Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

ePIC Performance on coherent J/ψ diffractive pattern

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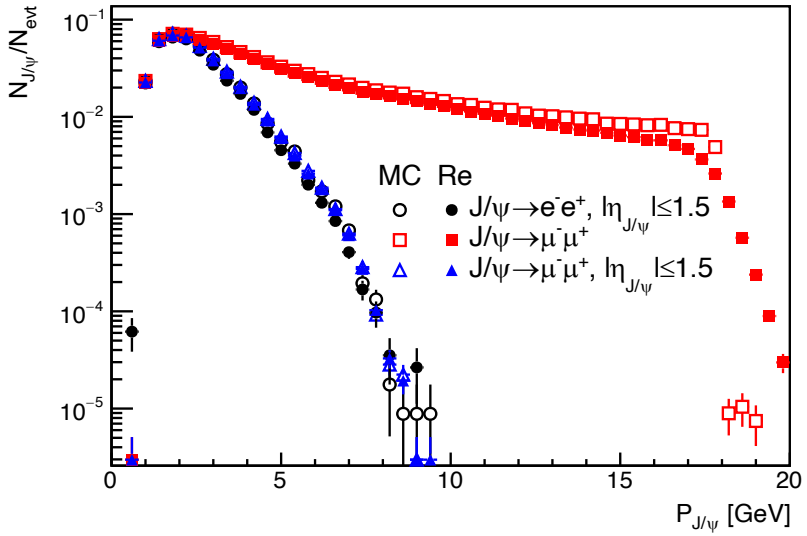
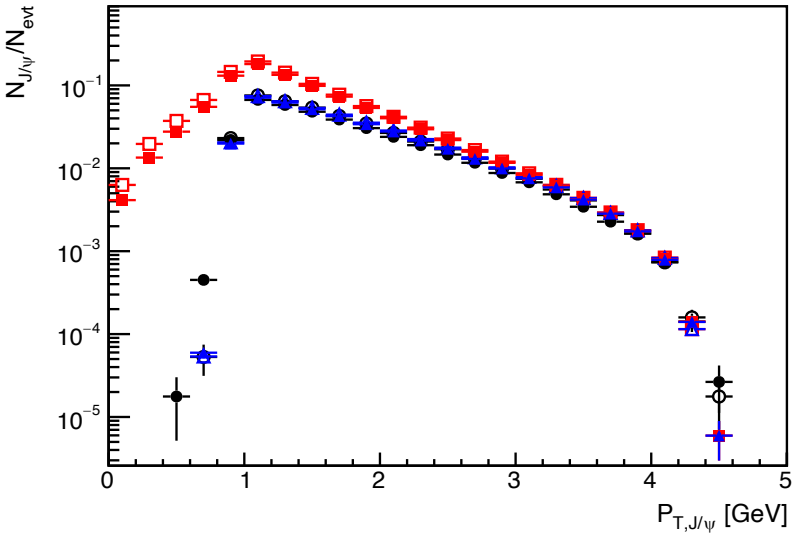
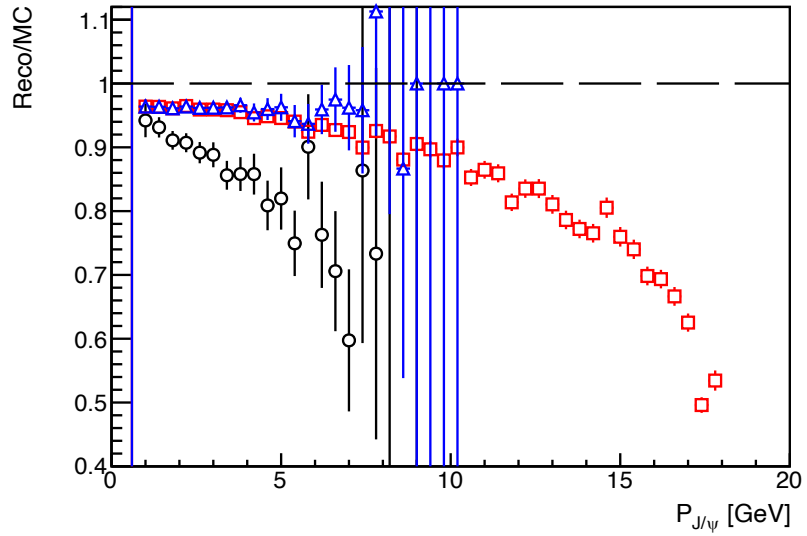
@BrookhavenLab

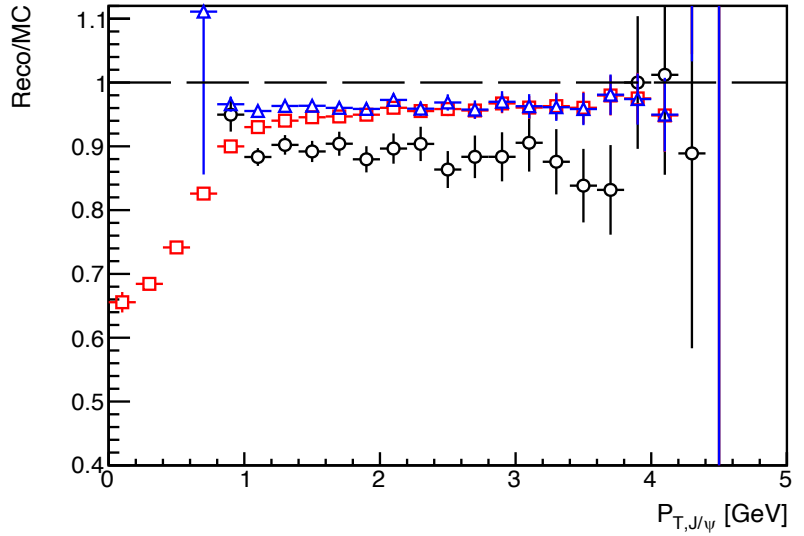
Last update

Big difference in J/ψ efficiency between dimuon and dielectron channels

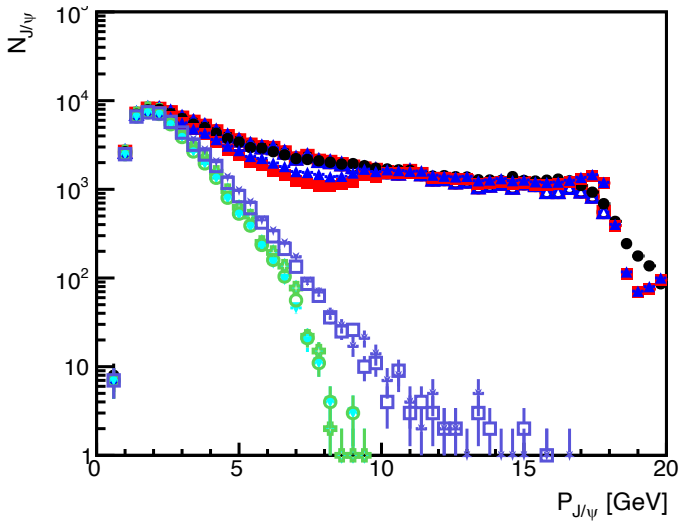


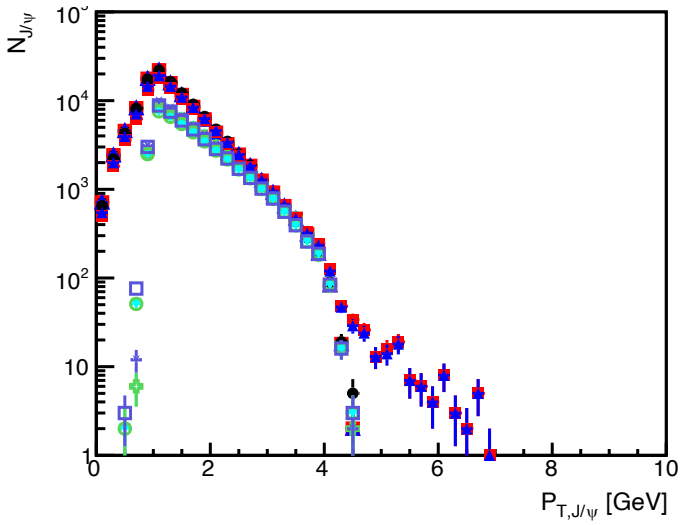


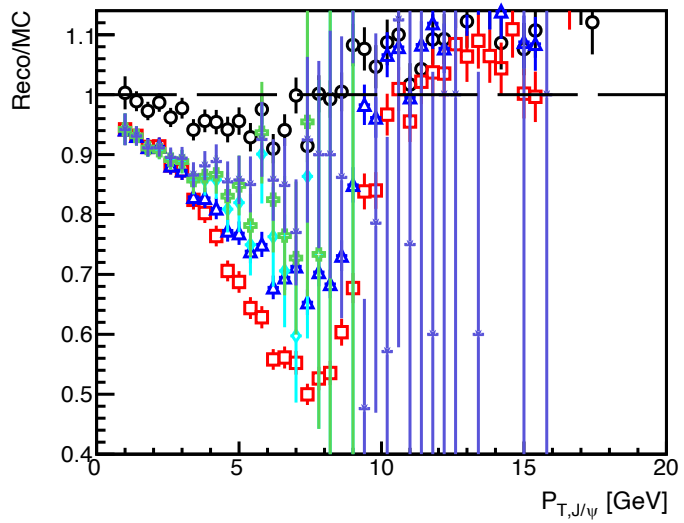


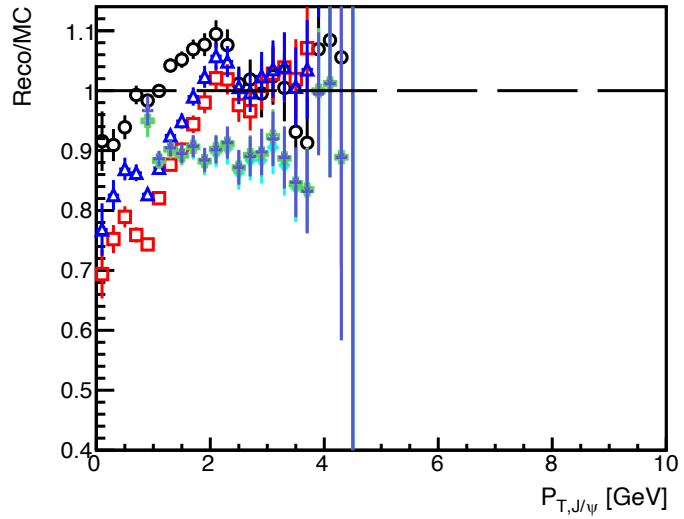


J/ψ efficiency with different selections





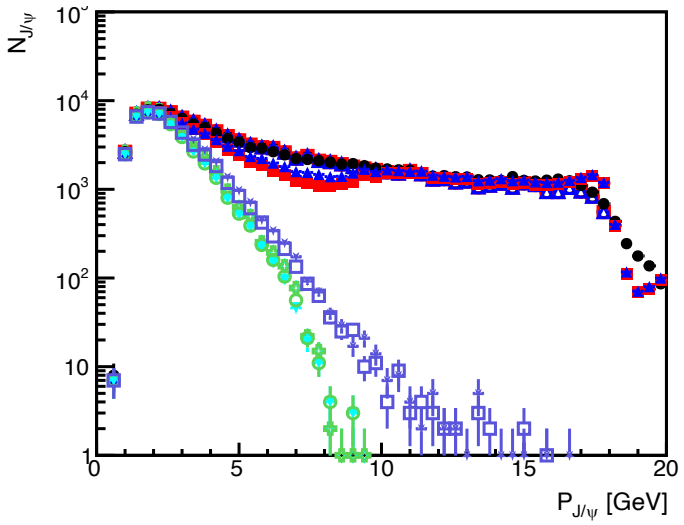


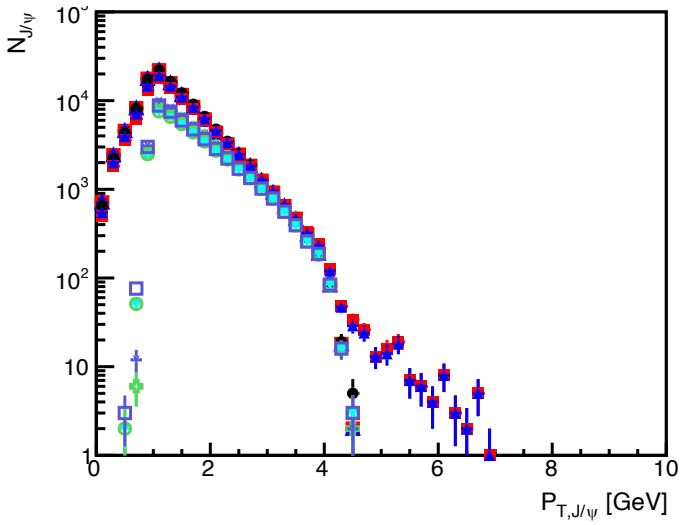


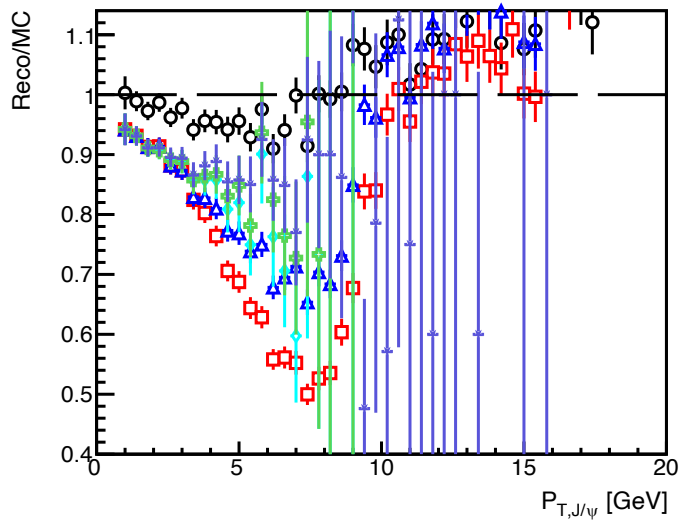
MC Re

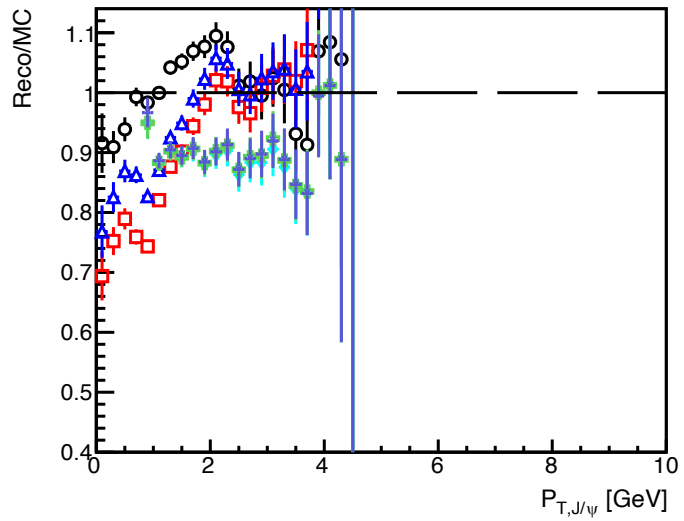
- trk $e^{\pm}$ Not bad
- trk $e^{\pm}$, EMC $e^{\pm}$ (η_e<-1.5) eff. drops significantly
- trk $e^{\pm}$, new EMC $e^{\pm}$ selection (η_e<-2 or (η_e<-1.5 & p_e<4GeV))
- trk $e^{\pm}$, EMC $e^{\pm}$ (η_e<-1.5), $|\eta_{J/\psi}| \leq 1.5$
- trk $e^{\pm}$, new EMC $e^{\pm}$ selection, $|\eta_{J/\psi}| \leq 1.5$
- trk $e^{\pm}$, new EMC $e^{\pm}$ selection, $\eta_{J/\psi}$>-1.5

J/ψ efficiency with different selections







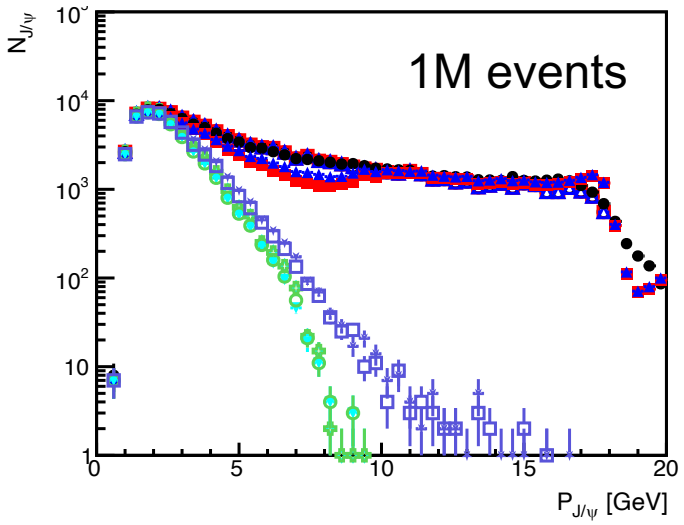


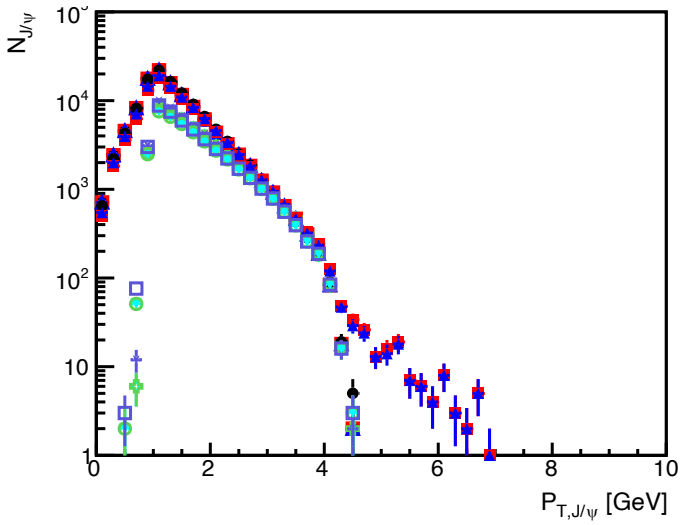
MC Re

- trk $e^{\pm}$
- trk $e^{\pm}$, EMC $e^{\pm}$ (η_e<-1.5)
- trk $e^{\pm}$, new EMC $e^{\pm}$ selection (η_e<-2 or (η_e<-1.5 & p_e<4GeV))
- trk $e^{\pm}$, EMC $e^{\pm}$ (η_e<-1.5), $|\eta_{J/\psi}|\leq 1.5$
- trk $e^{\pm}$, new EMC $e^{\pm}$ selection, $|\eta_{J/\psi}|\leq 1.5$
- trk $e^{\pm}$, new EMC $e^{\pm}$ selection, $\eta_{J/\psi}$>-1.5

Tried a different backward electron selection. It helped a little bit.

J/ψ efficiency with different selections





MC Re

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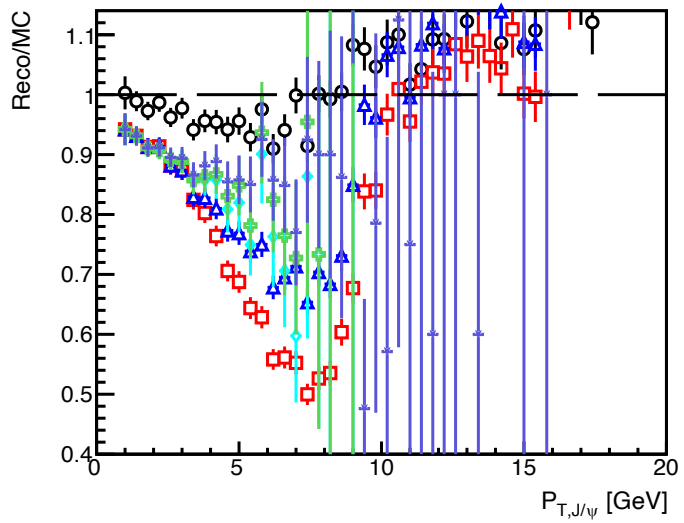
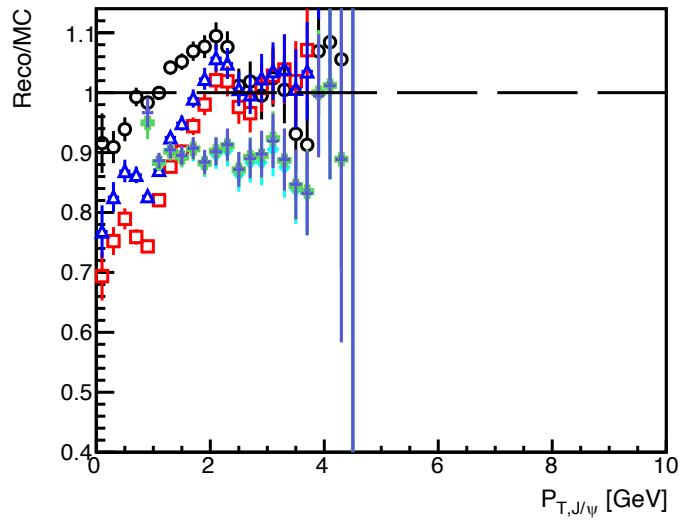
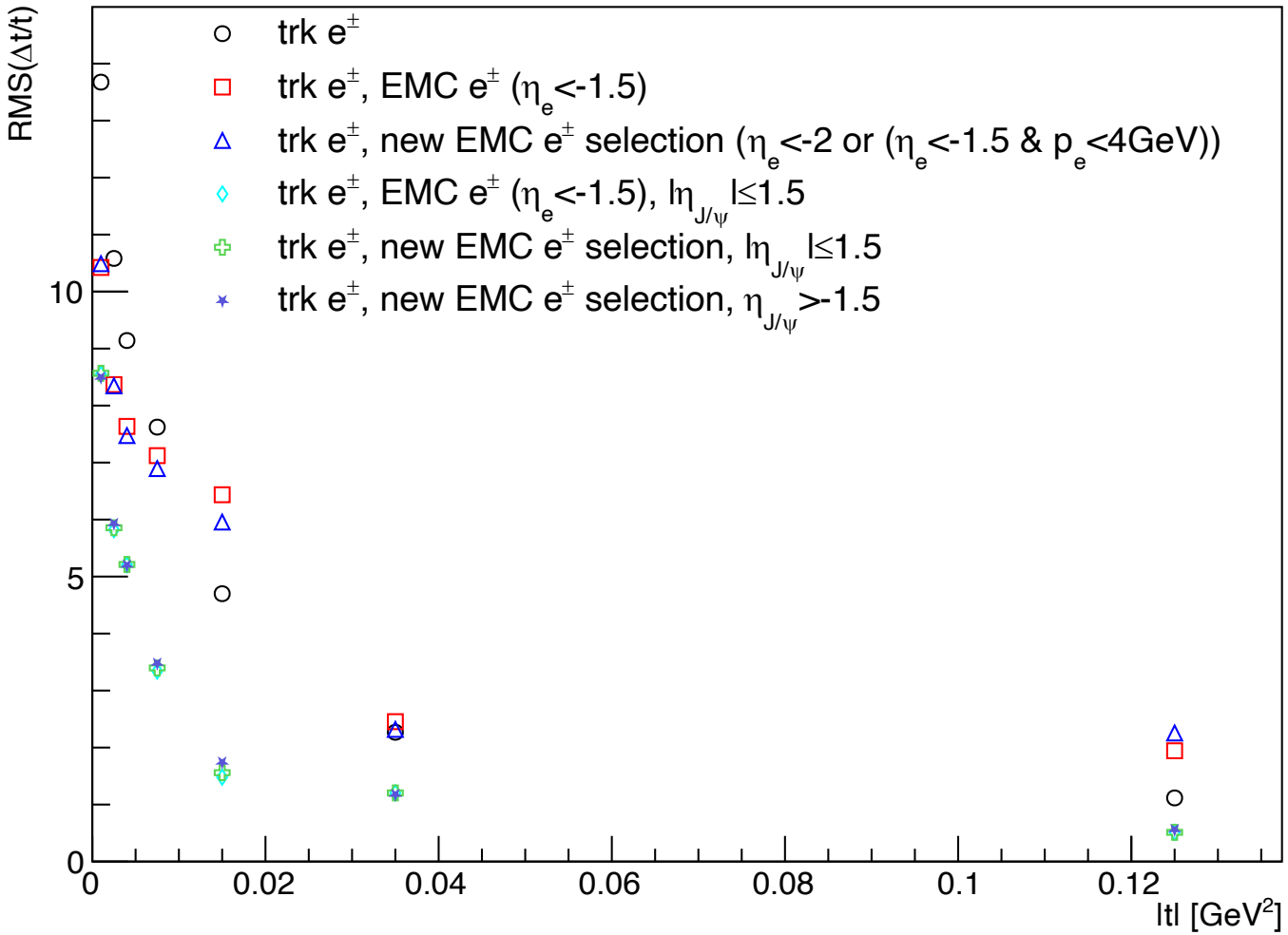




t resolution



- Using EMC for backward electron reduces J/ψ efficiency but improves the t resolution
- The $\eta_{J/\psi}$ requirement further improves the t resolution

Modifying ePIC central detector

Changes of the ePIC setup

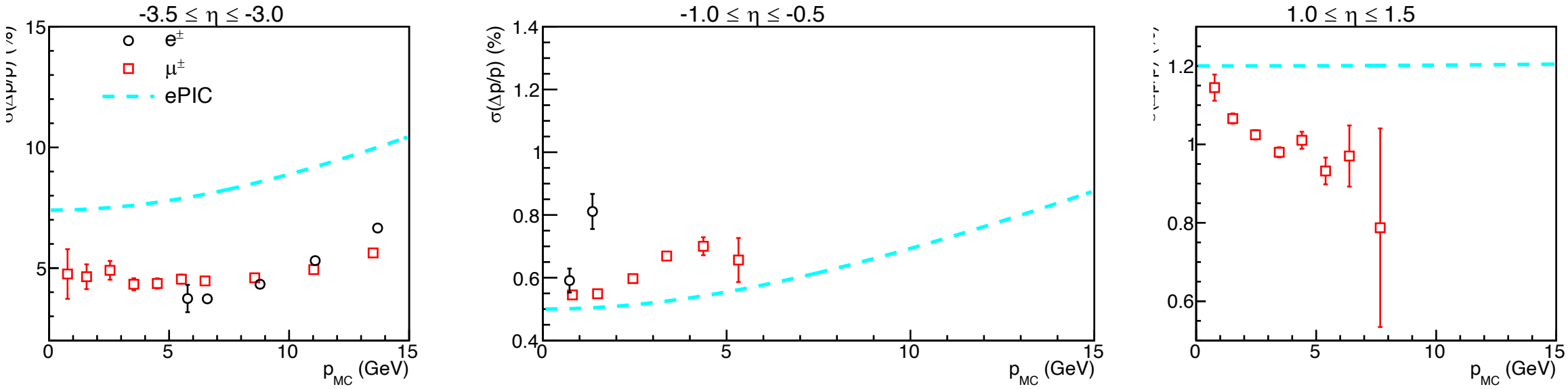
- Default: Brycecanyon + MPGD, silicon thickness=40um, B=1.7 T
- Modification of the silicon thickness in the backward tracker
  - 5um : lower than 5um may not work in the simulation. Possibly due to step size in Geant4.
  - 100um : Sanity check
- Magnetic field
  I had a hard time with the ATHENA solenoid setup. Eicrecon does not know how to do track reconstruction with a different field map.
  - B=3 T
    Scaled the ePIC magnetic field by a constant. I planned to scale the B=1.7T to 2T, but I made a typo in the scale factor…
  - Changed the epic solenoid to ATHENA solenoid dimension (not the geometry)

Momentum resolution with the default ePIC setup

Brycecanyon vs Craterlake

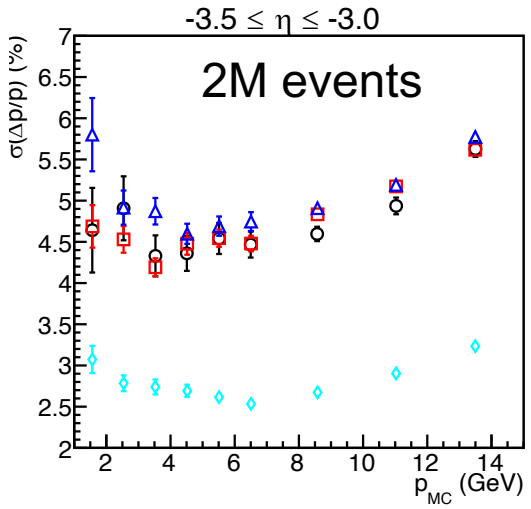
We are using nightly-build: Brycecanyon+MPGD

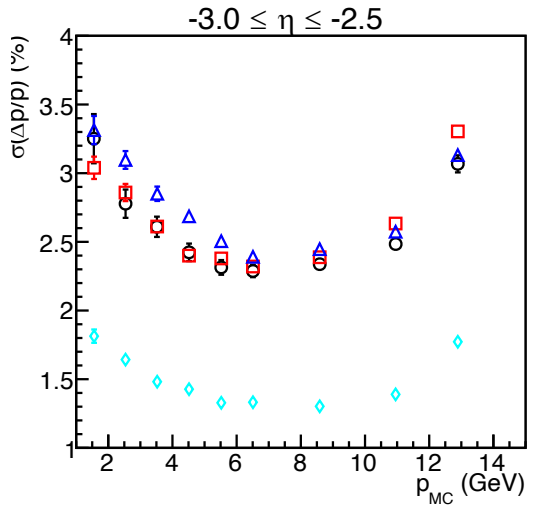
- What might change the performance?
  - Si Negative lever arm reduced: disk ED4 moved from -115cm → -105cm (disk ED3 also moved)
  - Additional MPGD layers in endcaps
  - Some services changes → less material in barrel (L2 support gone)

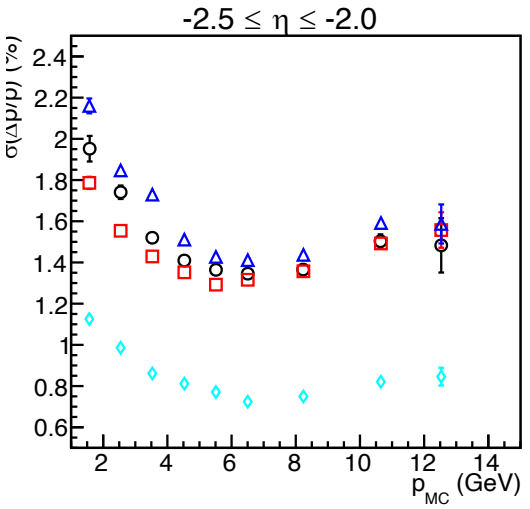


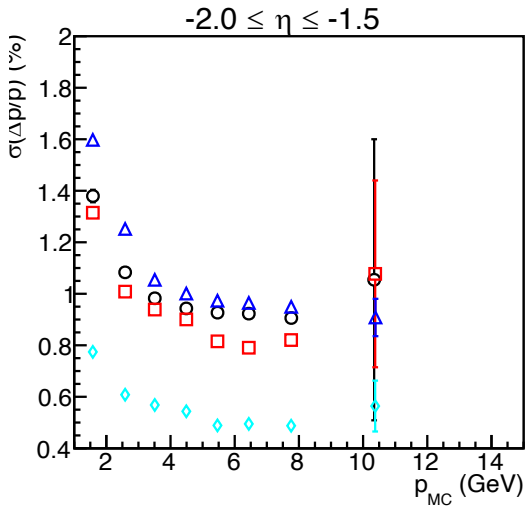
Momentum resolution of ePIC by Steven Maple (cyan line)
https://indico.bnl.gov/event/20126/contributions/78819/attachments/48723/82854/CraterlakeValidationPlots_2023_07_20.pdf

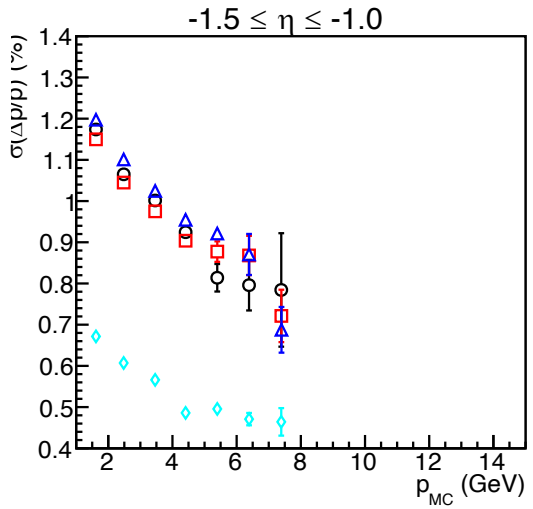
Backward muon momentum resolutions





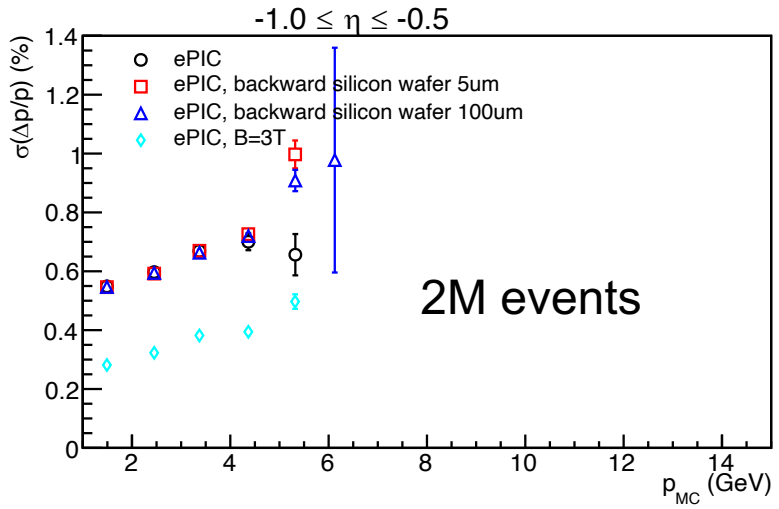


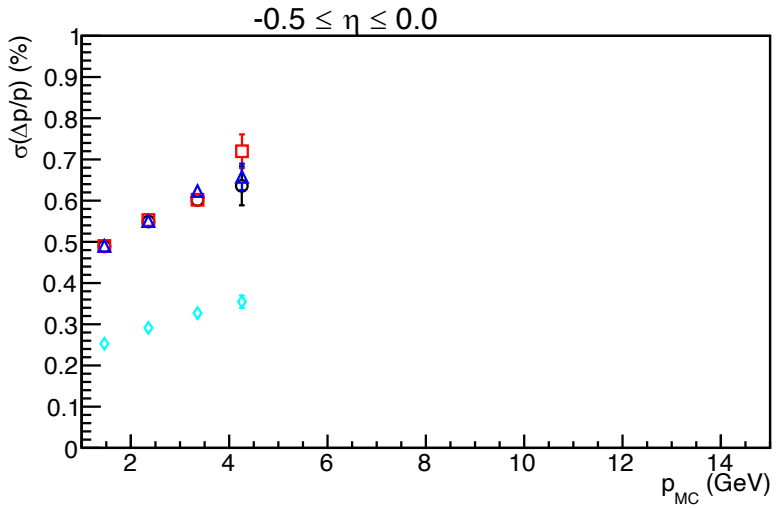


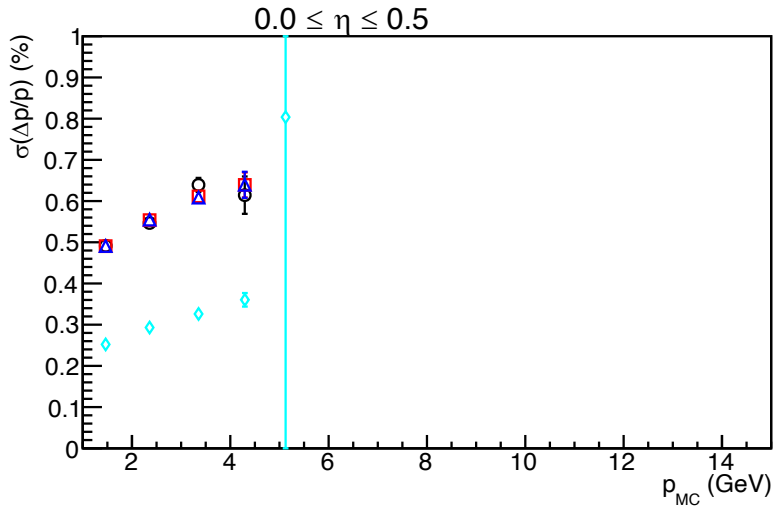


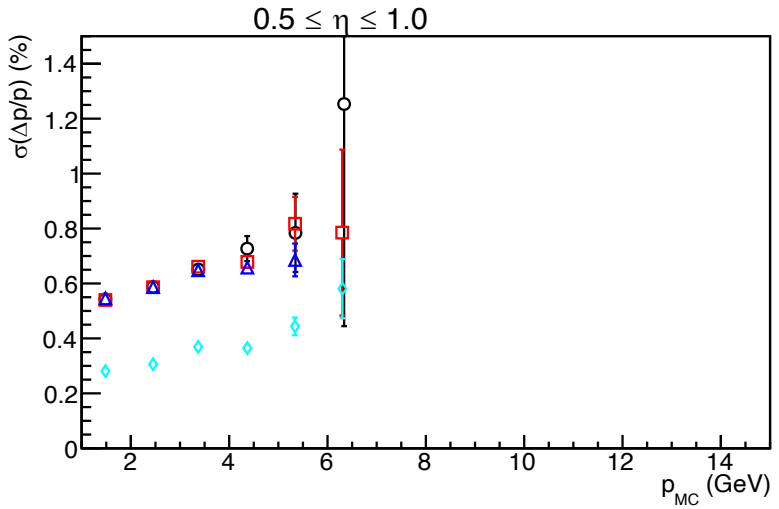
- ePIC
- ePIC, backward silicon wafer 5um
- ePIC, backward silicon wafer 100um
- ePIC, B=3T

Barrel muon momentum resolution

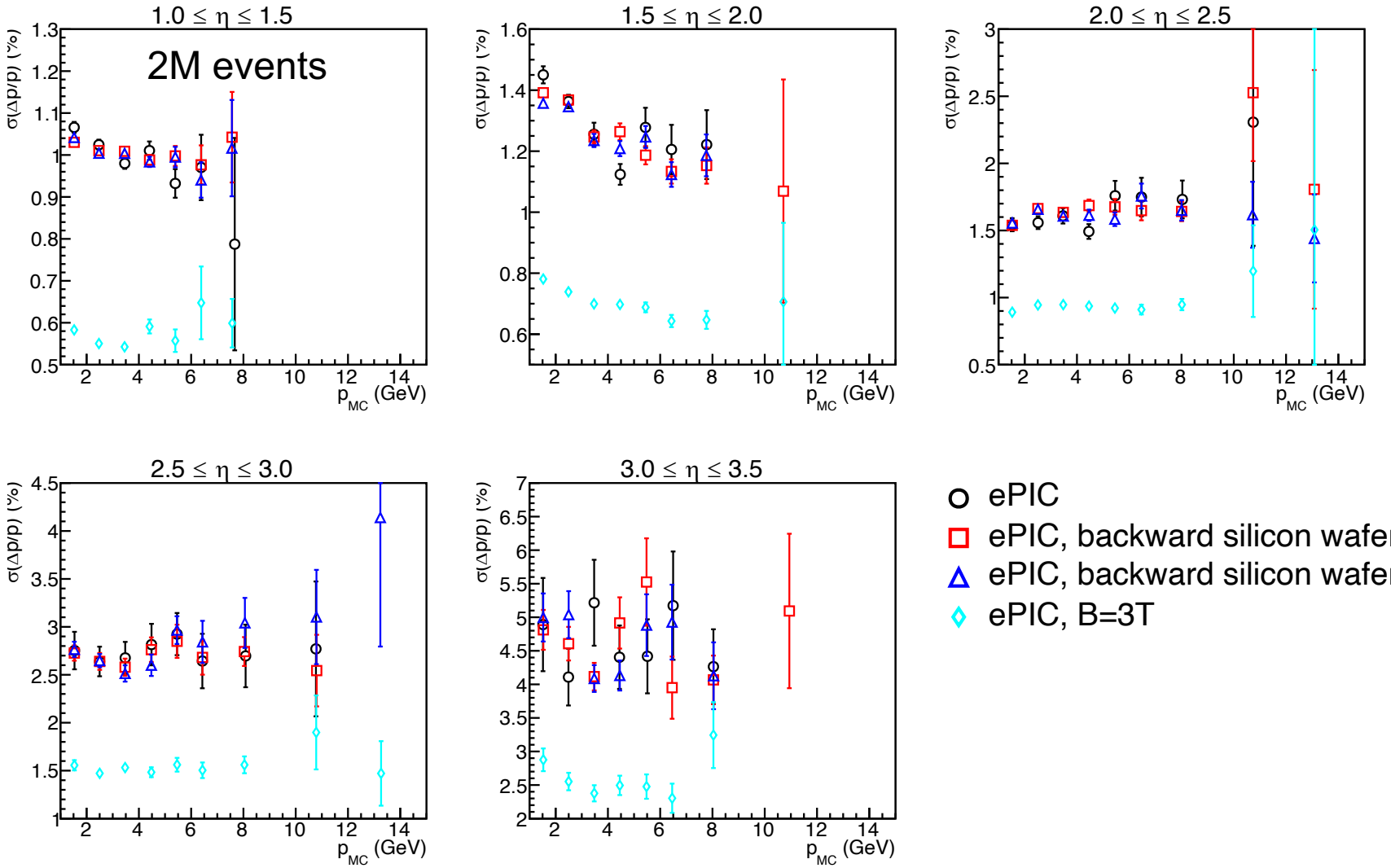




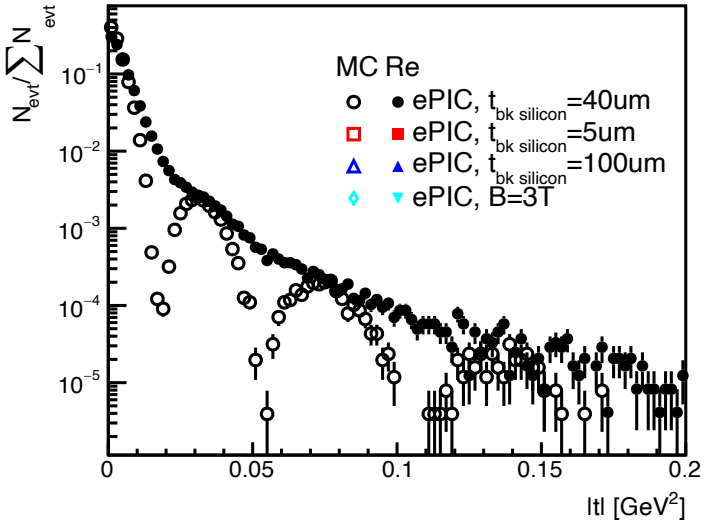


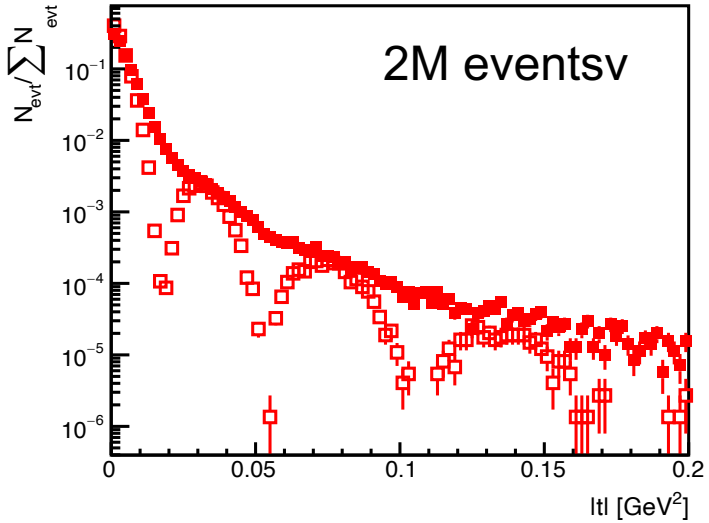


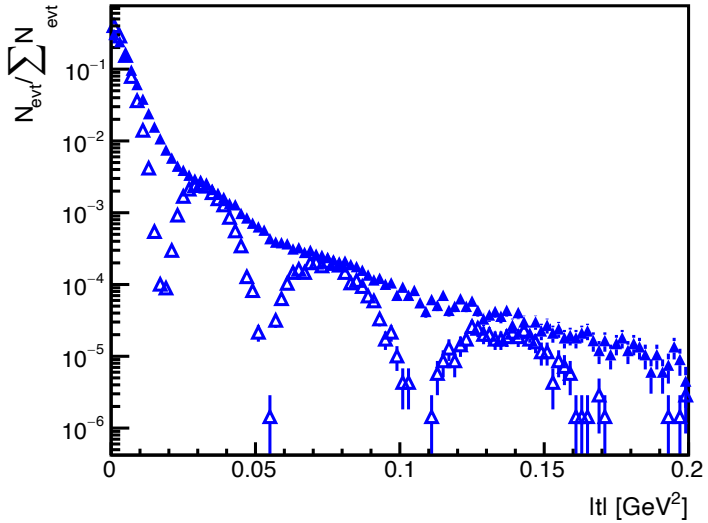
Forward muon momentum resolutions

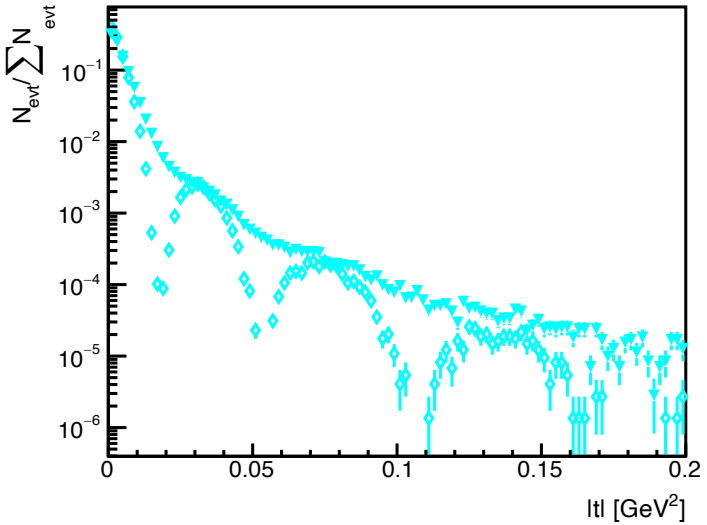


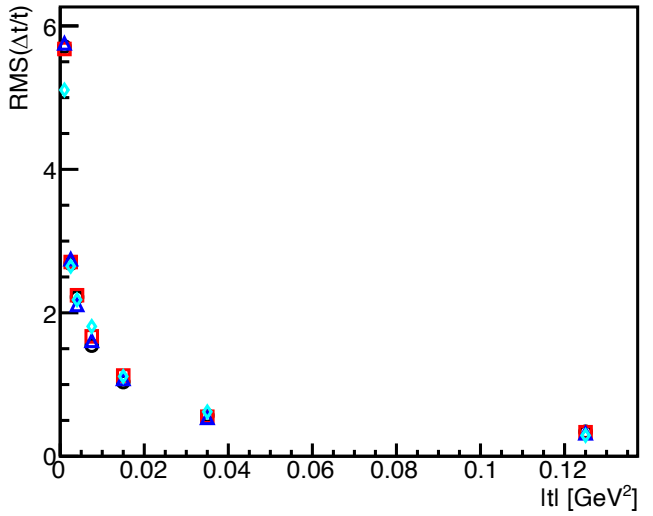
t distributions and resolutions











- Pixel size does not have a significant effect on t resolutions
- Magnetic field improves t resolutions at small t

Summary

- Using EMC for backward electron reduces J/ψ efficiency but improves the t resolution
- There's no significant improvement with the use of thinner silicon wafer
- A stronger magnetic field improves the t resolutions at small t

To-do list

- Steer away from the epic nightly-build
- Fix the scaling factor of the magnetic field
- Reduce electronics/supporting structure thickness in the backward tracker
- Play around backward tracker location
- Ask about ePIC muID performance / KEK KLM performance

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

Data Selections and Reconstructions

Single electron selection

If the electron $\eta < -1.5$, 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