Particle production studies for pfRICH

Jan Vanek

BNL

pfRICH meeting

12/21/2022

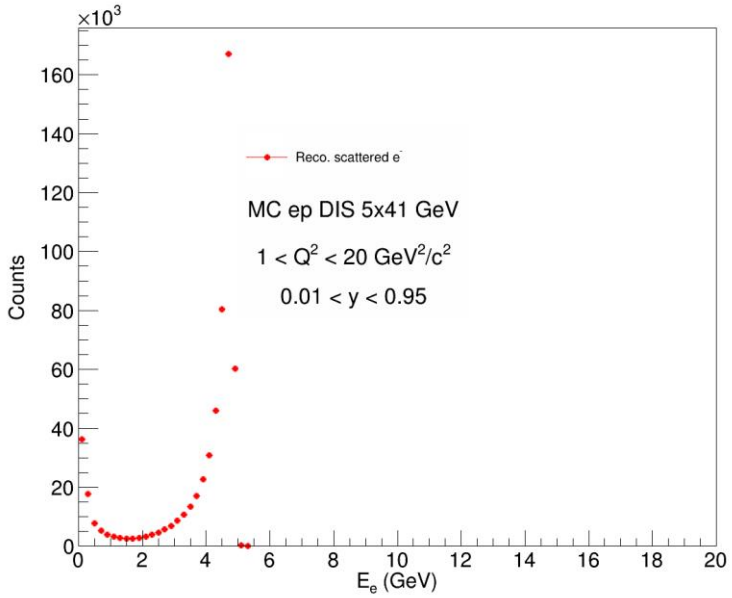
OVERVIEW

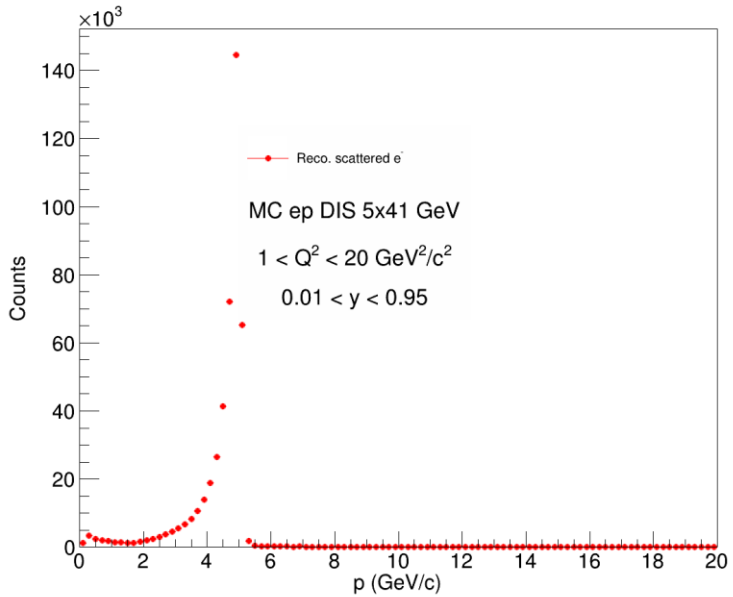
- Reconstruction of scattered electrons from reconstructed tracks
  - MC DIS ep collisions 5x41, 10x100, and 18x275 GeV
  - Reconstruction using eCAL and pfRICH
  - Comparison to MC scattered electrons
    - η distributions
    - Reconstructed scattered electron purity
  - Multiple p, Q^2 and y (inelasticity) bins
    - Same binning as for MC presented in the past

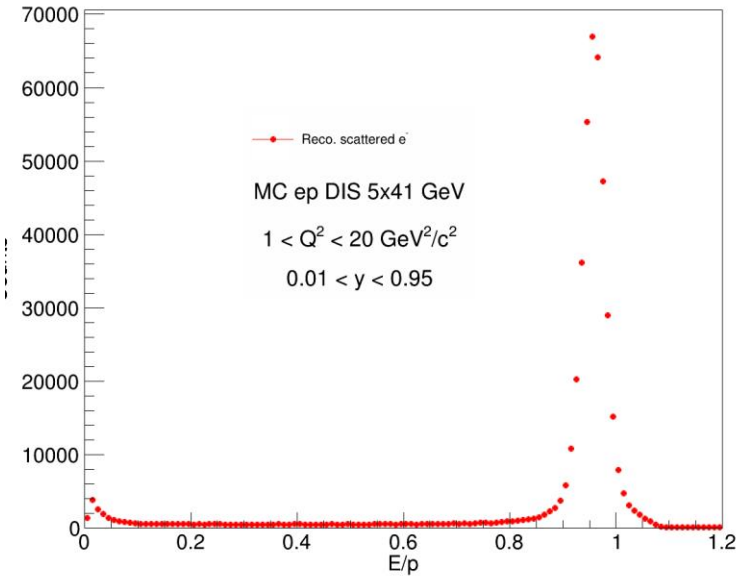
SCATTERED ELECTRON SELECTION USING ECAL

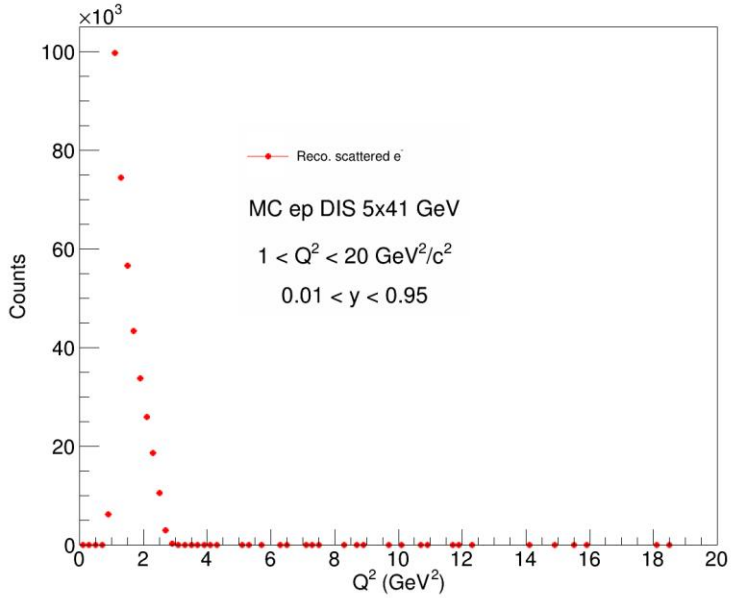
1. Find leading cluster in negative eCAL
   - Using EcalEndcapNClusters class
   - Leading cluster = cluster with highest energy in event
2. Find matching charged track
   - Using ReconstructedChargedParticles class
   - Using simID to do the matching
   - Get momentum of matched charged track
3. Use extracted energy and momentum for further analysis
   - Calculated E/p, Q2, y
   - Evaluated scattered electron candidate purity
     - Find PDG ID of selected candidates through simID and check if matching MC track is electron or not

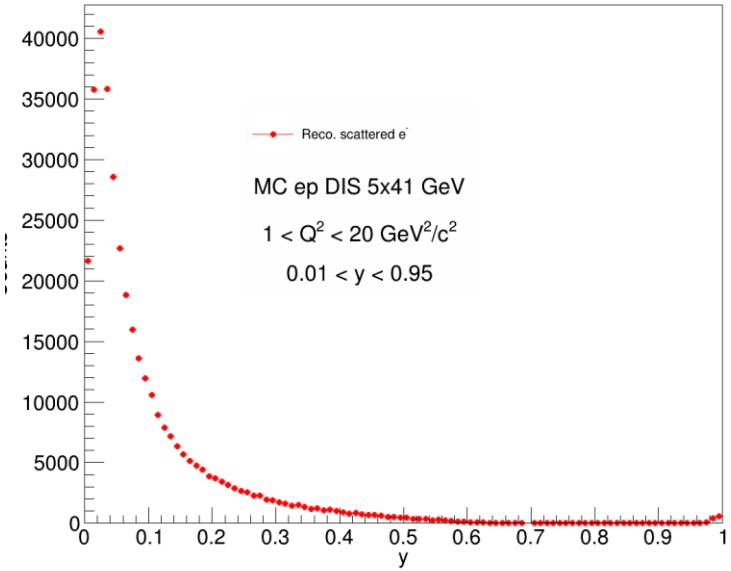
RECO. SCATTERED ELECTRON DISTRIBUTIONS











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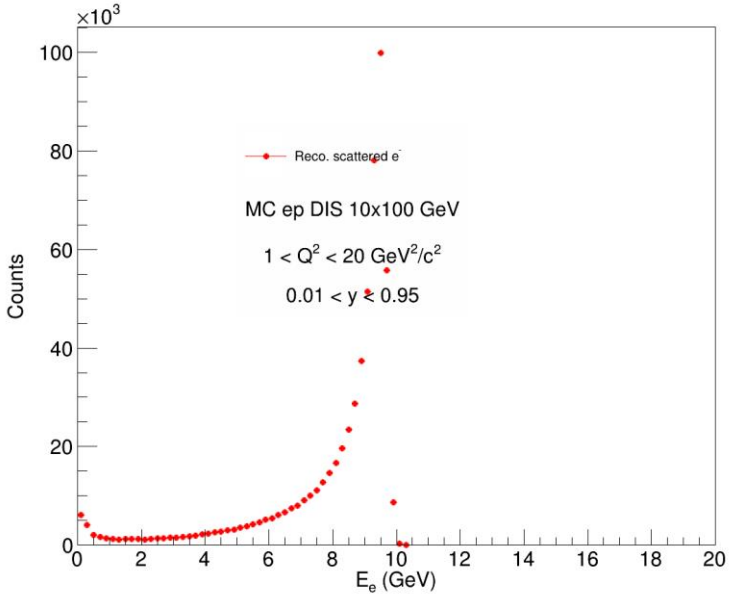

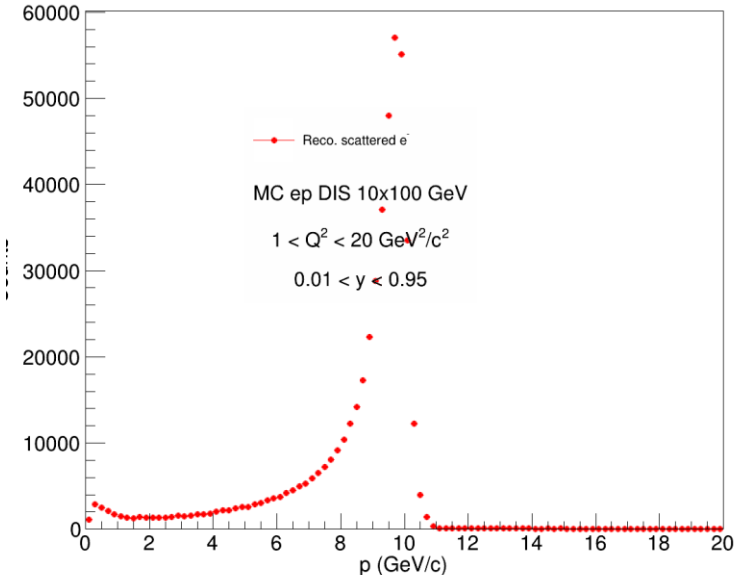

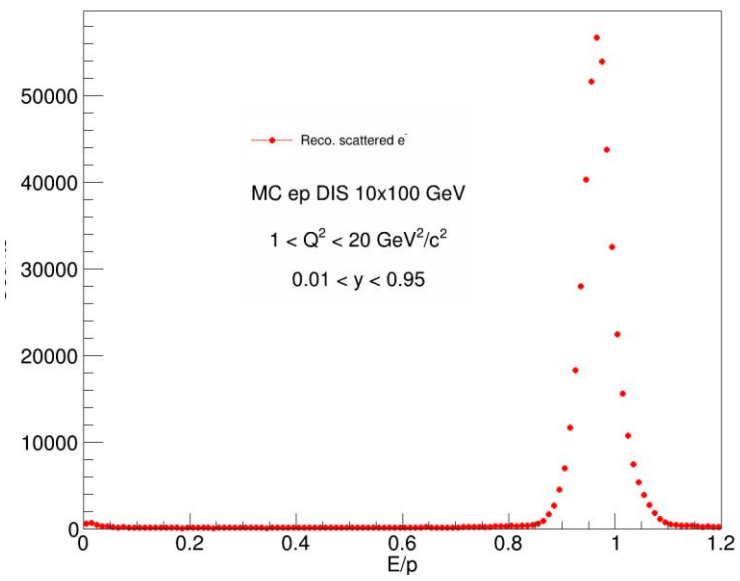

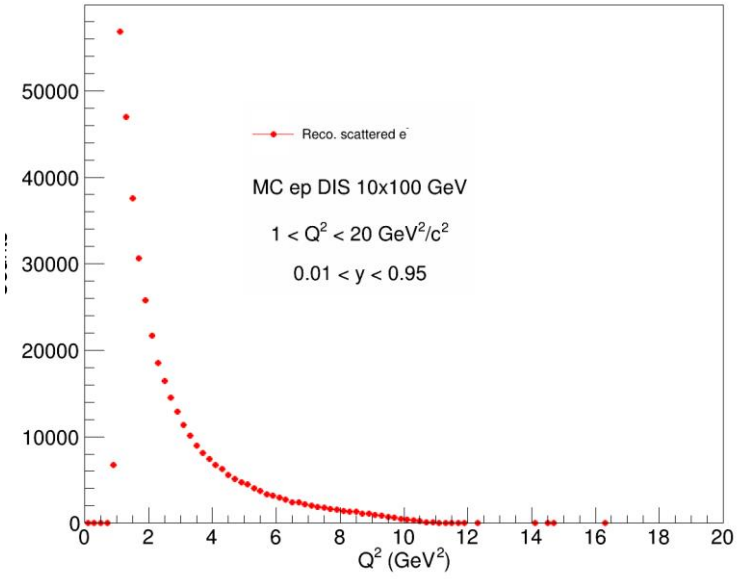

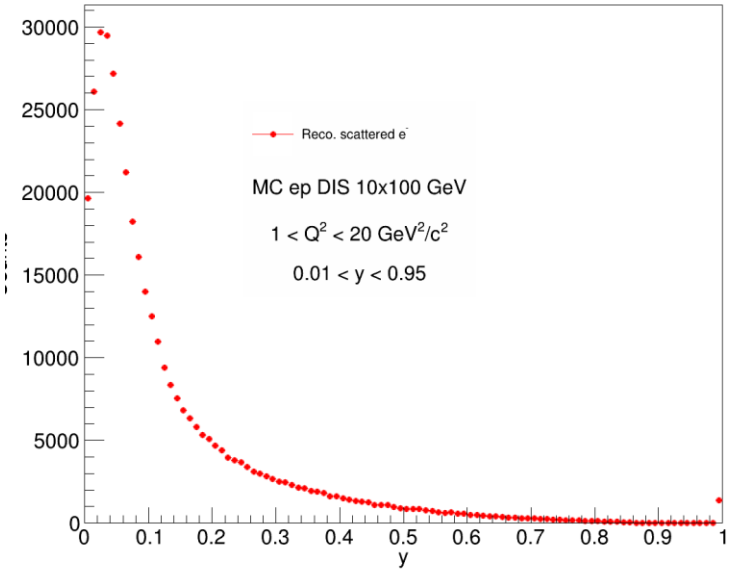

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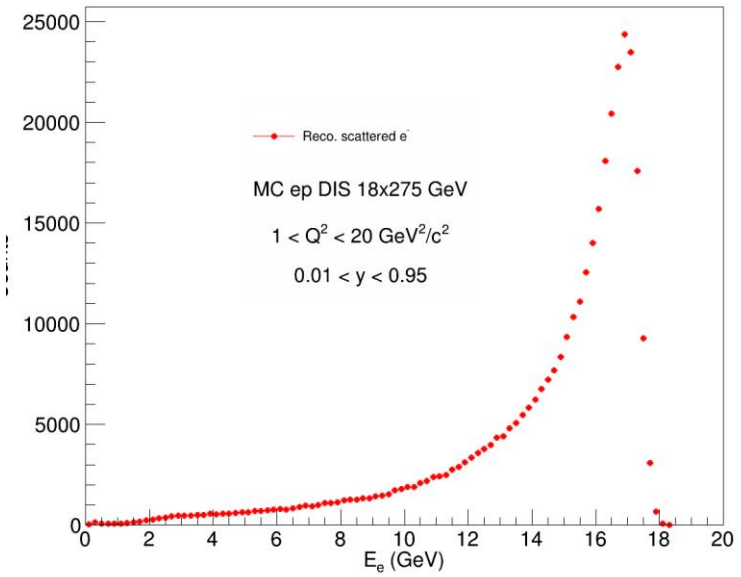
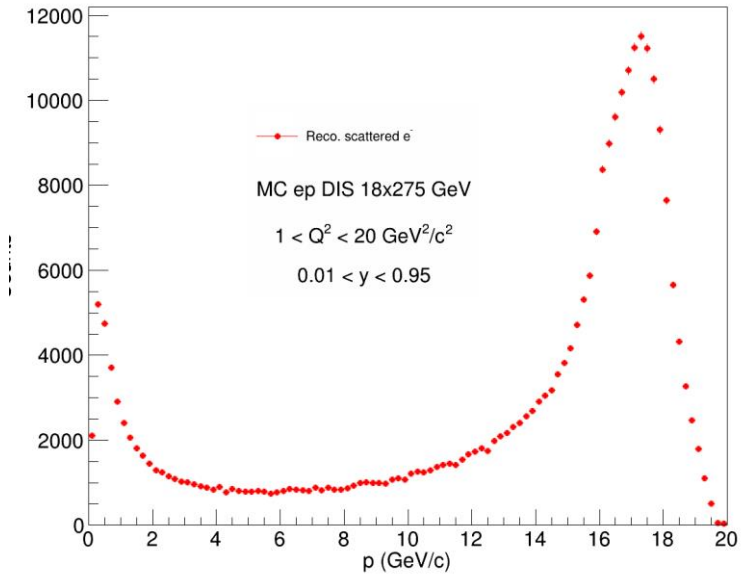
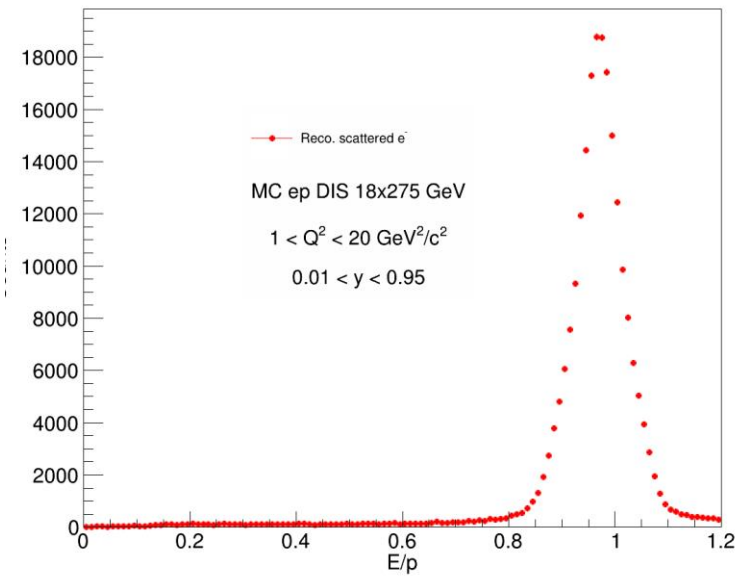
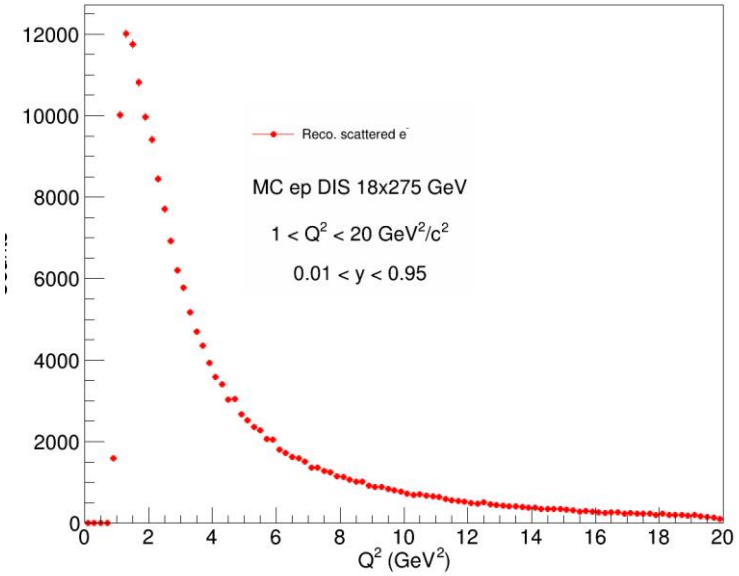
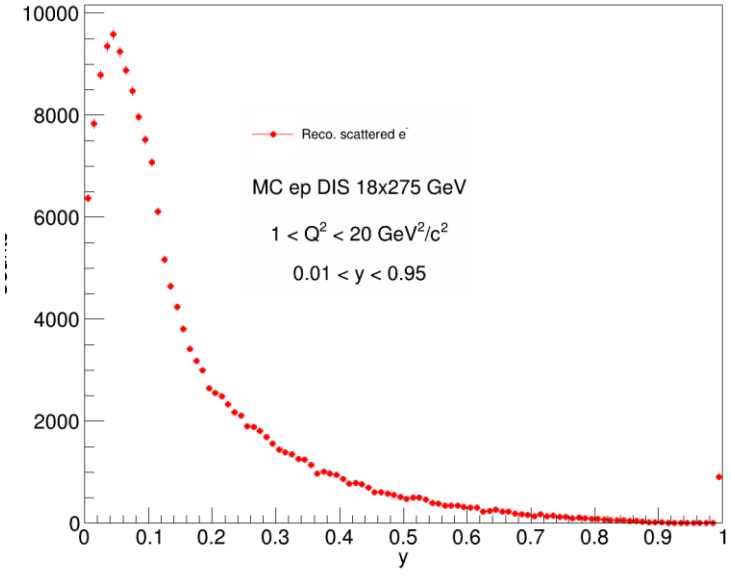




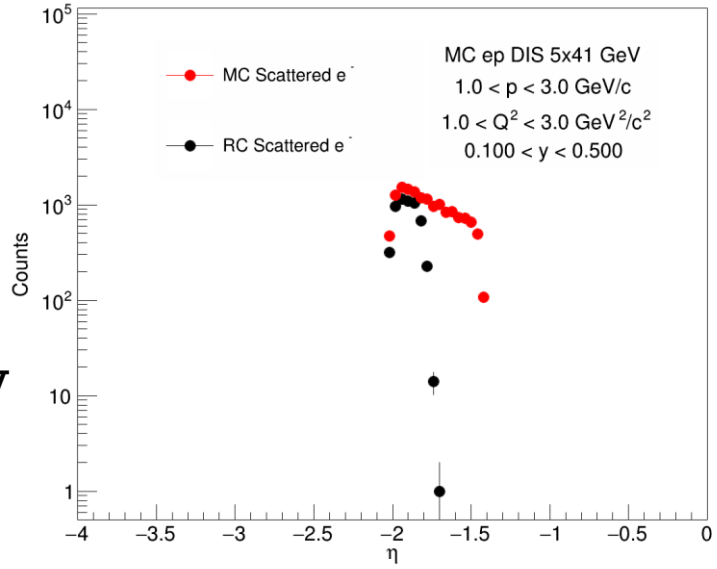


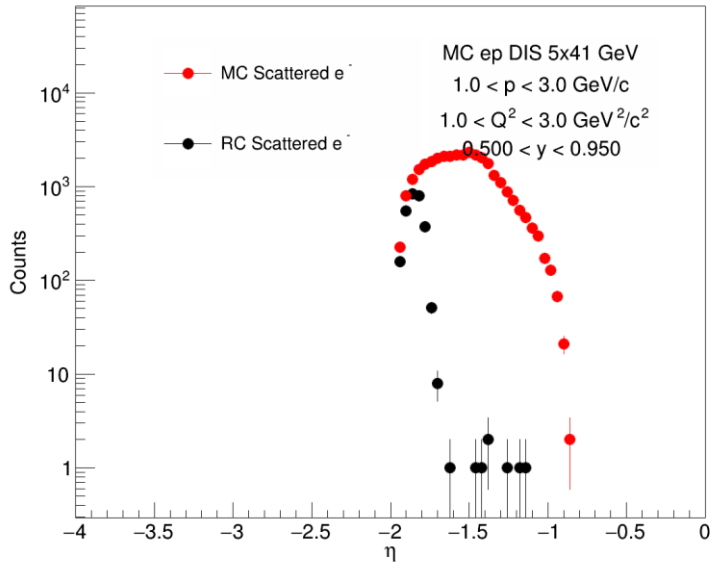




SCATTERED ELECTRONS – MC VS. RECO. (eCAL)

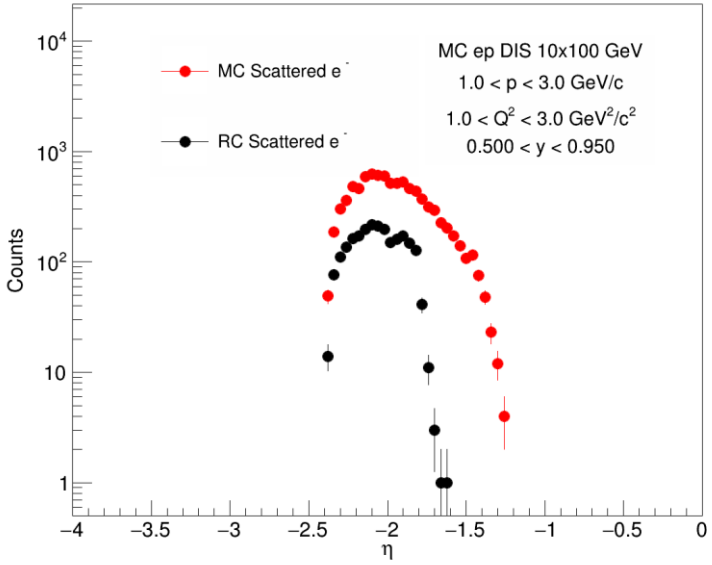
- MC DIS ep collisions at **5x41 GeV**
- Comparison of MC scattered electron and reconstructed scattered electron candidates
  - Reconstructed scattered electrons identified using eCAL
- Reconstructed and MC distribution seem to be consistent
  - Shape of RC distributions influenced by eCAL acceptance

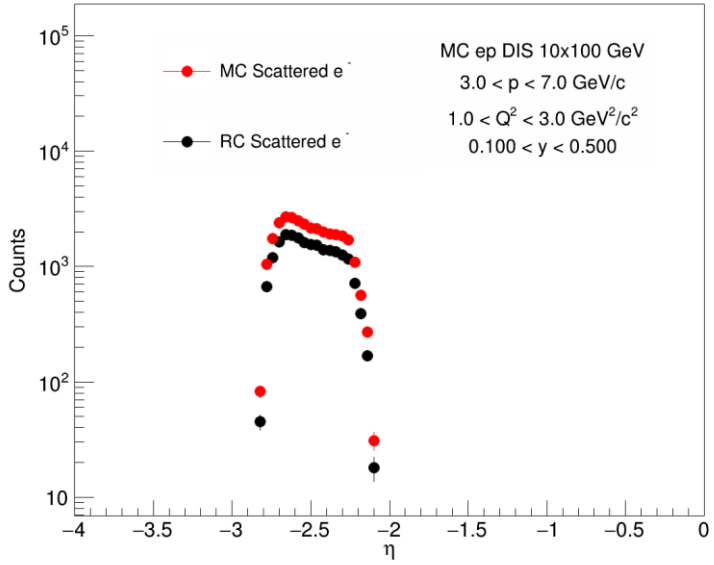


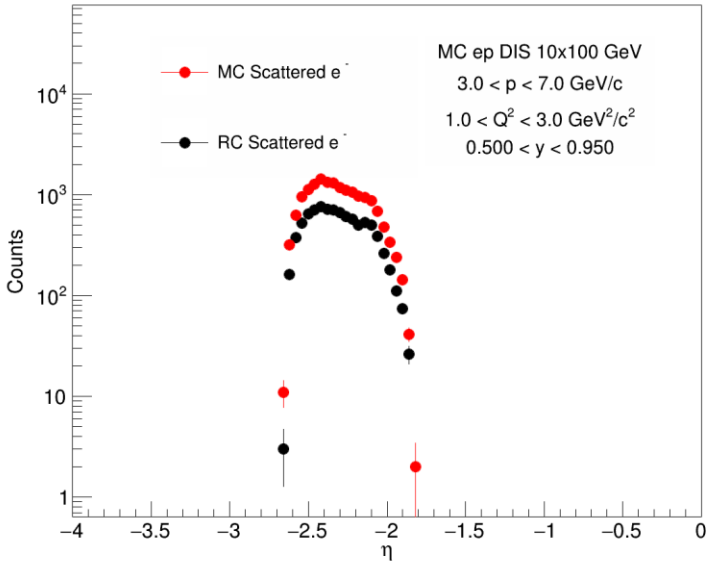


SCATTERED ELECTRONS – MC VS. RECO. (eCAL)

- MC DIS ep collisions at **10x100 GeV**
- Comparison of MC scattered electron and reconstructed scattered electron candidates
  - Reconstructed scattered electrons identified using eCAL
- Reconstructed and MC distribution seem to be consistent
  - Shape of distributions mostly well reproduced
  - Influence of cut efficiency and purity
  - Lower eCAL efficiency for lower *p*

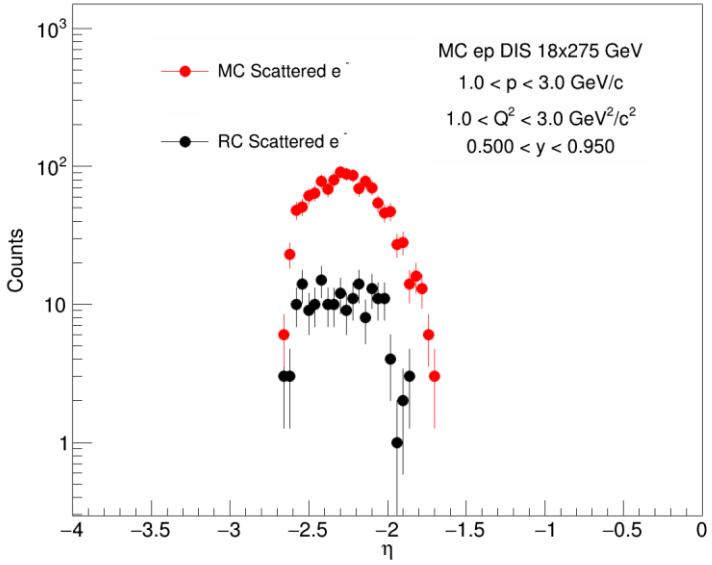


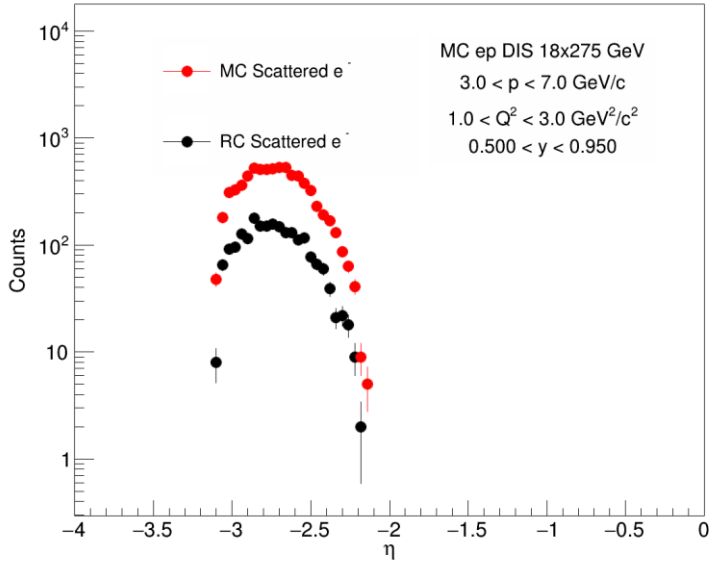


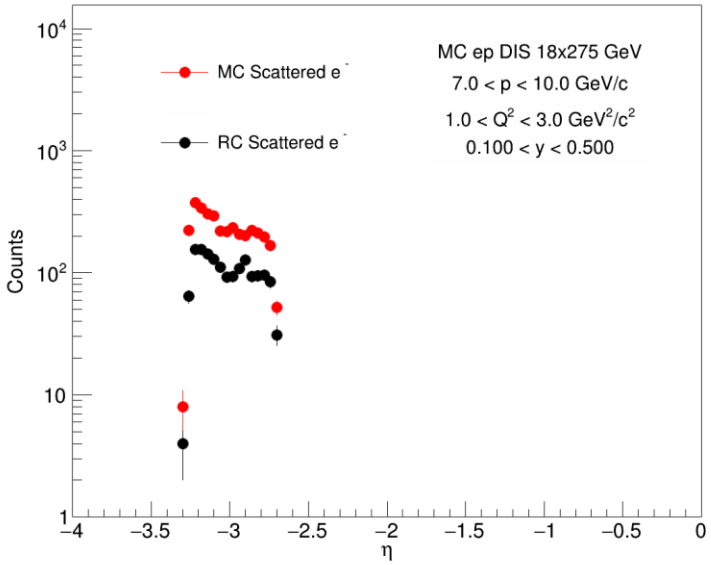


SCATTERED ELECTRONS – MC VS. RECO. (eCAL)

- MC DIS ep collisions at **18x275 GeV**
- Comparison of MC scattered electron and reconstructed scattered electron candidates
  - Reconstructed scattered electrons identified using eCAL
- Reconstructed and MC distribution seem to be consistent
  - Shape of distributions mostly well reproduced
  - Influence of cut efficiency and purity
  - Lower eCAL efficiency for lower *p*

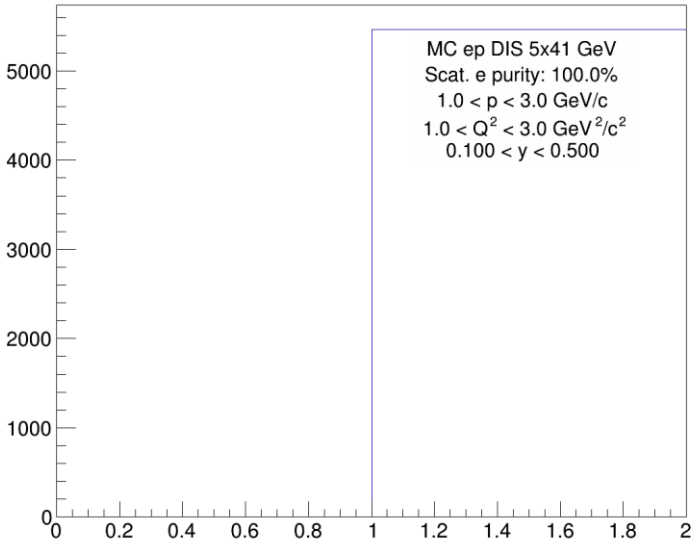


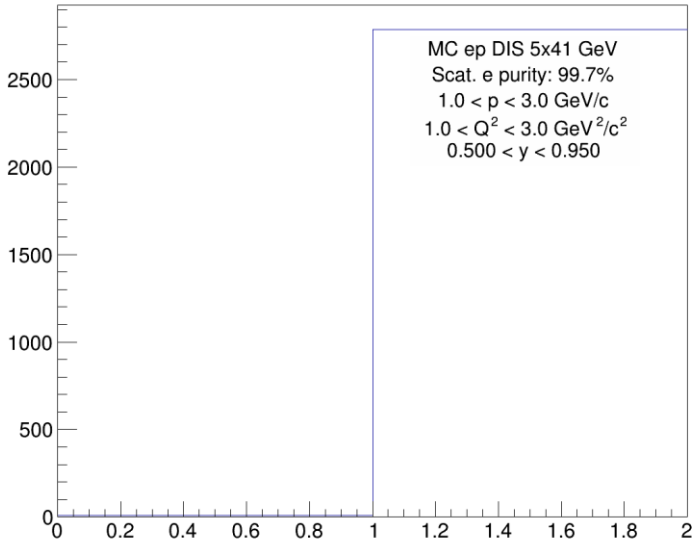




RECO. SCATTERED ELECTRON PURITY – eCAL

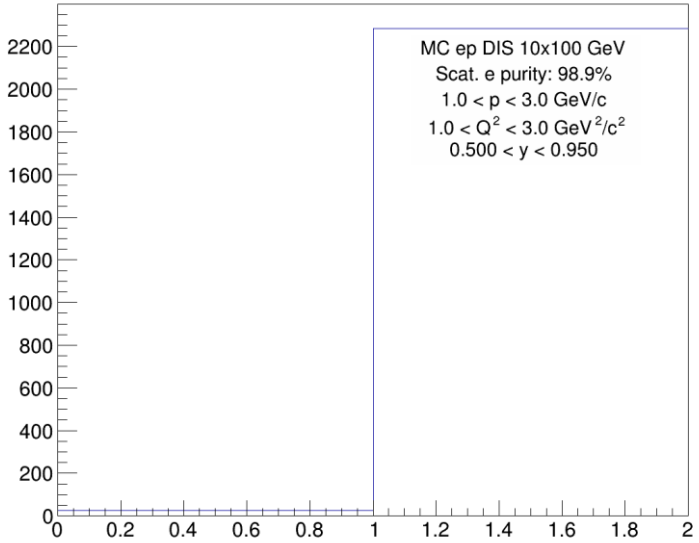
- MC DIS ep collisions at **5x41 GeV**
- Purity of reconstructed scattered electron candidates identified using eCAL
  - Extracted PDG ID of corresponding MC particles via simID
  - Bin 0-1: Number of other particles, mis-identified as electrons (N_b)
  - Bin 1-2: Number of MC electrons identified as RC electrons (N_e)
  - Purity = $N_e/(N_e + N_b)$
    - In figures
  - This method cannot distinguish background electrons and scattered electrons
    - Background electron levels should be small in most of the phase space

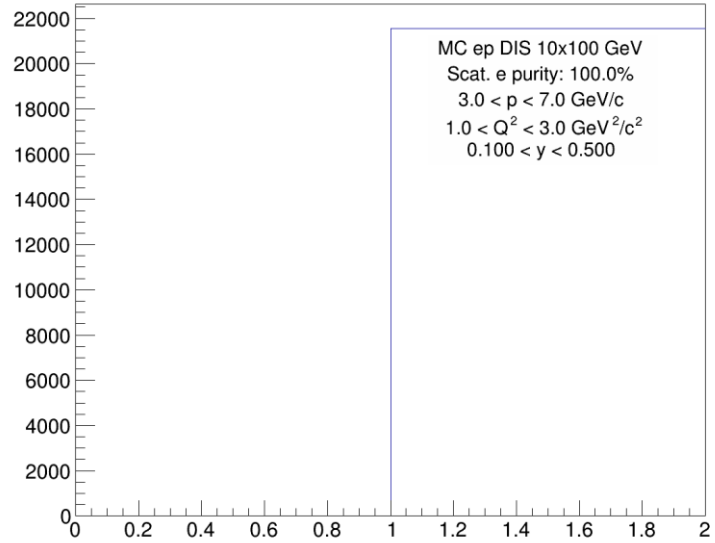


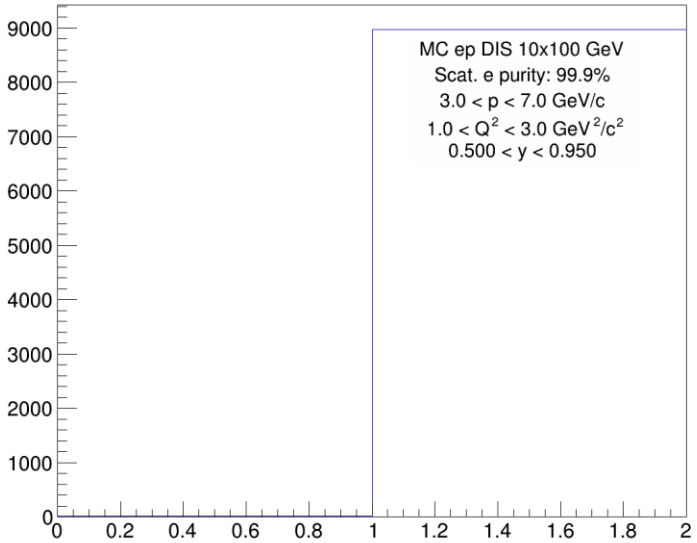


RECO. SCATTERED ELECTRON PURITY – eCAL

- MC DIS ep collisions at **10x100 GeV**
- Purity of reconstructed scattered electron candidates identified using eCAL
  - Extracted PDG ID of corresponding MC particles via simID
  - Bin 0-1: Number of other particles, mis-identified as electrons (N_b)
  - Bin 1-2: Number of MC electrons identified as RC electrons (N_e)
  - Purity = $N_e/(N_e + N_b)$
    - In figures
  - This method cannot distinguish background electrons and scattered electrons
    - Background electron levels should be small in most of the phase space







RECO. SCATTERED ELECTRON PURITY – eCAL

- MC DIS ep collisions at **18x275 GeV**
- Purity of reconstructed scattered electron candidates identified using eCAL
  - Extracted PDG ID of corresponding MC particles via simID
  - Bin 0-1: Number of other particles, mis-identified as electrons (N_b)
  - Bin 1-2: Number of MC electrons identified as RC electrons (N_e)
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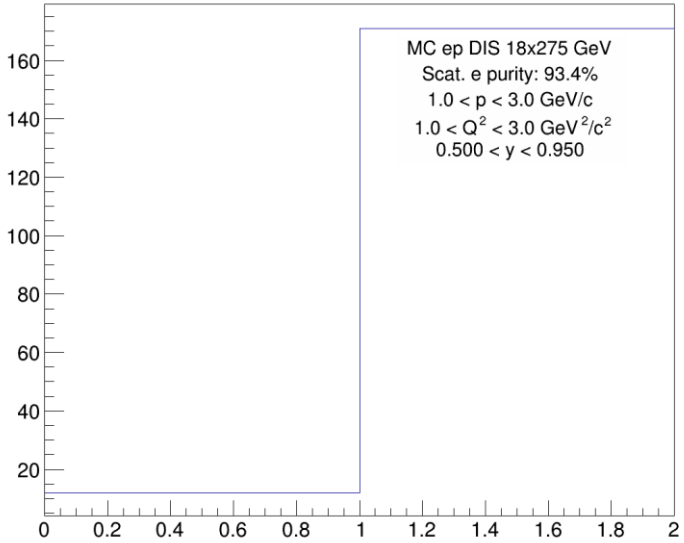
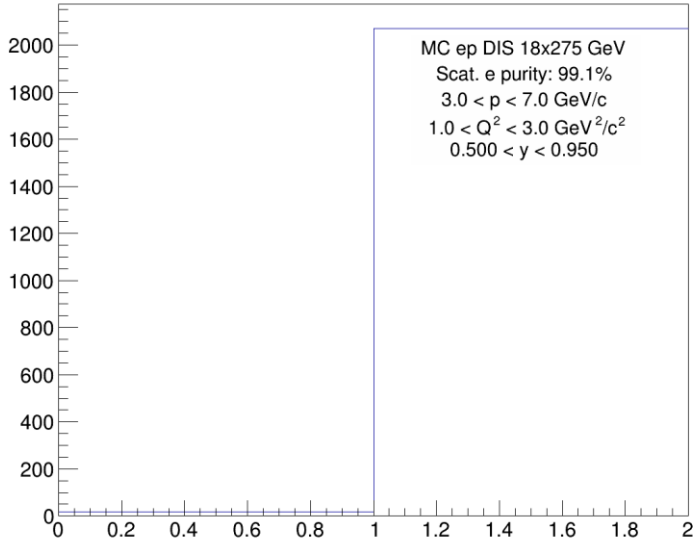
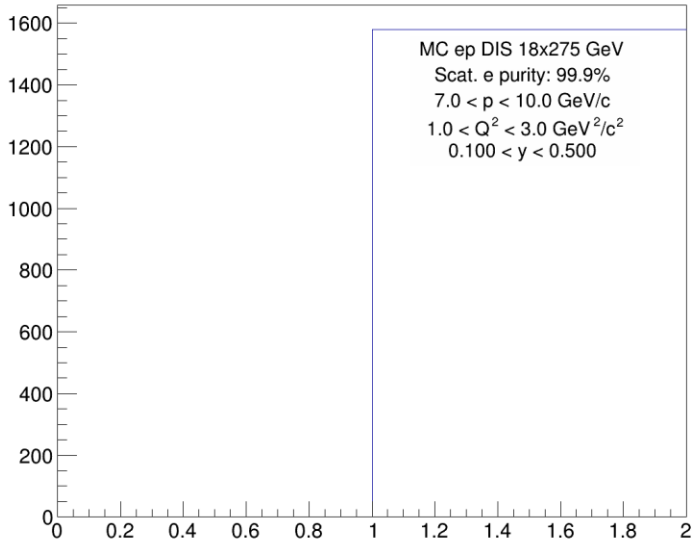


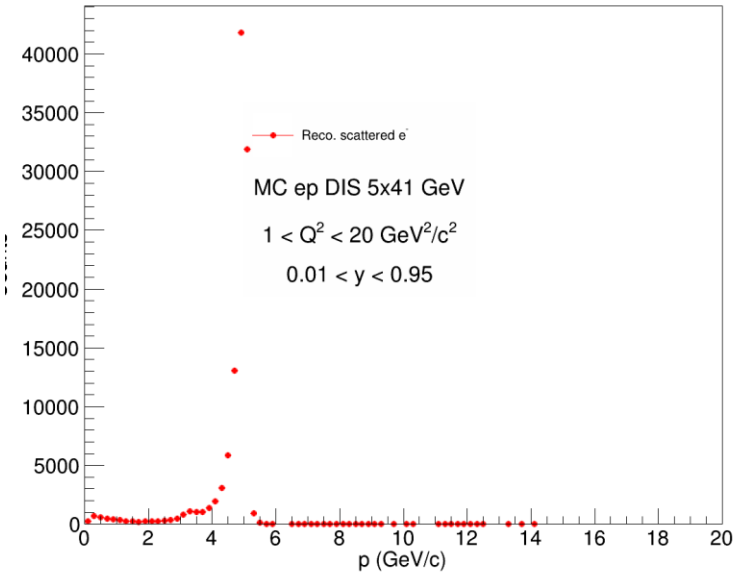


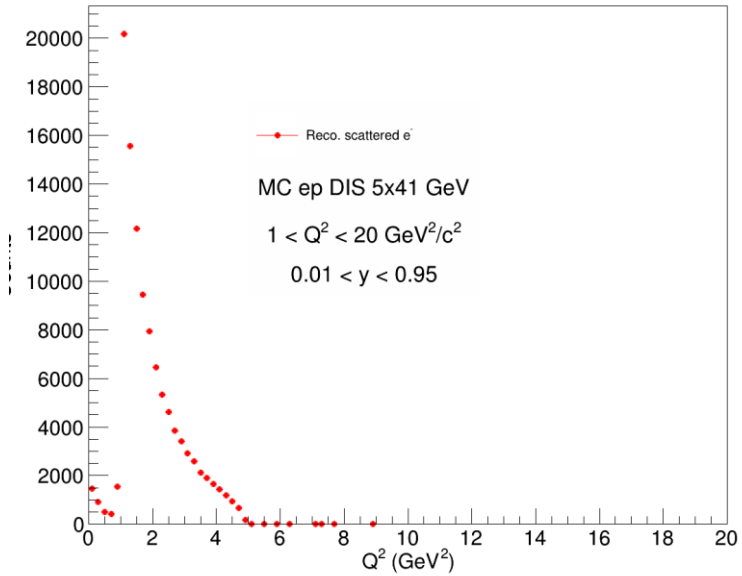


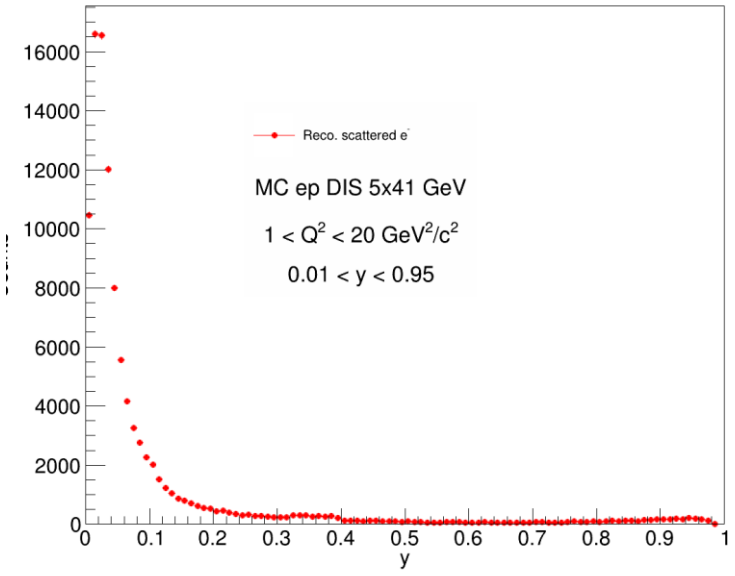
SCATTERED ELECTRON SELECTION USING pfRICH

1. Find leading momentum track
   - Using ReconstructedChargedParticles class
   - Accepting only tracks with negative charge
2. Match leading momentum track to MC
   - Via simID
3. In case MC is $\pi^-/K^-/\bar{p}$ find pfRICH PID probability
   - PID: Generate random number and compare to pfRICH PID probability
   - If hadron is well identified, do not accept it for further analysis
   - If track s not identified as $\pi^-/K^-/\bar{p}$, accept as scattered electron
     - Eventually would like pfRICH PID information directly for electrons
       - Not available in current pfRICH PID table
   - Rejecting tracks which don't have valid pfRICH information
   - Rejecting tracks which are not $e^-/\pi^-/K^-/\bar{p}$
     - Gives control over testing particle sample
     - Overall small influence on distributions and purities

RECO. SCATTERED ELECTRON DISTRIBUTIONS







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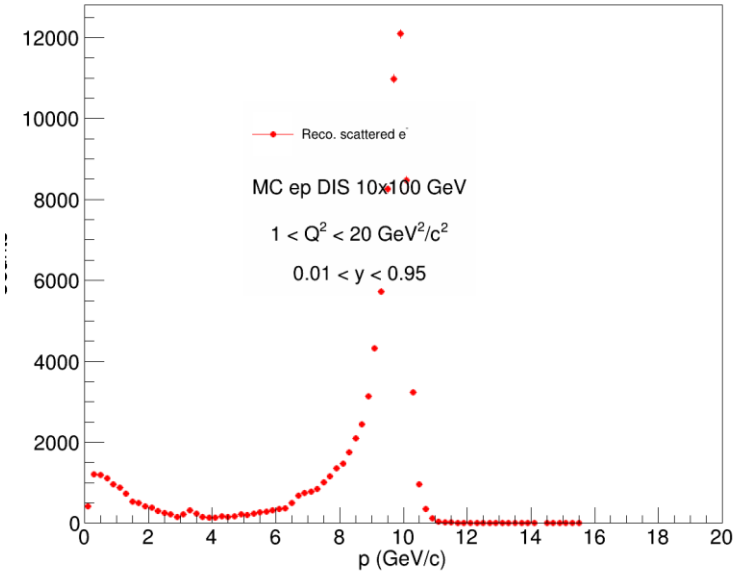

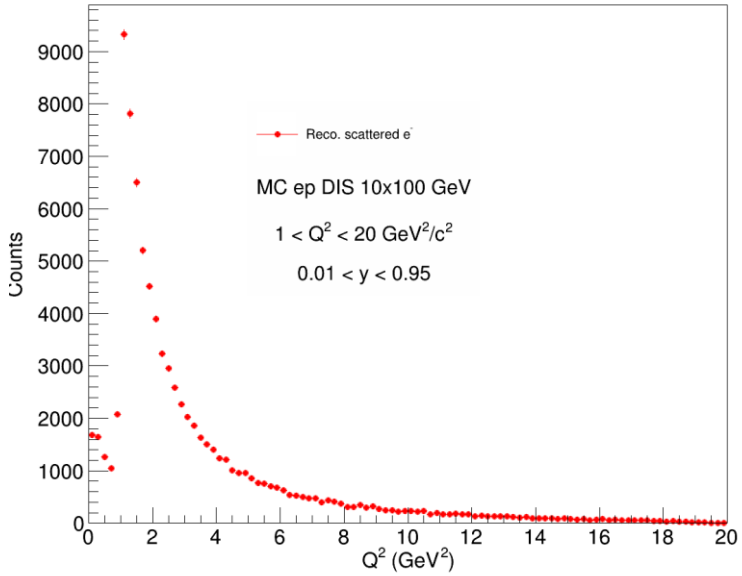

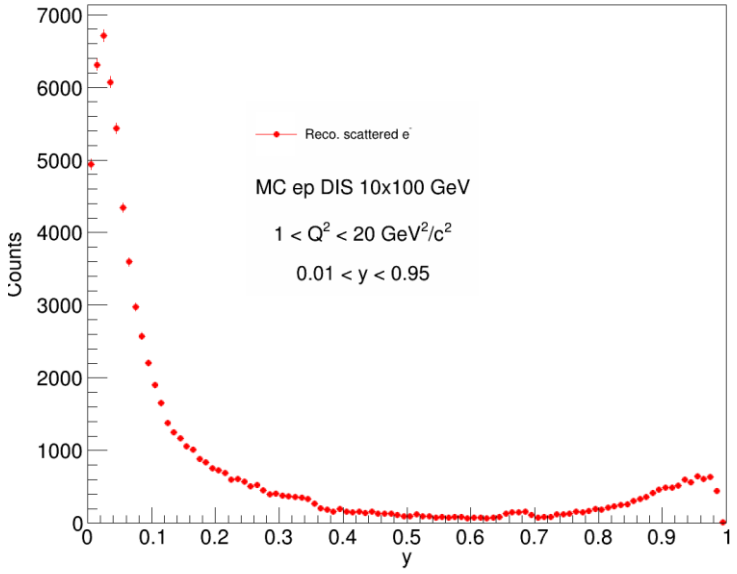

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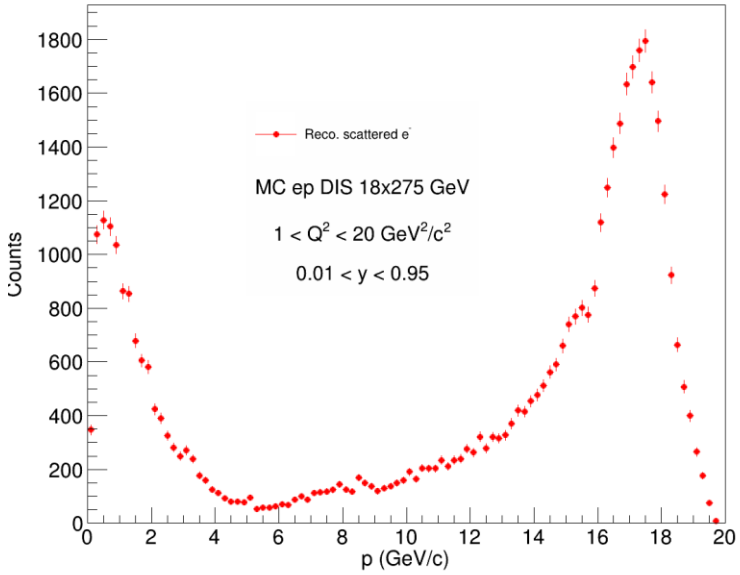

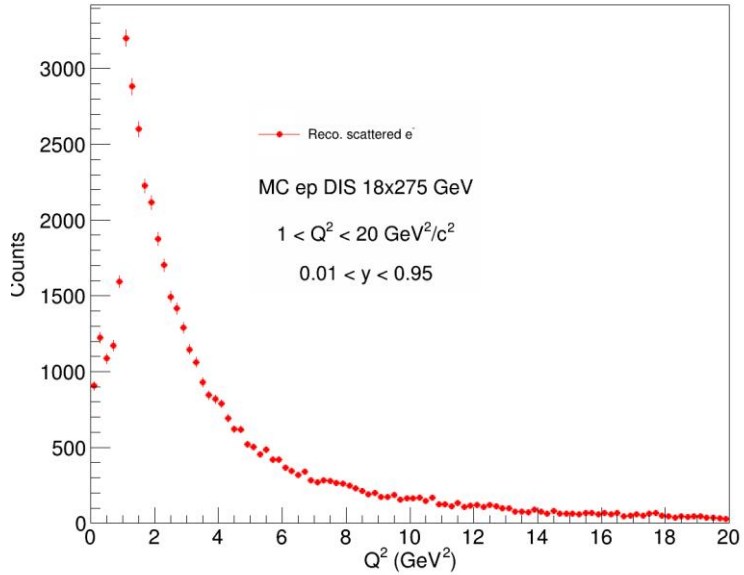

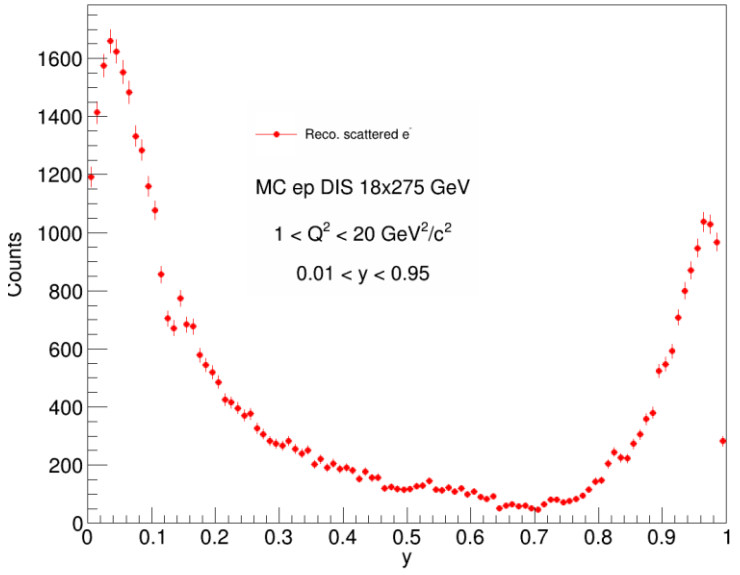

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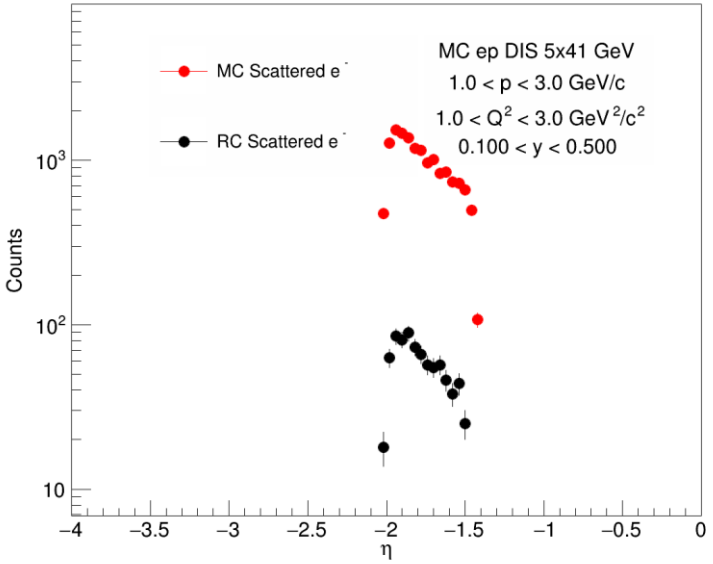

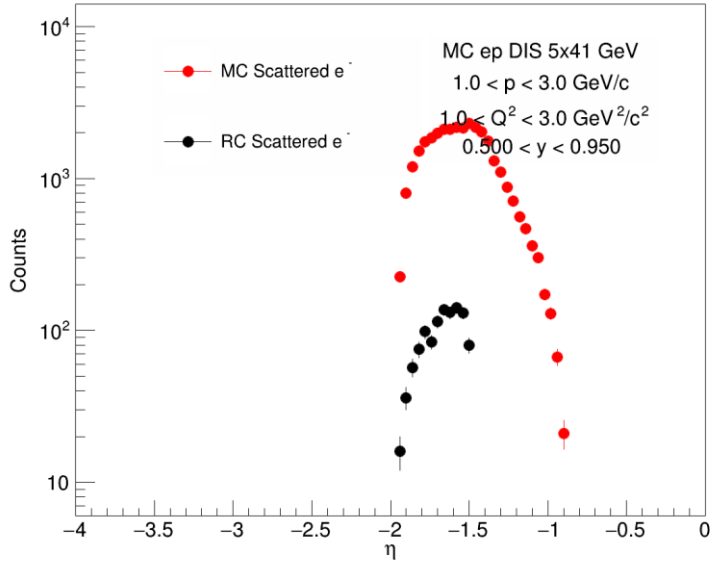

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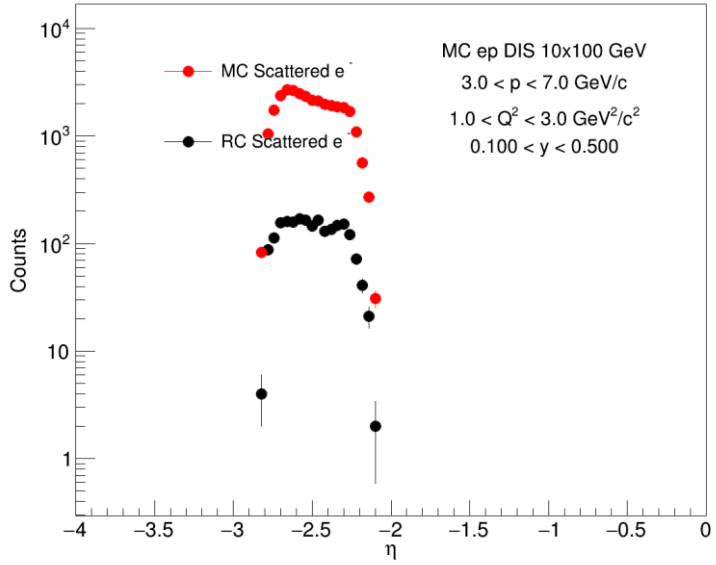

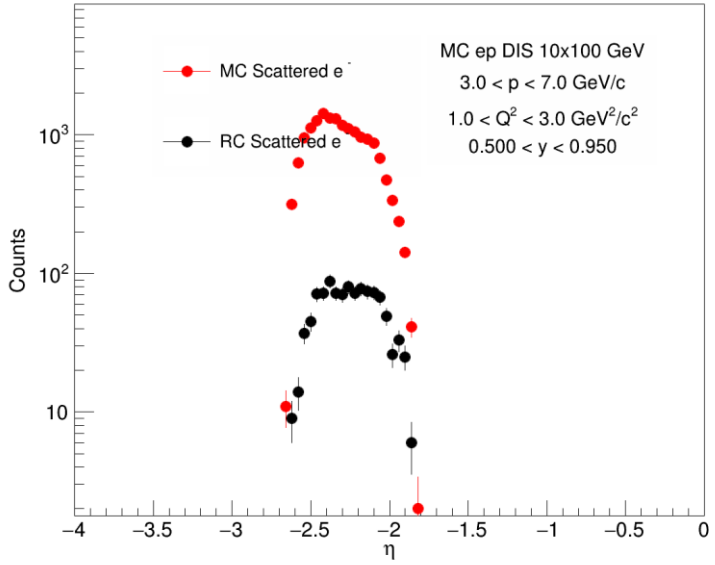

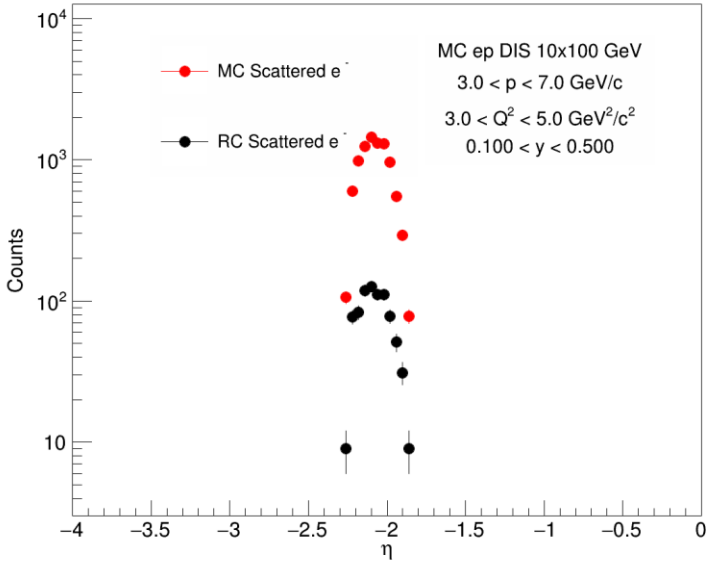

SCATTERED ELECTRONS – MC VS. RECO. (pfRICH)

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  - Shape of distributions mostly well reproduced
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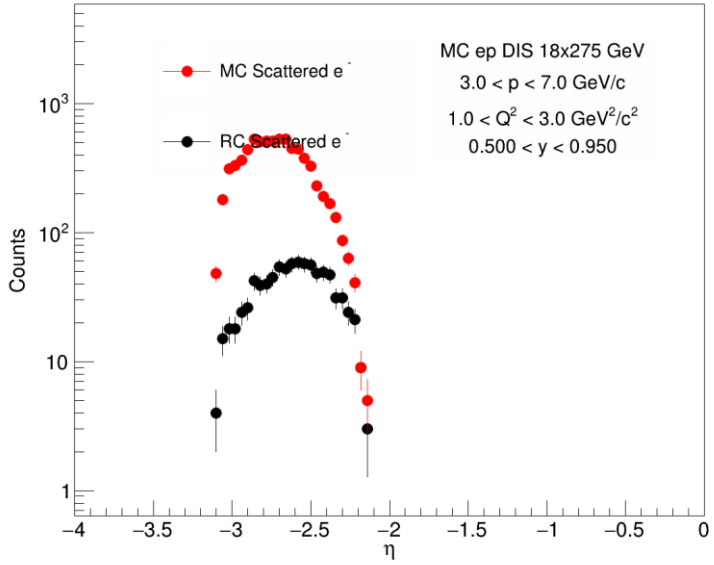

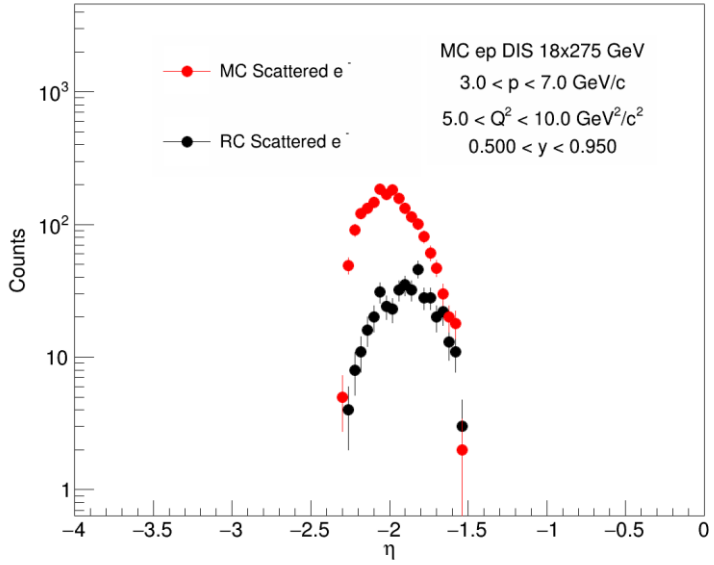

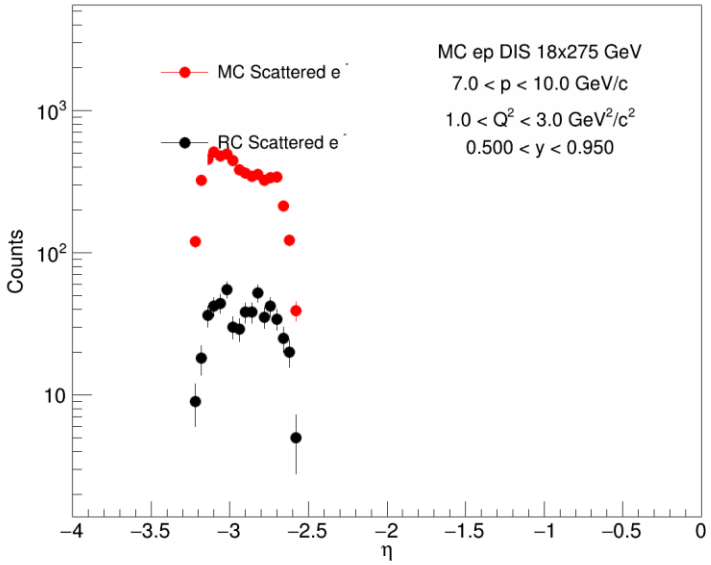

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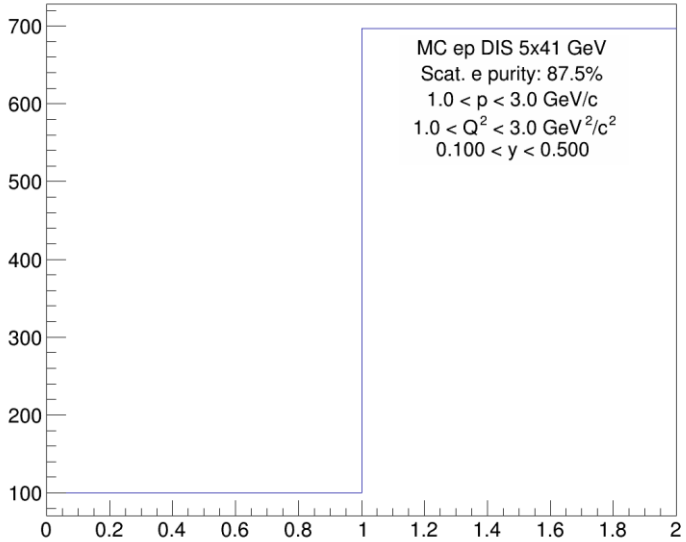
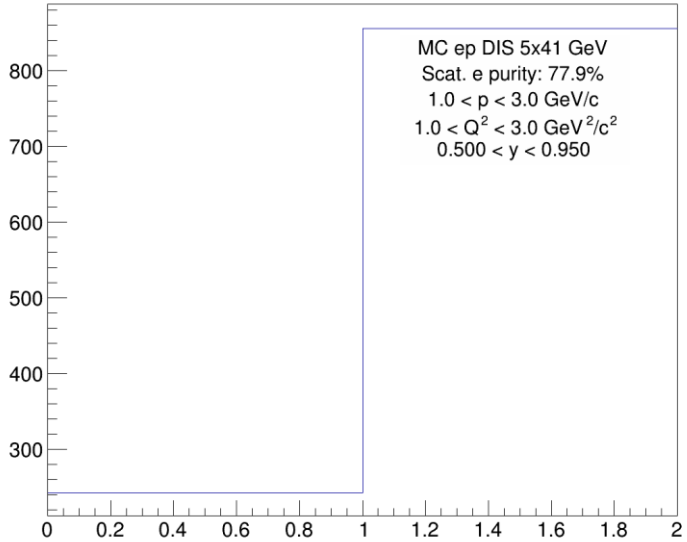
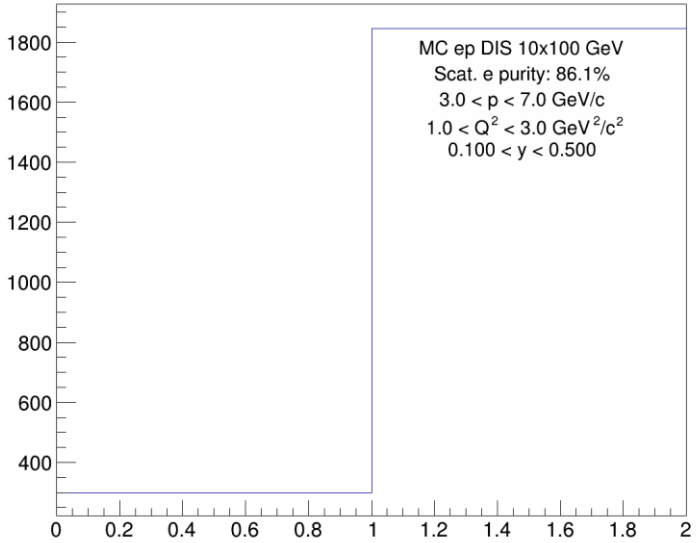
  - Bin 0-1: Number of other particles, mis-identified as electrons (N_b)
  - Bin 1-2: Number of MC electrons identified as RC electrons (N_e)
  - Purity = $N_e/(N_e + N_b)$
    - In figures
  - Lower purity than with eCAL, but still quite good
    - May improve with electron PID information in pfRICH

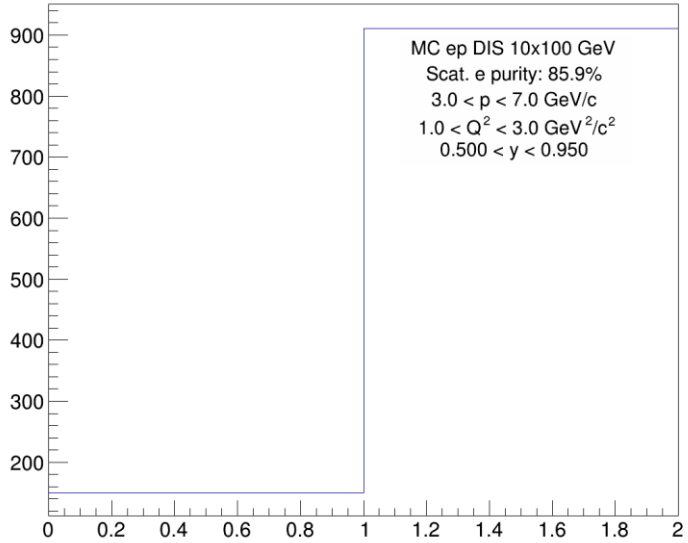


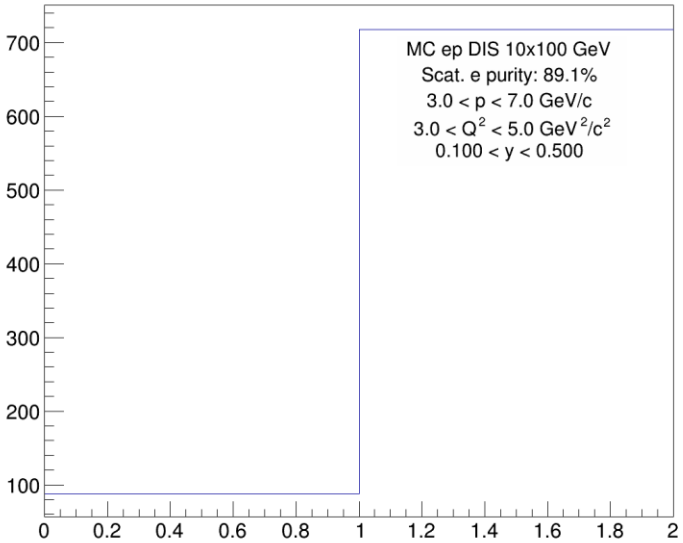


RECO. SCATTERED ELECTRON PURITY – pfRICH

- MC DIS ep collisions at **10x100 GeV**
- Purity of reconstructed scattered electron candidates identified using eCAL
  - Extracted PDG ID of corresponding MC particles via simID
  - Bin 0-1: Number of other particles, mis-identified as electrons (N_b)
  - Bin 1-2: Number of MC electrons identified as RC electrons (N_e)
  - Purity = $N_e/(N_e + N_b)$
    - In figures
  - Lower purity than with eCAL, but still quite good
    - May improve with electron PID information in pfRICH

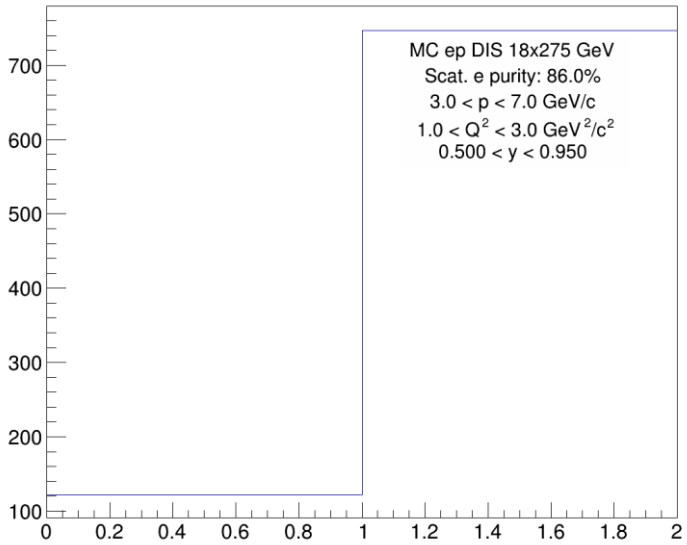


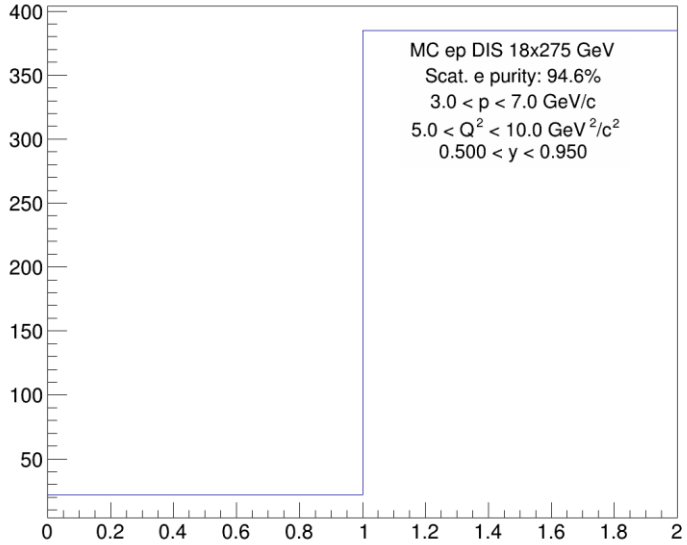


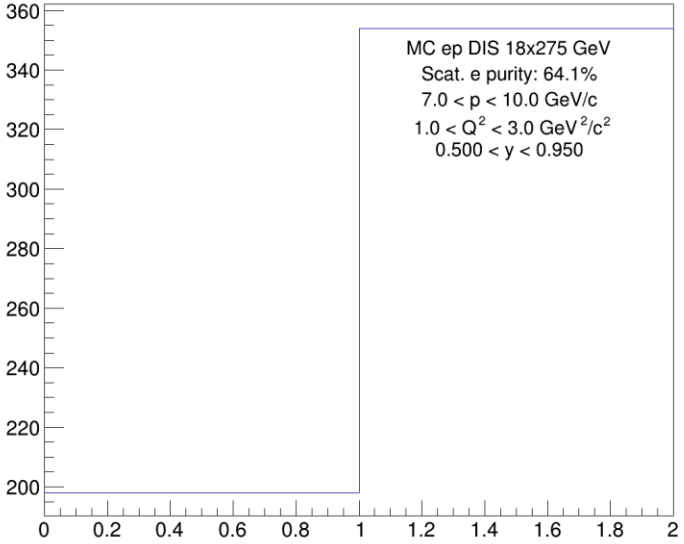


RECO. SCATTERED ELECTRON PURITY – pfRICH

- MC DIS ep collisions at **18x275 GeV**
- Purity of reconstructed scattered electron candidates identified using eCAL
  - Extracted PDG ID of corresponding MC particles via simID
  - Bin 0-1: Number of other particles, mis-identified as electrons (N_b)
  - Bin 1-2: Number of MC electrons identified as RC electrons (N_e)
  - Purity = $N_e/(N_e + N_b)$
    - In figures
  - Lower purity than with eCAL, but still quite good
    - May improve with electron PID information in pfRICH at low momenta
    - At high momenta can use eCAL







SUMMARY

- Added reconstruction of scattered electrons using eCAL and pfRICH
  - MC DIS ep collisions 5x41, 10x100, and 18x275 GeV
- eCAL provides very good scattered electron selection
  - Very good performance at high momenta, as expected
- pfRICH also provides good selection of scattered electrons
  - Potential to go to lower momenta than with eCAL only
    - Timing information?
  - Lower efficiency than eCAL
    - Less particles are accepted
  - Overall lower scattered electron purity than with eCAL
    - Still good performance
    - Possibly will be improved with new pfRICH simulation

THANK YOU FOR ATTENTION