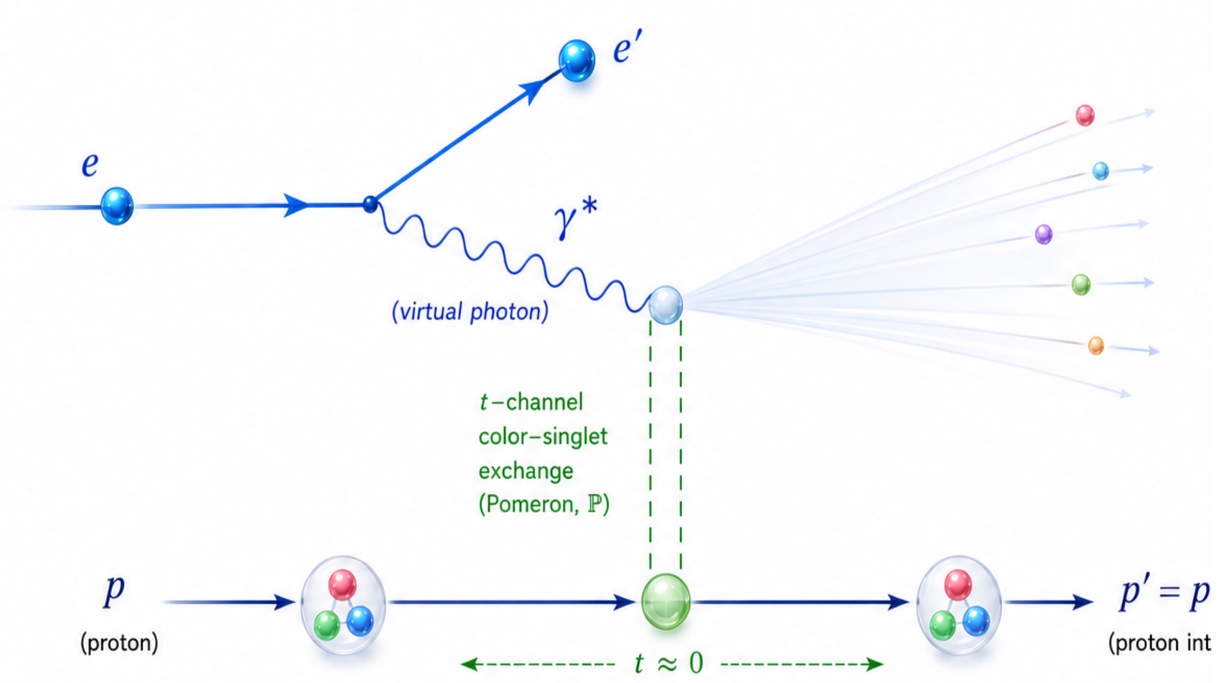
Inclusive diffraction on proton

ePIC Performance

Arjun Kumar

Inclusive diffraction on proton

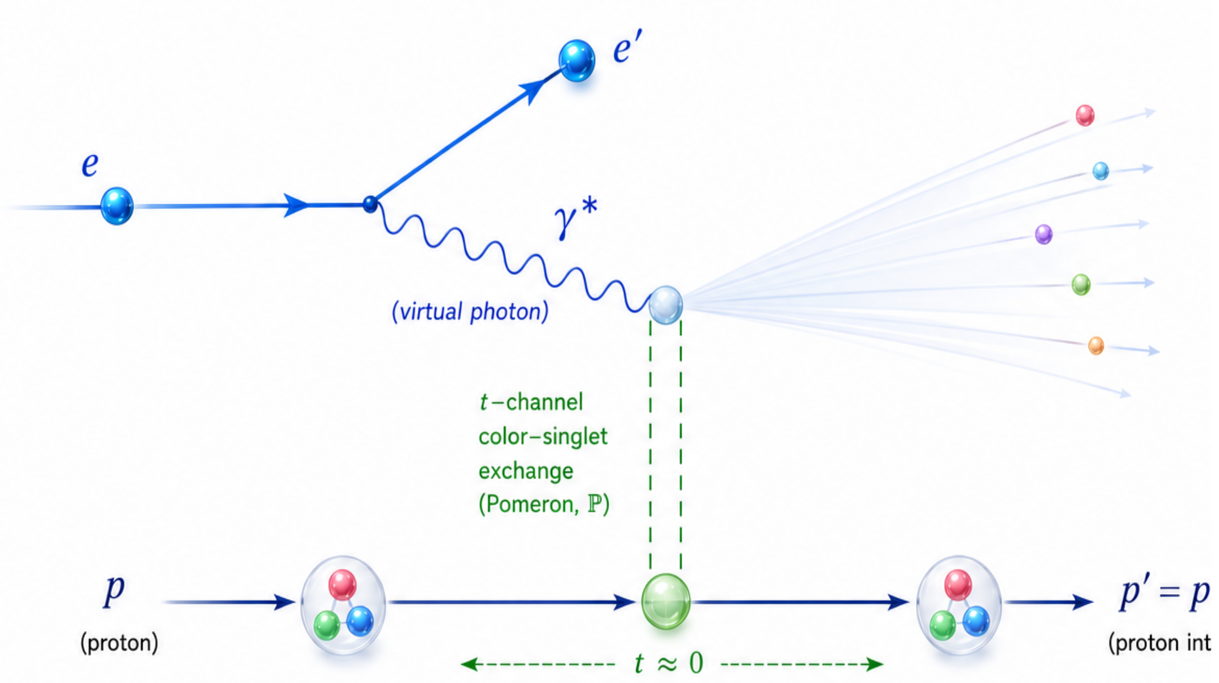


- $e + p \rightarrow e' + X + p'$
- Measure the scattered electron and the forward proton
- Motivation: Baseline measurement for studying nuclear suppression of diffractive structure function i.e $R^{A}_{\mathrm{diff}} = \dfrac{F^{D}_{2,A}}{A\,F^{D}_{2,p}}$

Inclusive diffraction is special:

whole target wavefunction must stay coherent, a bridge between long distance physics and calculable parton dynamics

Inclusive diffraction on proton



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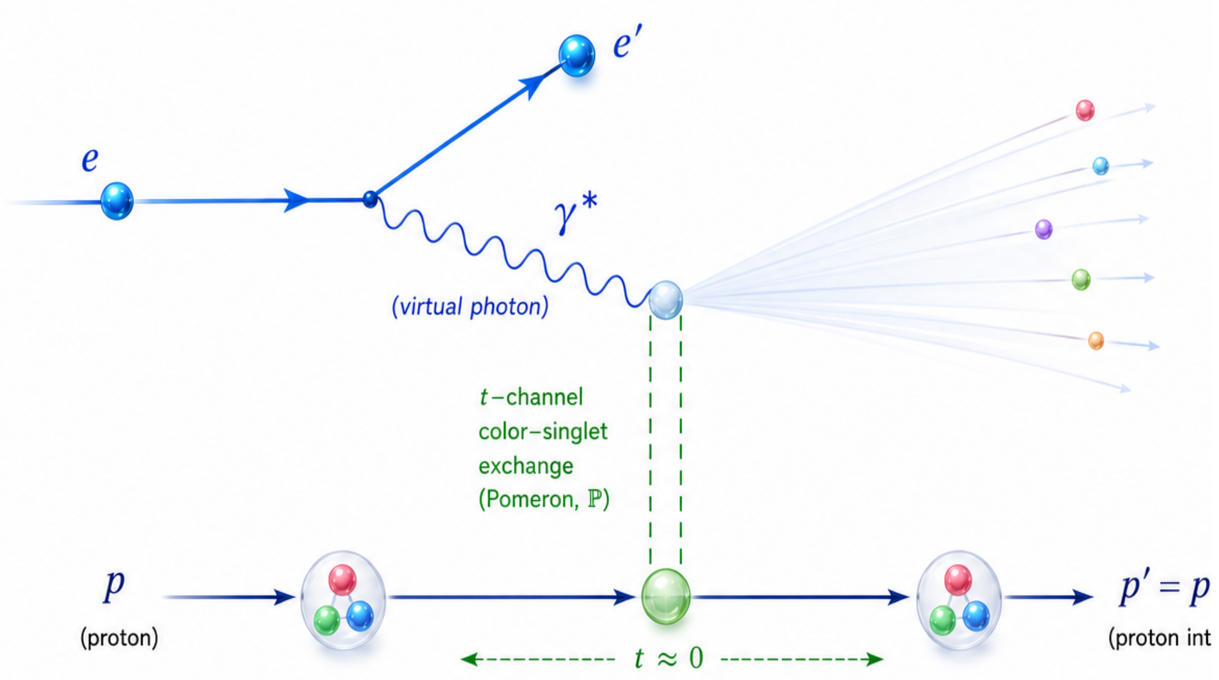
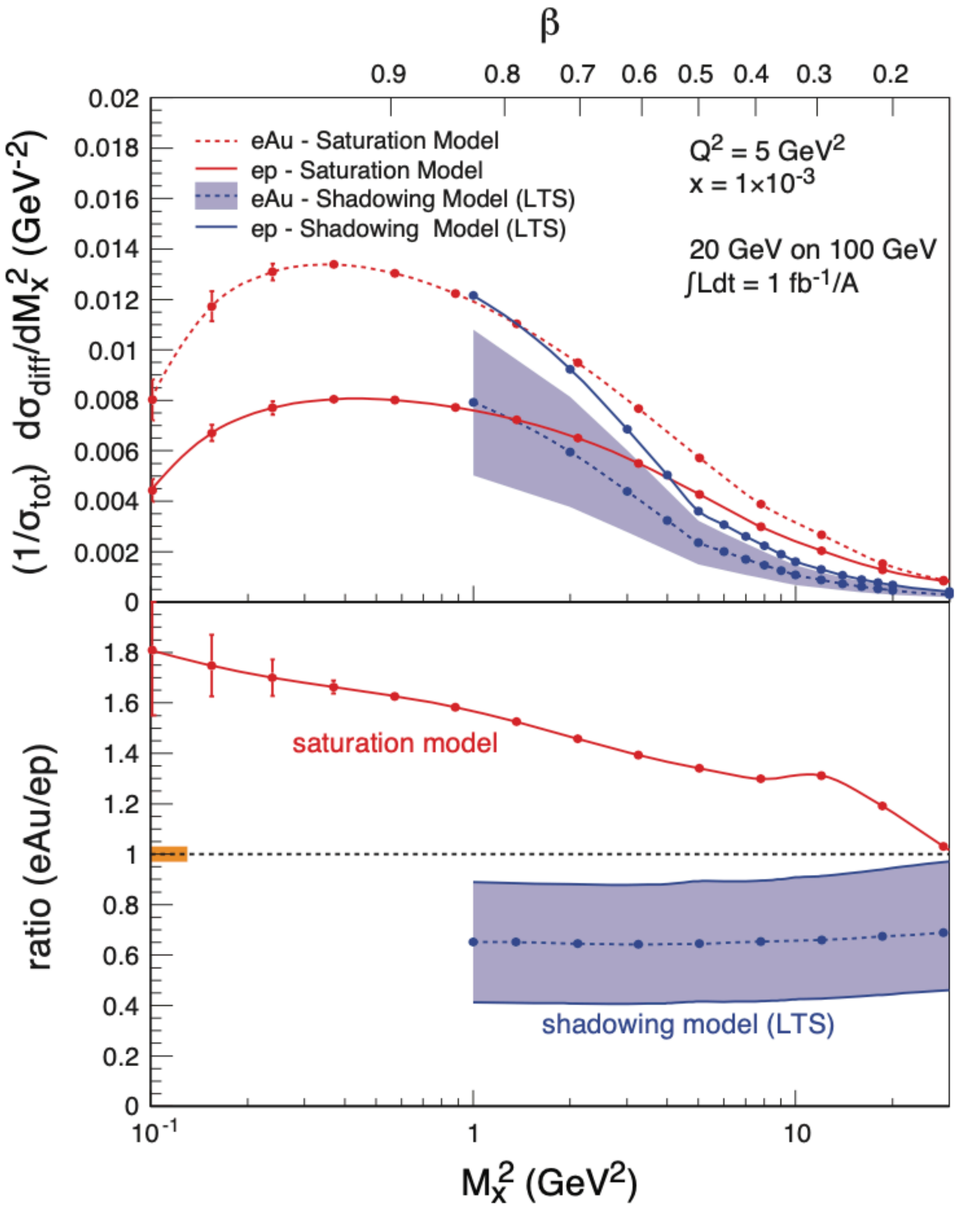
Inclusive diffraction is special:

Important observable for Imaging and Saturation program at EIC

Inclusive diffraction on proton





Inclusive diffraction is special:

Important observable for Imaging and Saturation program at EIC

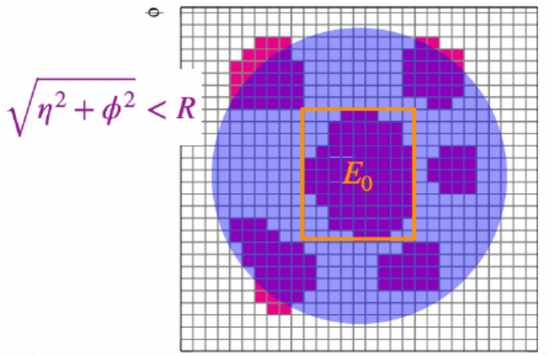
Electron-Finder for scattered electron

- **MC ID**: MC outgoing electron using initial beam electron genealogy
- **Truth ID**: Reconstructed electron using truth MC electron link
- **Det ID**: Using cluster and tracking to find the electron

Current detector-based electron ID

`edm4eic::ReconstructedParticleCollection ElectronID::FindScatteredElectron()`

- Loop over all reconstructed particles, and apply cuts on:
  - Require negative tracks
  - $0.9 < E/p < 1.2$
  - Isolated cluster
    $R = 0.4$
    $E_0/\Sigma E_R < 0.9$

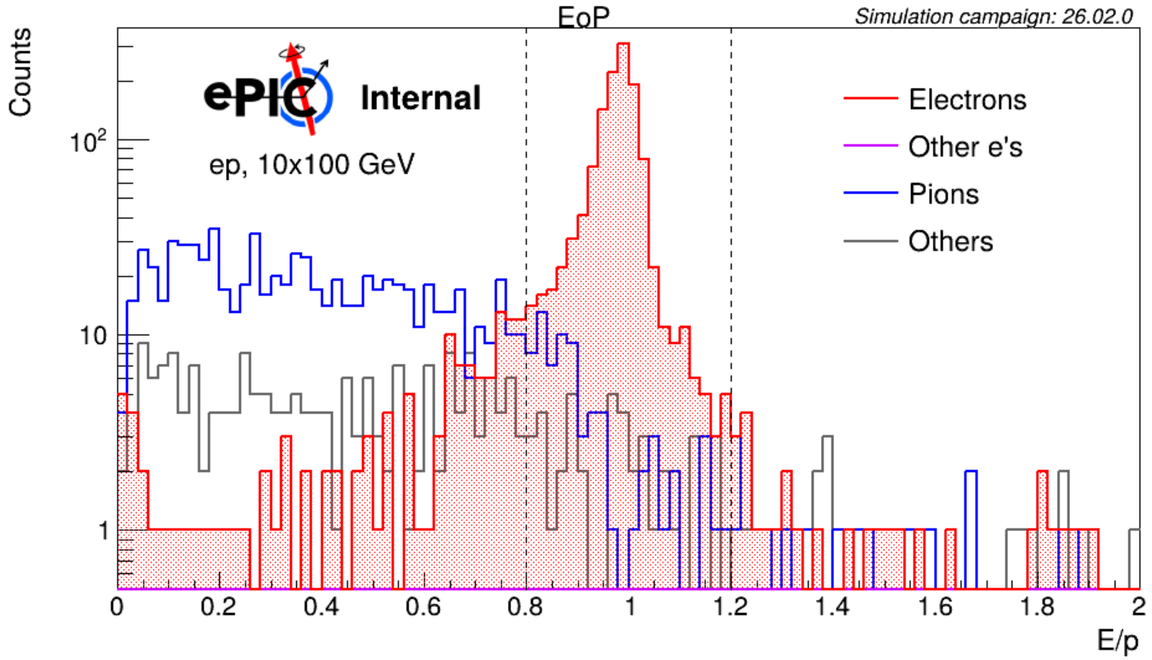


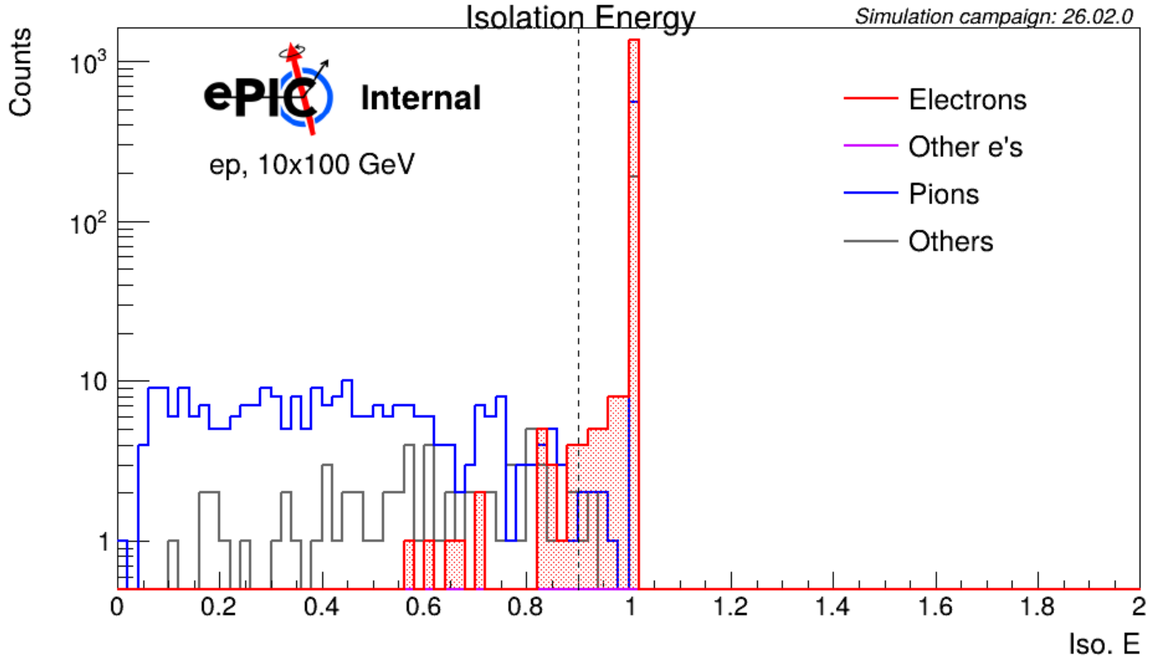
- If > 1 particles in collection, can use:
  `edm4eic::ReconstructedParticle SelectHighestPT(edm4eic::ReconstructedParticleCollection)`

Tyler K. (JGU Mainz)

From Win's slides at Physics Readiness Workshop

Electron-Finder for scattered electron

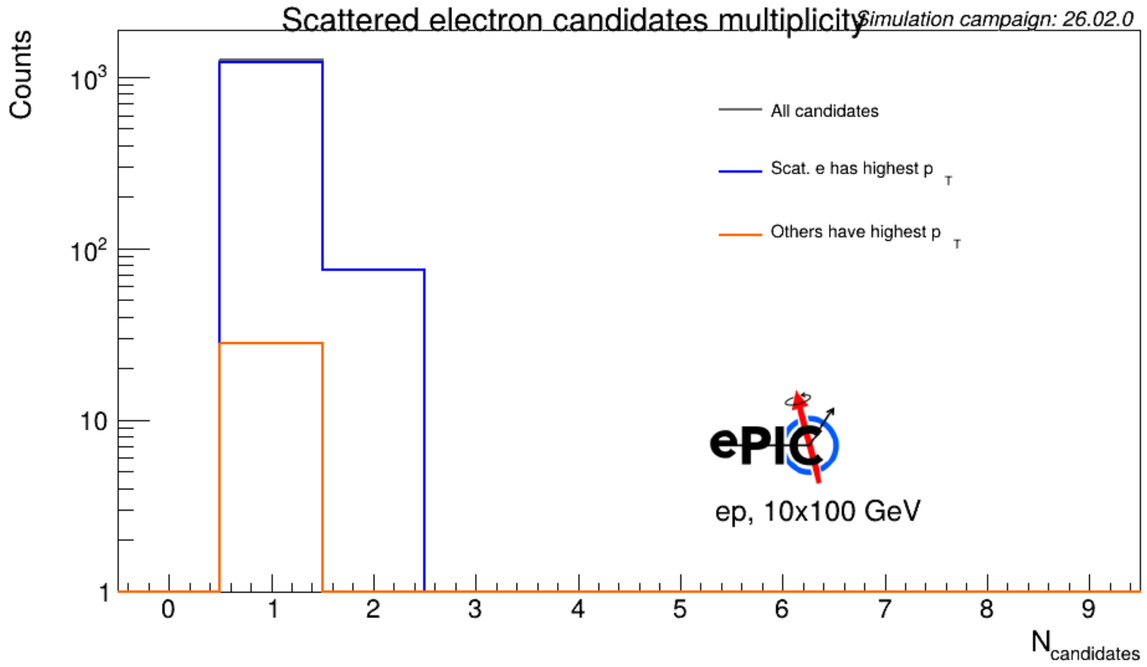


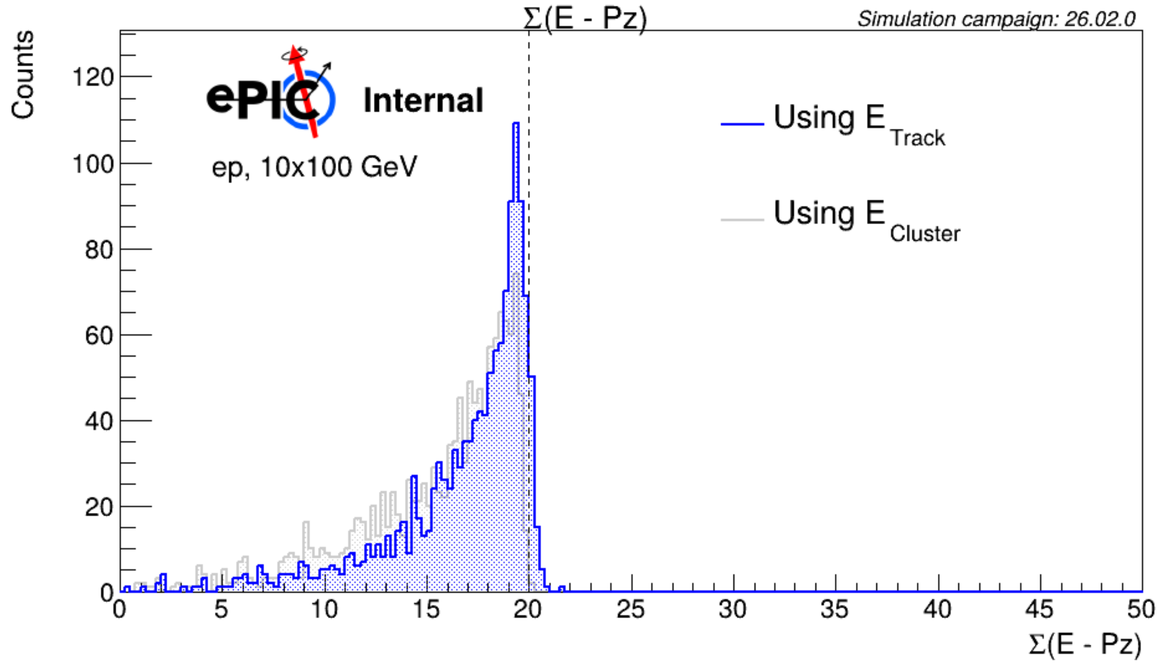


Using Rapgap for samples from 26.02.0 campaign

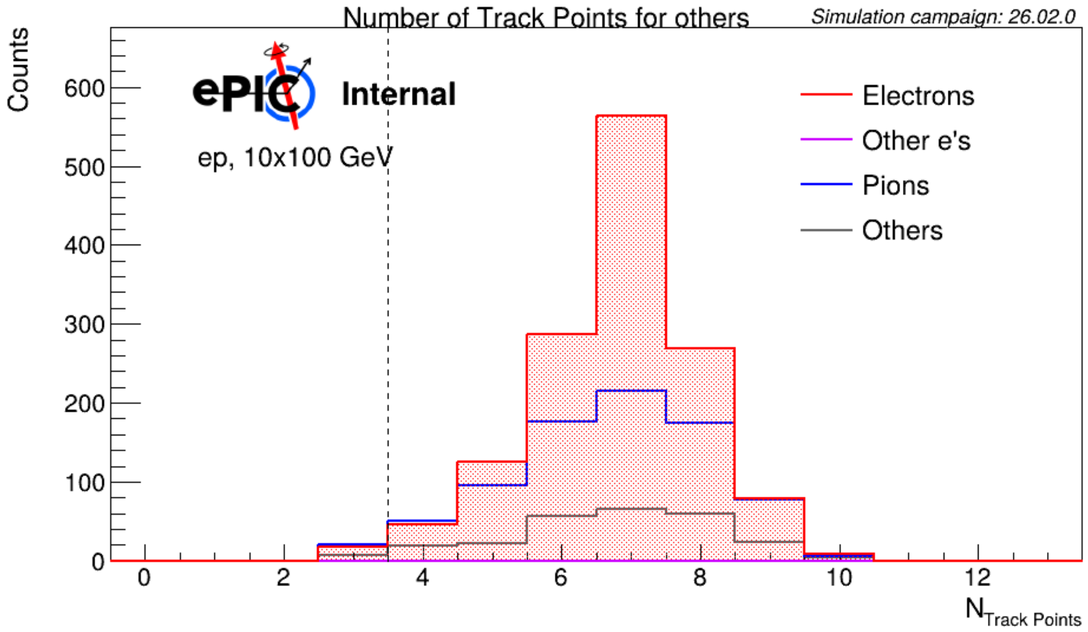
Using Win's code for electron finder

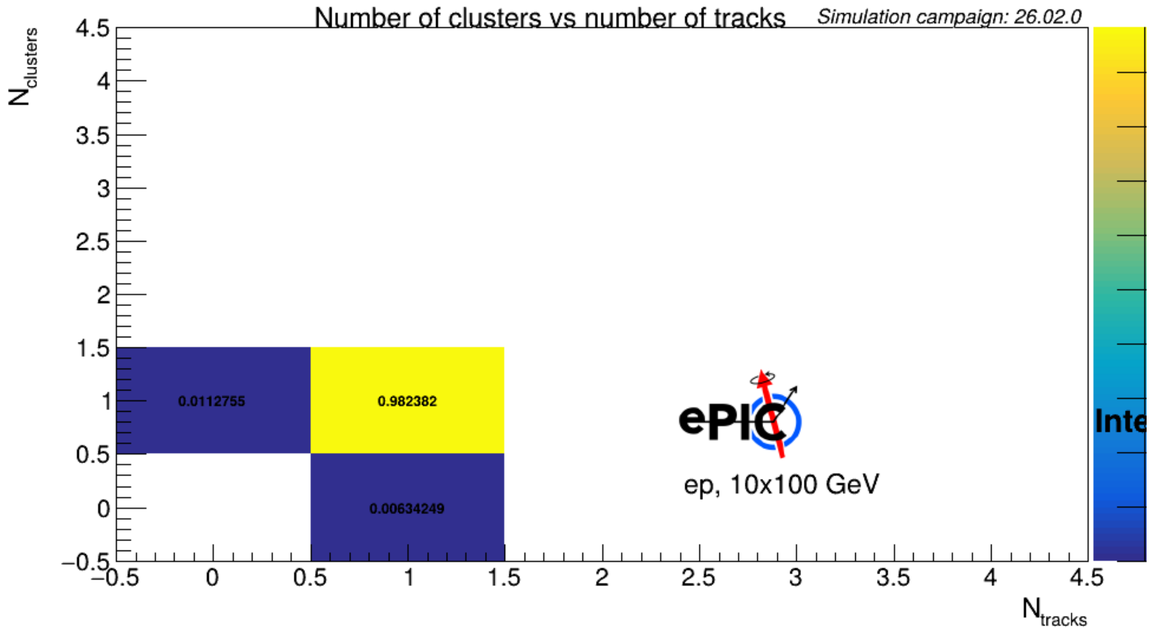
Electron-Finder for scattered electron





Electron-Finder for scattered electron





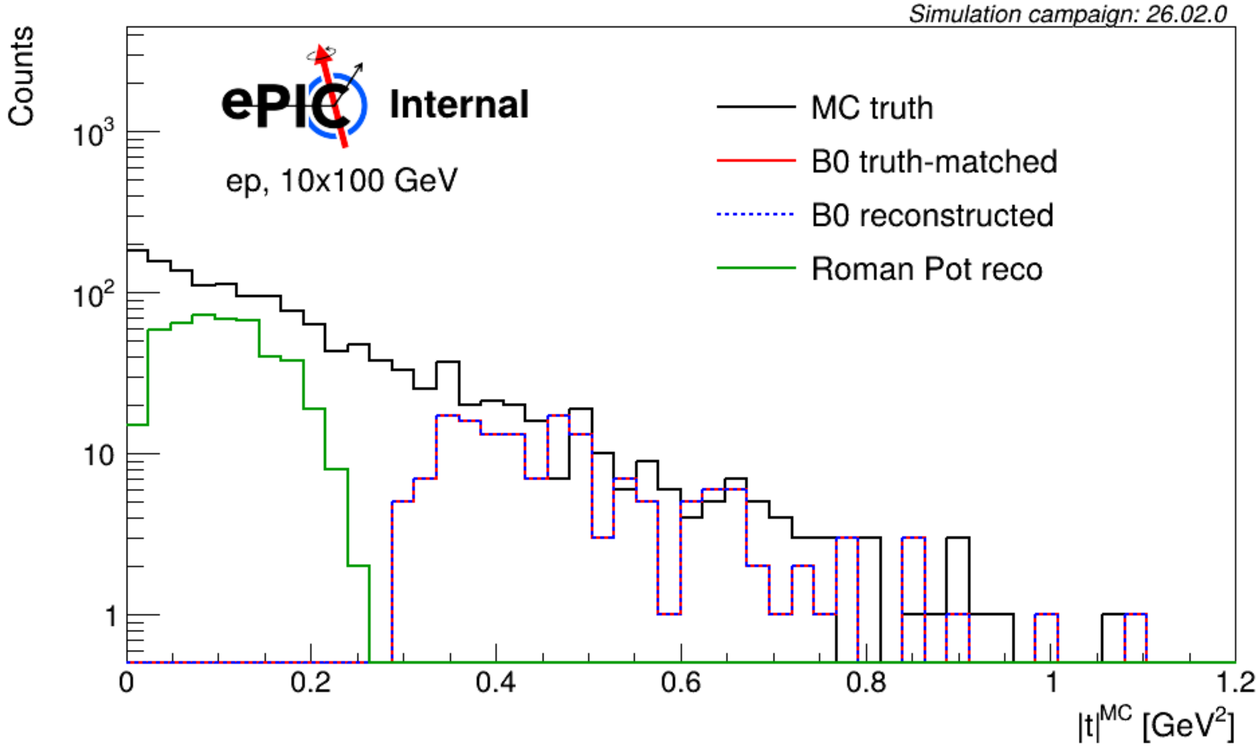
Identification of Forward proton

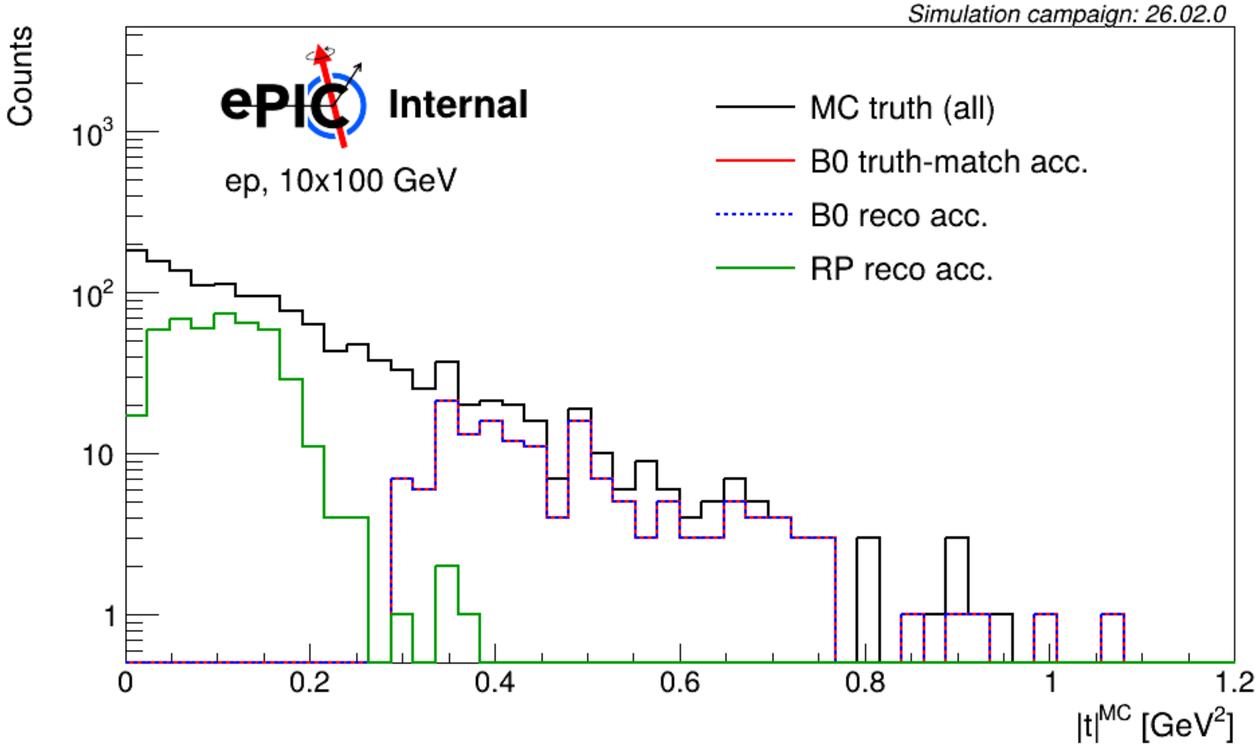
- **MC Particles**: MC truth Particles
- **ReconstructedTruthSeededChargedParticles**: B0 reconstructed charged tracks
- **ReconstructedTruthSeededChargedParticlesAssociations**: MC-to-reco matching for B0
- **ForwardRomanPotRecParticles:** Roman pot reconstructed particles

- Looping over all particles and require positive charge
- Selection based on 5.5 mrad <= theta <= 20 mrad for B0
- RP theta cut : 0-5mrad

*RP reconstructed particles already in head-on frame in simulation file

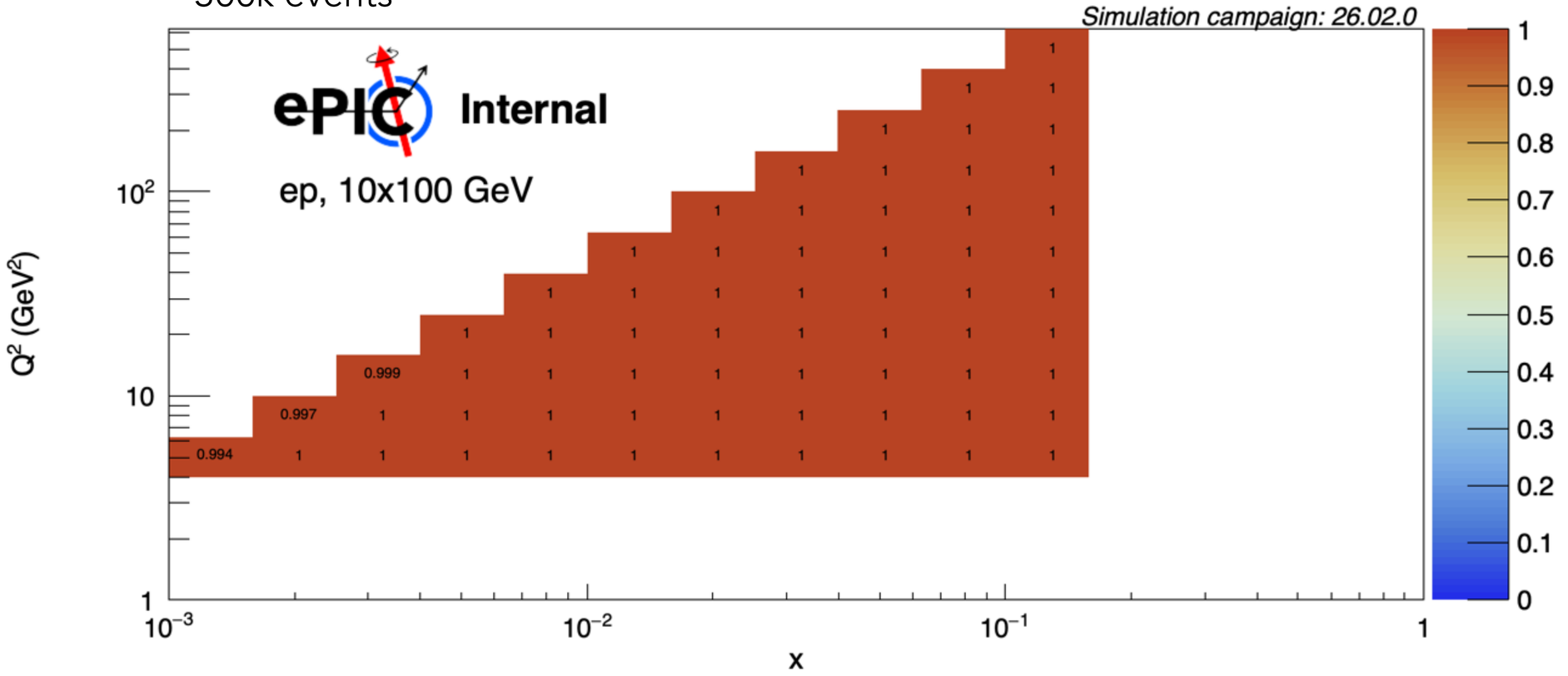
Identification of Forward proton





Acceptance

~300k events

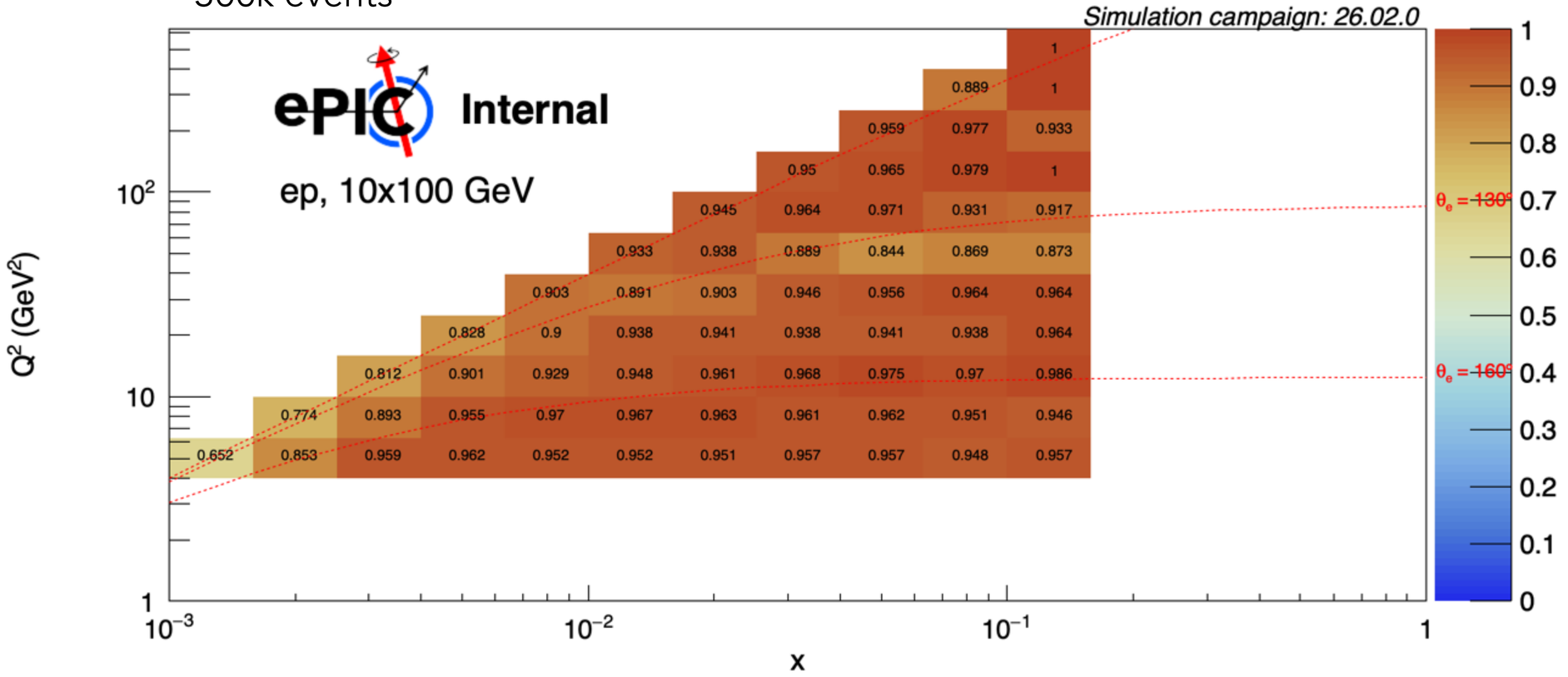


No. of truth electrons (assoc. link)
Total MC Electrons

MC electron in acceptance of detector
Total MC Electrons

Efficiency

~300k events

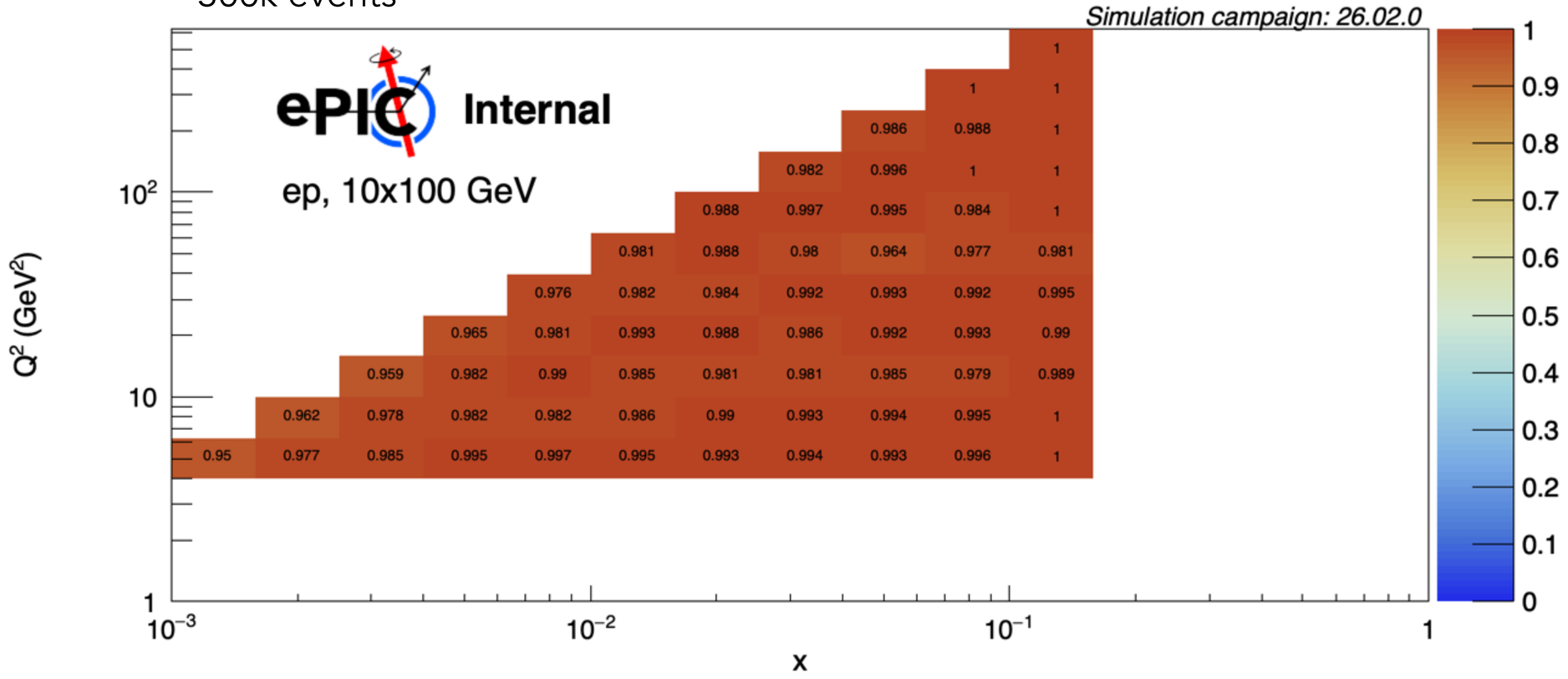


$$\frac{\text{No. of Reconstructed electrons}}{\text{Total MC Electrons}}$$

$$\frac{\text{Signal events + Background events (passing cuts)}}{\text{Total MC Electrons}}$$

Purity

~300k events



eID Reconstructed electrons

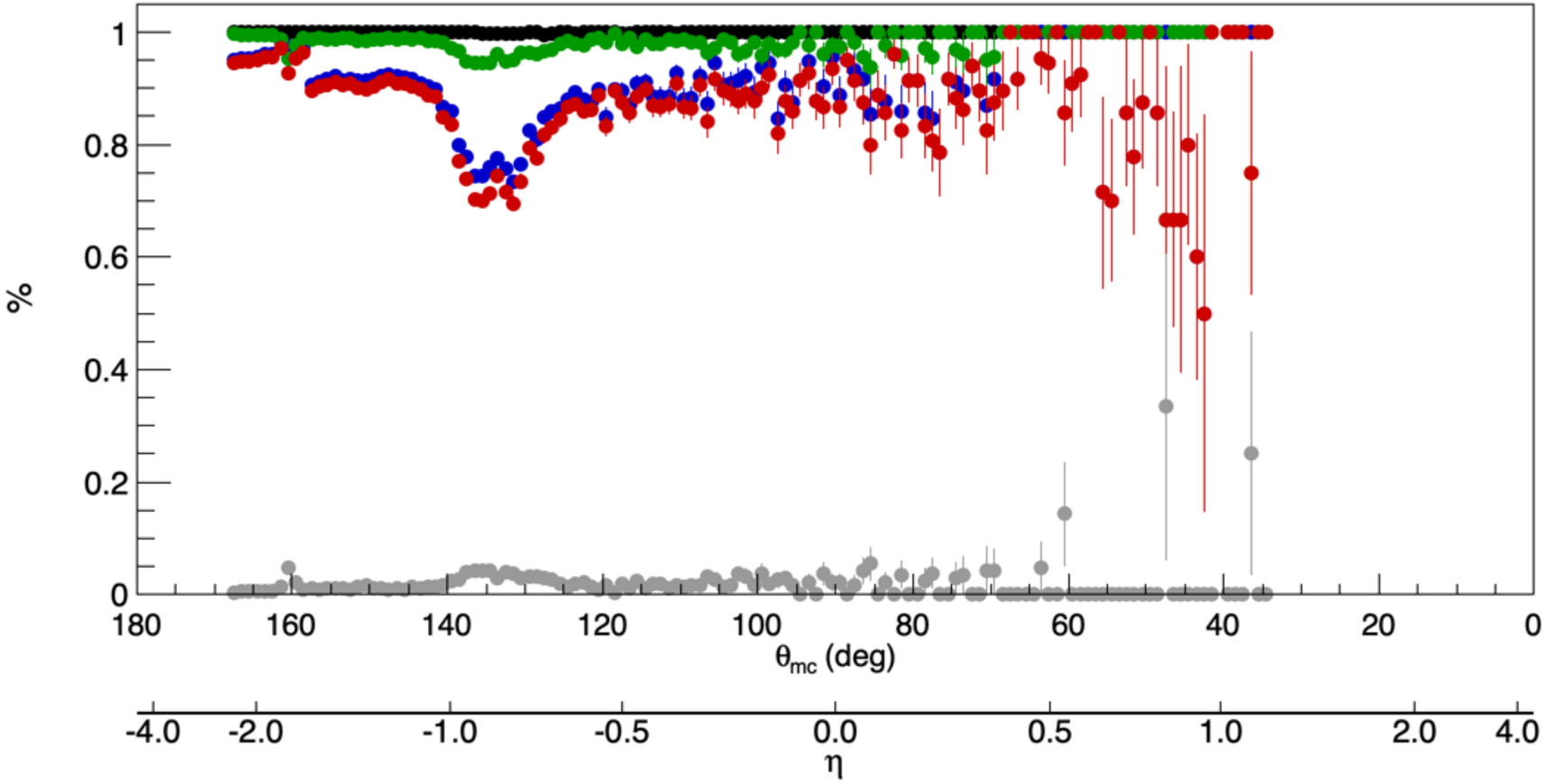
Reconstructed electrons

Signal events

Signal events + Background events (passing cuts)

Angular

~300k events



ePIC Internal

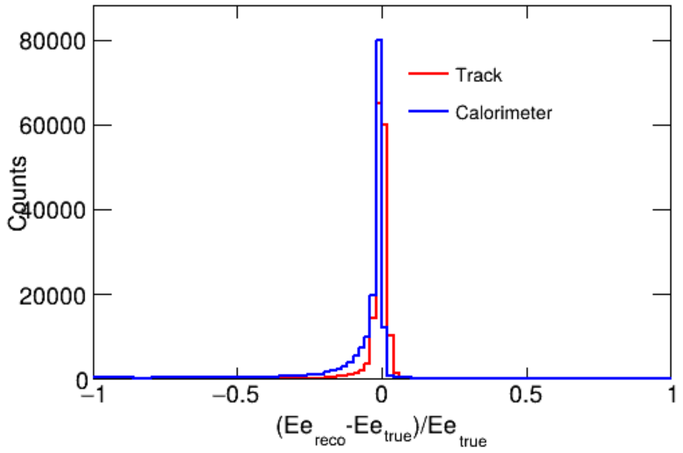
ep, 10x100 GeV

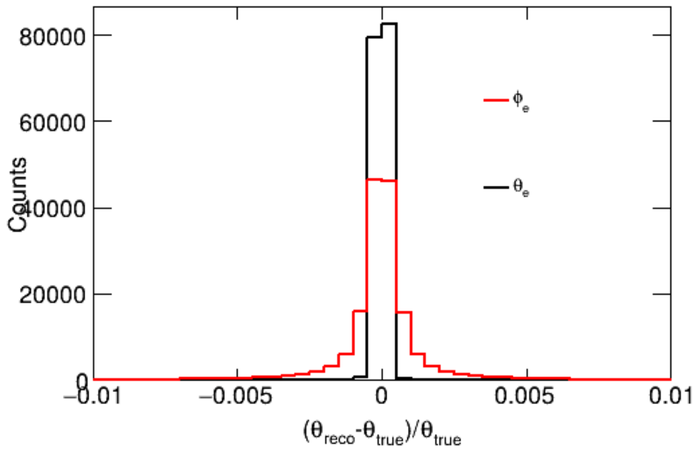
- Acceptance
- Efficiency
- Purity
- Overall rate
- π contamination

Simulation campaign: 26.02.0

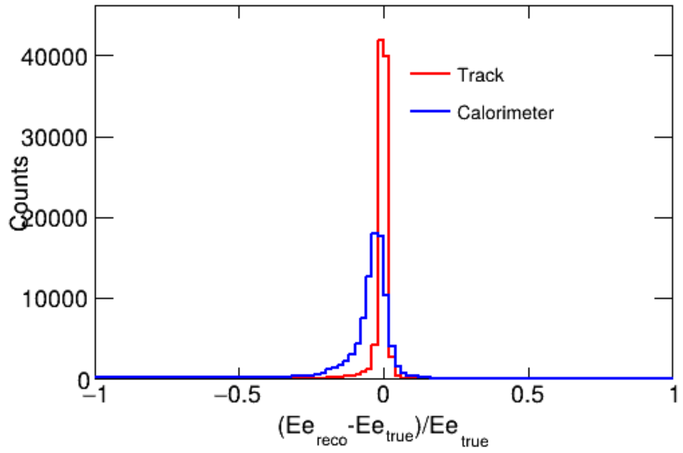
Resolution

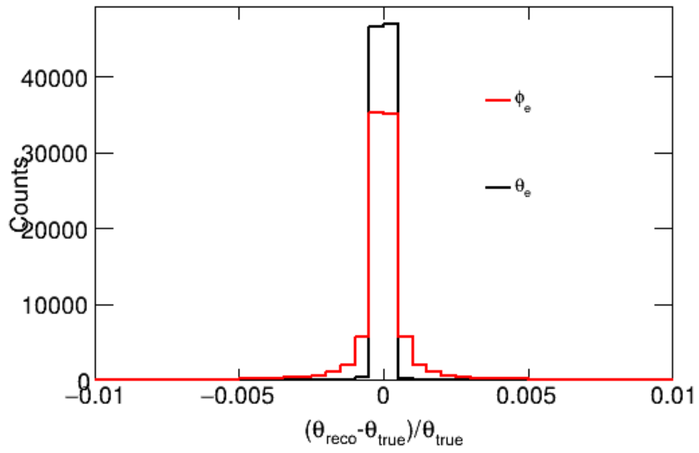
$Q^2 < 10$ GeV^2



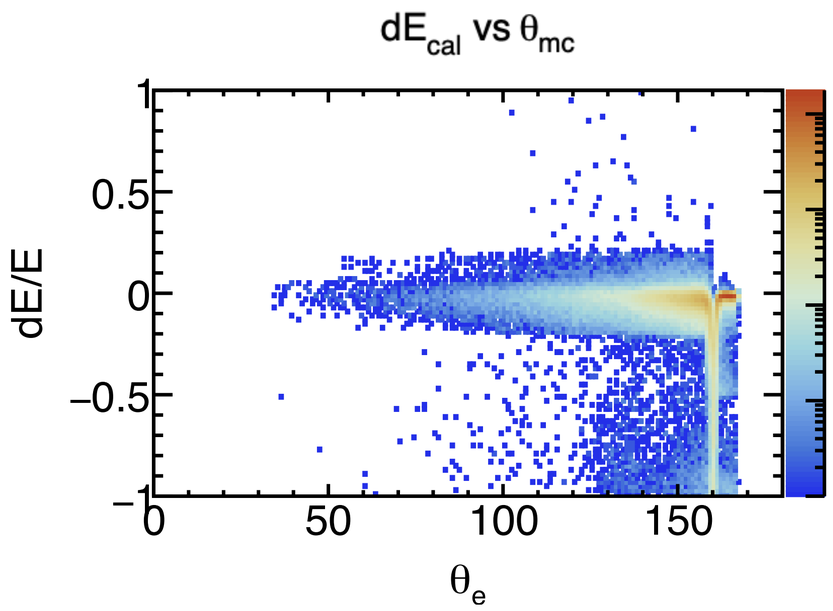


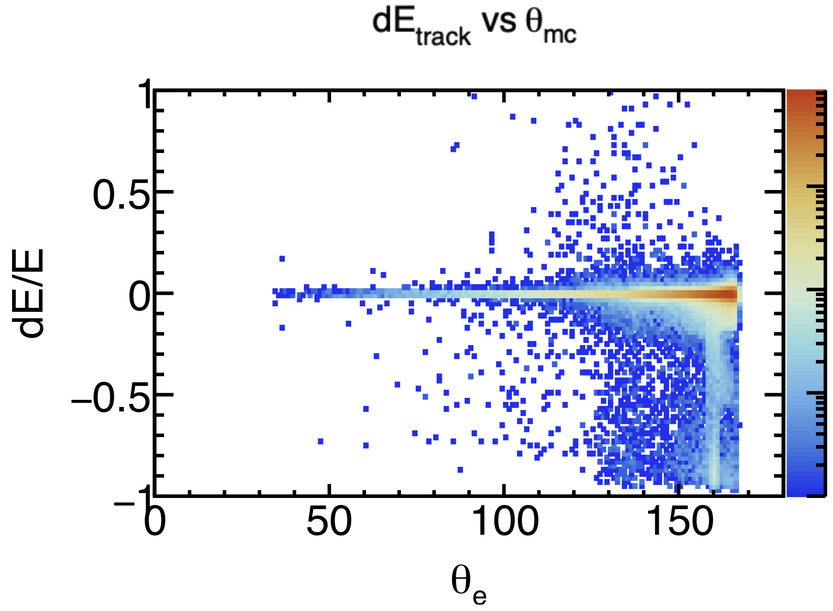
$Q^2 > 10$ GeV^2





Resolution


dE_cal vs θ_mc
dE/E
θ_e
1
0.5
0
−0.5
−1
0
50
100
150

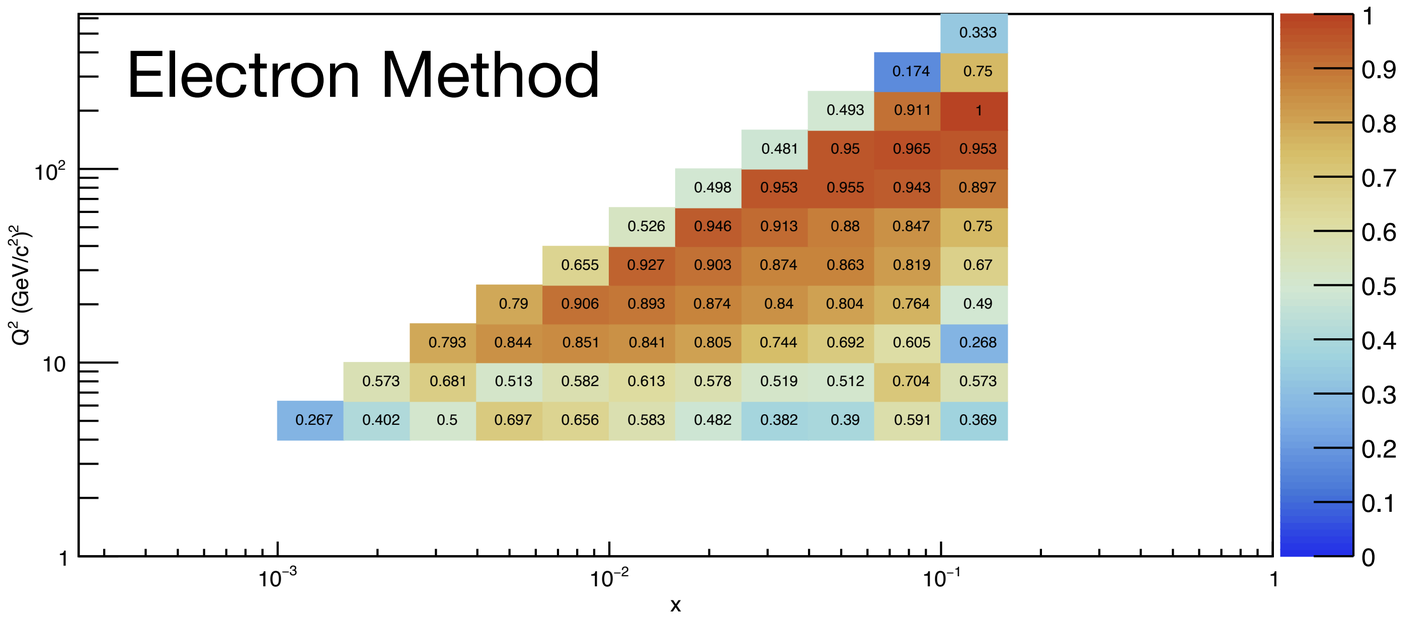

dE_track vs θ_mc
dE/E
θ_e
1
0.5
0
−0.5
−1
0
50
100
150

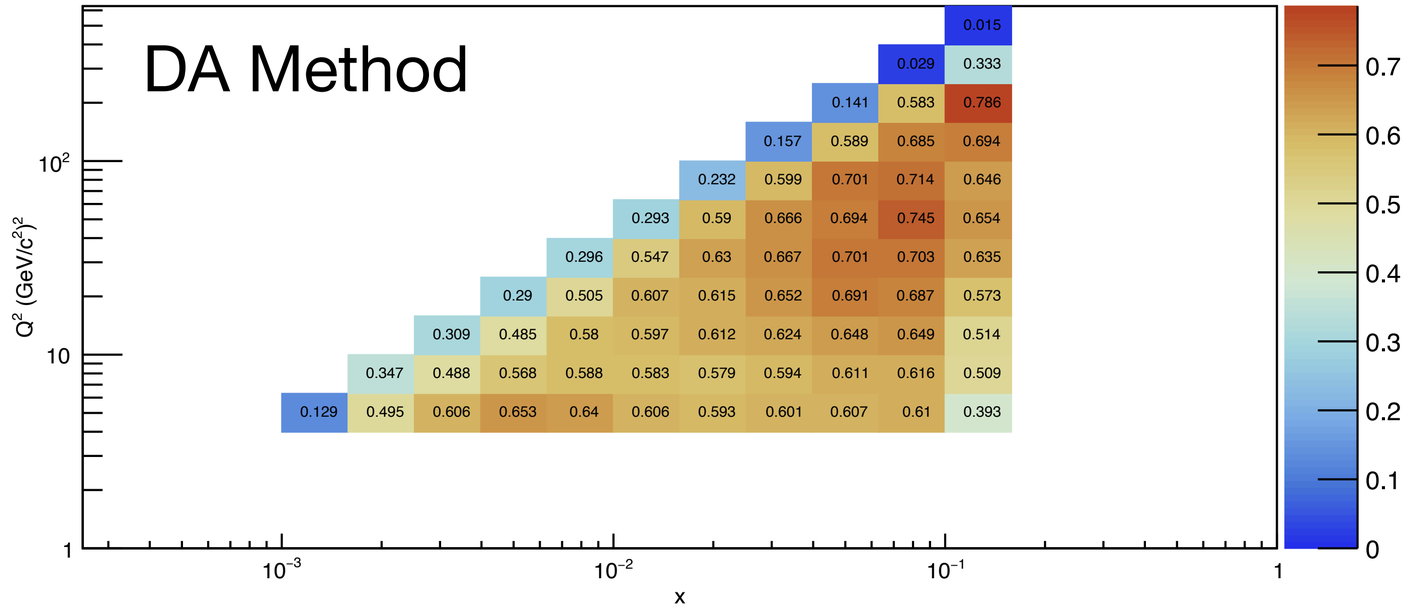
Kinematic reconstruction

Algorithm	Q^2	Inelasticity y	Bjorken x
Electron (E)	$2E_0E_e(1+\cos\theta_e)$	$1-\frac{E_e(1-\cos\theta_e)}{2E_0}$	$\frac{Q^2}{4E_0E_\beta y}$
Jacquet-Blondel (JB)	$\frac{p_{t,h}^2}{1-y}$	$\frac{\delta_h}{2E_0}$	
Double-Angle (DA)	$\frac{4E_0^2}{\tan(\frac{\theta_e}{2})(\tan(\frac{\theta_e}{2})+\delta_h/p_{t,h})}$	$\frac{\delta_h/p_{t,h}}{\tan(\frac{\theta_e}{2})+\delta_h/p_{t,h}}$	
Sigma (Σ)	$\frac{E_e^2\sin^2\theta_e}{1-y}$	$\frac{\delta_h}{\delta_h+E_e(1-\cos\theta_e)}$	
E-Sigma ($e\Sigma$)	Q_E^2	$\frac{Q_E^2}{4E_0E_\beta x_\Sigma}$	x_Σ

$$p_{t,h}^2=(\sum_h p_{x,h})^2+(\sum_h p_{y,h})^2 \qquad \delta_h=\sum_h E_h-p_{z,h}$$

Correct bin assignment / stability





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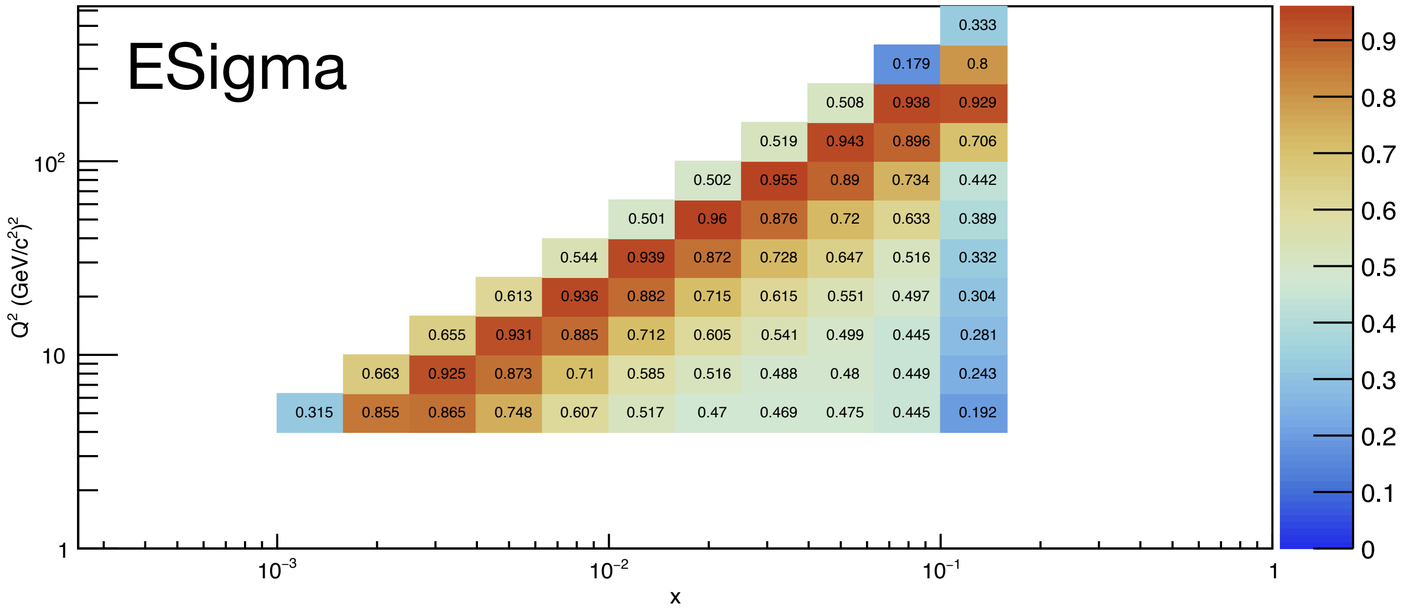

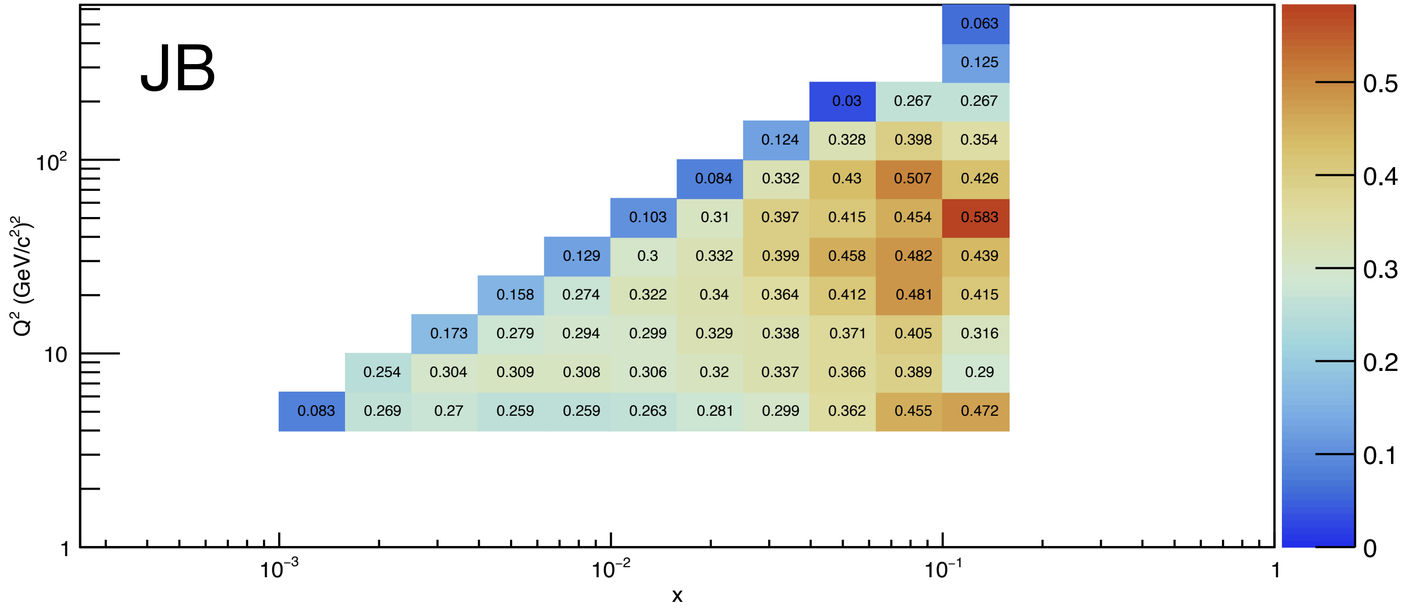

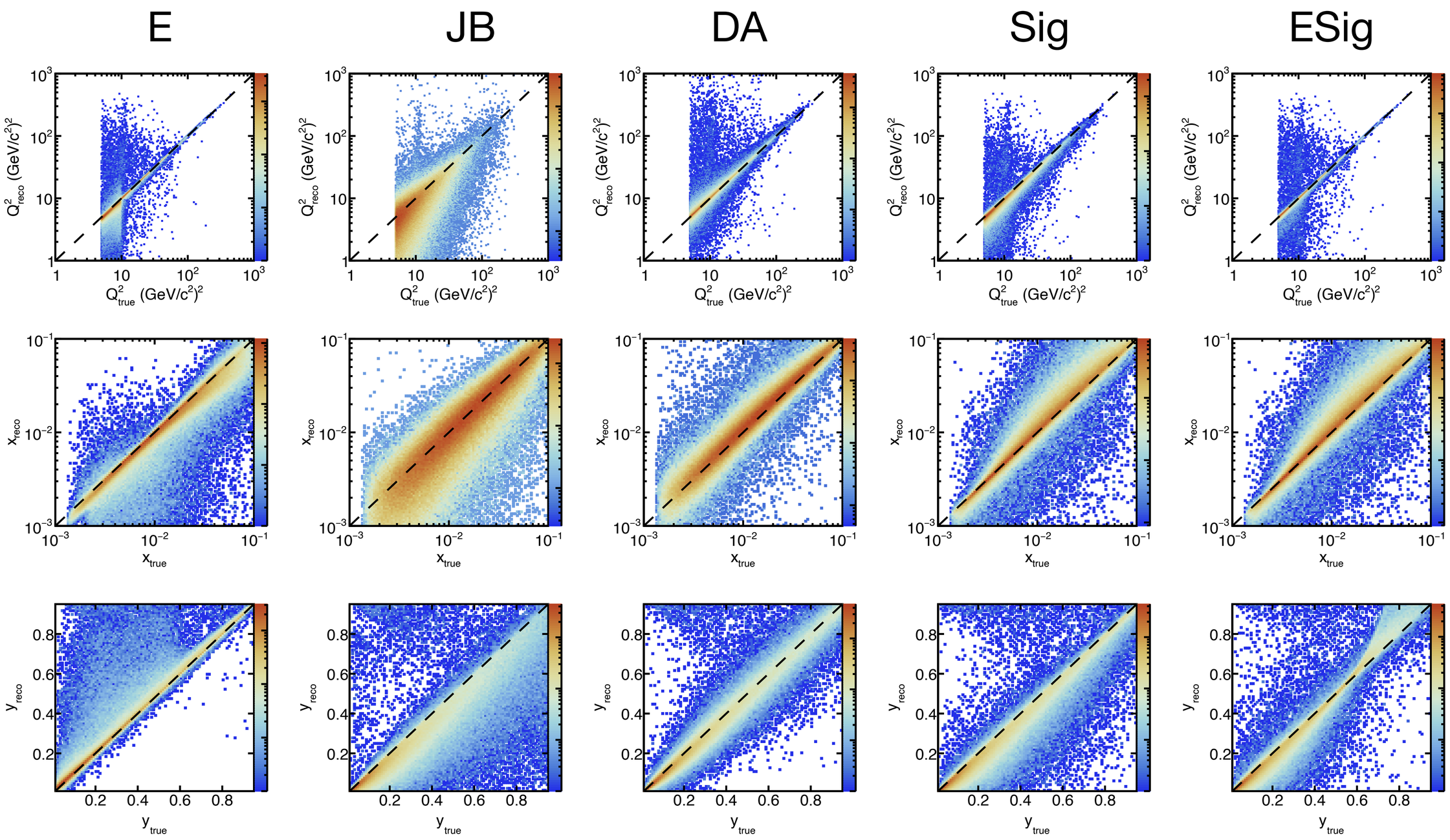
E
JB
DA
Sig
ESig
Q^2_{reco} (GeV/c^2)^2
Q^2_{true} (GeV/c^2)^2
x_{reco}
x_{true}
y_{reco}
y_{true}

Next Steps

- Diffractive structure functions and t-spectrum
- Radiative effects
- Rapidity gap method