Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

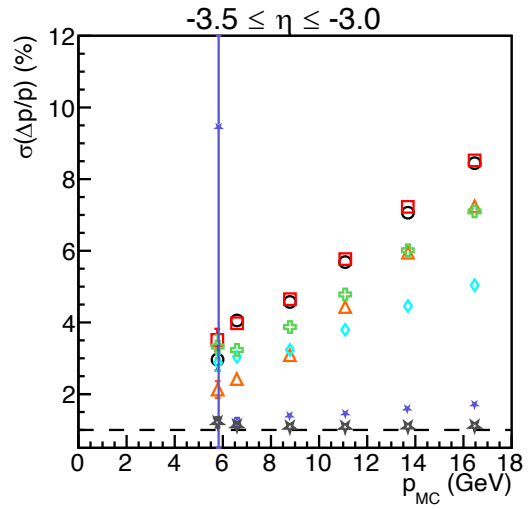
ePIC Performance on Coherent J/ψ Diffractive Pattern

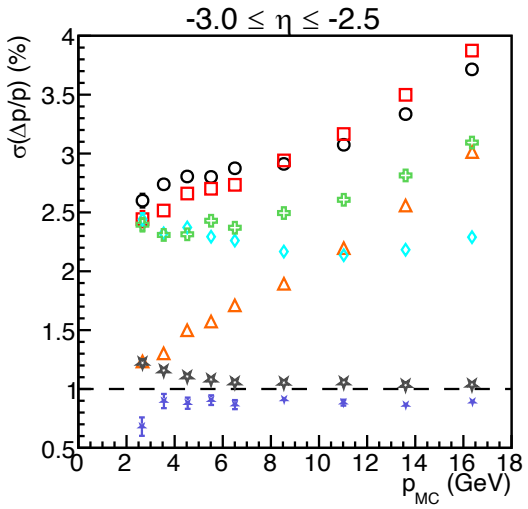
Cheuk-Ping Wong

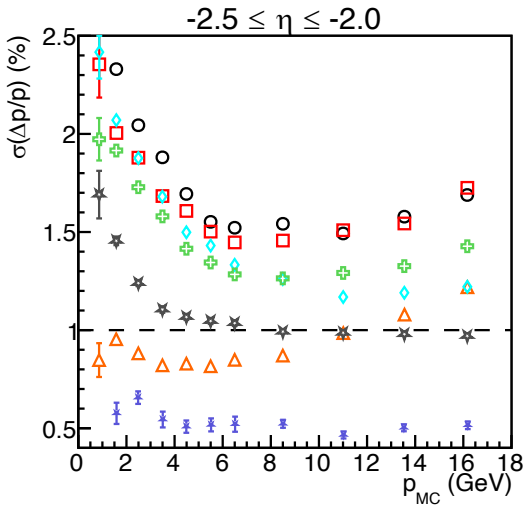
12-04-2023

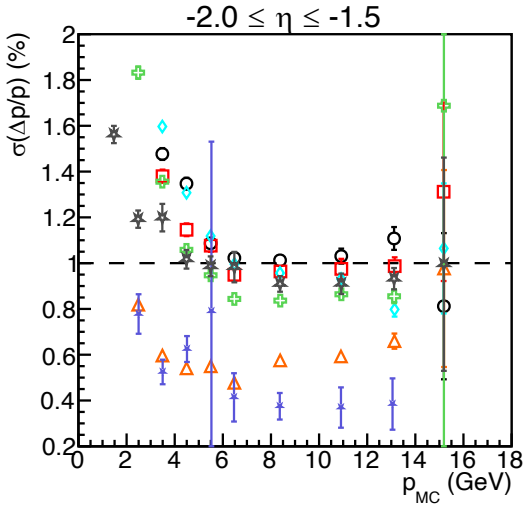
@BrookhavenLab

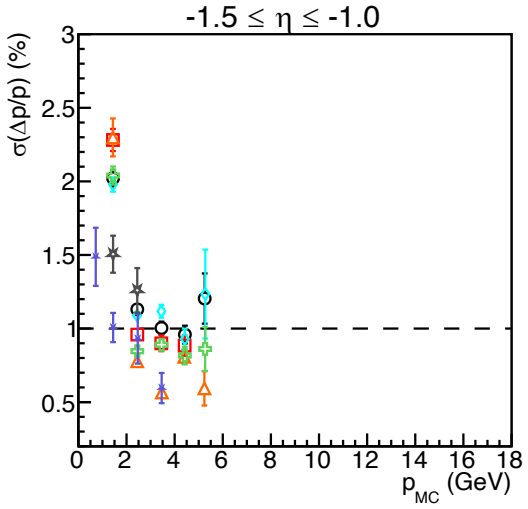
Momentum Resolution (e^-)







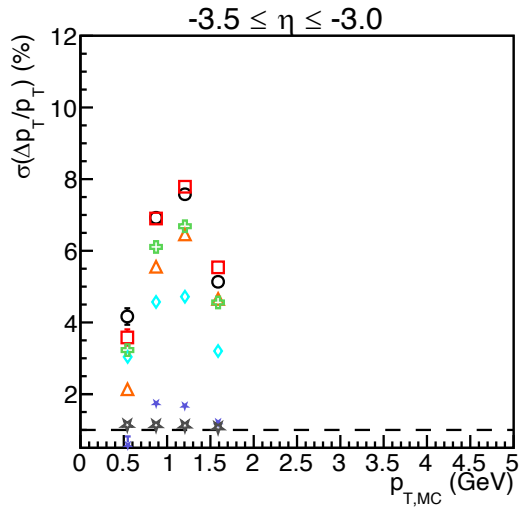


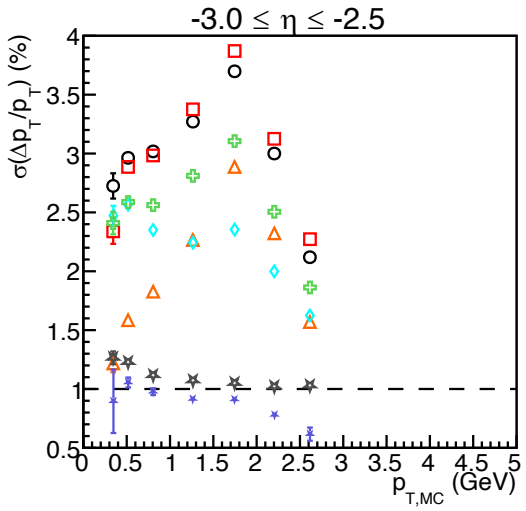


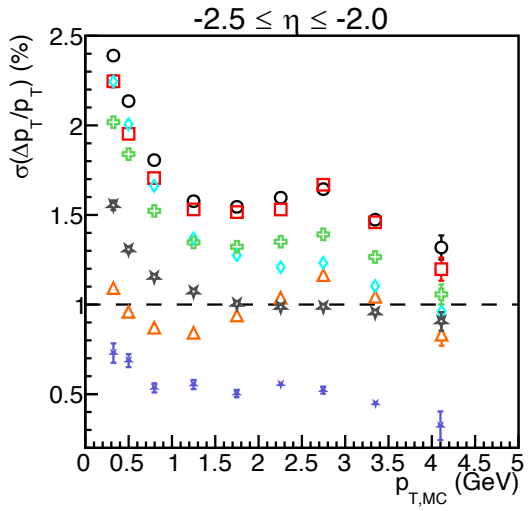
- ePIC
- ePIC, $t_{backward\ silicon}$=5um
- ePIC, t_{alumi}=5um, t_{CF}=5um
- ePIC, bk disk max loc. 170cm
- ePIC, B=2T
- ePIC,$t_{alumi,CF}$=0um,t_{Si}=5um,pix=10um,B=2T (100k events)
- Ecal e

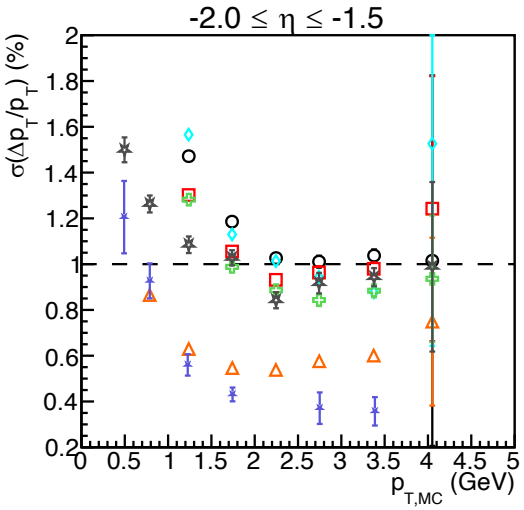
I tried to increase the length of the backward tracking system too, but does not work as I expected

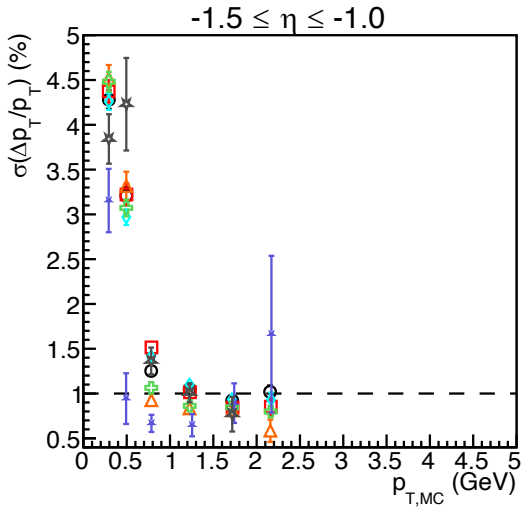
Transverse Momentum Resolution (e^-)











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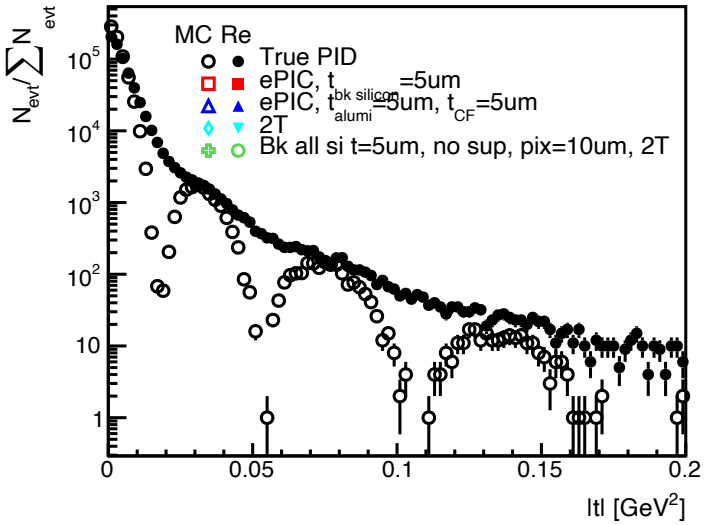
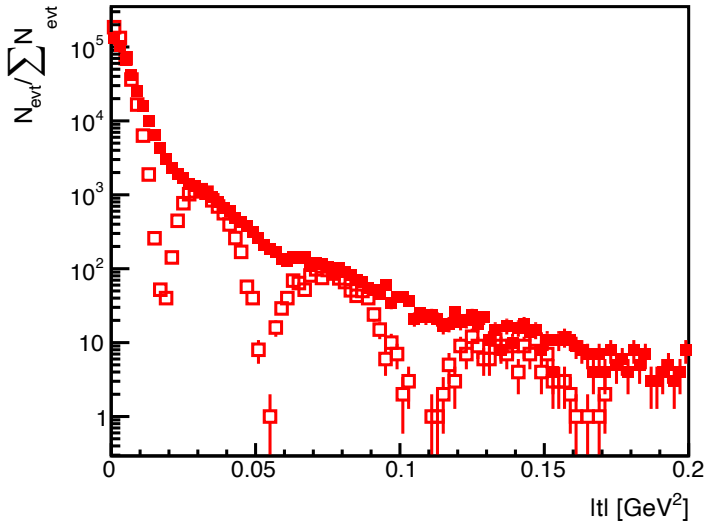
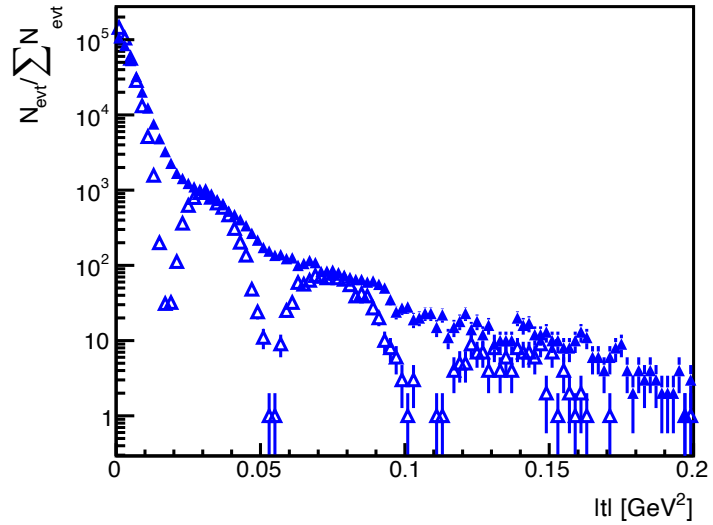
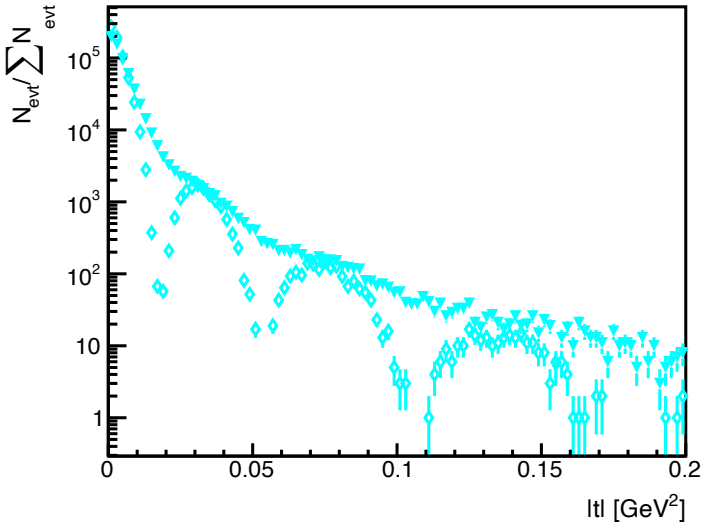
t Resolution

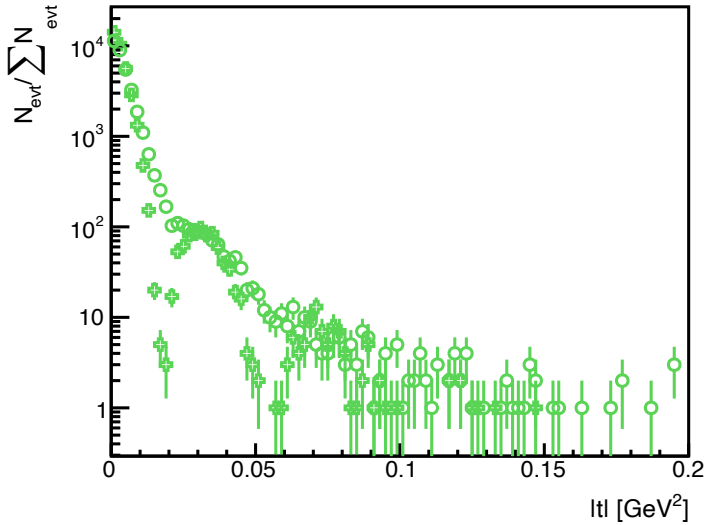
No muon ID smearing

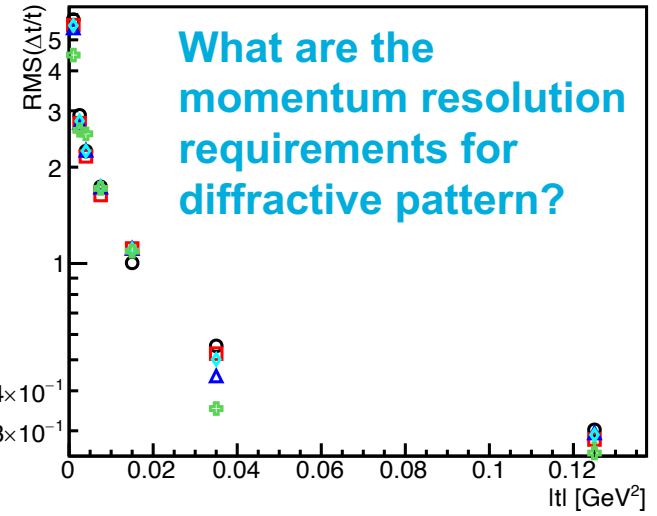








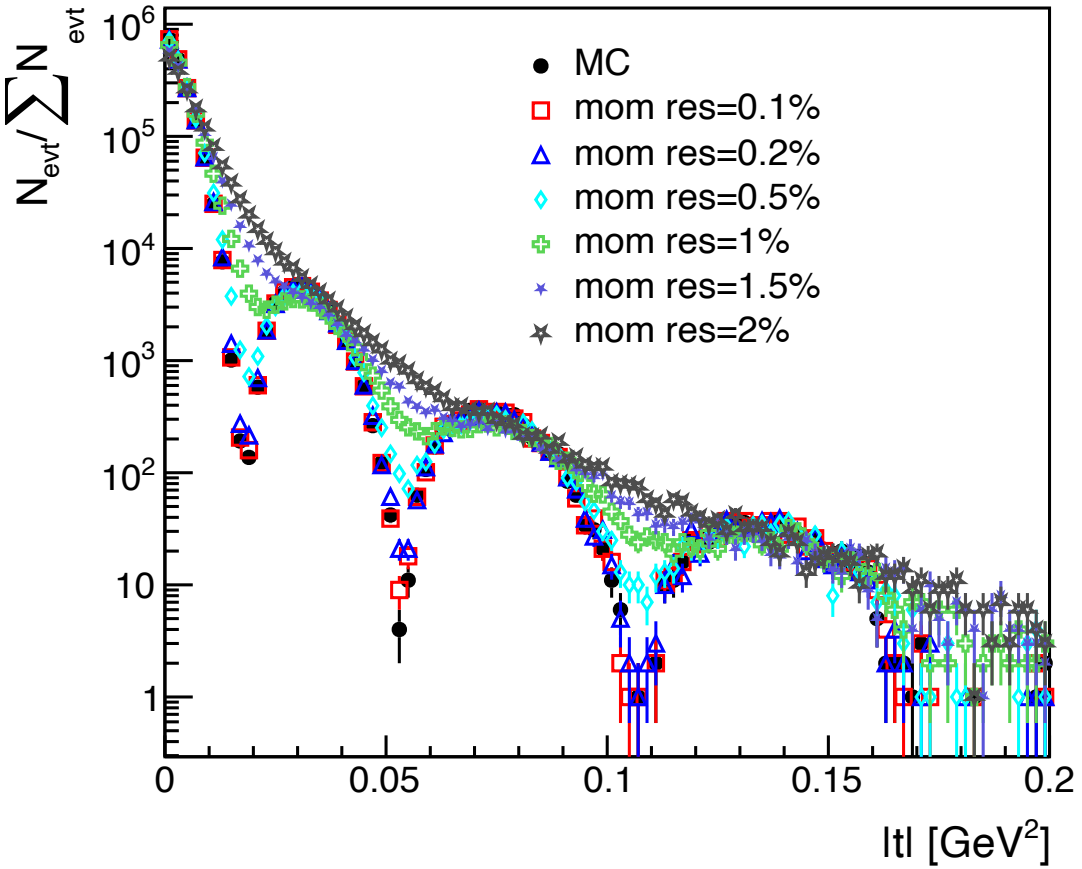


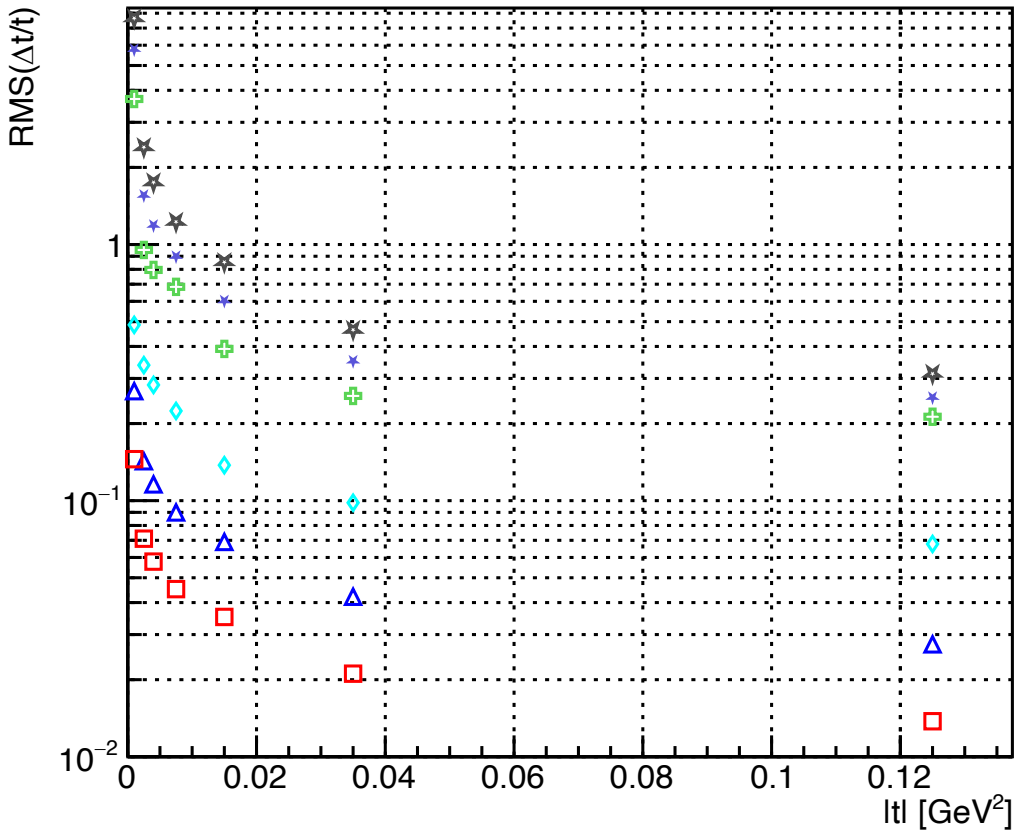


What are the momentum resolution requirements for diffractive pattern?

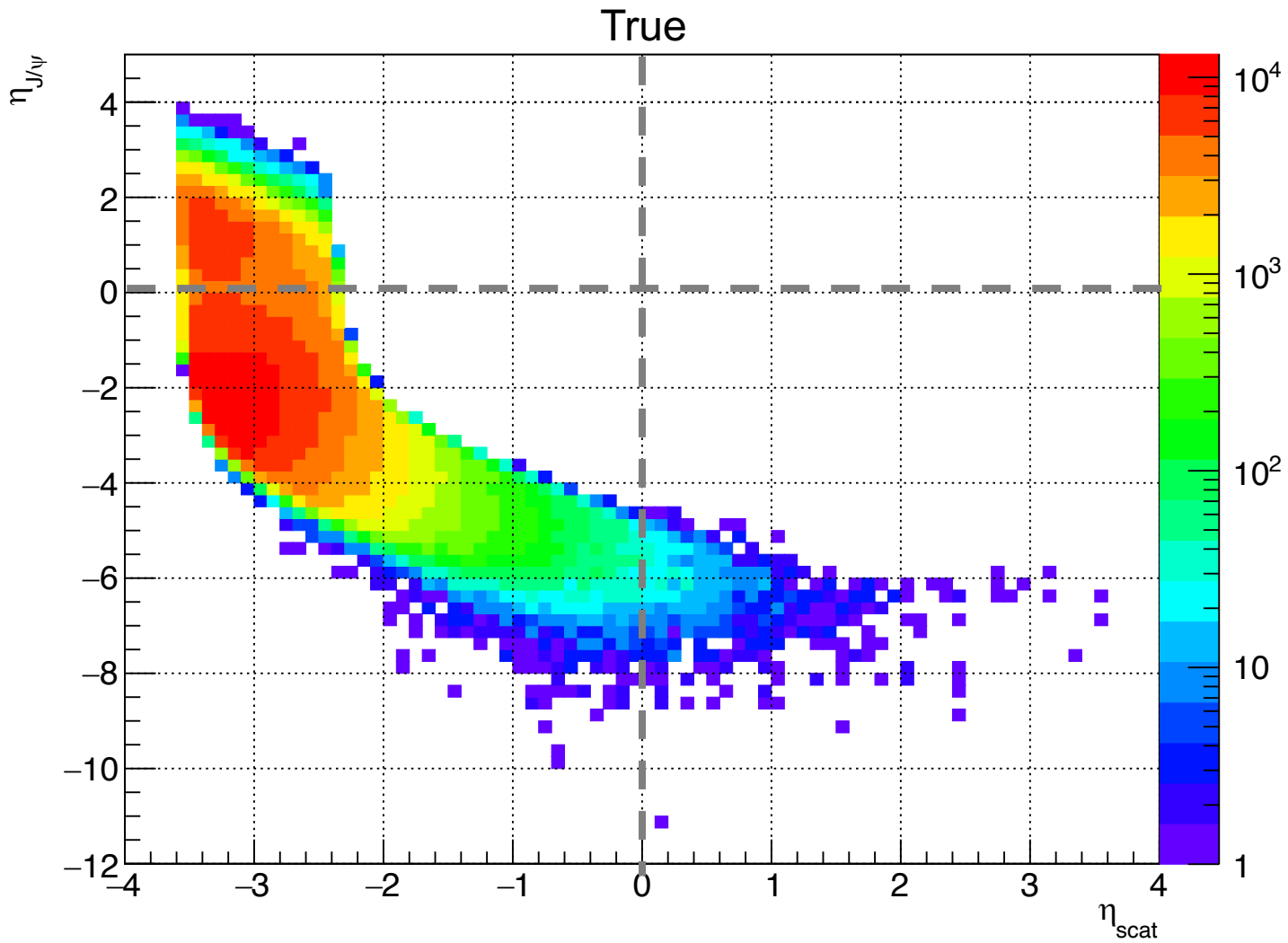
Momentum Smearing

- Gaussian smearing on momentum
- Uniform momentum resolution independent of momentum or pseudorapidity
- No muon ID smearing

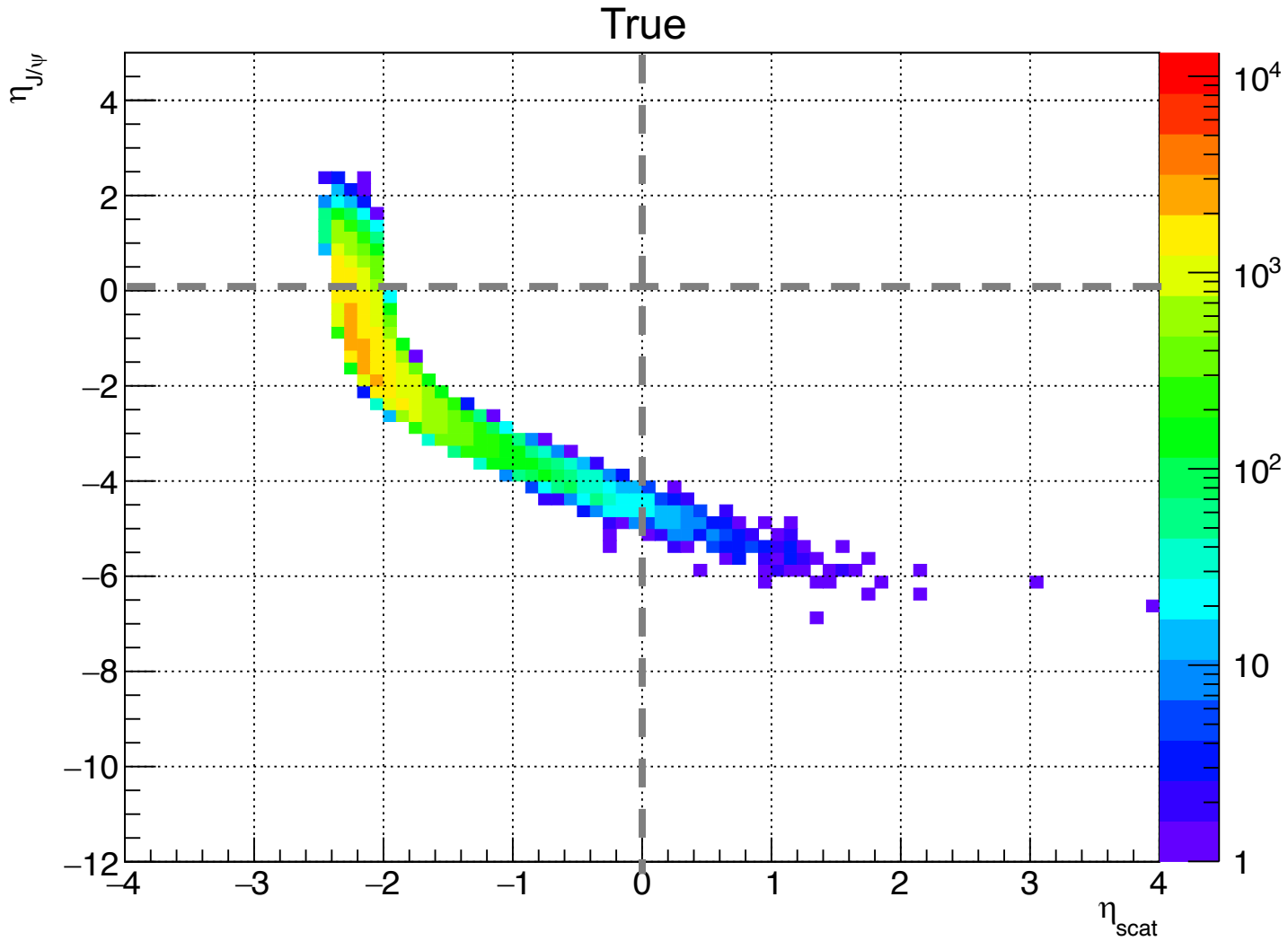




$\eta_{J/\psi}$ v.s. $\eta_{scattered\ e}$ $(1 < Q^2 < 10\ \mathrm{GeV}^2)$



$\eta_{J/\psi}$ v.s. $\eta_{scattered\ e}$ ($Q^2 > 10$ GeV^2)



Summary

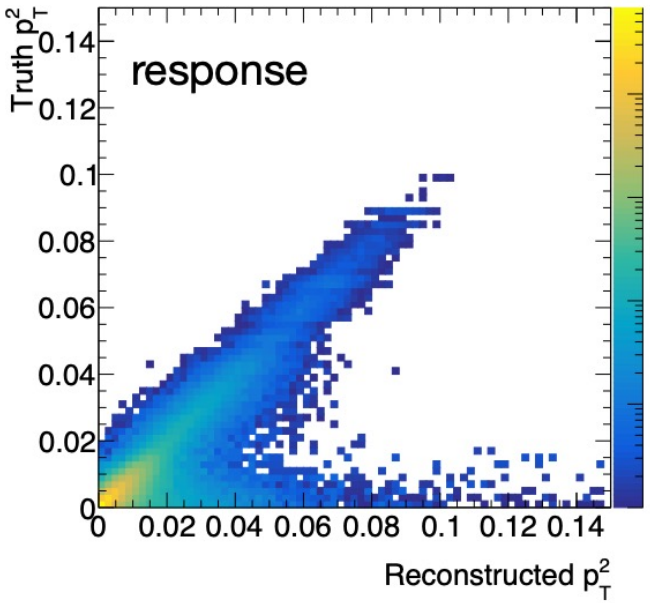
- Trying to implement all possible improvements in the backward tracking system
- Need to achieve <1% momentum resolution at pseudorapidity below -3

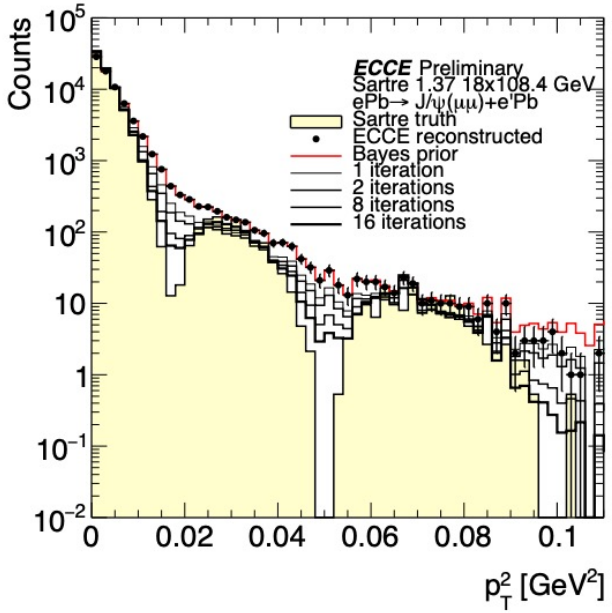
To-Do: Unfolding

Peter Steinburg, ECCE

Unfolding

simple exercise, using Sartre only, and Bayesian unfolding (in ROOT)





Sartre+BeAGLE, just to build response which populates both branches: truth reweighed to observed: identifies problem as tails extending from *t*~0

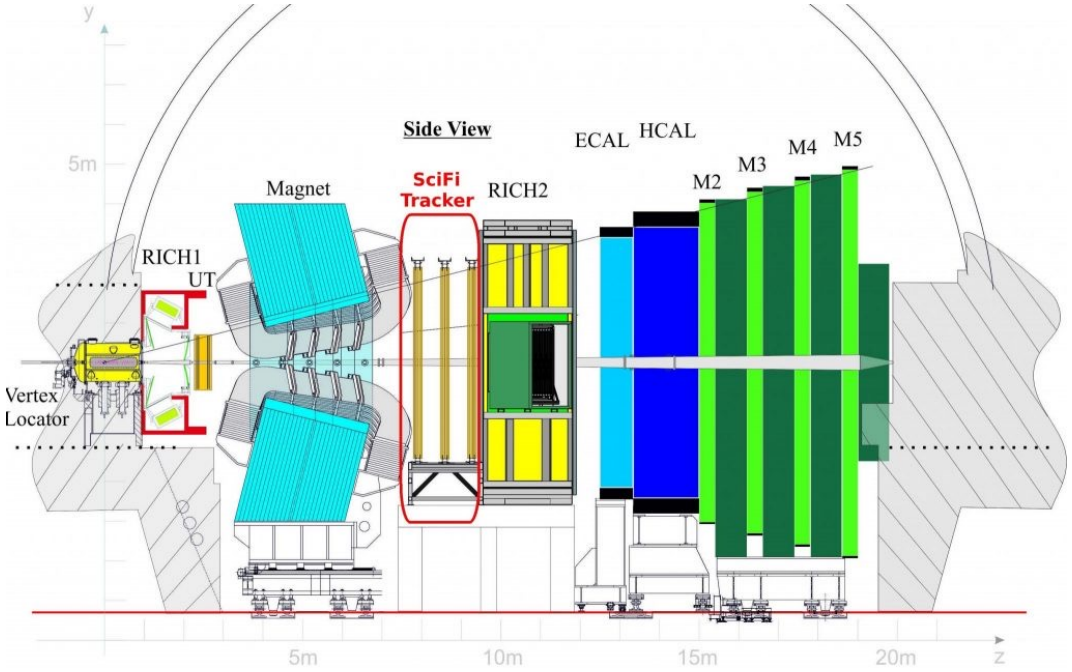
Kinks in final distributions sufficient to start unfolding in right direction, but no obvious convergence

https://indico.bnl.gov/event/18385/contributions/73101/attachments/46047/77833/Steinberg_EICUG20230216.pdf

Scintillating Fiber?

LHCb SciFi (https://arxiv.org/pdf/1710.08325.pdf)

- Scintillating fiber diameter of 250um
- <70um spatial resolution
  Cavet: the tracking system of LHCb includes multiple subsystems and has a long expansion volume
- SiPM sensors are cooled down to -40 degrees Celsius



- Questions:
  - How many layers of scintillating fiber can we afford, material budget-wise?
  - What is the smallest scintillating fiber in diameter in the market?

Backup

Simulation Setup

Sartre

- eAu at 18x110 GeV
- $Q^2 \geq 1$ GeV^2
- Coherent events only
- Forced $J/\psi \rightarrow l^+ l^-$
- No background

Detector

- ePIC-2023.10.0
- epic_craterlake_18x110_Au.xml
- B=1.7 T or 2T

Data Selections and Reconstructions

Single electron selection

If the electron $\eta < -2.5$, use Ecal energy instead of momentum from tracking

$\boldsymbol{J/\psi}$ reconstruction

- |pid| = 11
- Opposite charges cut on dilepton pair
- If the reconstructed mass is within 2 standard deviations, the e+ and e- are labeled as "$\boldsymbol{J/\psi}$ decayed" dielectrons

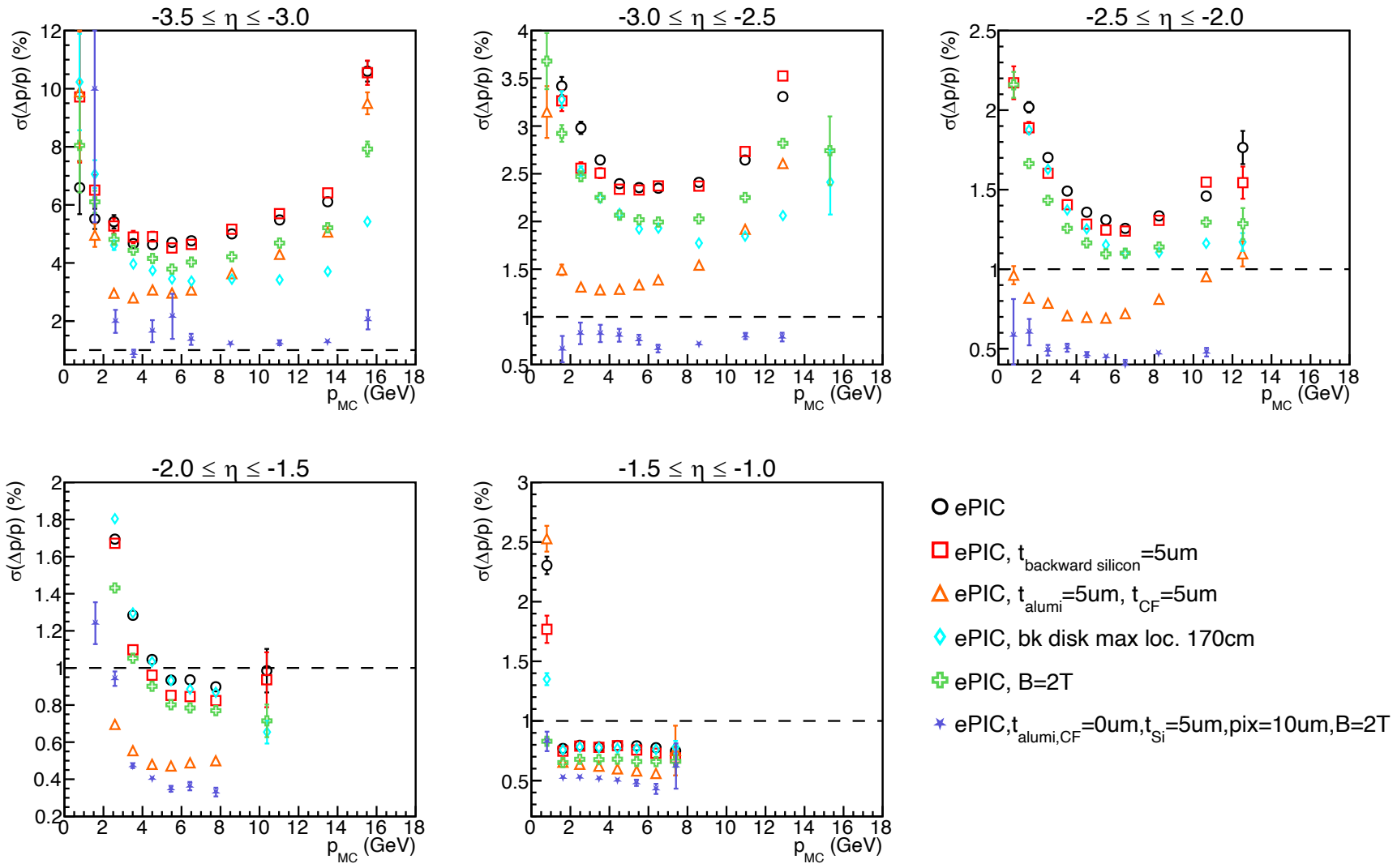
Q^2

- Scattered electrons must be negatively charged
- "$\boldsymbol{J/\psi}$ decayed" electrons are excluded
- $Q^2 = -(e_{beam} - e_{scattered}).M2()$

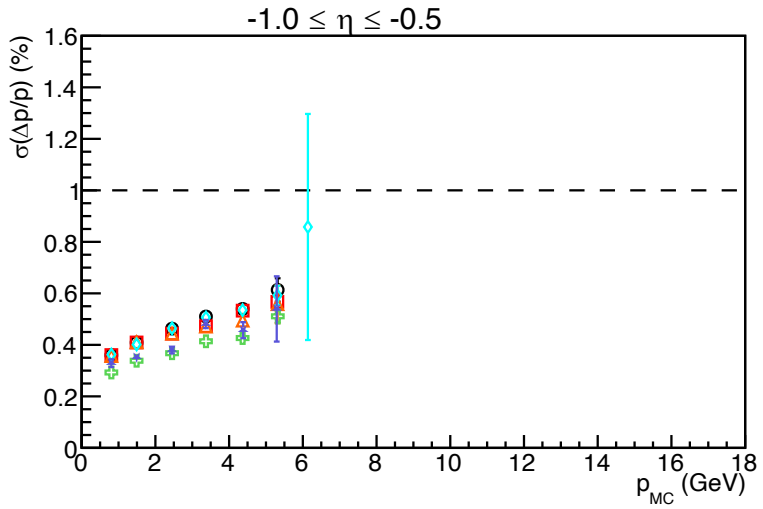
t from method L

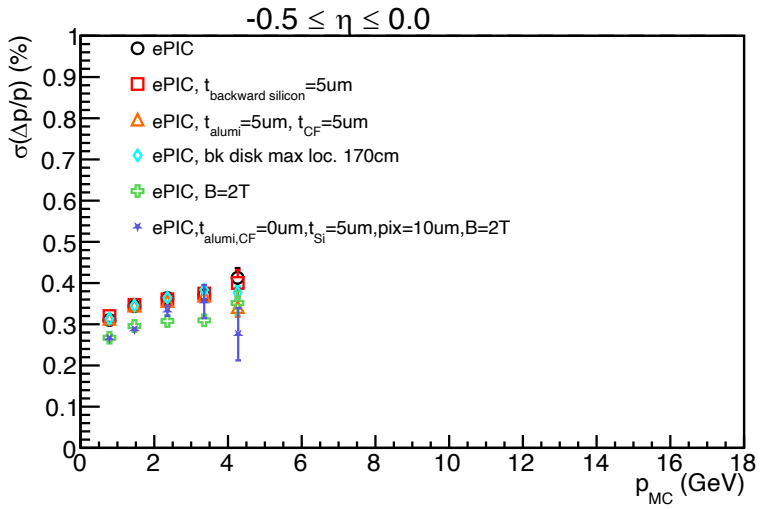
- Removed events with a mis-reconstructed $Q^2 < 1$ GeV^2
- Reconstructed $\boldsymbol{J/\psi}$ $|\eta| < 1.5$
- Require information of the proton beam
- Better t resolutions

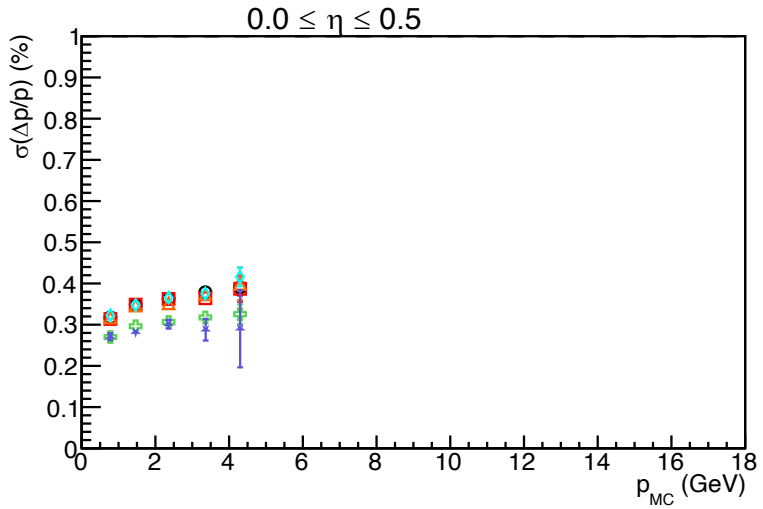
Backward Momentum Resolution ($\mu^{+/-}$)

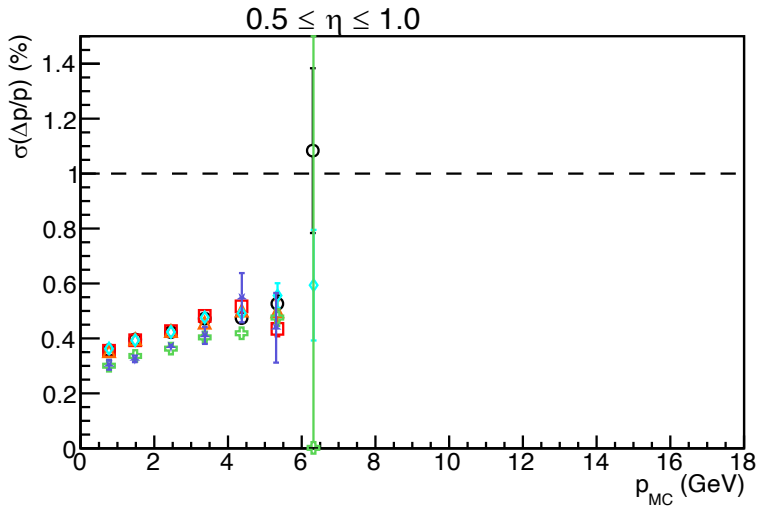


Barrel Momentum Resolution ($\mu^{+/-}$)

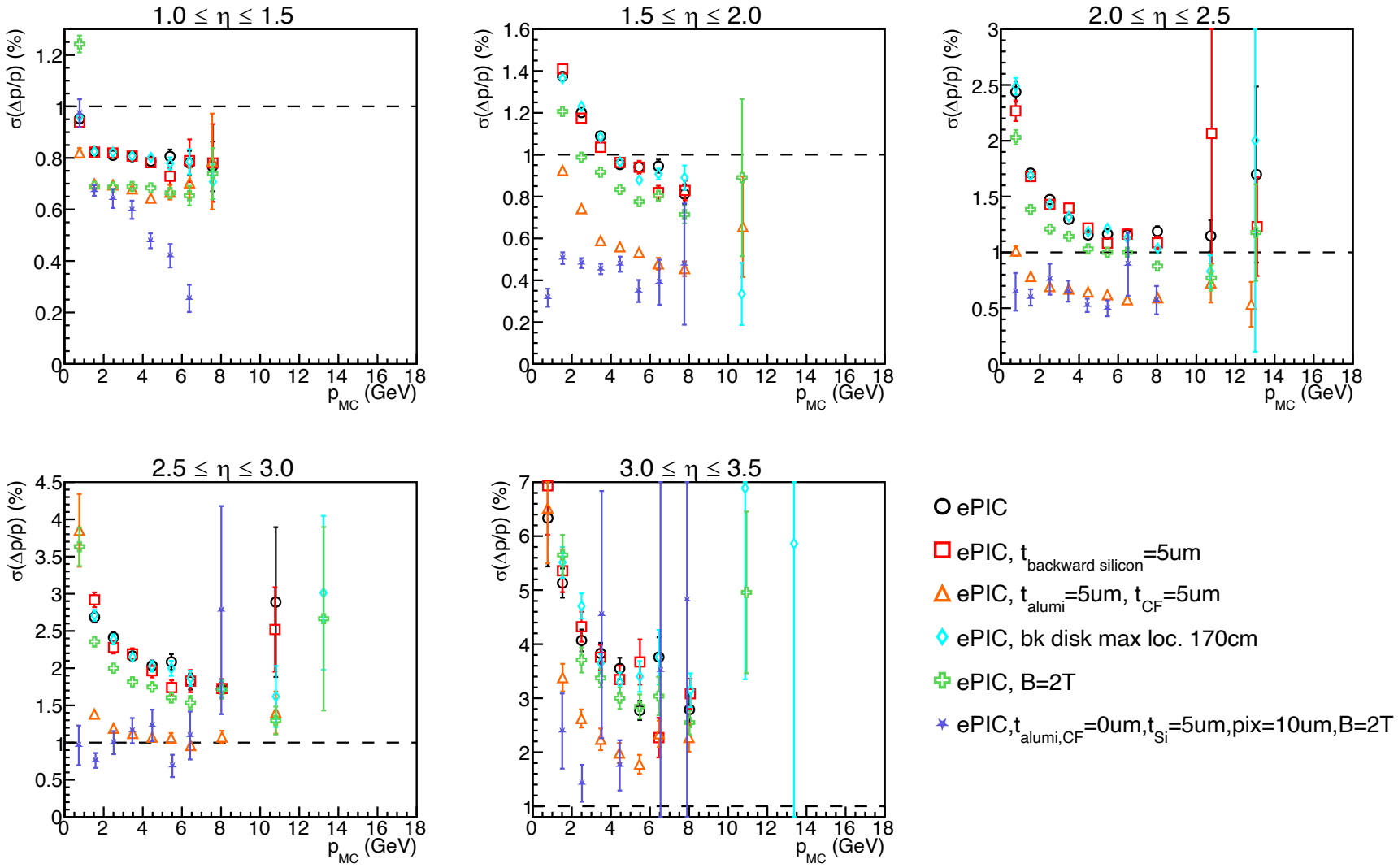




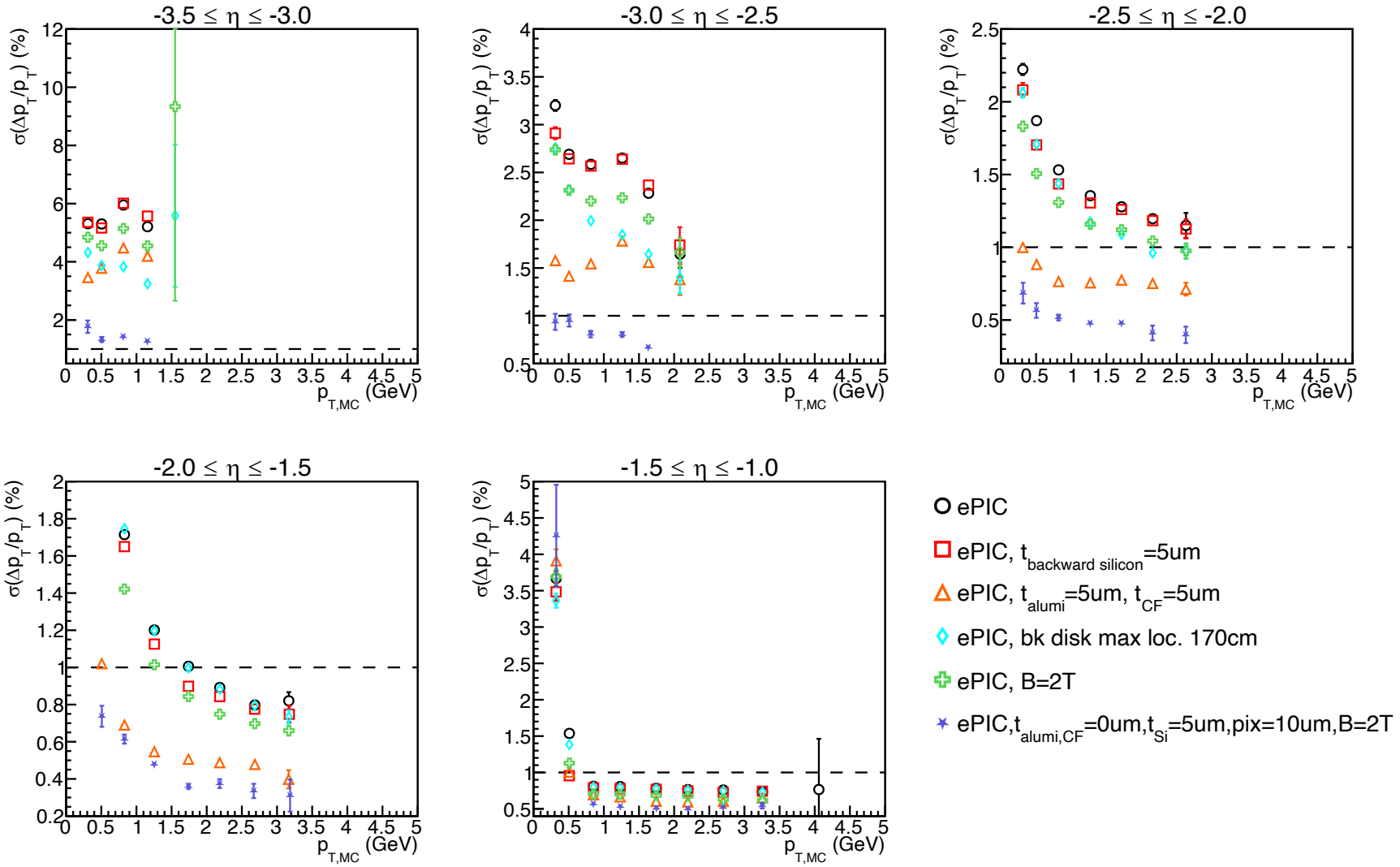




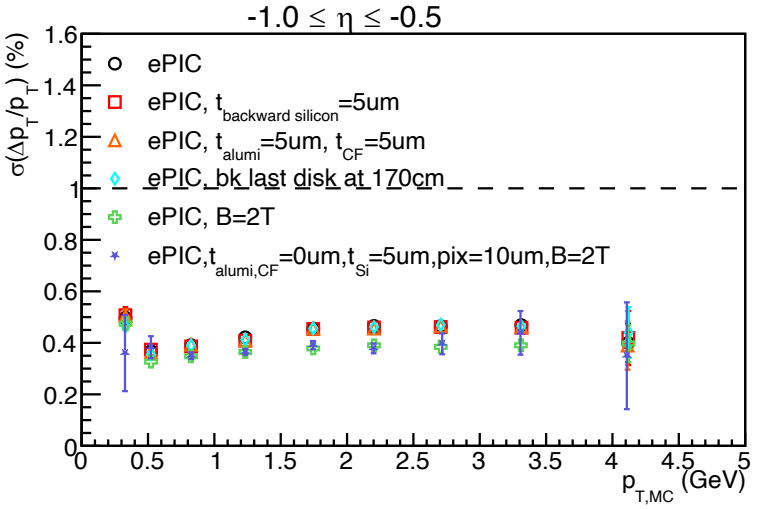
Forward Momentum Resolution ($\mu^{+/-}$)

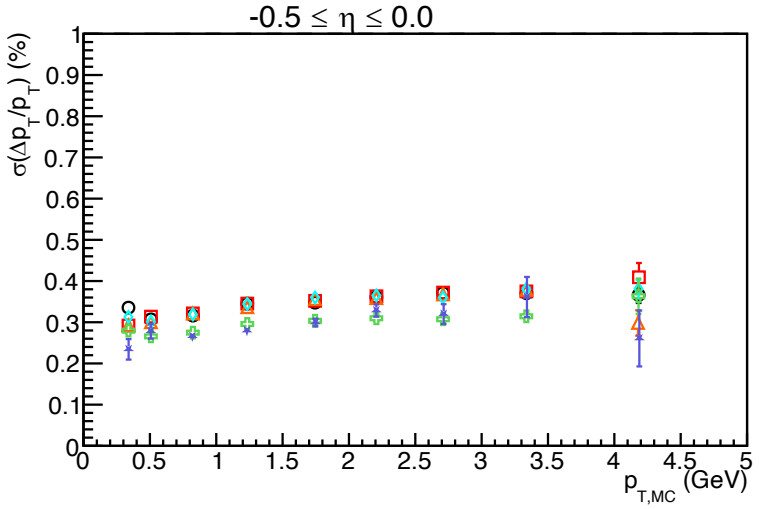


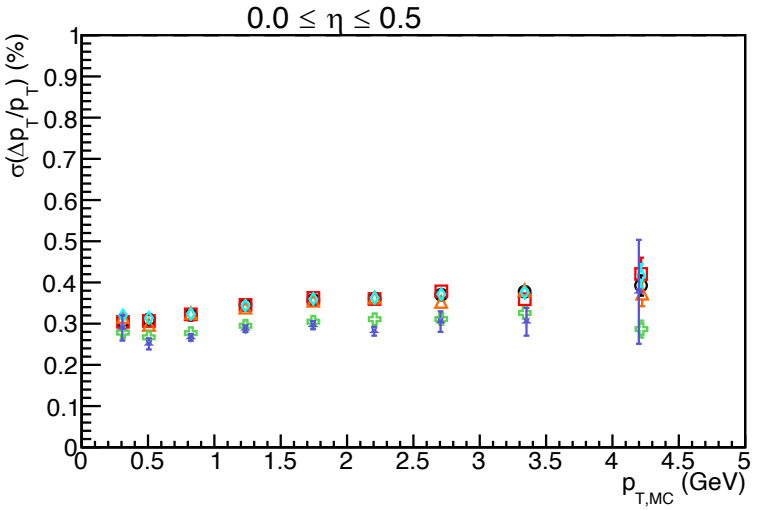
Backward Transverse Momentum Resolution ($\mu^{+/-}$)

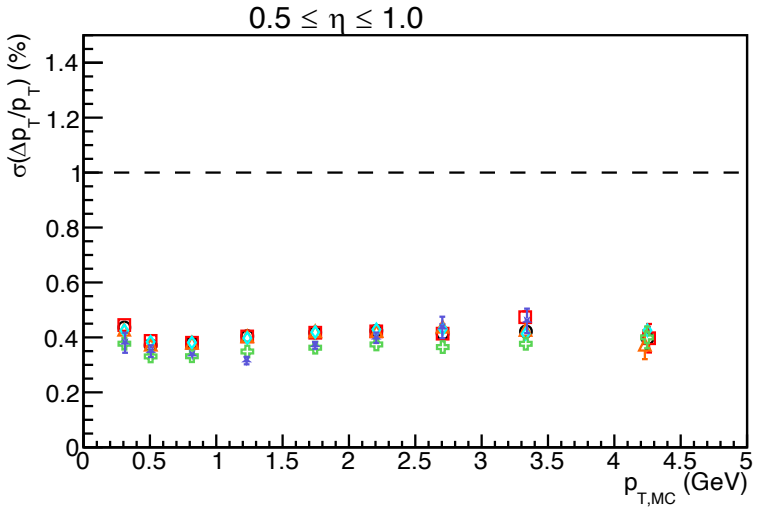


Barrel Transverse Momentum Resolution ($\mu^{+/-}$)









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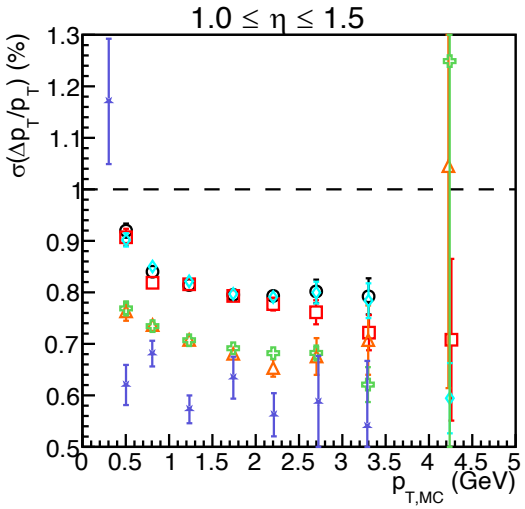

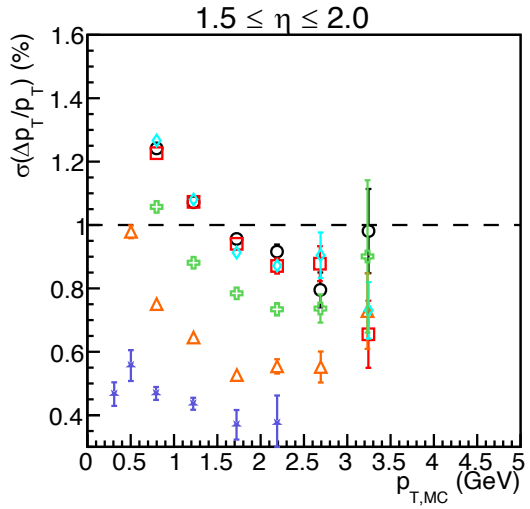

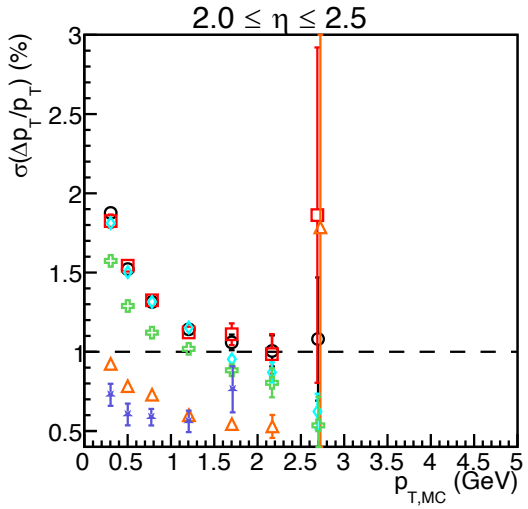

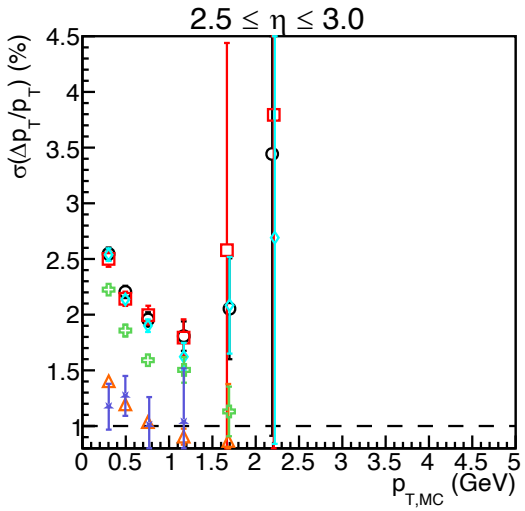

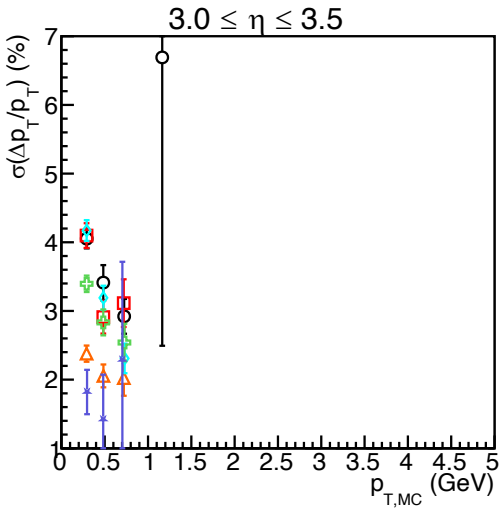

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