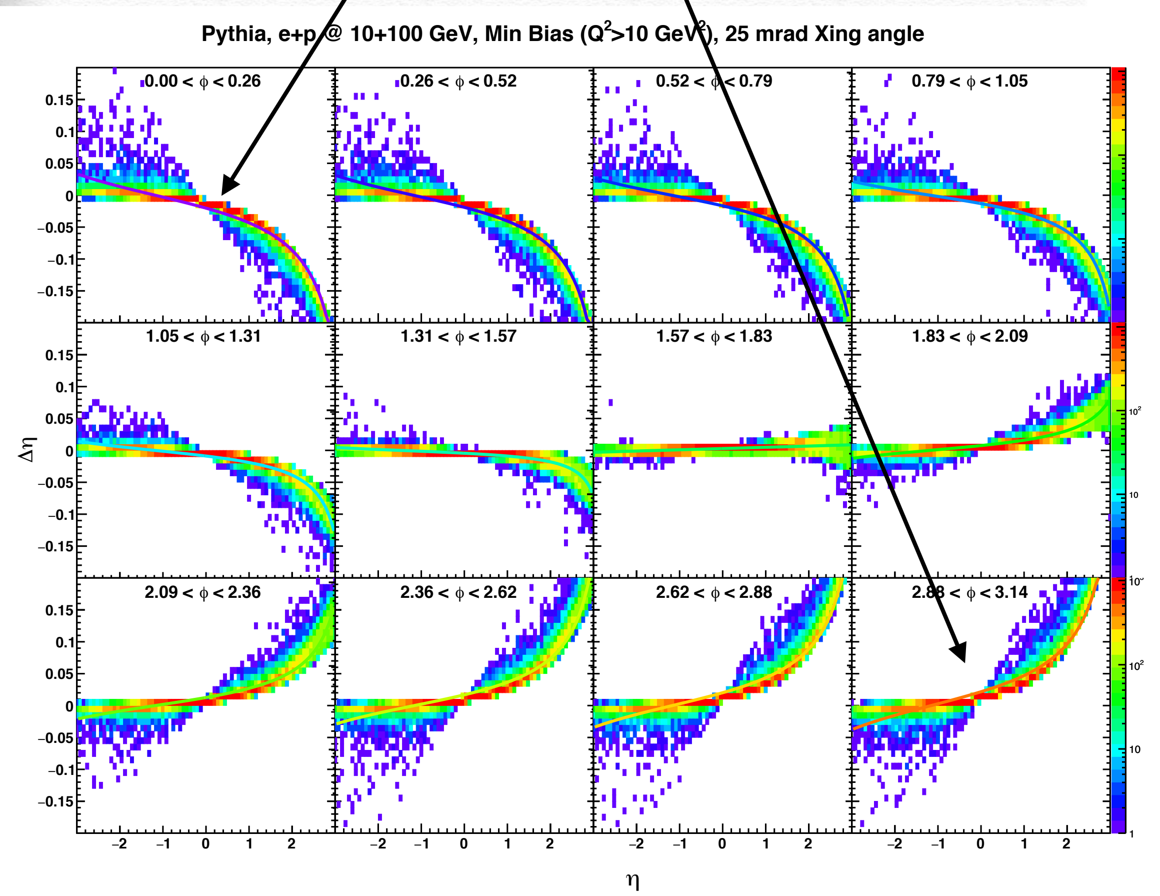
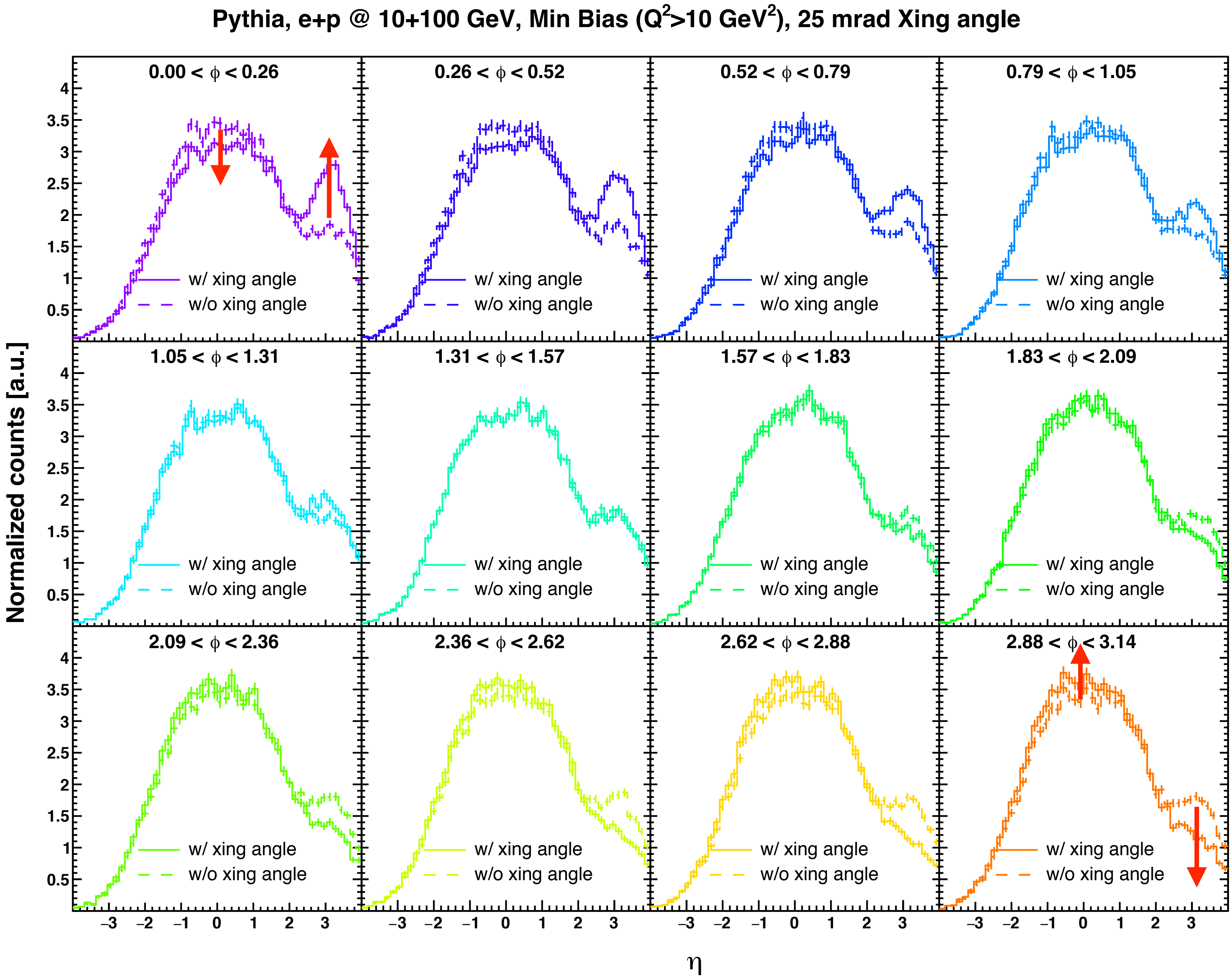
Larger effect along x axis



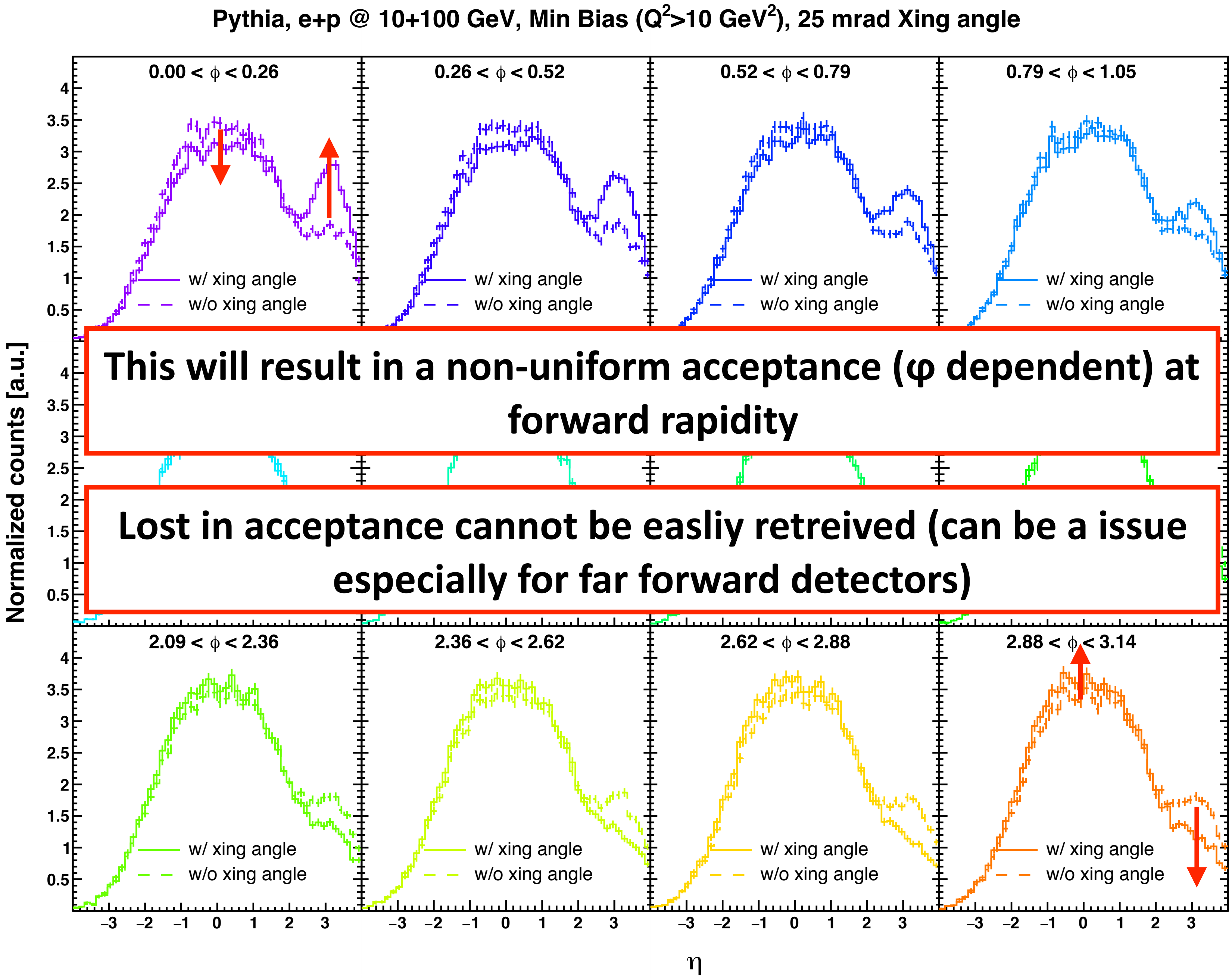


Larger effect at very forward rapidity

D^0 η distribution w & w/o Xing angle



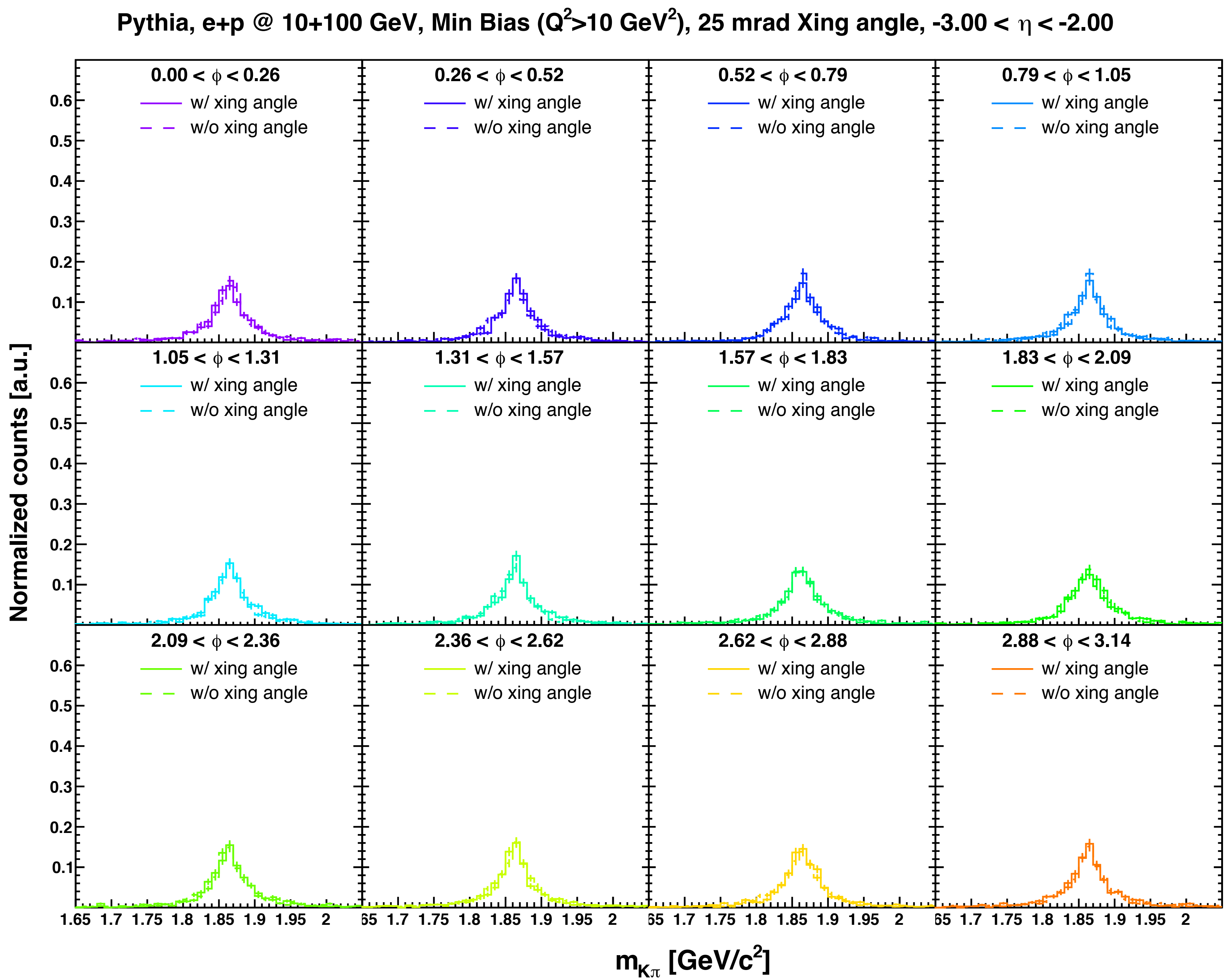
D^0 η distribution w & w/o Xing angle



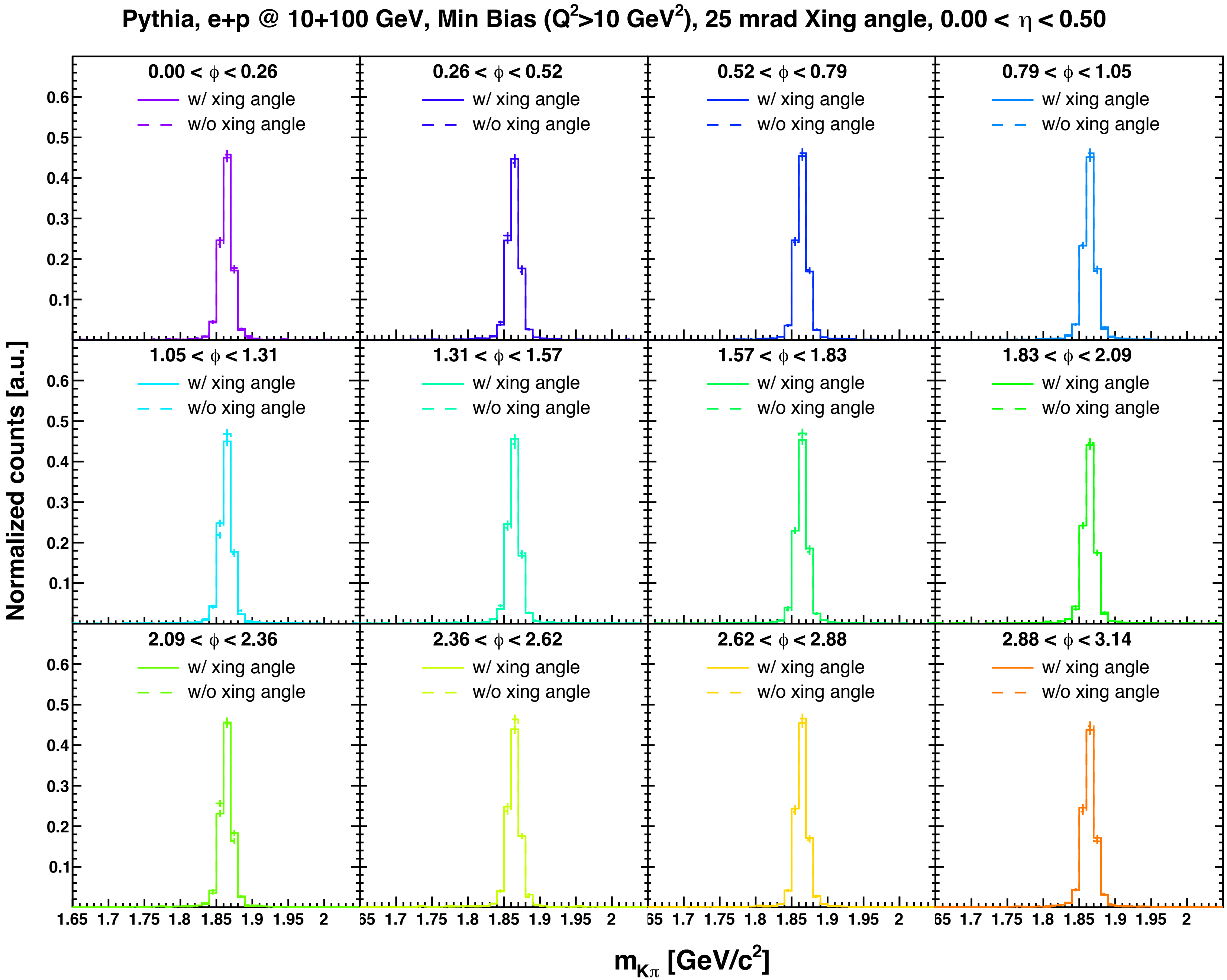
This will result in a non-uniform acceptance (φ dependent) at forward rapidity

Lost in acceptance cannot be easliy retreived (can be a issue especially for far forward detectors)

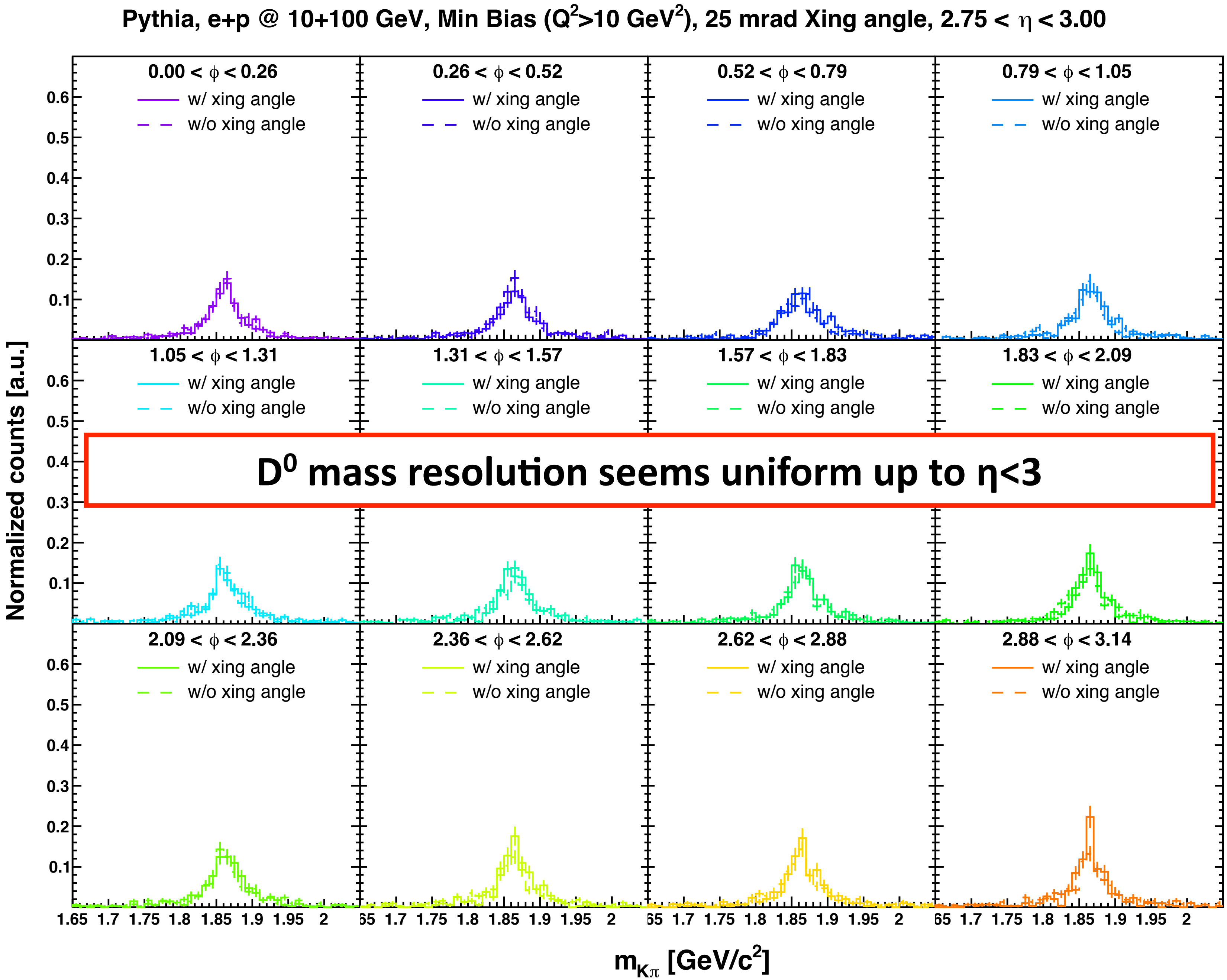
D^0 mass resolution w & w/o Xing angle



D^0 mass resolution w & w/o Xing angle



D^0 mass resolution w & w/o Xing angle

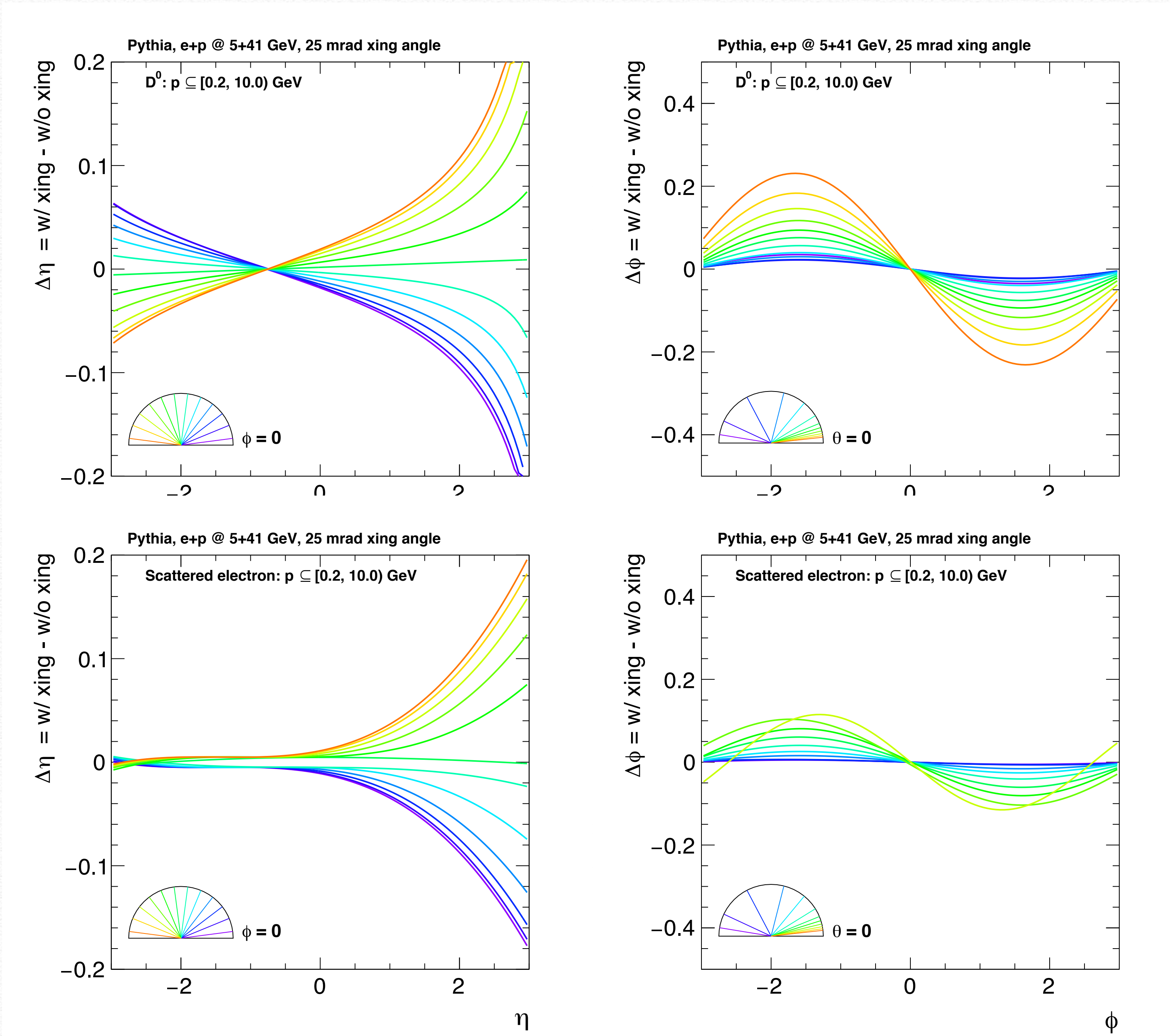


Summary

- After implementing Xing angle:
  - The particle production (σ) become ϕ dependent
  - Such effect can be corrected after boosting/rotating the event back to the head-on frame
  - However the particles out-of-acceptance in the lab-frame cannot be retrieved ➞ a non-uniform acceptance in the head-on frame at forward rapidity along ϕ
- Effect on D^0 measurement:
  - No significant effect on the mass resolution
  - More particles around ϕ~0 (more combinatorial background for heavy flavor hadrons) ➞ worse S/B ratio
  - Acceptance correction will be ϕ dependent

$$\sigma_r^{c\bar{c}}(x_B, Q^2) = \frac{dN(D^0 + \overline{D}^0)/2}{\mathcal{L} \cdot \varepsilon \cdot \mathcal{B}(D^0 \to K\pi) \cdot f(c \to D^0) \cdot \mathrm{d}x_B \mathrm{d}Q^2} \times \frac{x_B Q^4}{2\pi\alpha^2[1 + (1-y)^2]}$$

Different energy combination: 5+41GeV



Different energy combination: 10+100GeV