Inclusive PWG simulation requirements for barrel region

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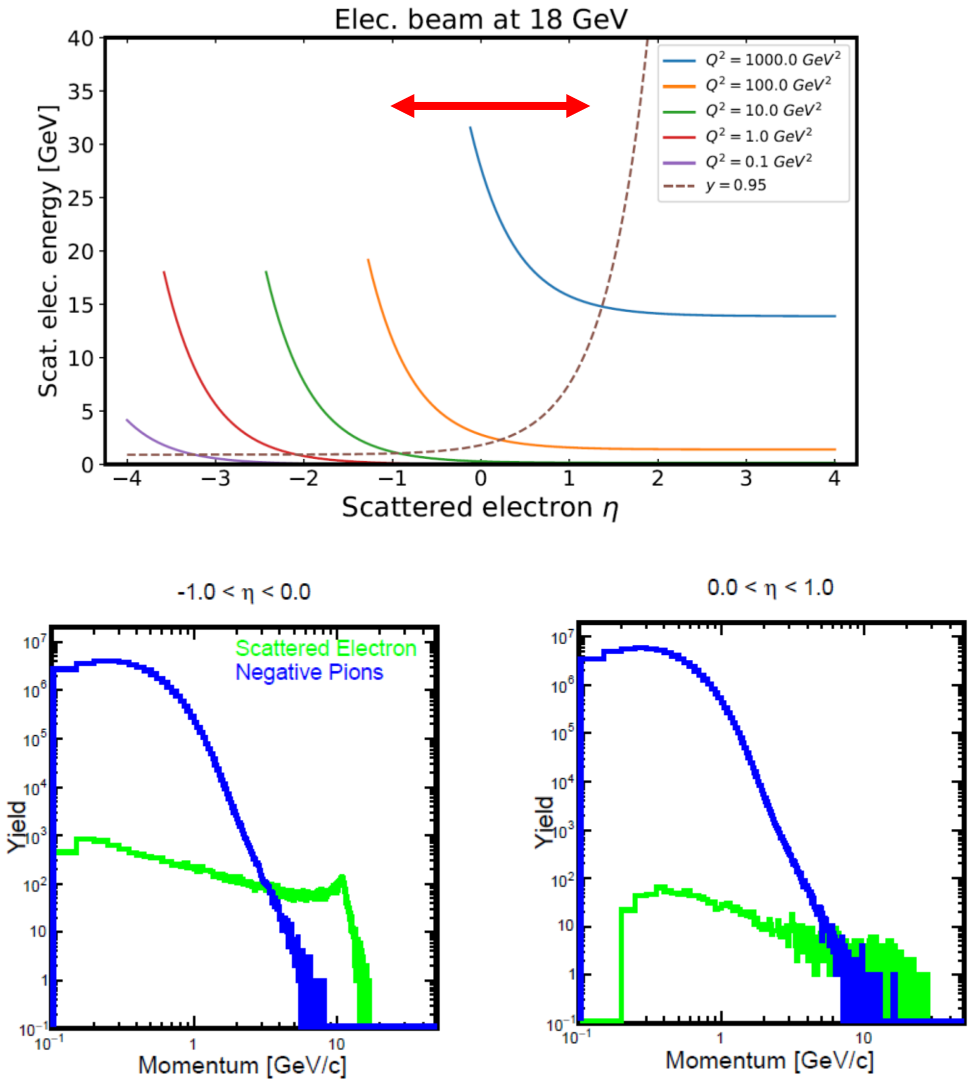
(for the Inclusive conveners)

Importance of barrel ECAL

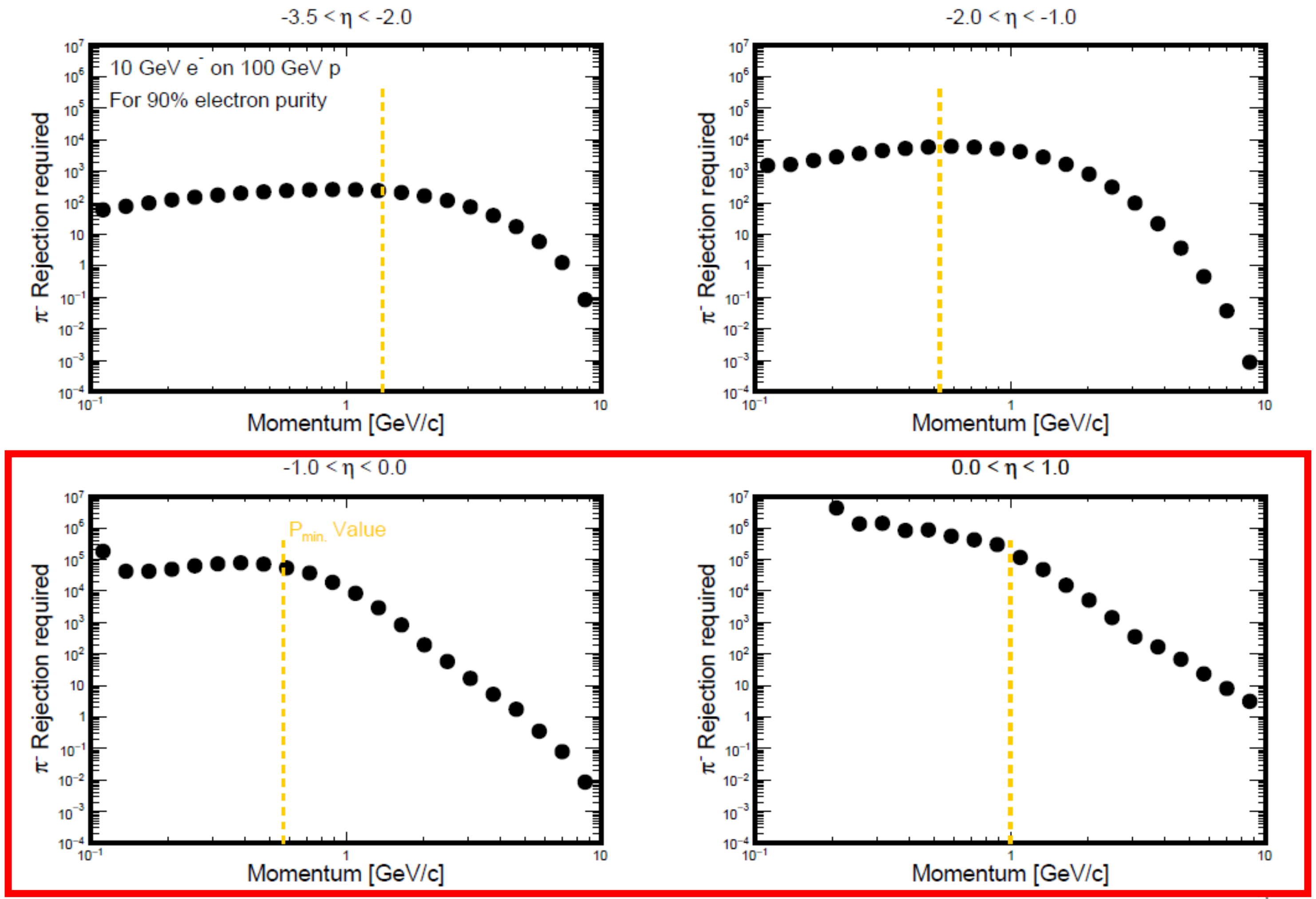
- In the barrel region, reconstruction of the scattered electron kinematic will rely on the tracking detector.
- For inclusive analyses, therefore, the primary role of the barrel ECAL will be the rejection of the negative pion background which originates largely from the low Q^2 part of the ep/A cross section.



Pythia6

Pion rejection requirements

- To achieve 90% final electron purity , a pion suppression up to 10^5 is needed above the minimum momentum threshold (y < 0.95 in barrel region).
- Including imperfect electron efficiency would adjust this slightly.



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How to achieve high scattered electron purity

- There are several methods to suppress the raw backgrounds for the scattered electron.
  1. EMCal and PID detector responses for each electron candidate.
  2. Event-level requirement on the total measured $E\text{-}p_z$.
  3. Isolation cuts on electron candidates.
  4. Veto on far-backwards electron tagger.
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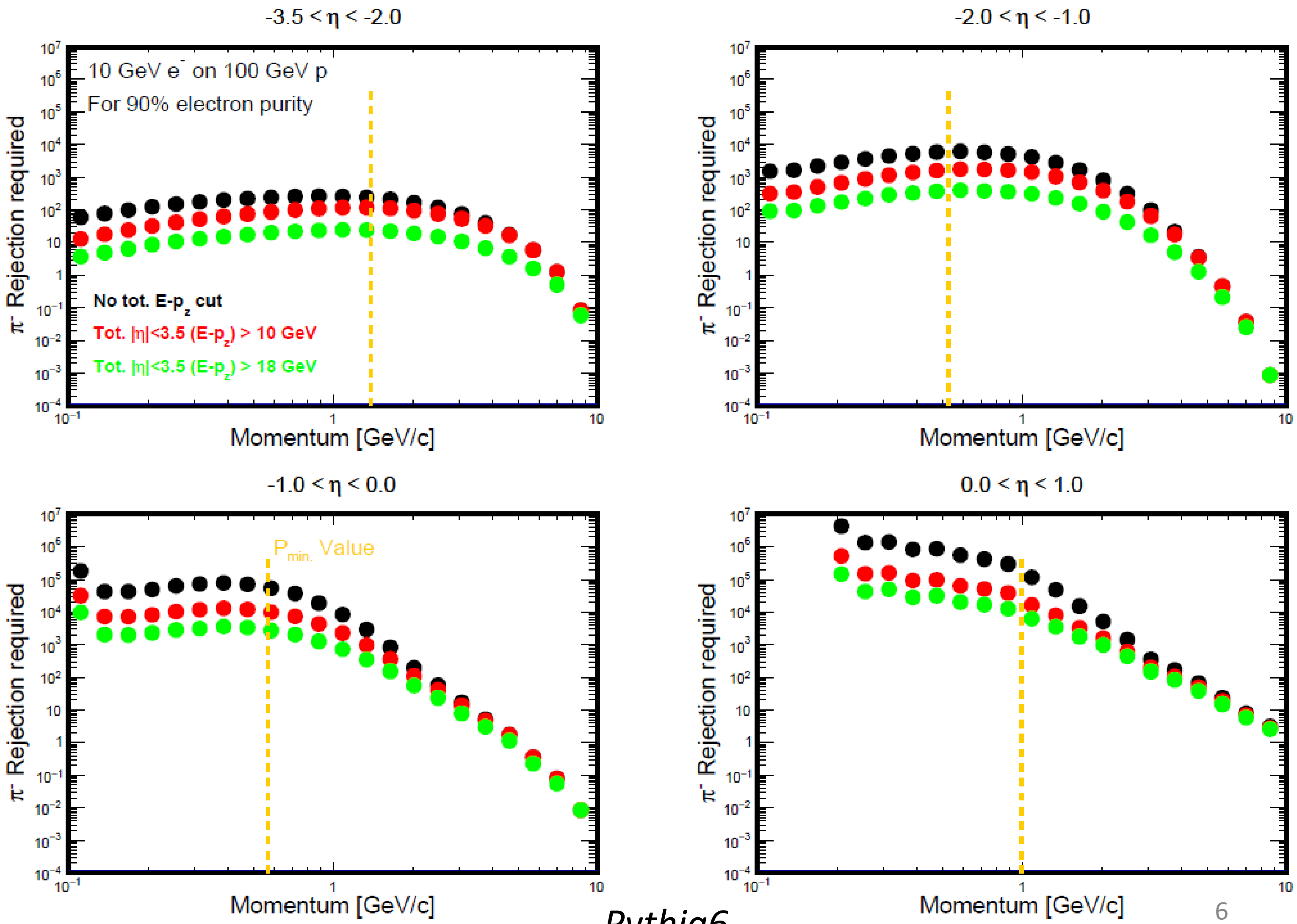
- In the detector proposals, parameterized approaches were taken to estimate the final scattered electron purity. These suggested >90% purity could be achieved.
- We need to repeat this work using the full *ePIC* simulation.
- This requires developing an electron finder that works on minimum bias data – not only for signal events.

Example: sensitivity to total E-p_z determination

- Plots to the right show the rejection factor after applying certain cuts on total E-p_z. The sum is over generated particles within the main detector acceptance.
- The effect of this cut is more pronounced at lower momentum, as expected.
- This shows that the final requirement on the detector performance will depend on the total E-p_z resolution of the detector.



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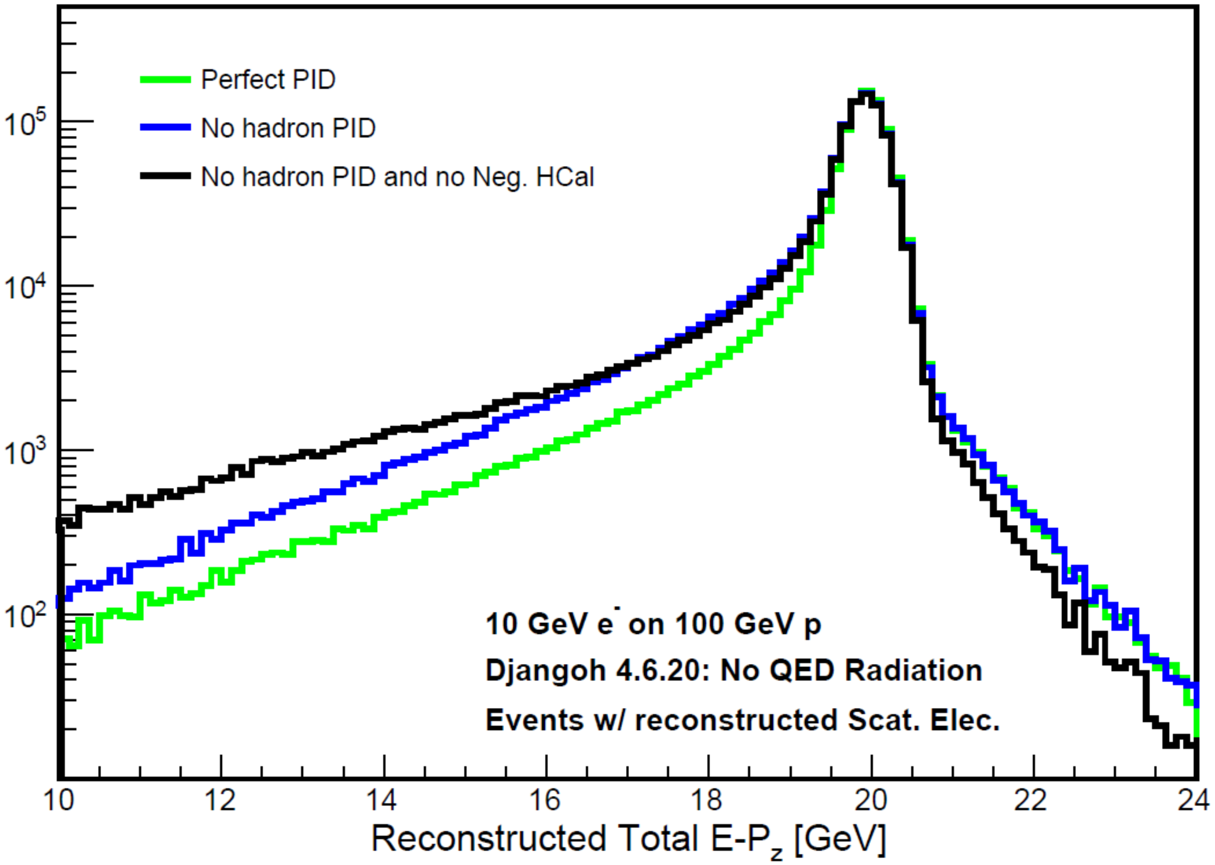
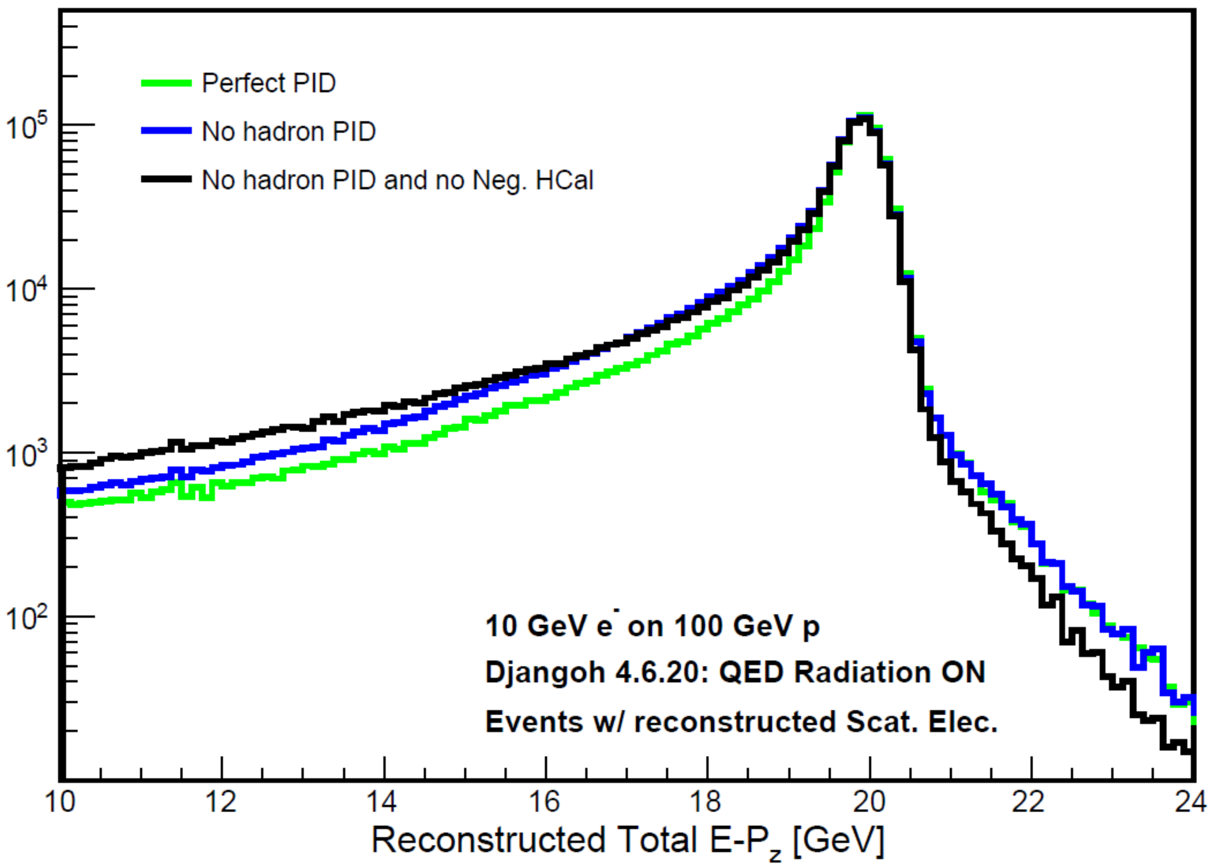
Fast simulation E-p_z resolution: Yellow Report reference detector

No QED effects included



QED effects turned ON

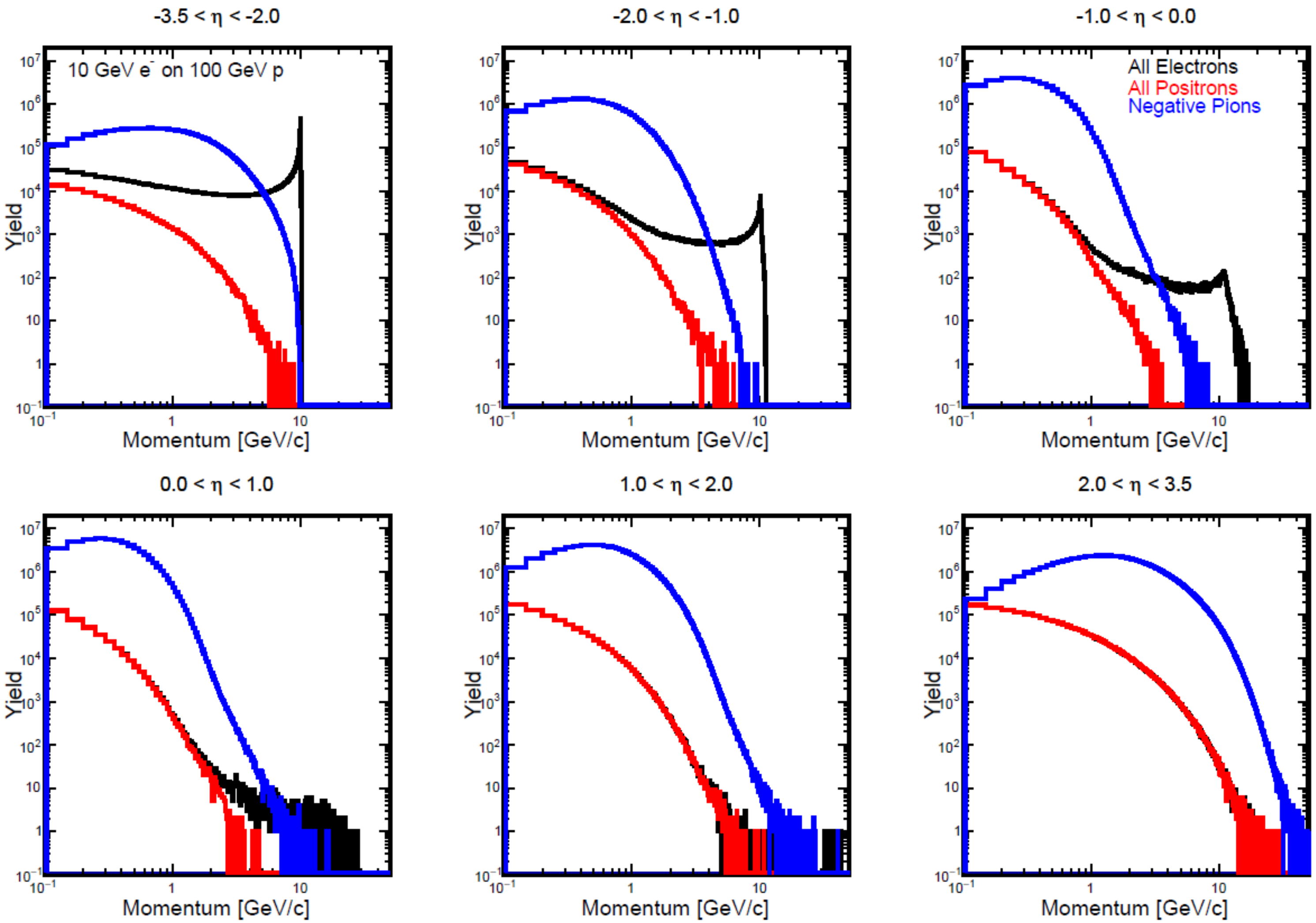


Simulation needs

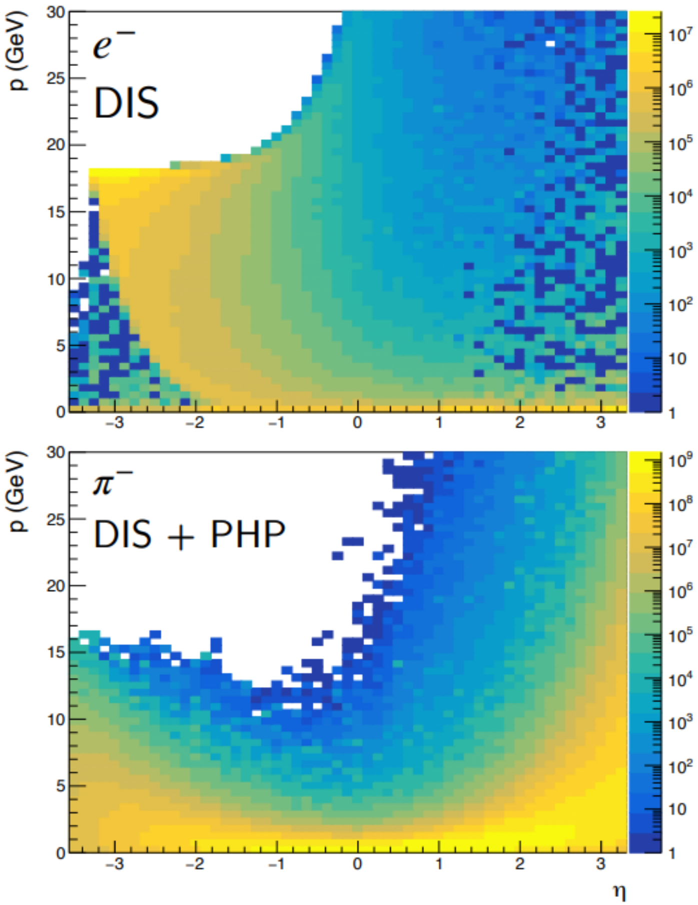
- Our signal inclusive DIS event samples have been passed through the *ePIC* simulation. We want to calculate total E-p_z resolution for these events. Some ongoing issues with reconstructing neutral particles.
- We also are developing a reconstruction algorithm for the scattered electron (electron finder) and want to test it on minimum-bias events. We need:
  1. Track projections to be saved to ROOT files. Right now, we can do analysis with track projections using an EICRecon processor (Plugin) only. See here.
  2. We have some minimum-bias events generated. We would like some of these run through the *ePIC* simulation if possible to test how well a full simulation and realistic electron finder can suppress pion background.
- In the interim, single-particle simulations can be used to estimate overall pion rejection factors and compare to our requirements.

BACKUP

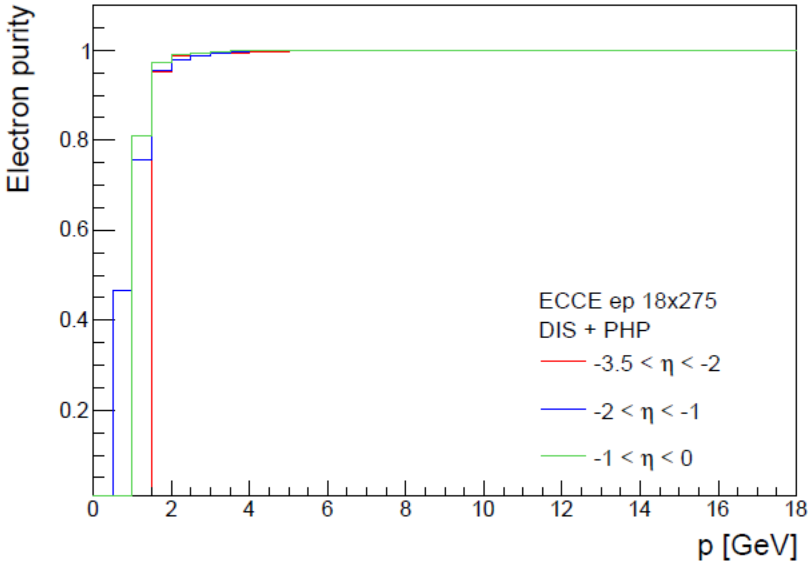
Raw backgrounds

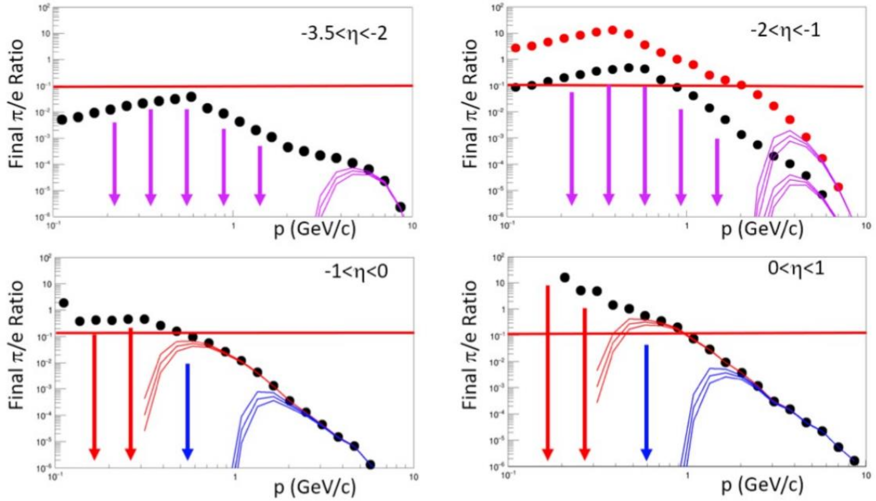


Proposal studies – Electron purity



- Studies done using raw pion-to-electron ratios and applying parameterizations of calorimeter and PID detector responses.





Fast simulation for reconstruction of total E-p_z

η range	Tracker σ_p/p [%]	EmCal σ_E/E [%]	HCal σ_E/E [%]	σ_θ [Rad]	σ_ϕ [Rad]
-4.0 – -2.0	$0.1 \cdot p \bigoplus 0.5$	$2/\sqrt{E} \bigoplus 1.0$	$50/\sqrt{E}$	$0.01/\left(p \cdot \sqrt{\sin\theta}\right)$	0.01
-2.0 – -1.0	$0.05 \cdot p \bigoplus 0.5$	$7/\sqrt{E} \bigoplus 1.0$	$50/\sqrt{E}$		
-1.0 – +1.0	$0.05 \cdot p \bigoplus 0.5$	$12/\sqrt{E} \bigoplus 1.0$	$85/\sqrt{E} \bigoplus 7.0$		
+1.0 – +2.5	$0.05 \cdot p \bigoplus 1.0$	$12/\sqrt{E} \bigoplus 1.0$	$50/\sqrt{E}$		
+2.5 – +4.0	$0.1 \cdot p \bigoplus 2.0$	$12/\sqrt{E} \bigoplus 1.0$	$50/\sqrt{E}$		

Charged particles
Photons
Neutral hadrons

General comments:

1. Parameterization based on Yellow Report detector matrix, with minor changes.
2. We only study events where the scattered electron is reconstructed.
3. We use the tracker to reconstruct the momentum (energy) of the scattered electron for this study.
4. When the radiated photon is within the detector acceptance, we assume it is separated from the scattered electron and can be treated as any other photon.
5. For all particles, we use a minimum P_t acceptance of $P_t > 0.25$ GeV/c.

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Charged particles
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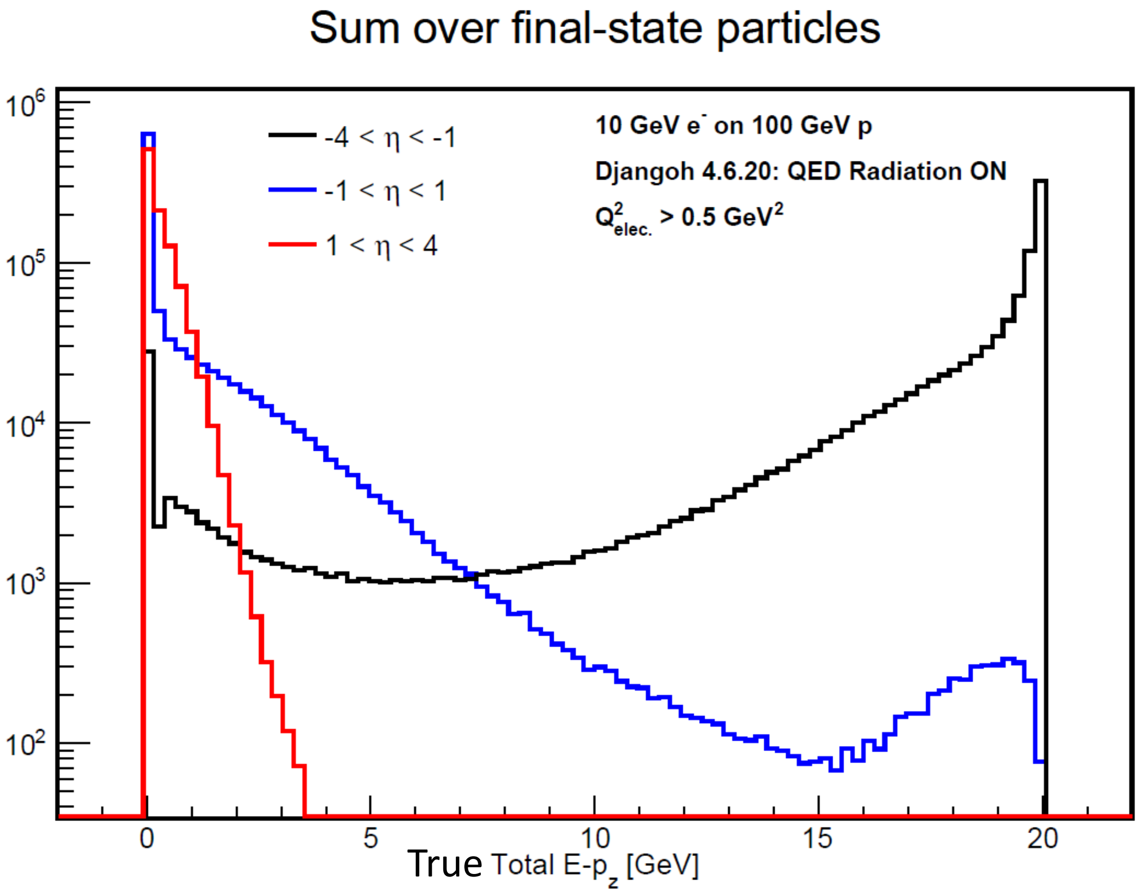
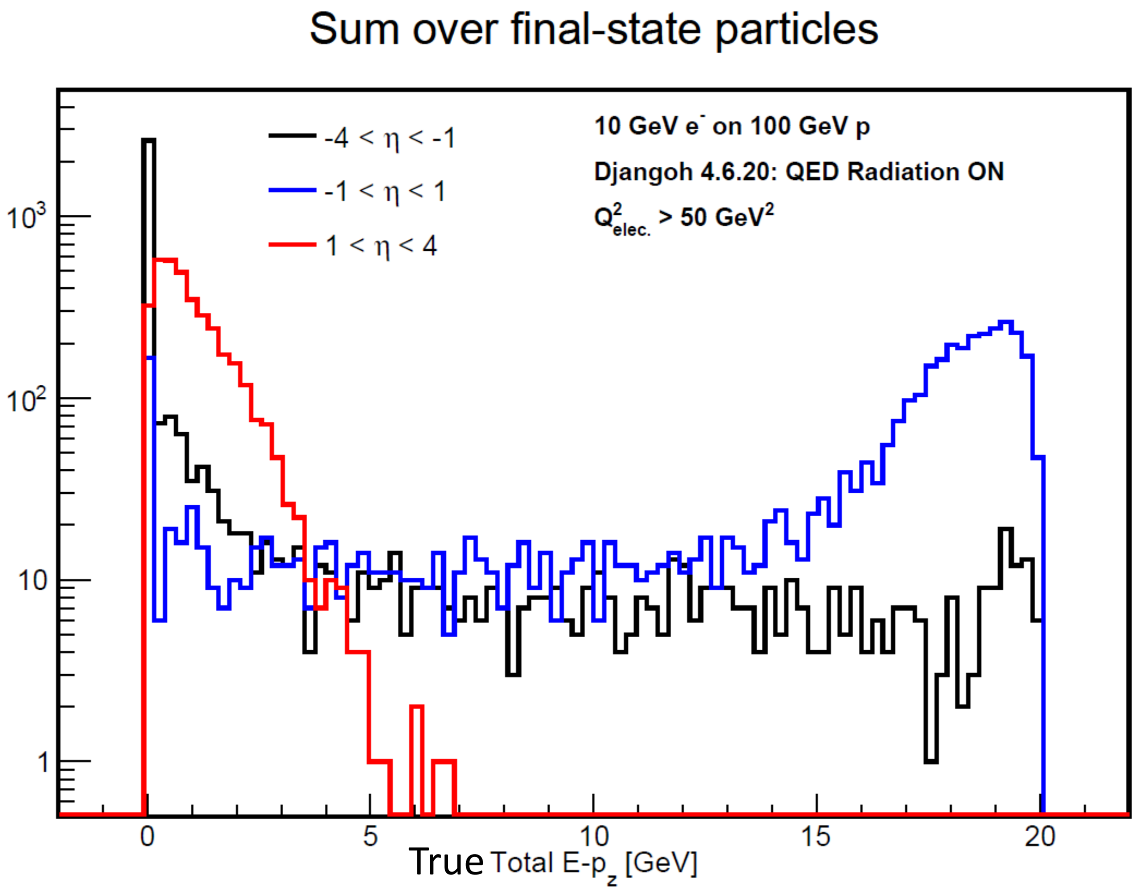
We studied three different detector settings within the above detector configuration:

1. Perfect PID for all reconstructed particles.
2. No hadronic PID: for charged particles other than electrons and positrons, reconstruct particle using charged pion mass; for neutral hadrons, reconstruct using zero mass.
3. No hadronic PID and no backwards HCal: same as setting 2, with HCal from -4 < eta < -1 removed.

Where in the detector does most of the total E-p_z go?





Distribution of the total E-p_z in the detector depends strongly on the scattered electron kinematics.

Hadronic final-state (HFS) distribution and total E-p_z

- The HFS will carry a total E-p_z approximately equal to the inelasticity times twice the electron beam energy $(2yE_e)$.
- The HFS will go into the hadron endcap at lower values of y – this is, when is carries a small amount of the total E-p_z. The exception may be at very high x and Q^2 for the high beam energy setting.