Coherent J/ψ diffractive pattern simulation with the ePIC detector

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What's new

- Updated data selections
  - Use backward Ecal instead of tracking for electrons at $\eta < 1.5$
  - Added $|\eta_{J/\psi}| < 1.5$ requirement to reduce contamination from the scattered electron in J/ψ reconstruction
- Coherent $J/\psi \rightarrow \mu^{+}\mu^{-}$ event from Sartre

Simulation Setup

- Sartre
- eAu at 10x108 GeV
- 1M events
- $Q^2 \geq 1$ GeV^2
- Forced $J/\psi \rightarrow e^+e^-/\mu^+\mu^-$
- No background
- File locations
  - $J/\psi \rightarrow e^+e^-$
    S3/eictest/EPIC/EVGEN/EXCLUSIVE/DIFFRACTIVE_JPSI_ABCONV/Sartre/Coherent/sartre_bnonsat_Au_jpsi_ab_eAu_1.hepmc3.tree.root
  - $J/\psi \rightarrow \mu^+\mu^-$
    /gpfs02/eic/jkim/JPsi/coherent/sartre_bsat_Au_jpsi_muons_1_coherent.hepmc

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 or 13 (Most likely using true PID in DD4hep)
- Opposite charges cut on dielectron pair
- If the reconstructed mass is within 2 standard deviations, the e+ and e- are labeled as "$\boldsymbol{J/\psi}$ decayed" dielectrons
- No $\boldsymbol{J/\psi}$ $|\eta| < 1.5$ applied in invariant mass to keep the efficiency in separating decayed electrons and scattered electrons

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

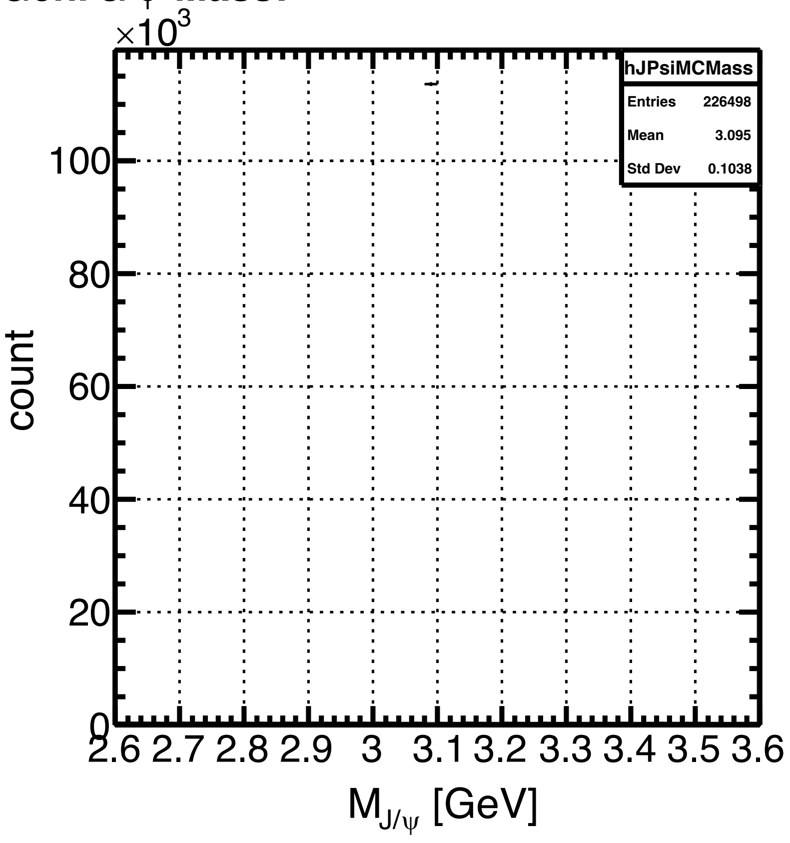
- Removed events with a mis-reconstructed $Q^2 < 1$ GeV^2
- Reconstructed $\boldsymbol{J/\psi}$ $|\eta| < 1.5$
- Require information of the proton beam
- Better t resolutions

Updated coherent $J/\psi \to e^+e^-$ simulations

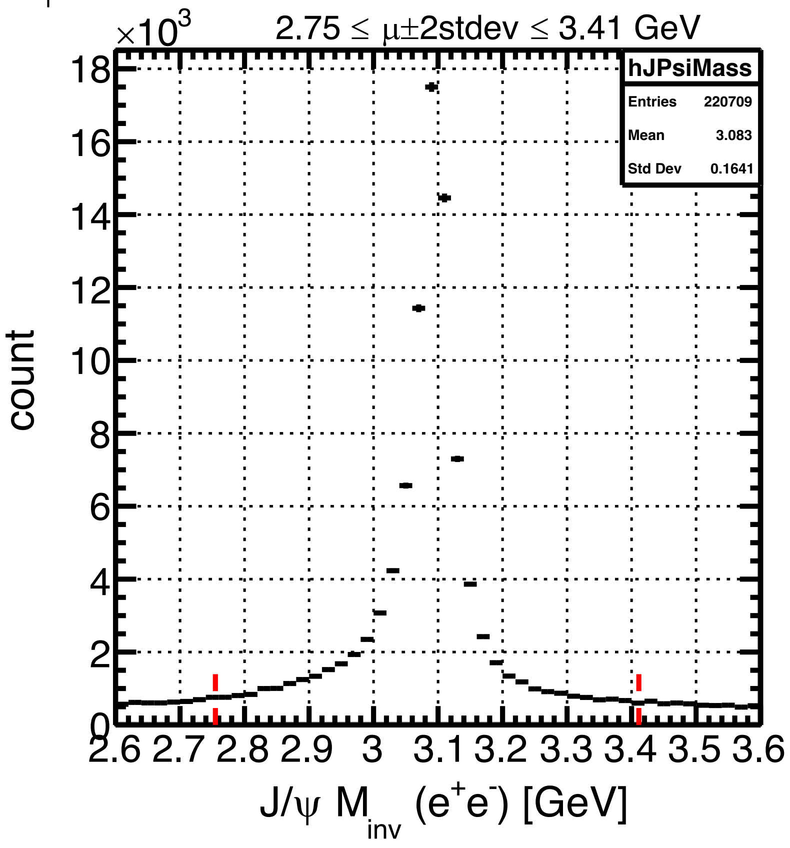
Invariant mass

No J/ψ $|\eta| < 1.5$ applied in invariant mass to keep the efficiency in separating decayed electrons and scattered electrons

Gen. J/ψ Mass:



J/ψ Mass:



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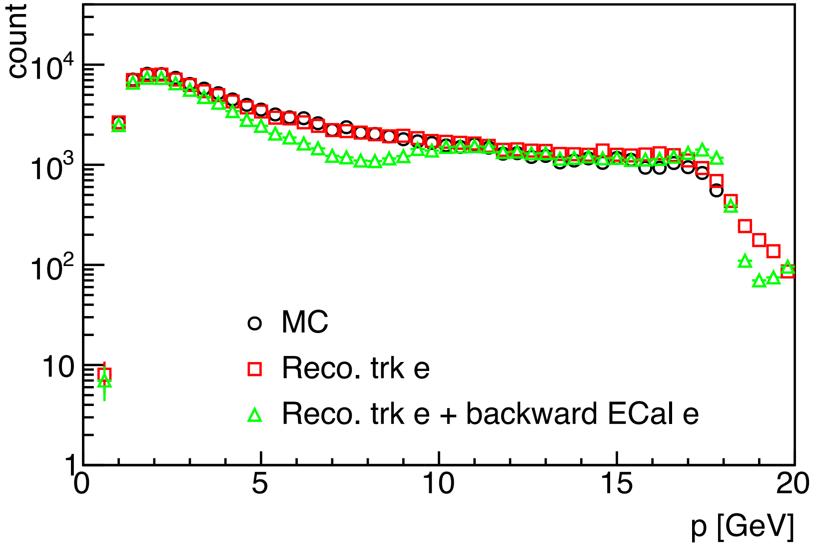
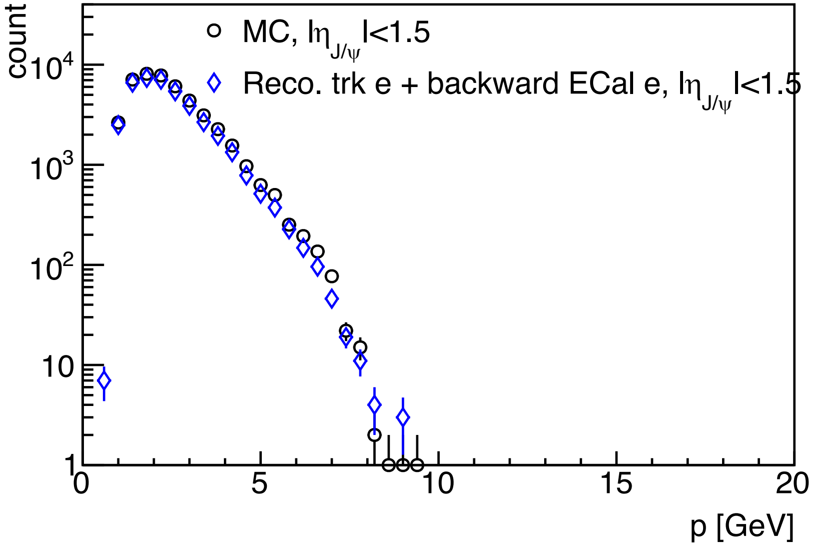
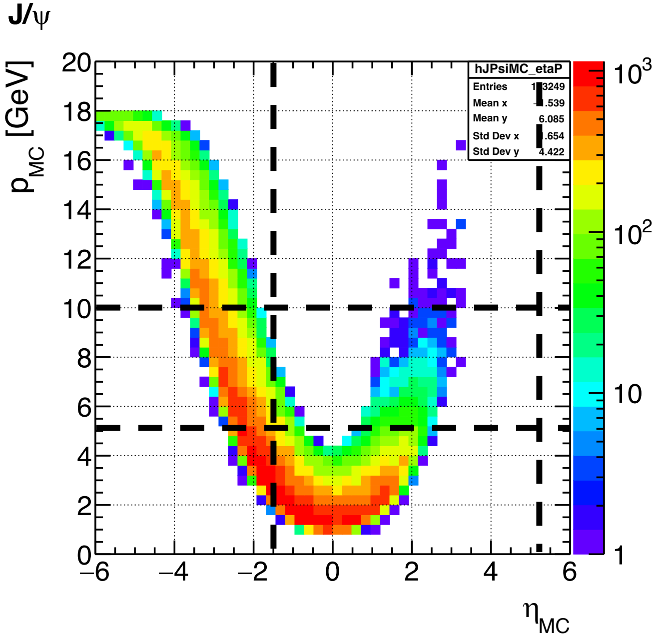
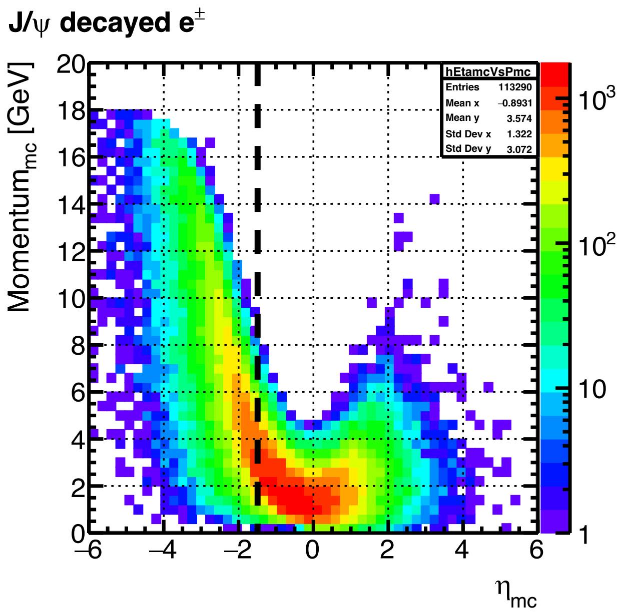
J/ψ Momentum

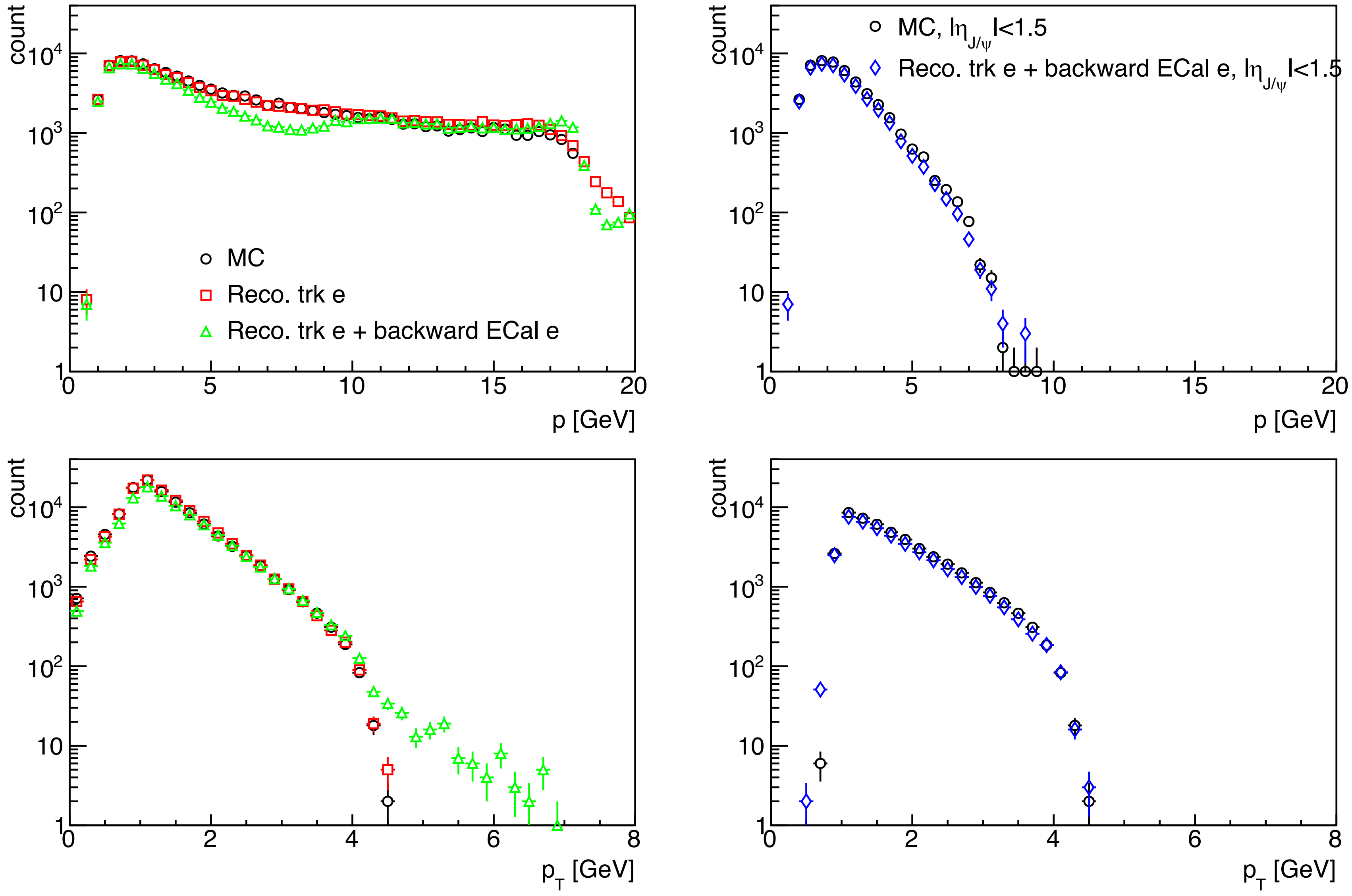








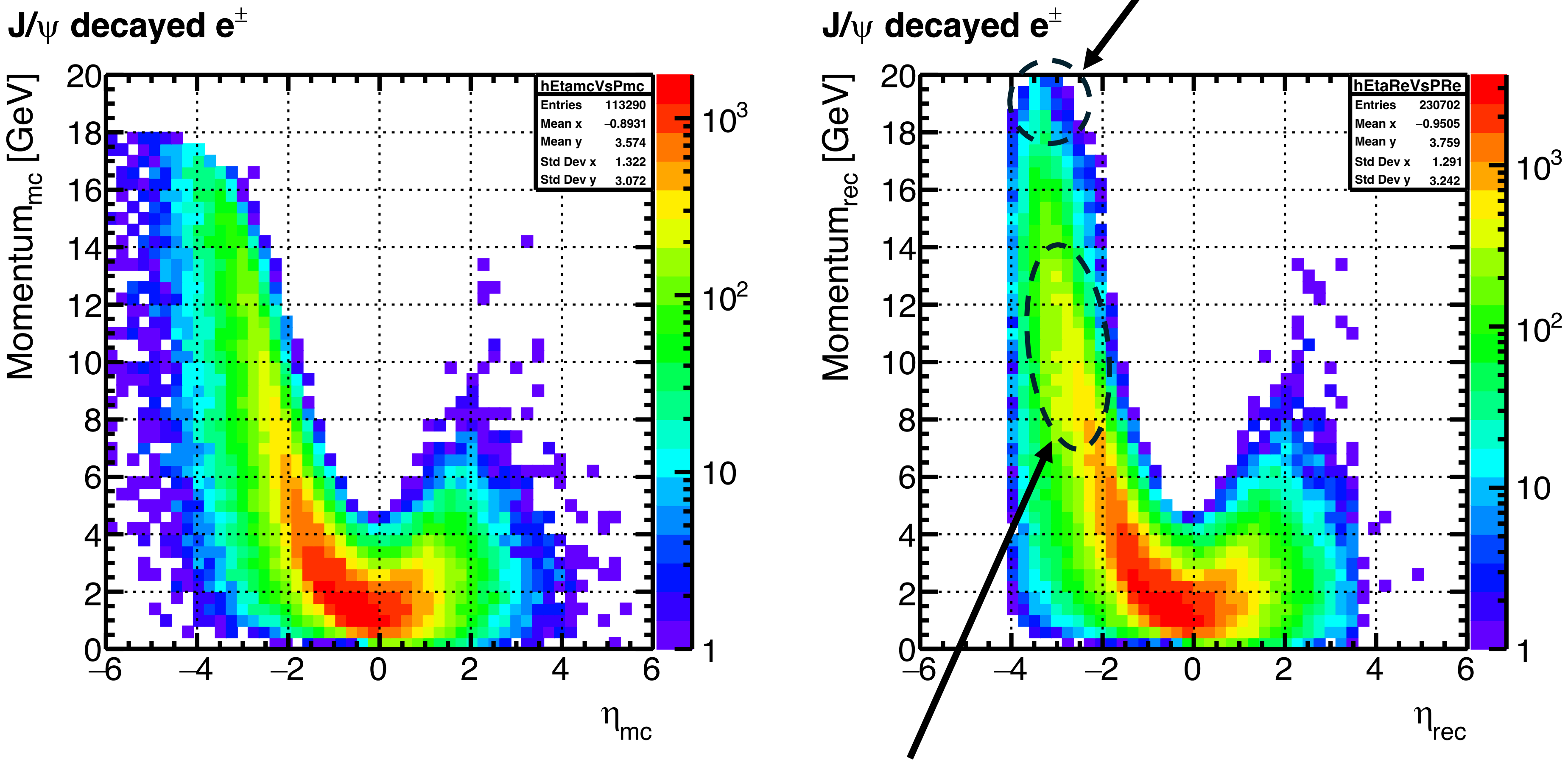
J/ψ Momentum



J/ψ Decayed $e^{\pm}$ Kinematics

Track electron only

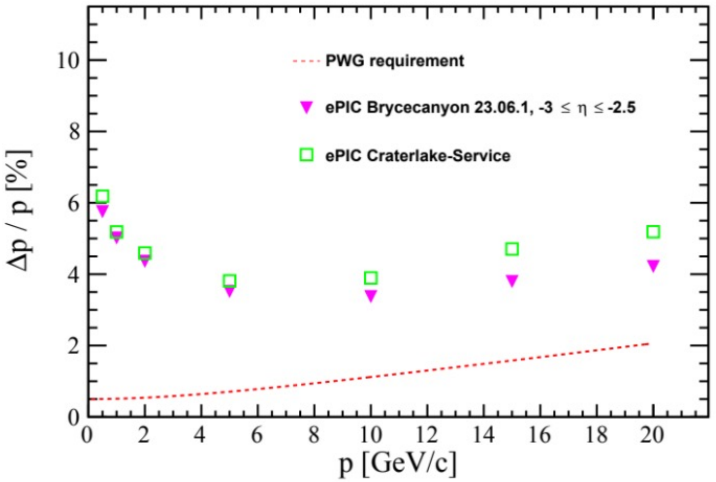
Mis-reconstruction at high momentum
Mostly from tracking

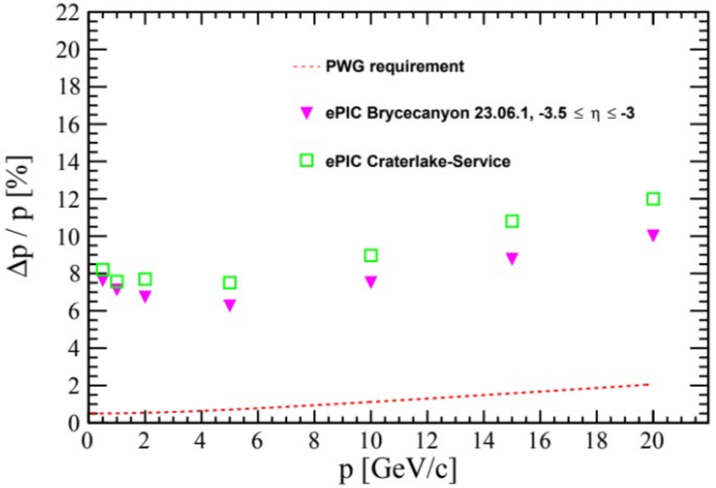


Combinatorial background from scattered electrons

J/ψ Decayed $e^{\pm}$ Kinematics

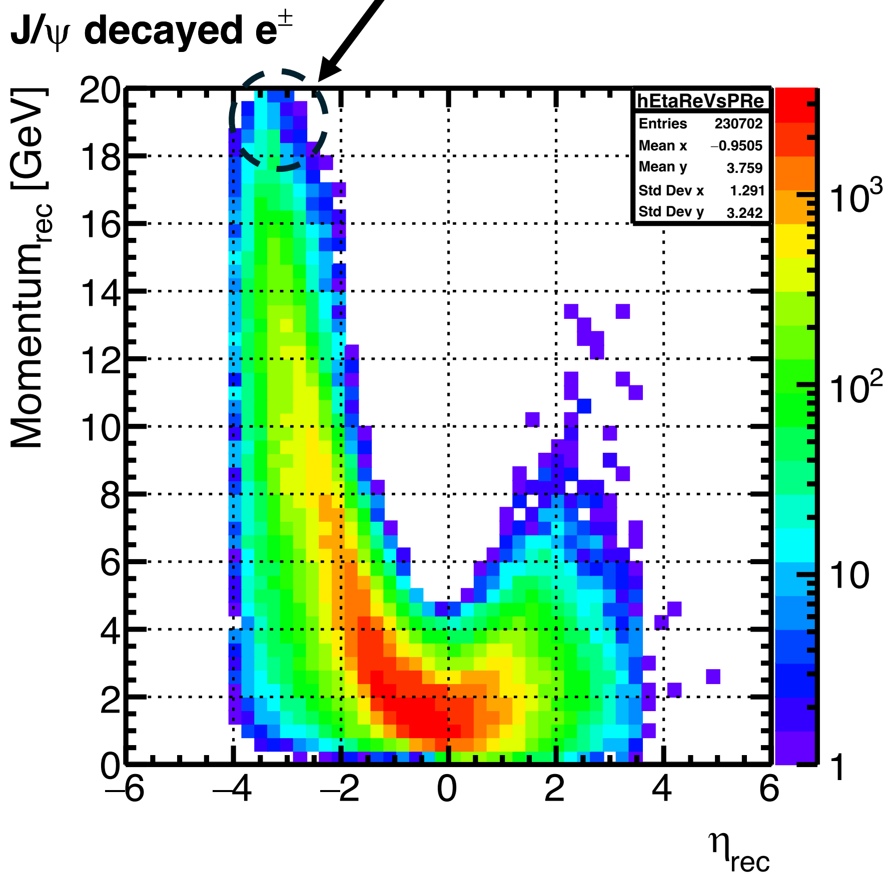
Track electron only





Stephen Maple, July 2023
https://indico.bnl.gov/event/20126/

Mis-reconstruction at high momentum
Mostly from tracking

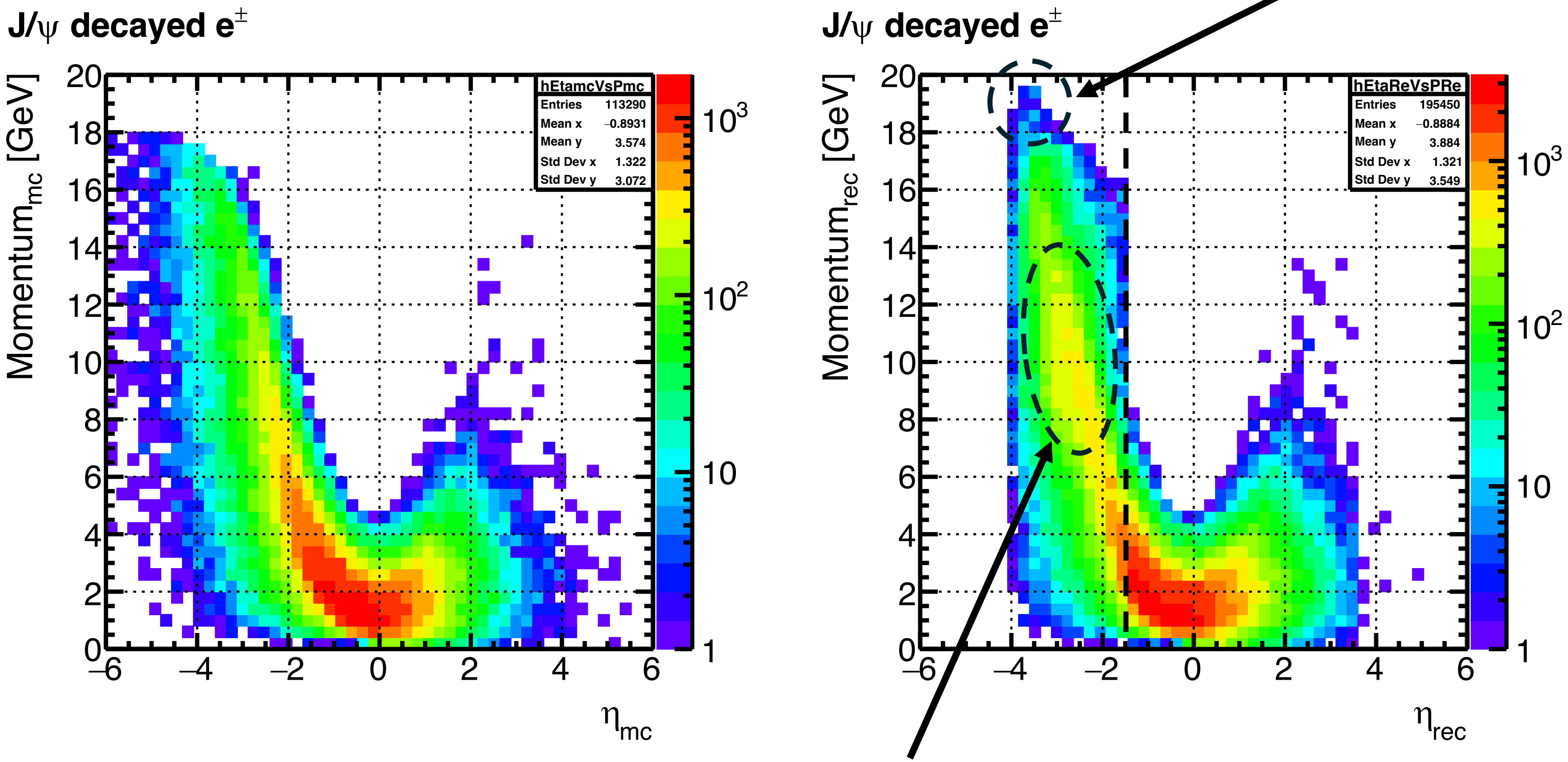


Investigate better backward tracking for detector 2

J/ψ Decayed $e^{\pm}$ Kinematics

Track electron + backward Ecal electron

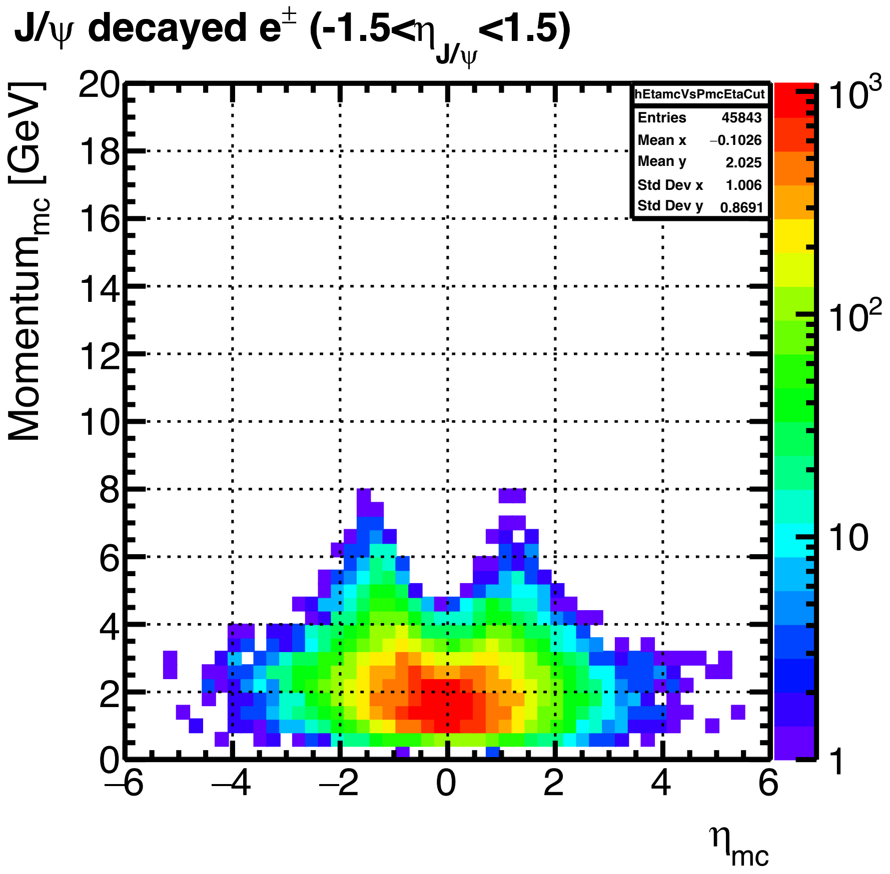
Better with the use of backward Ecal

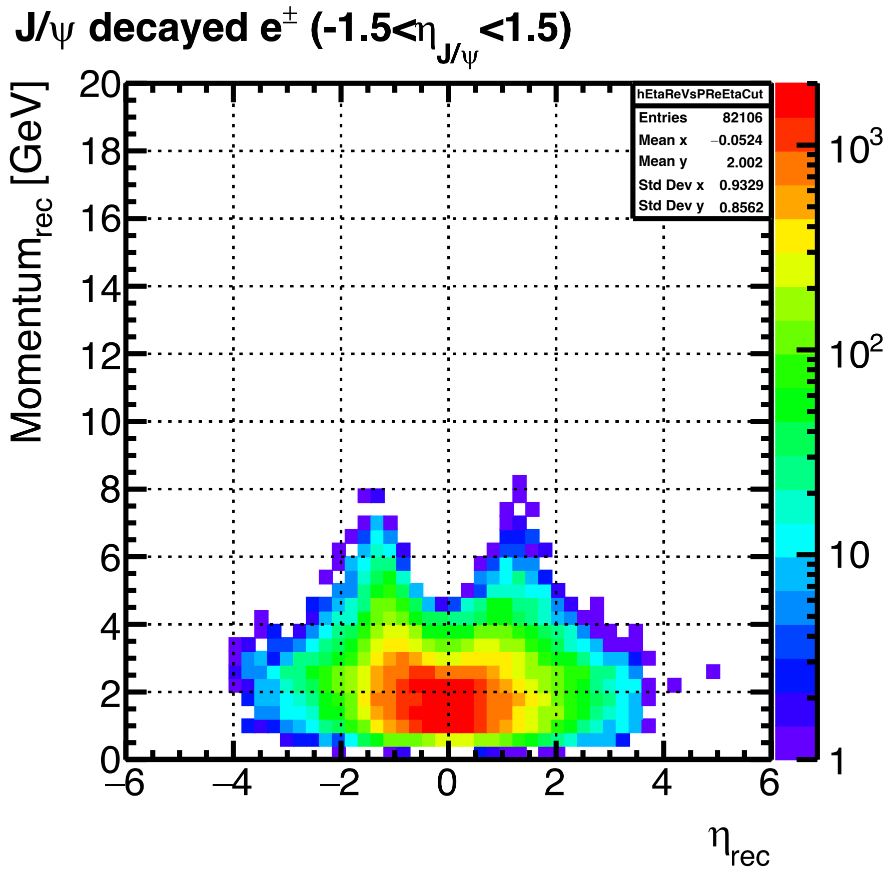


Combinatorial background from scattered electrons

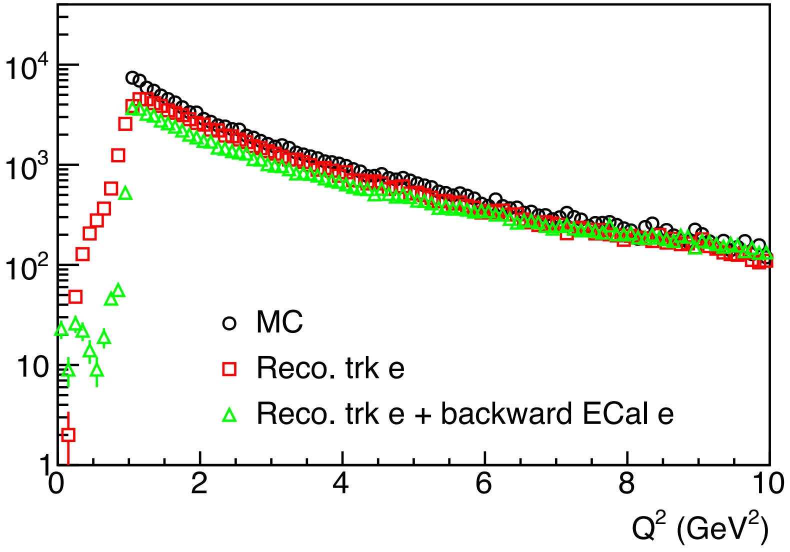
J/ψ Decayed $e^{\pm}$ Kinematics

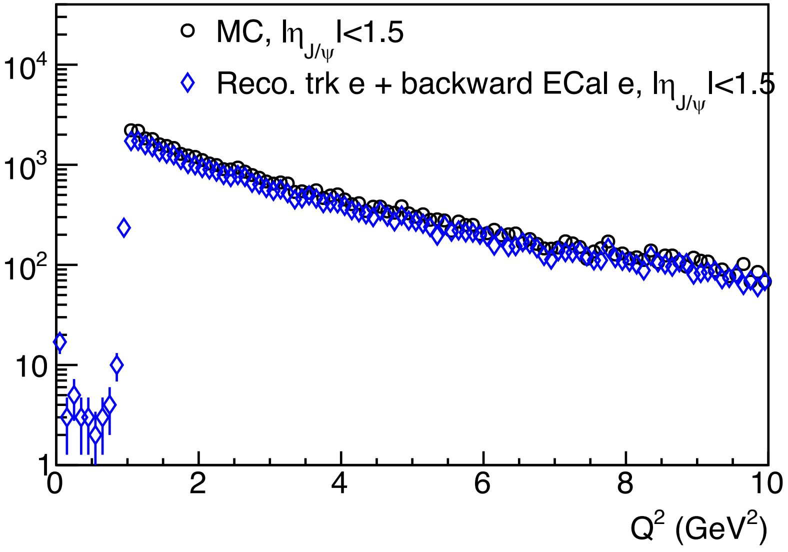
Track electron + backward Ecal electron + $|\eta_{J/\psi}| < 1.5$





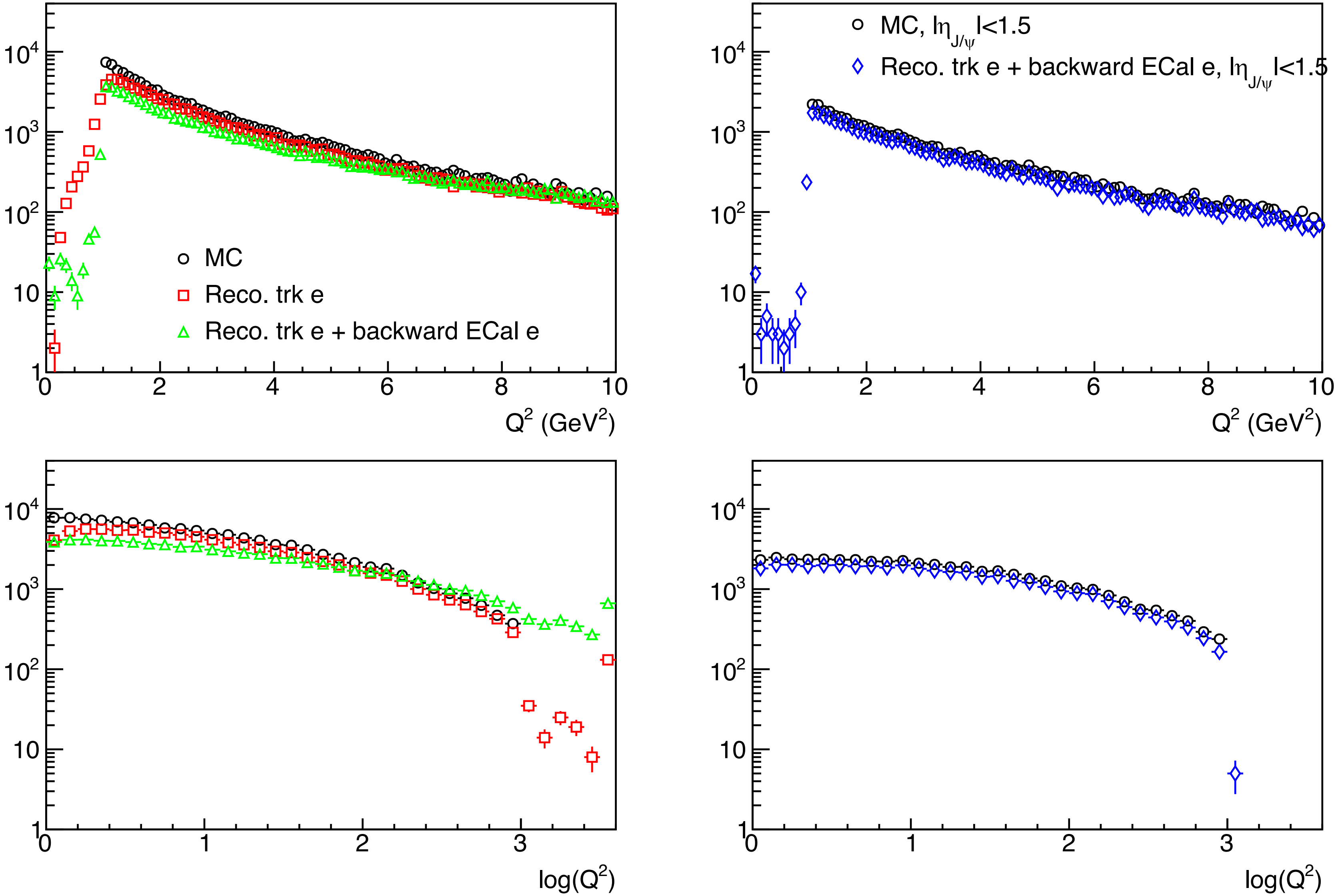
Q^2 Distribution





Q^2 Distribution

Reduced mis-reconstruction at low and high Q^2 with the use of backward Ecal electron and $|\eta_{J/\psi}| < 1.5$ selection



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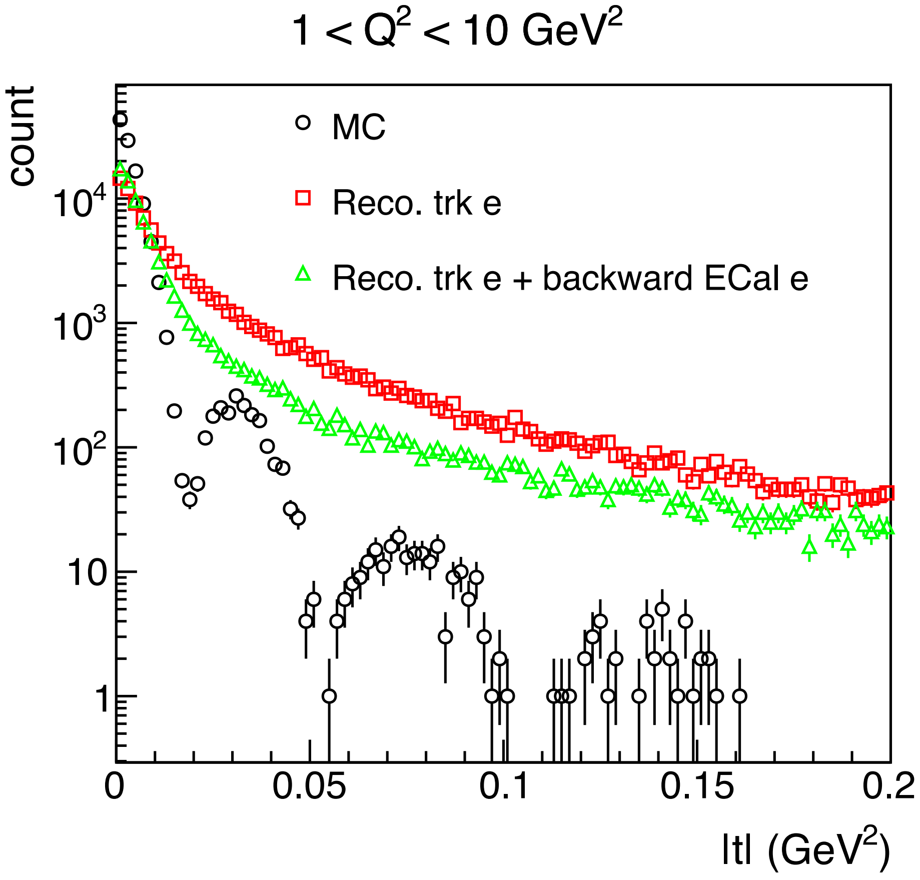
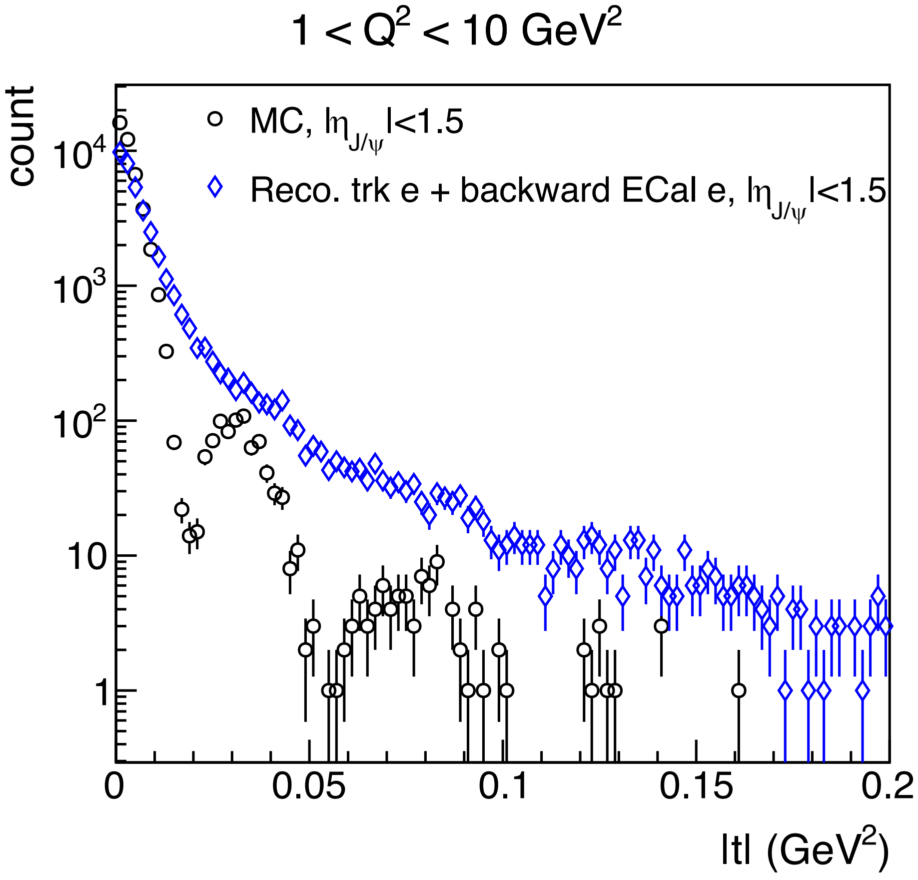
t Distributions

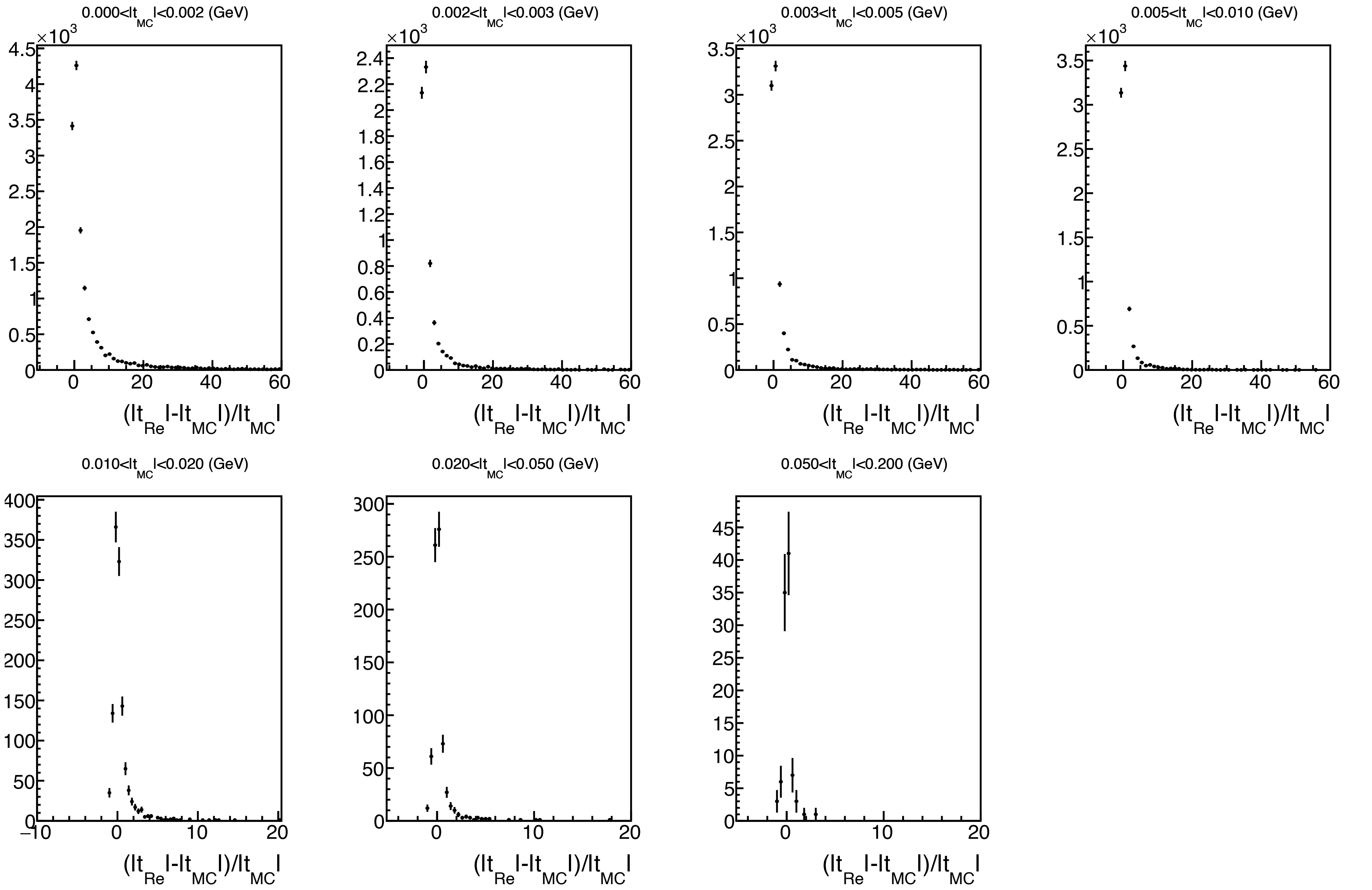
Reduced background at high |t| with the $|\eta_{J/\psi}| < 1.5$ selection



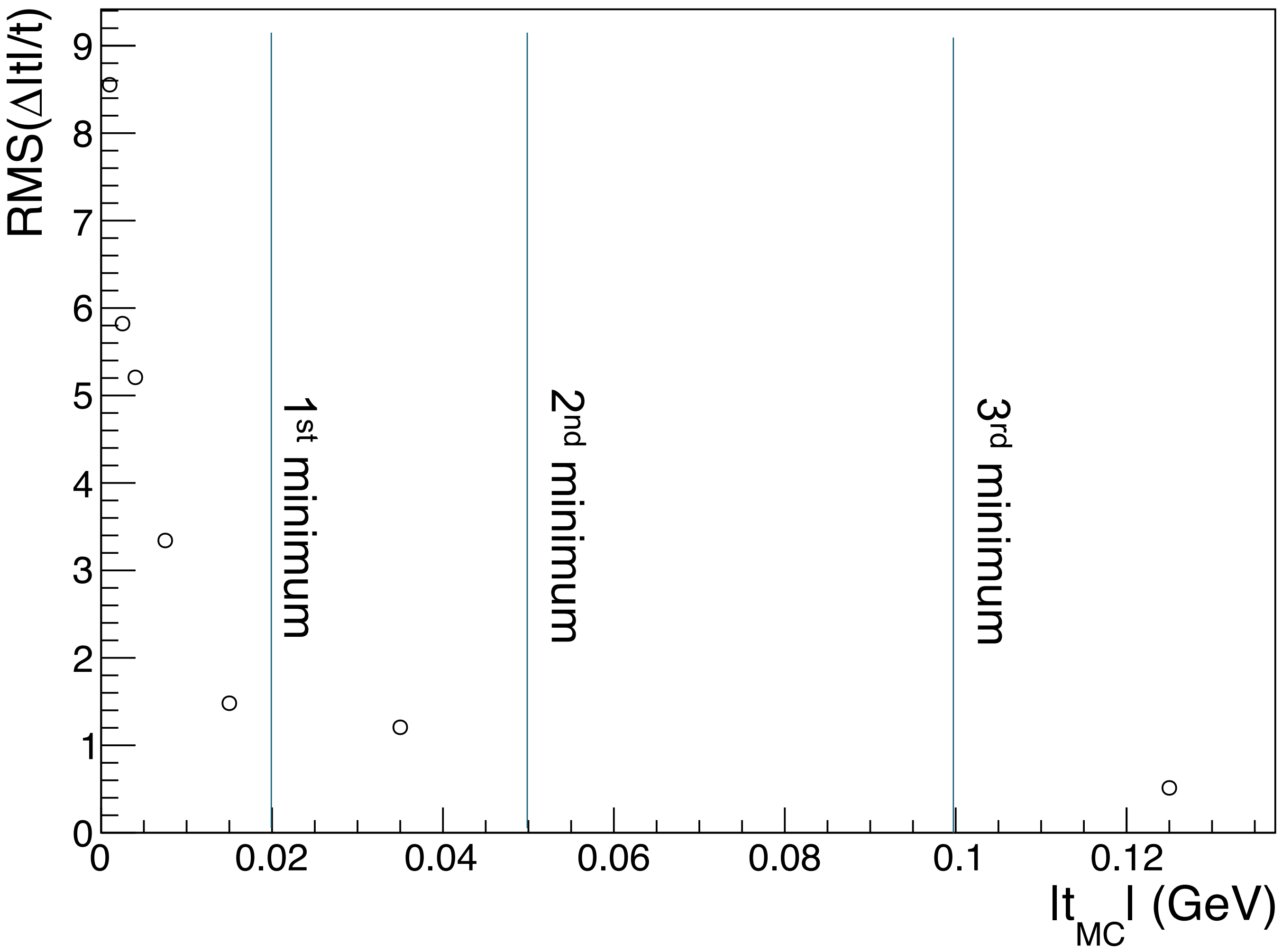


t Resolutions

Δt is mostly positive

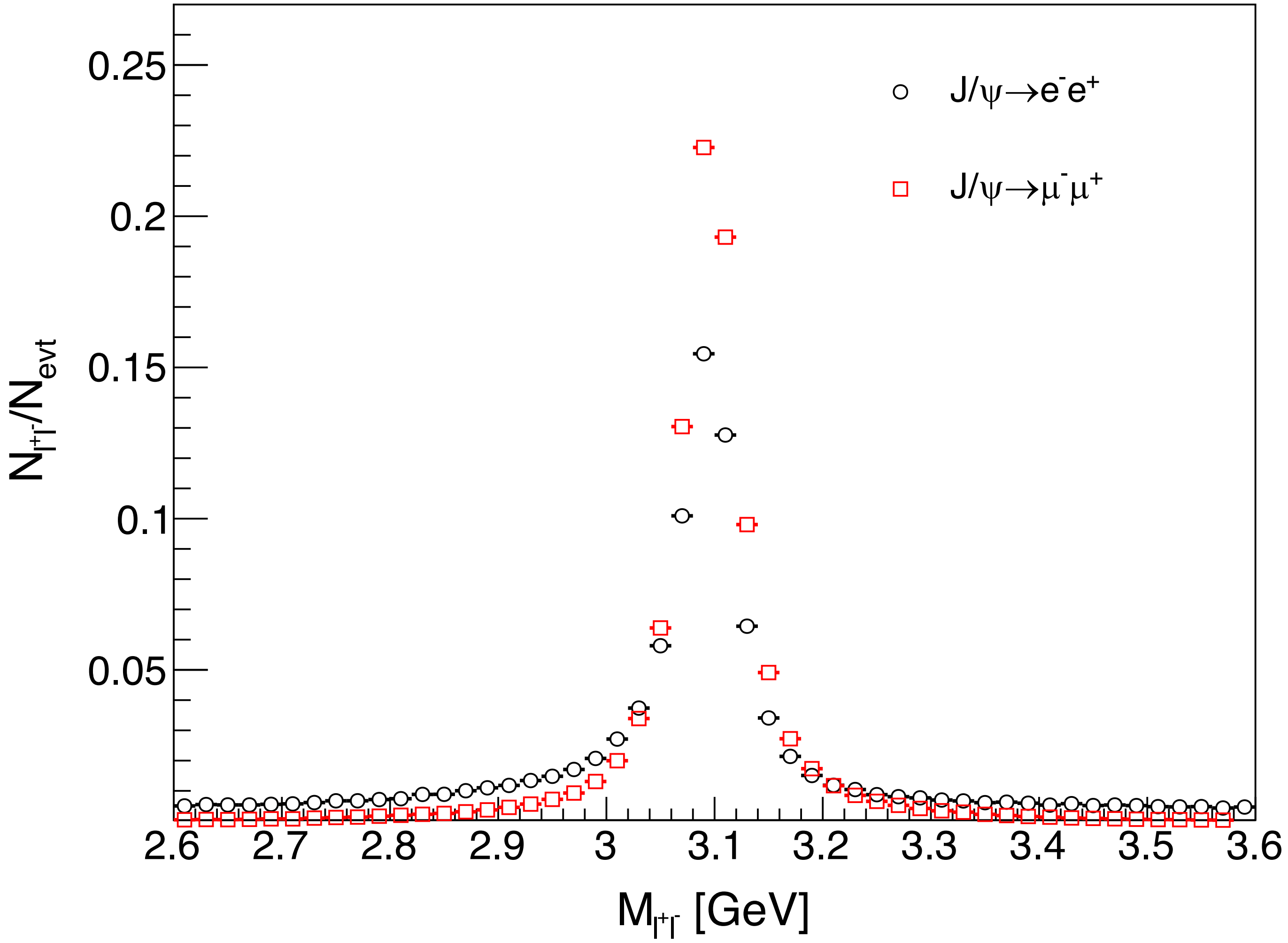


t Resolutions

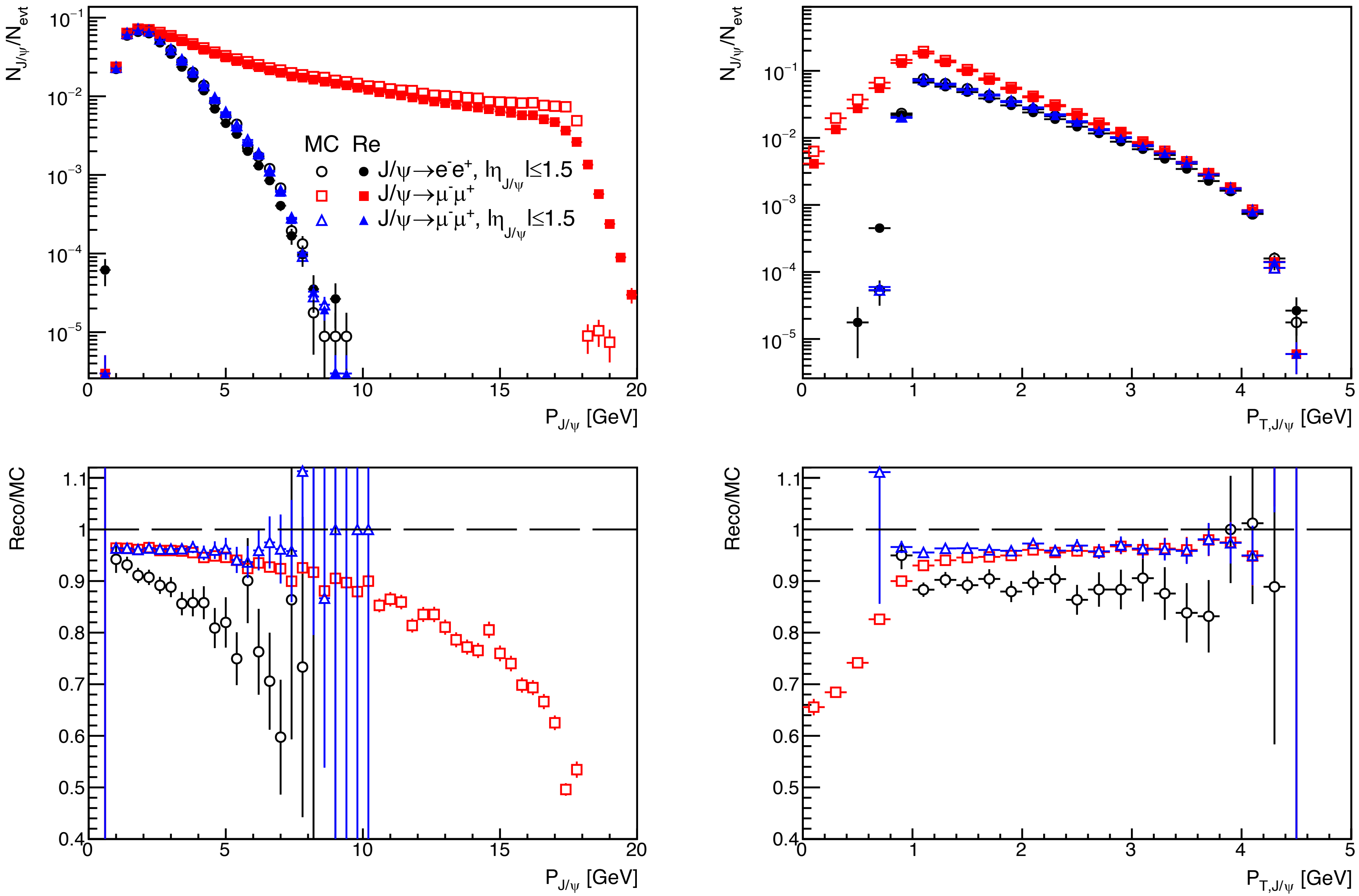


Dielectron channel vs dimuon channel

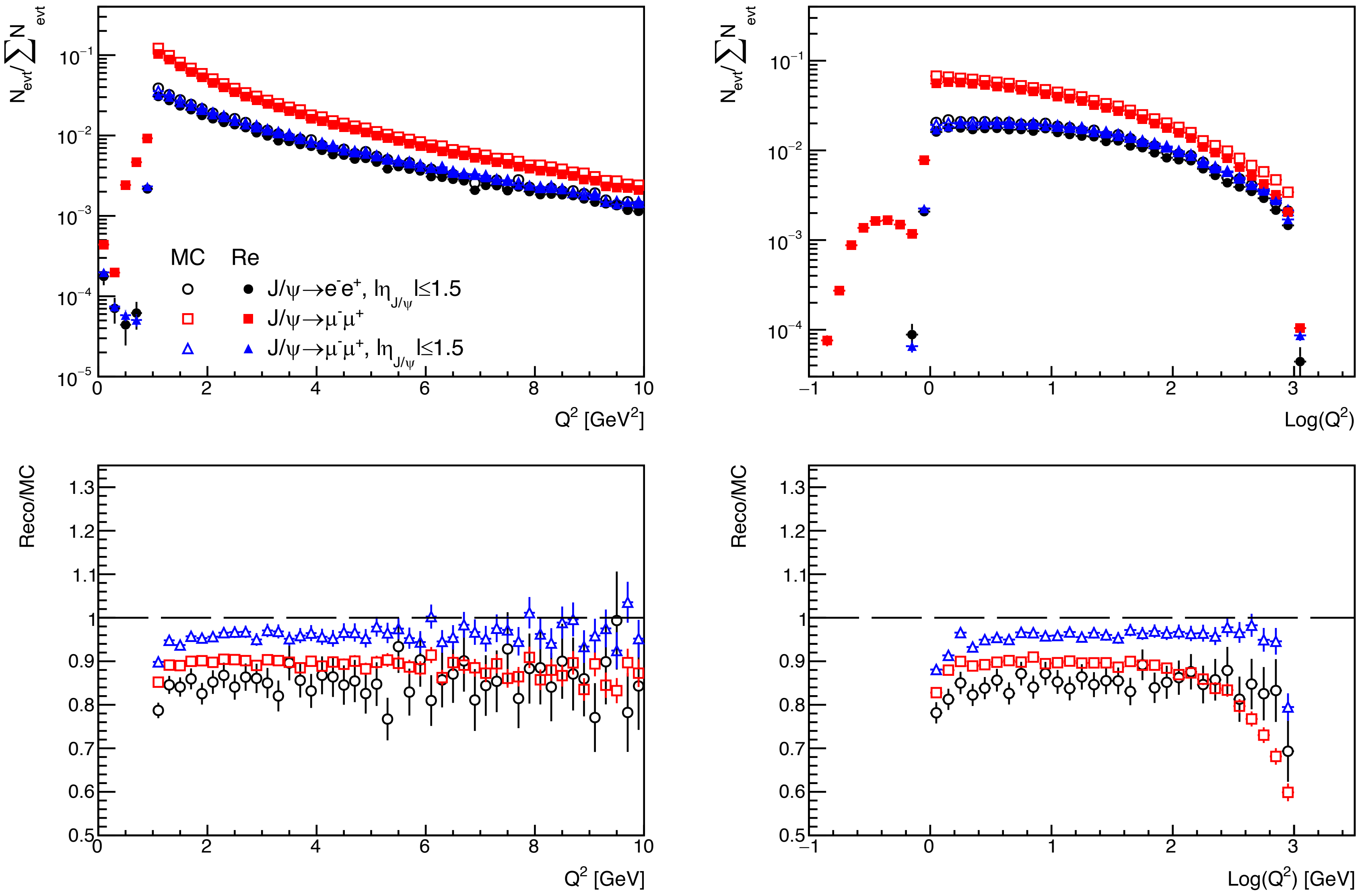
Invariant Mass



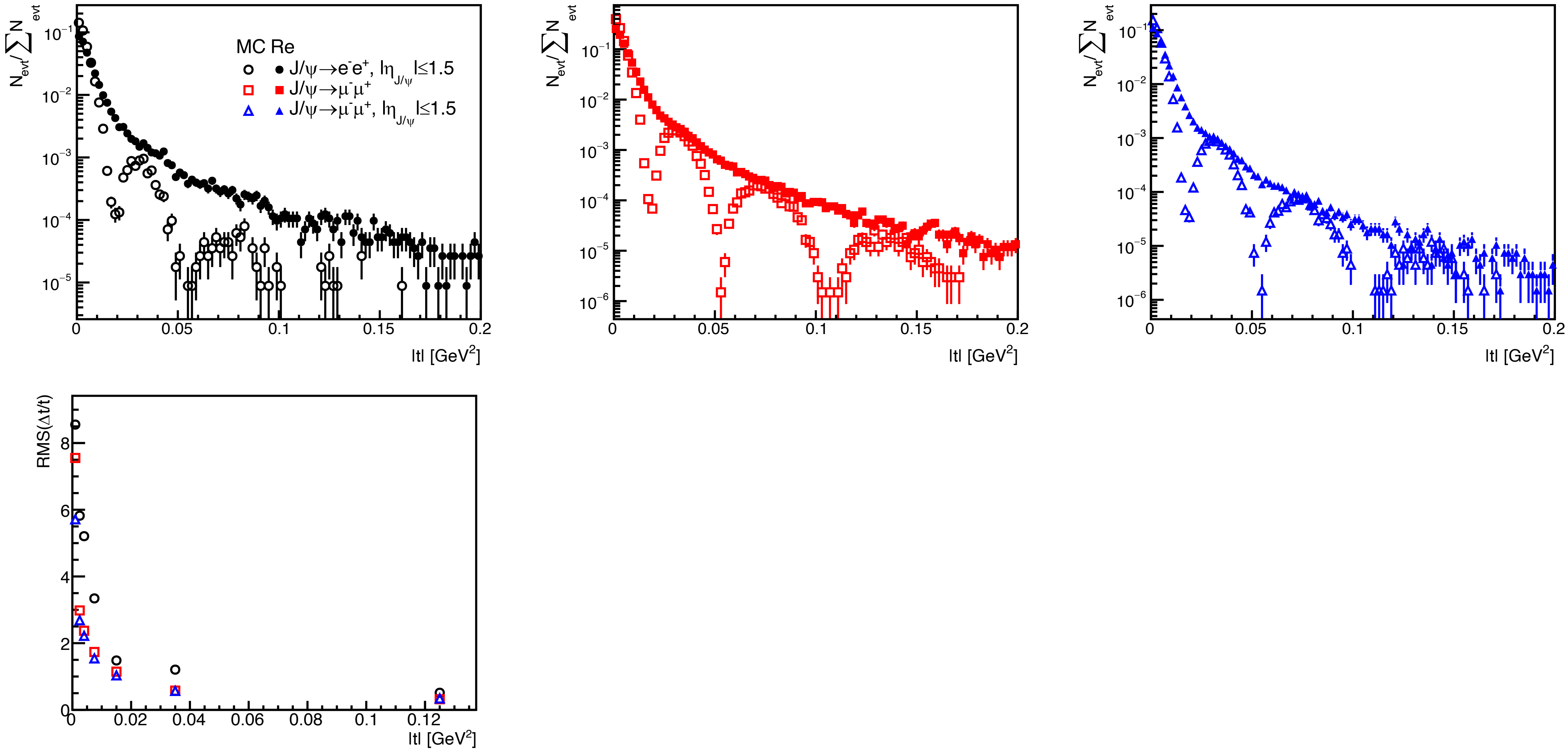
J/ψ momentum



Q^2 distribution



t distribution and resolution



Summary

Updated data selections

- Use backward Ecal energy for electrons at $\eta < 1.5$ and the $|\eta_{J/\psi}| < 1.5$ requirement improved the t reconstruction
- $|\eta_{J/\psi}| < 1.5$ does reduce statistics

Compared dielectron and dimuon channels

- Cleaner J/ψ reconstruction
- Higher J/ψ efficiency as a function of momentum
- Better Q^2 efficiency
- Better t resolution

To-do List

- Fast sim for backward tracking for detector2
- Modify detector setup in simulations
  - Replace ePIC solenoid with ATHENA solenoid
    - Double check with momentum resolution
  - Replace Hcals with KLM