Analysis of Athena full simulation (Reco)

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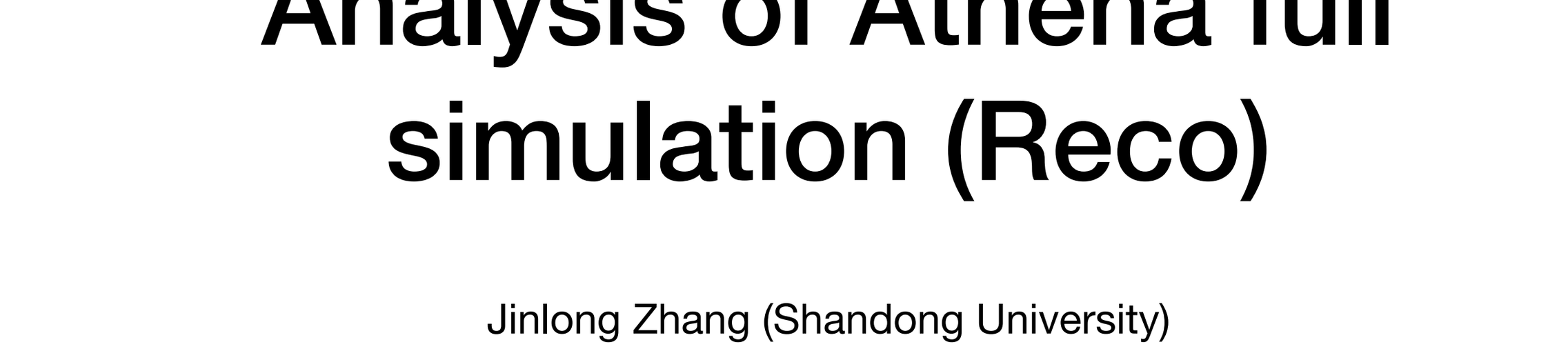
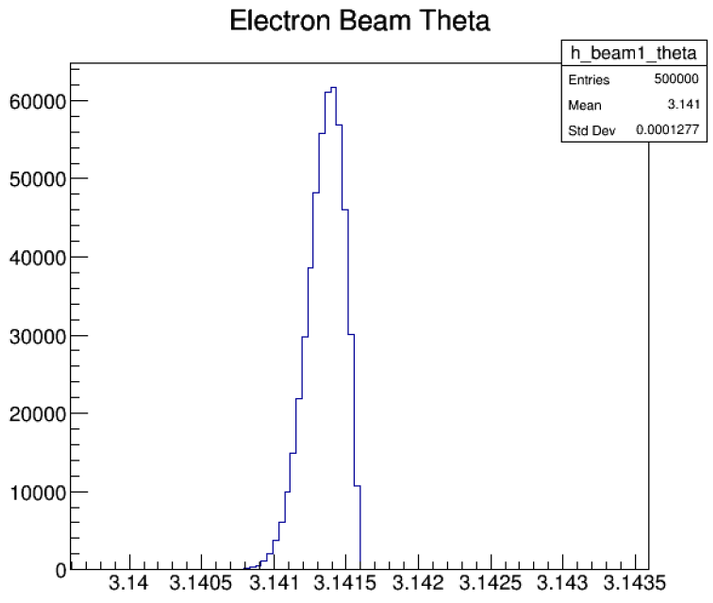
Files used:

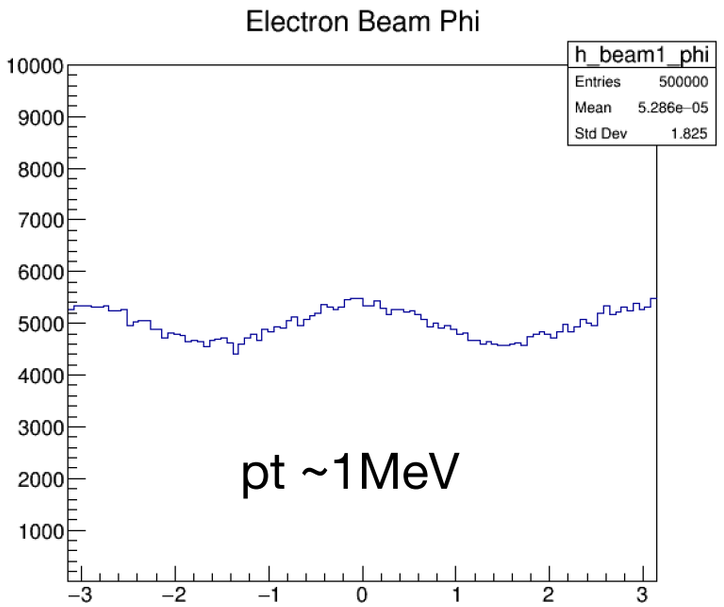
https://dtn01.sdcc.bnl.gov:9000/minio/eictest/ATHENA/RECO/master/DIS/NC/18x275/minQ2=1/

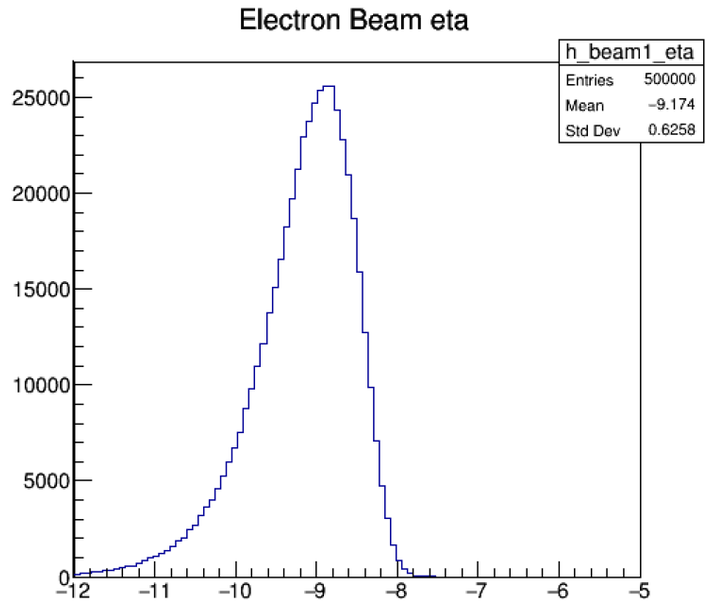


- beam crossing angle

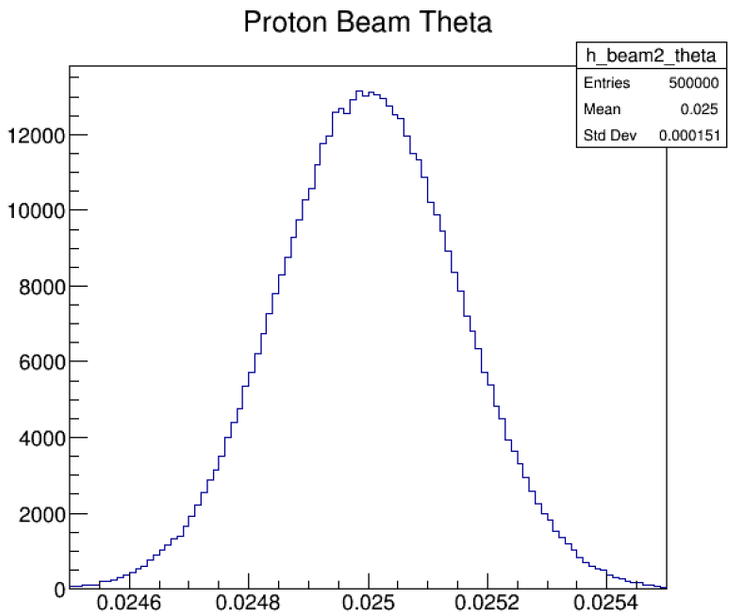
Electron beam

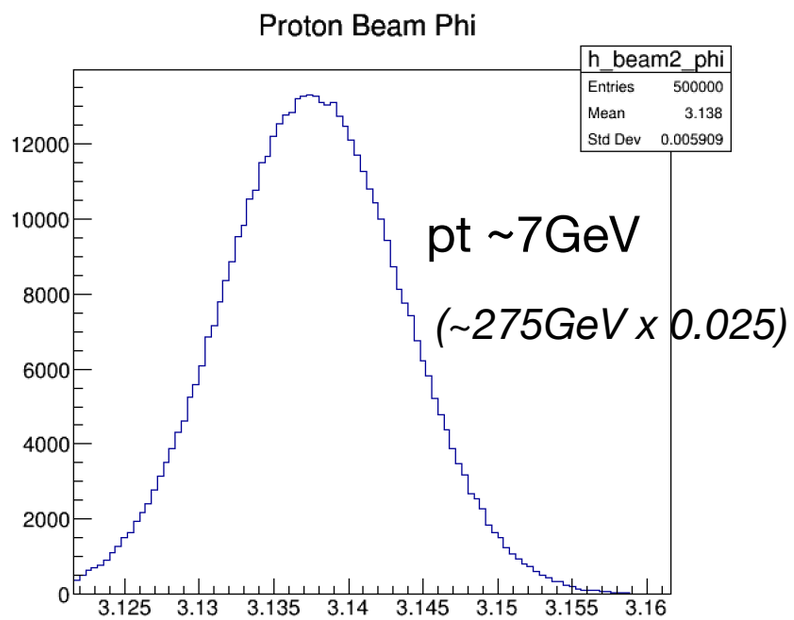


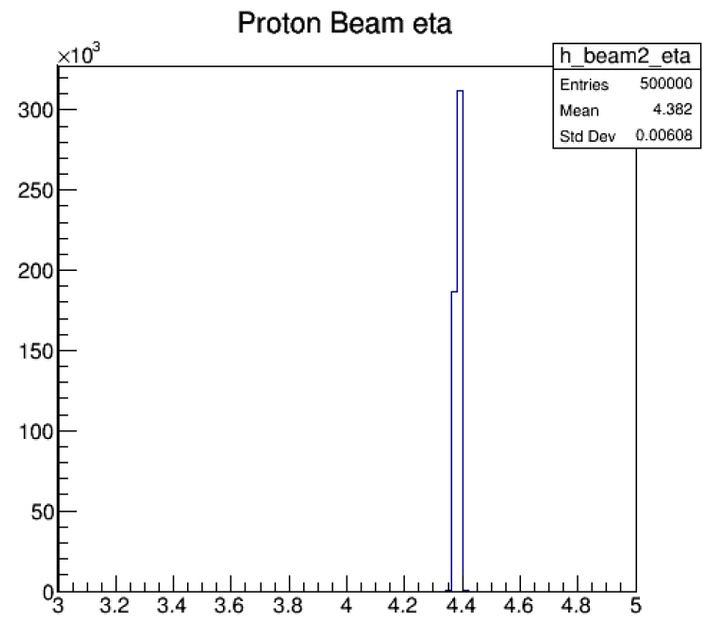




Proton beam

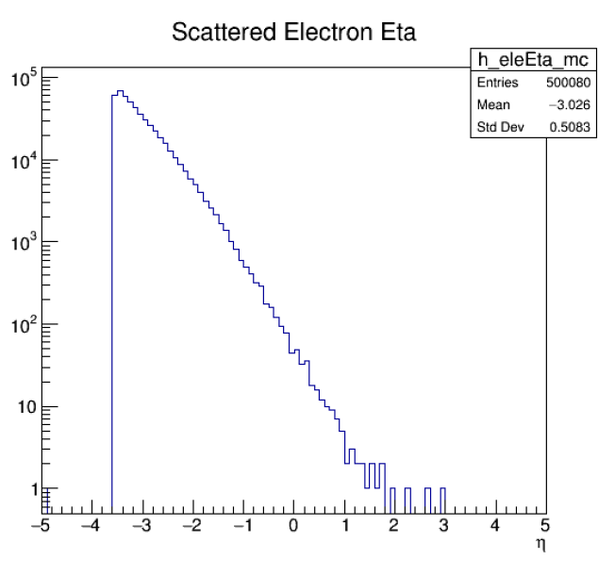


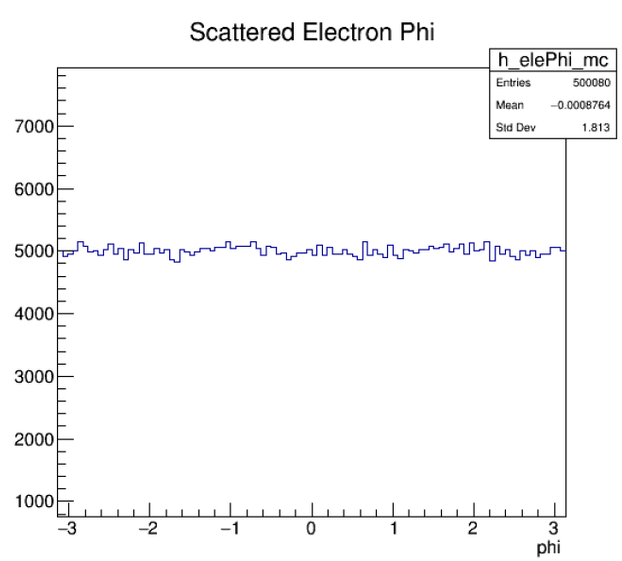


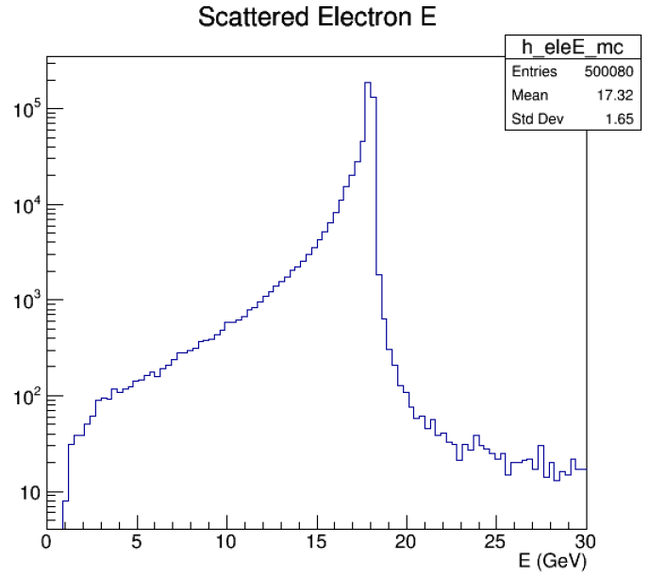


- Final state particles (truth level)

Scattered electrons

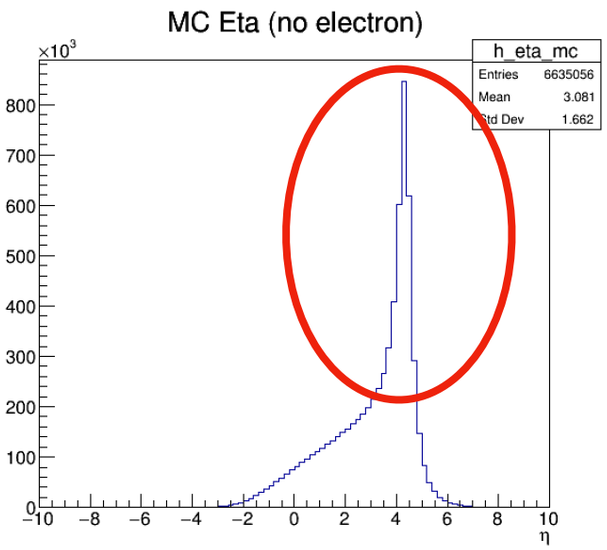


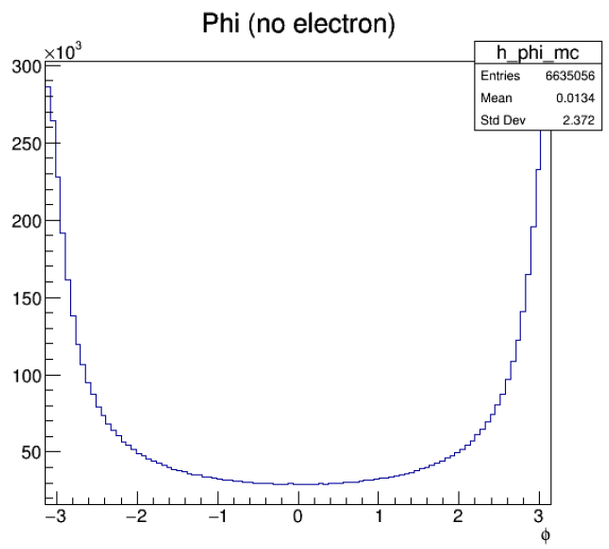


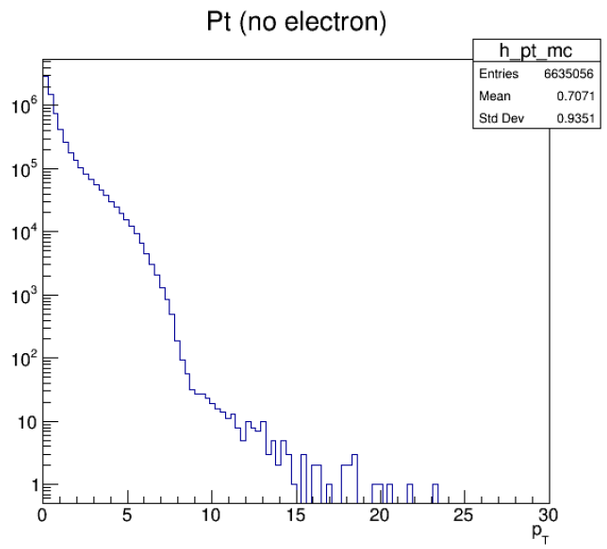


No visible effect from initial state pT

Other final state particles except for scattered electrons

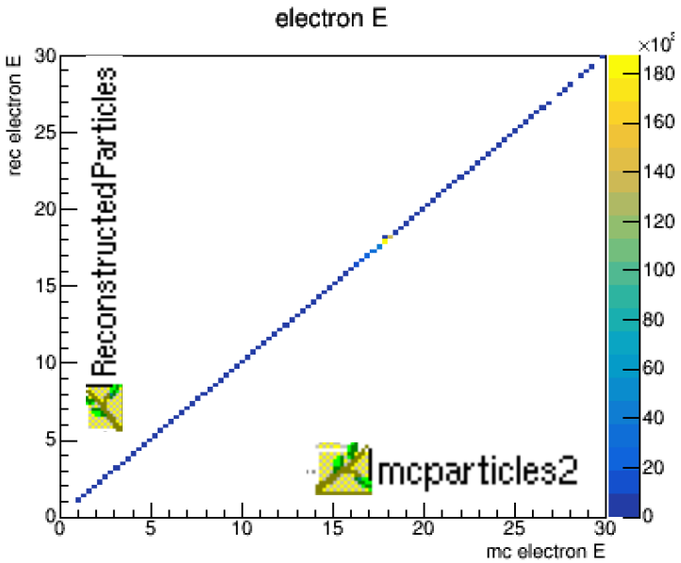


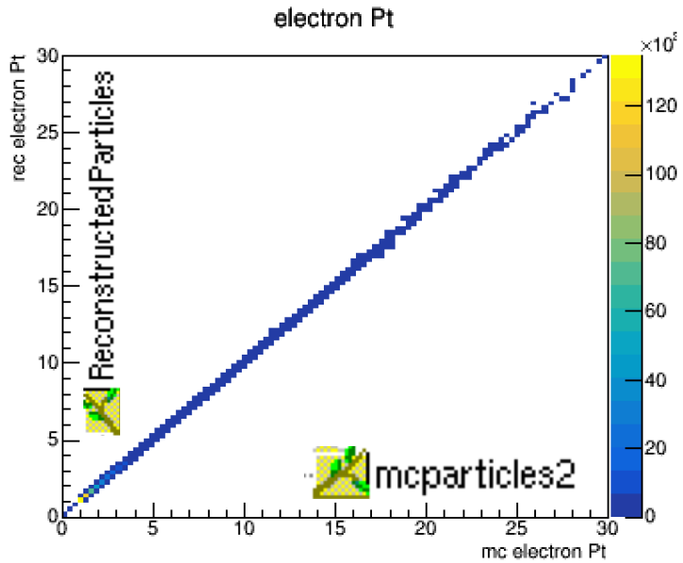


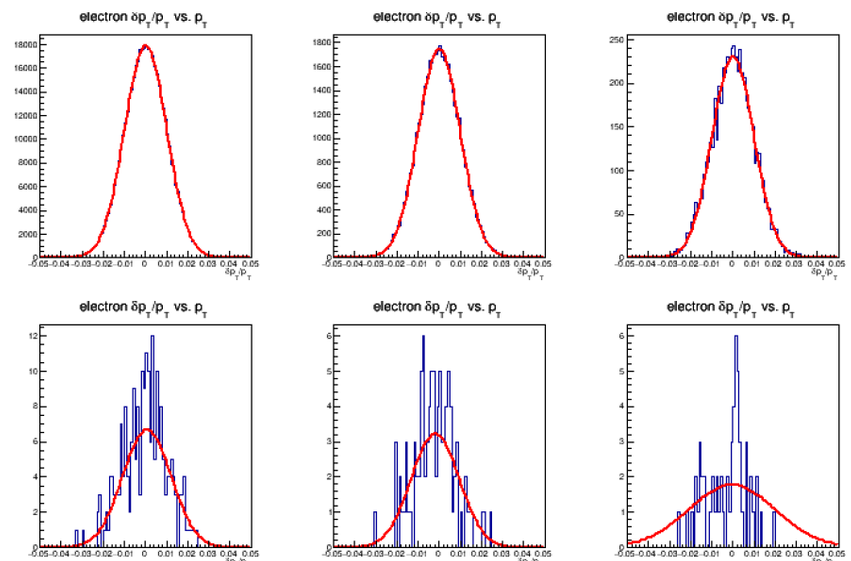


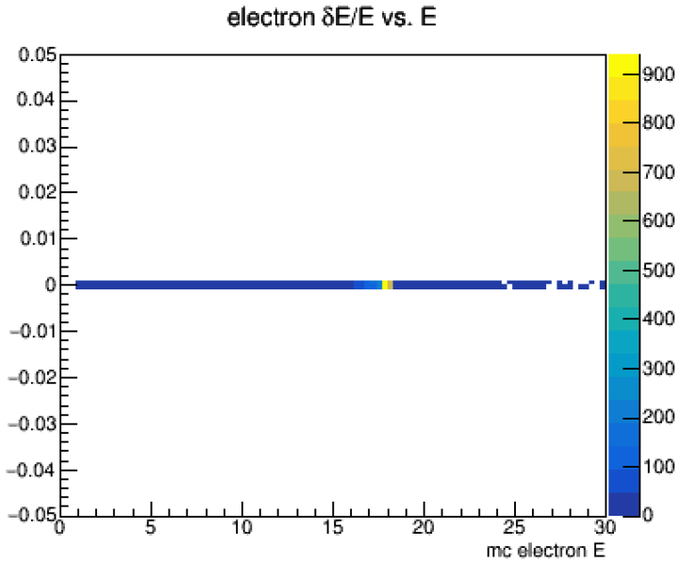
Significant beam angle effect
at very forward region

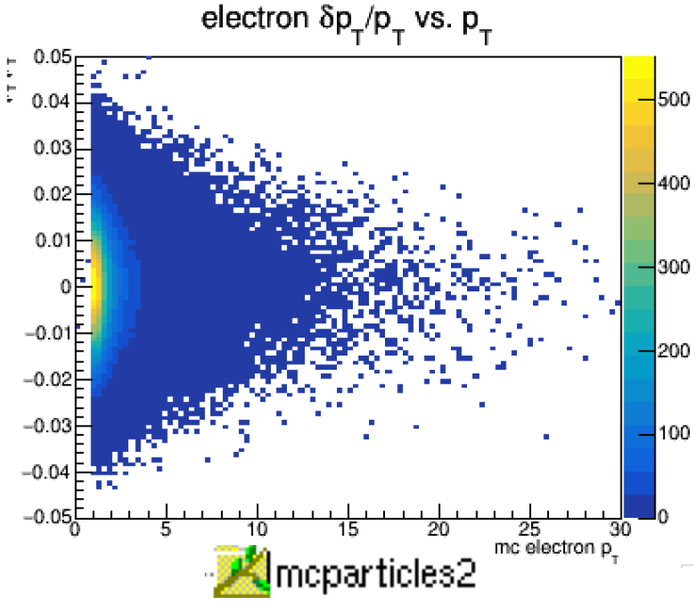
- Energy and momentum resolutions

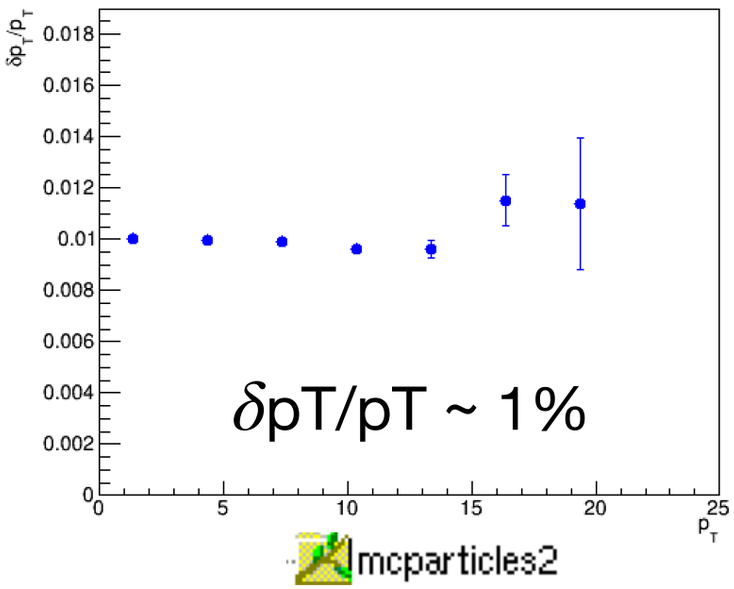








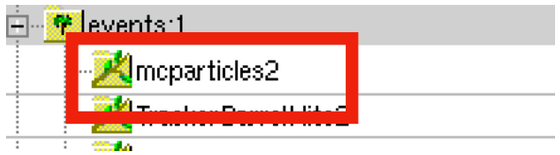


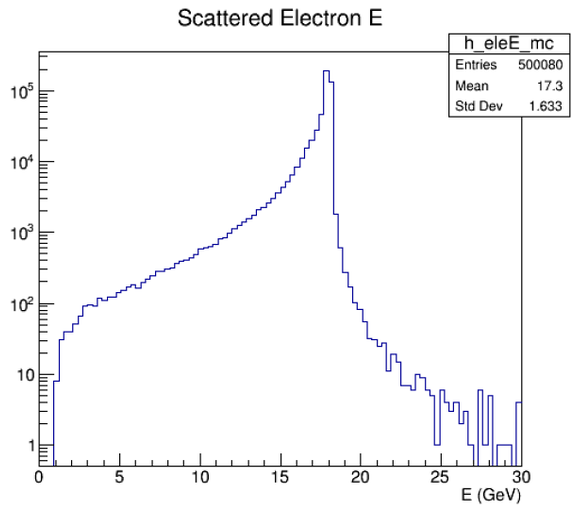


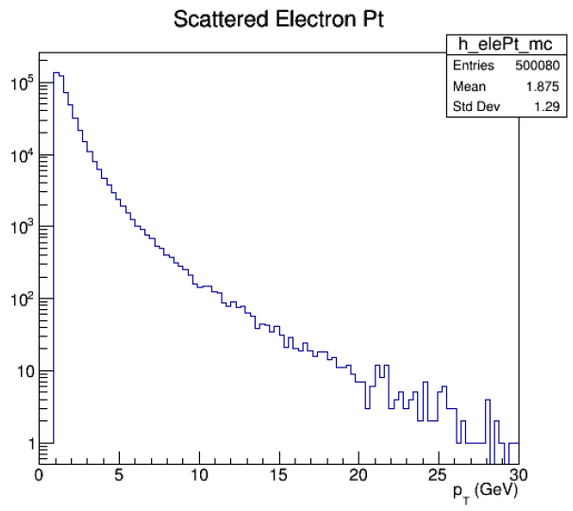
- no detector effect for energy

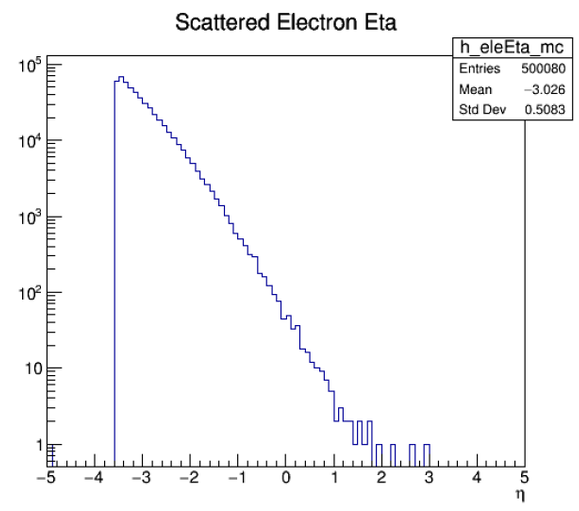
- momentum resolution doesn’t depend on pT

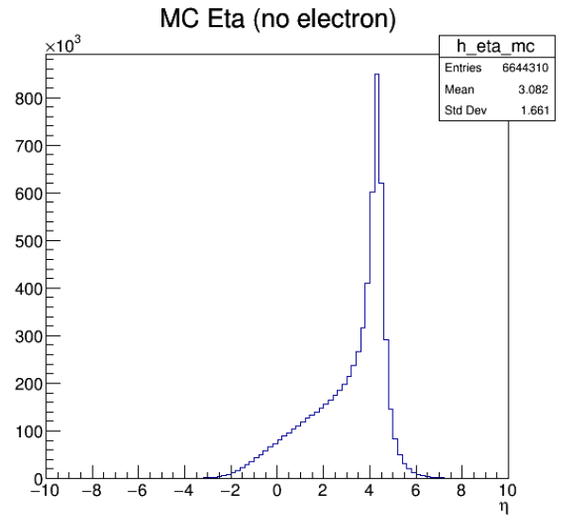
- ReconstructedParticles vs mcparticles2

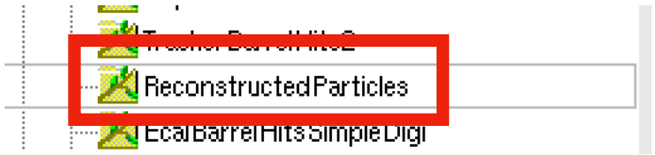




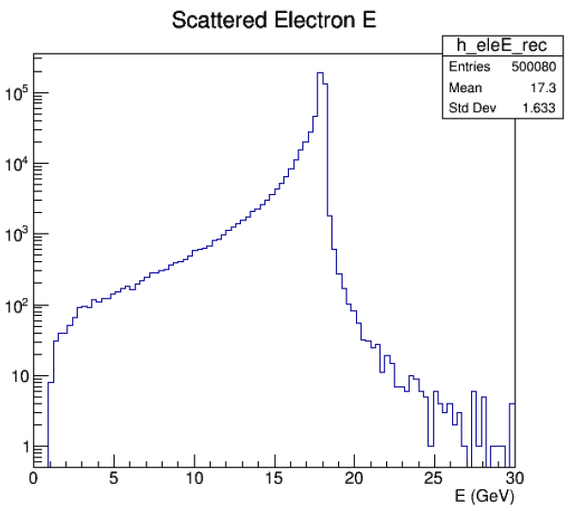


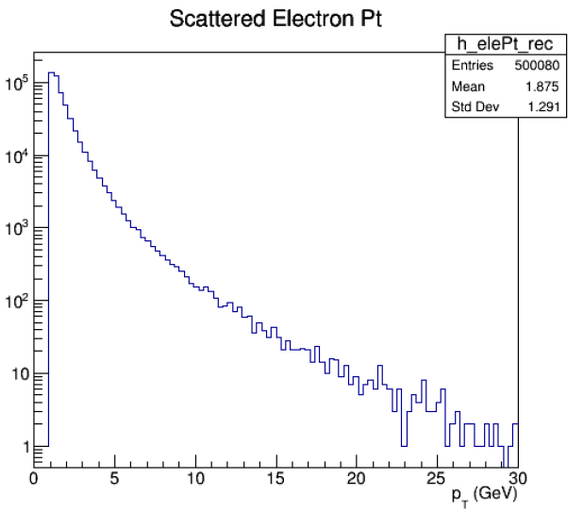


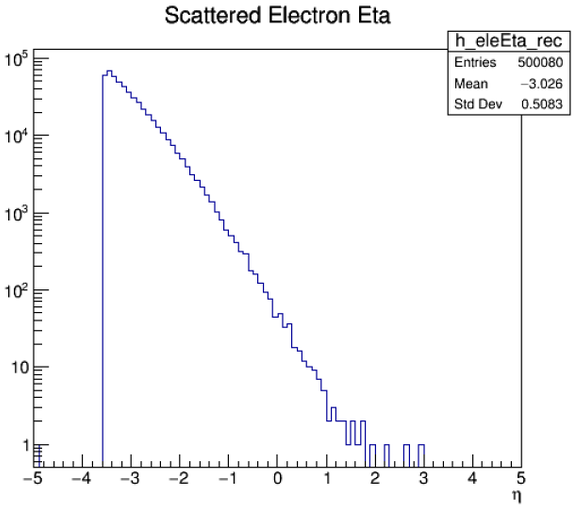


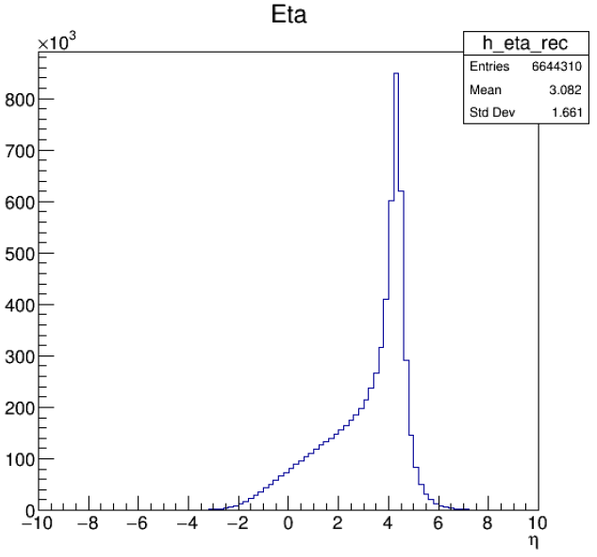


- No detector effect on Energy, Eta, Acceptance ??



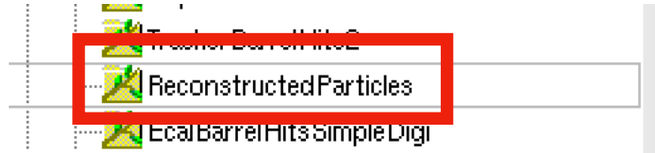


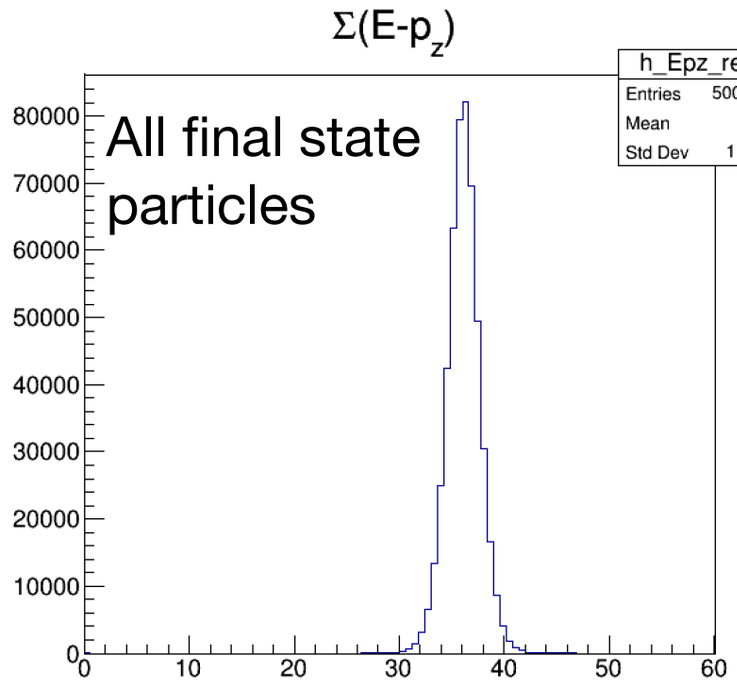




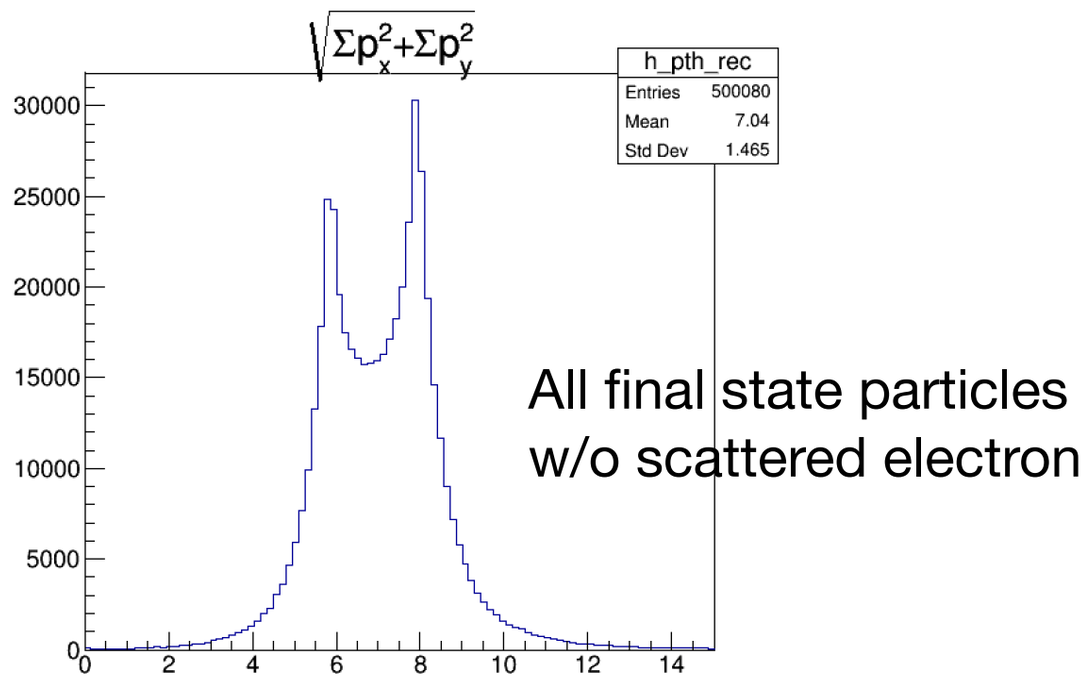
All Σ(E-pz) and hadronic $\sqrt{\Sigma p_x^2 + \Sigma p_y^2}$

Needed by kinematics reconstruction using hadronic methods





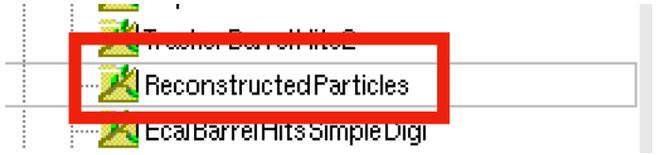
No visible impact from beam crossing angle



Strongly boosted

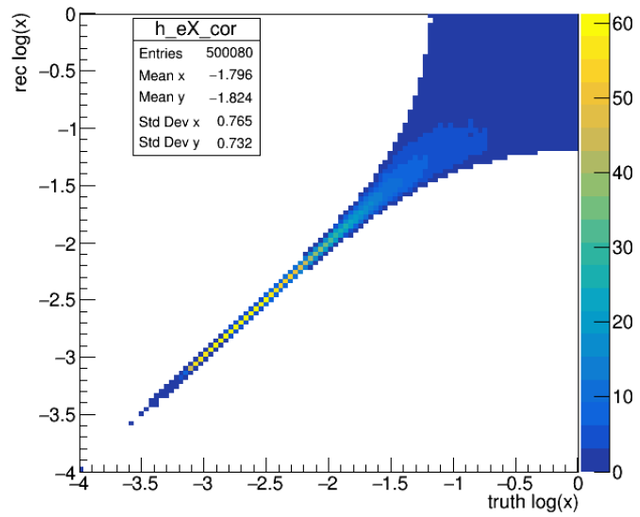
Boost back to head-on frame?

Electron method

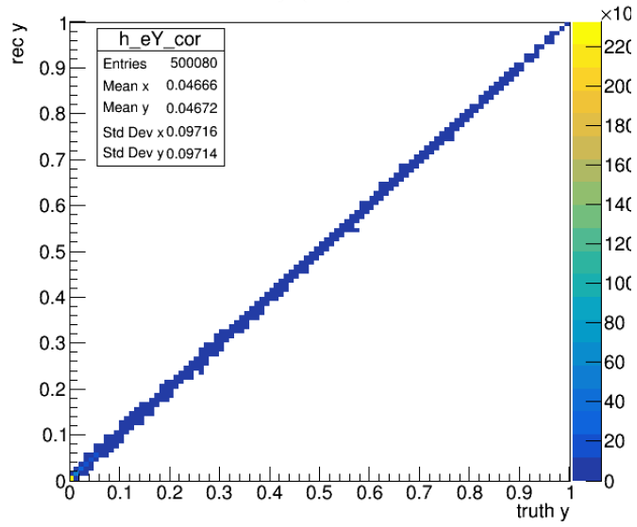



```
// electron method
void GetKinematics_e(TLorentzVector const &ebeam,TLorentzVector const &escat, Float_t cme,
    Float_t *x,Float_t *y,Float_t *Q2)
{
  Float_t theta = TMath::Pi() - escat.Theta();
  //Float_t theta = escat.Theta();
  *y = 1 - escat.E()*cos(theta/2.)*cos(theta/2.)/ebeam.E();
  *Q2 = 2.*escat.E()*ebeam.E()*(1.-cos(theta));
  *x = *Q2/cme/(*y);
}
```

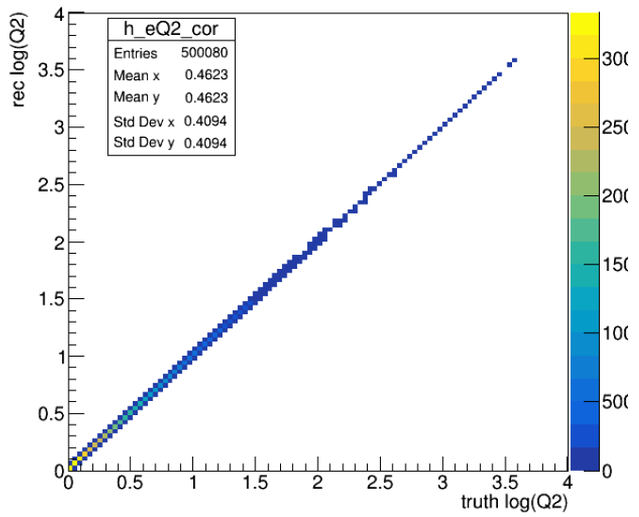
x (ele)



y (ele)

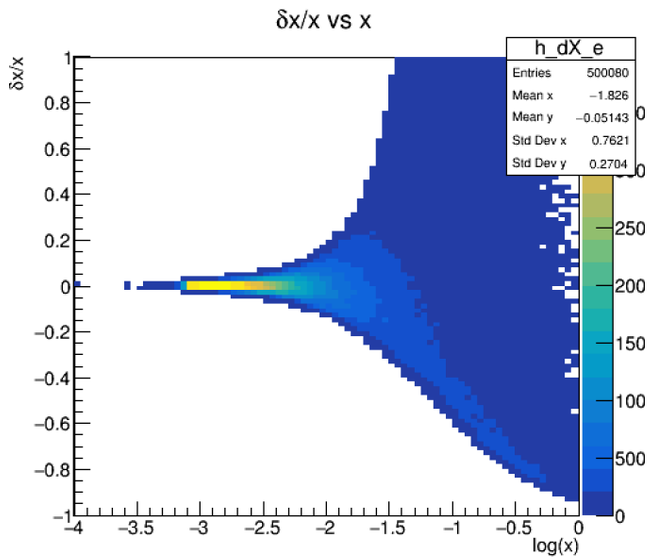


Q2 (ele)

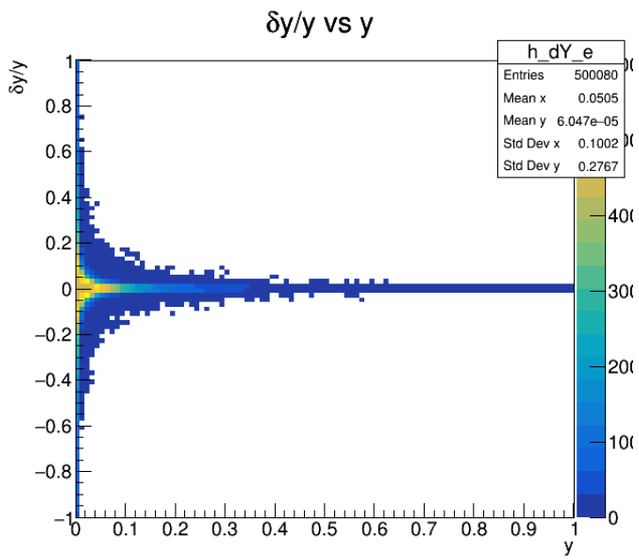


Truth x, y, Q2 using Lorentz vectors from *mcparticles2*

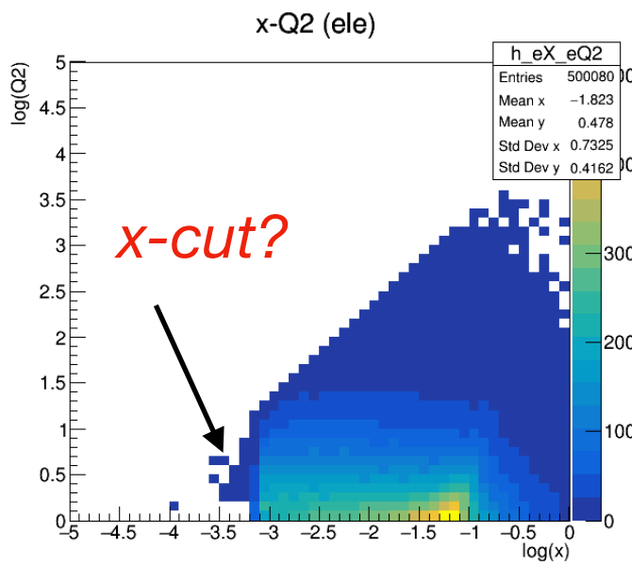
δx/x vs x



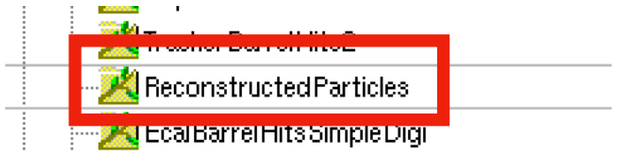
δy/y vs y



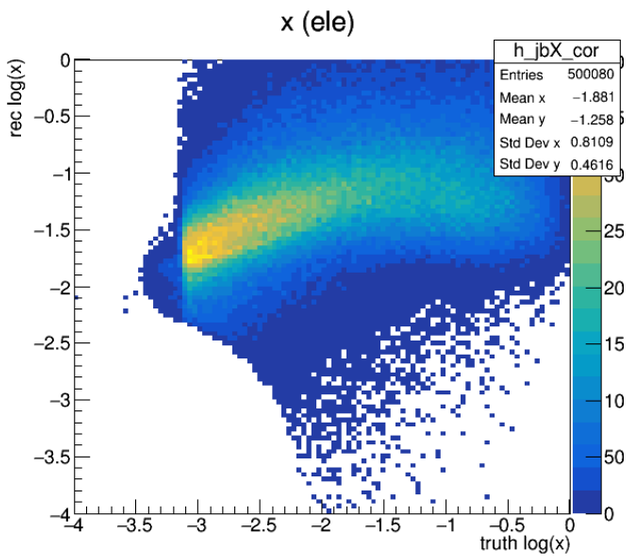
x-Q2 (ele)

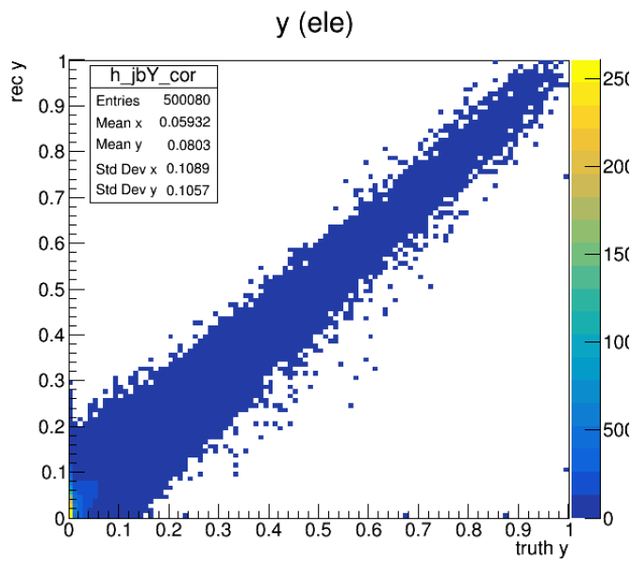


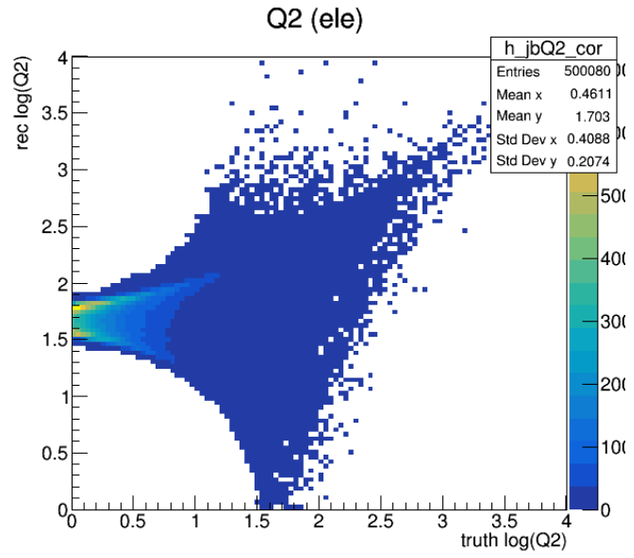
JB



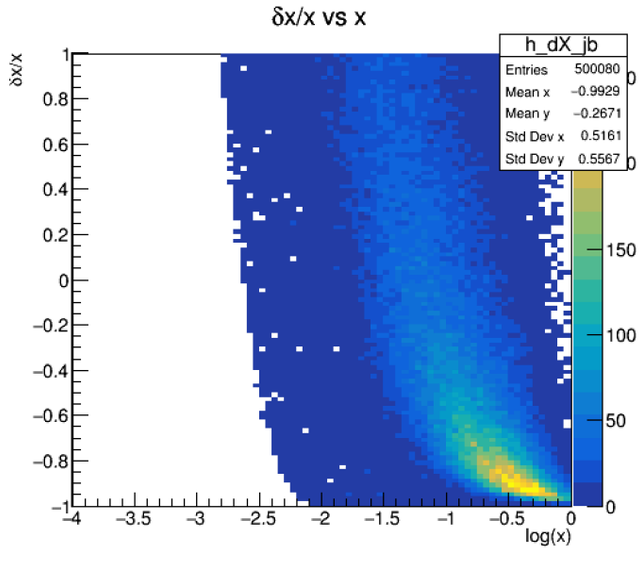

```
// Jacquet-Bloded Method
void GetKinematics_jb(Float_t Epzh, Float_t pth, Float_t cme, TLorentzVector const &ebeam,
    Float_t *x,Float_t *y,Float_t *Q2)
{
  *y = Epzh/2./ebeam.E();
  *Q2 = pth*pth/(1-*y);
  *x = *Q2/cme/(*y);
}
```

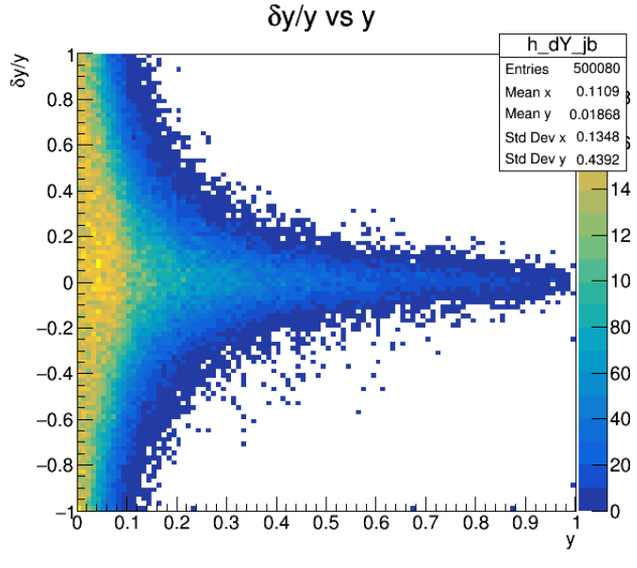


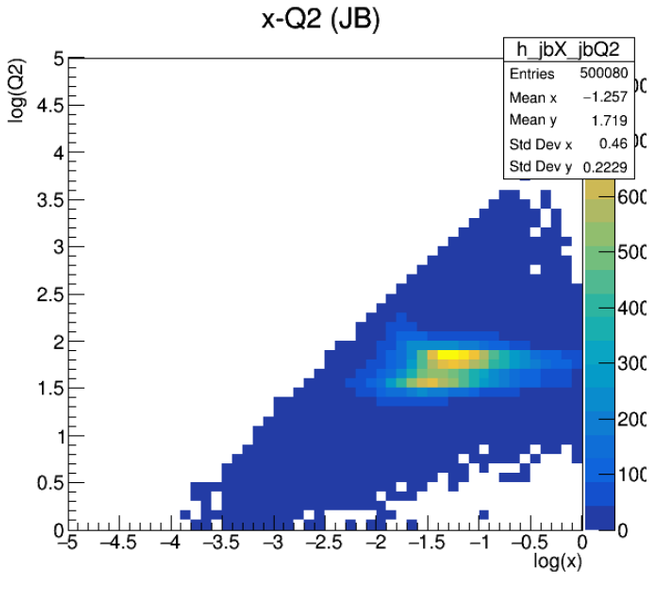




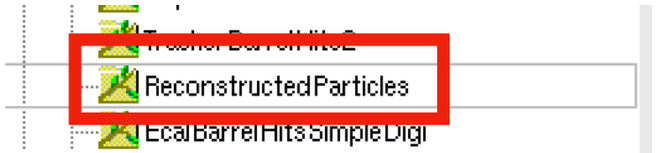
Truth x, y, Q2 using Lorentz vectors from *mcparticles2*



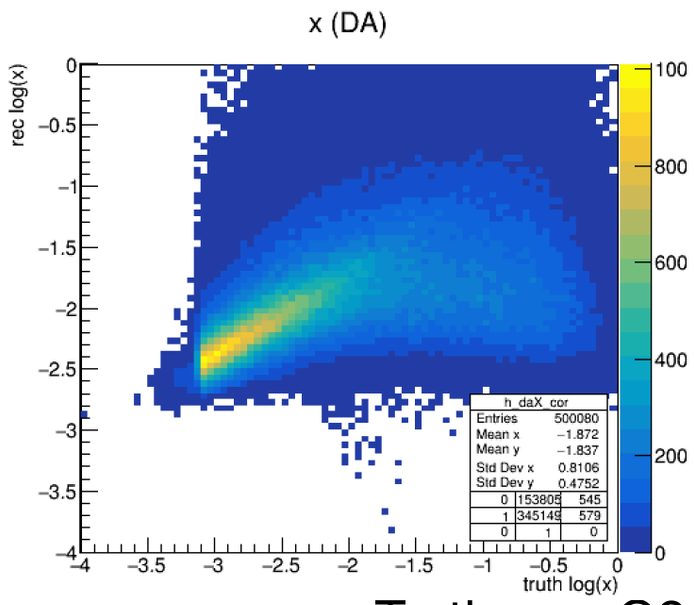


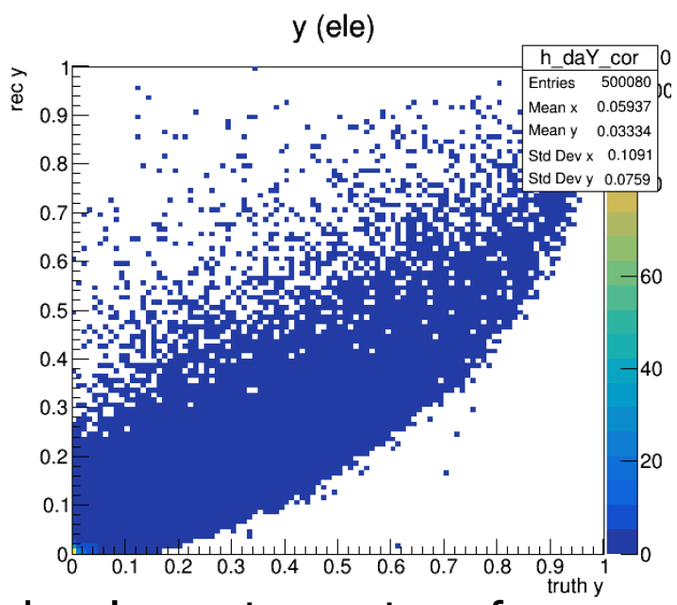


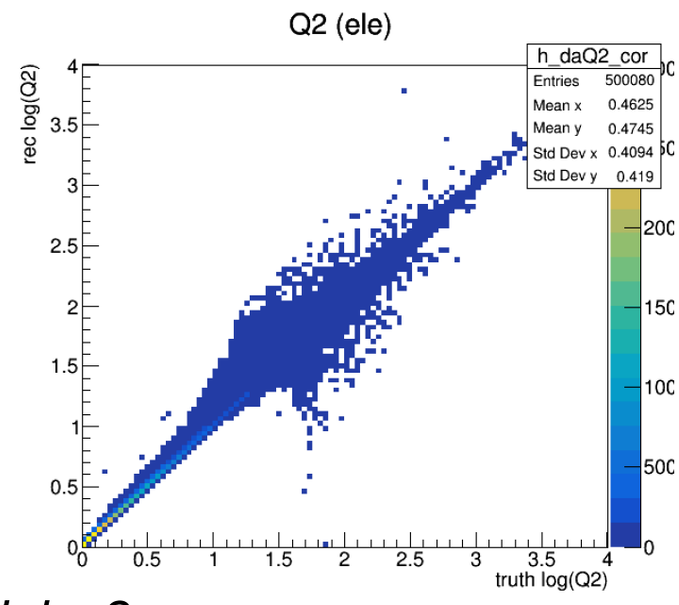
DA



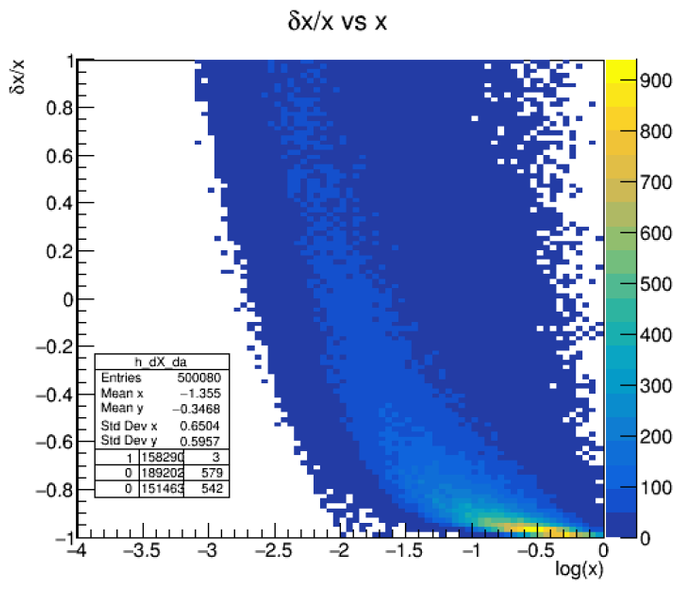

```
// double-angle method
void GetKinematics_da(Float_t Epzh, Float_t pth, Float_t cme, TLorentzVector const &ebeam,
    TLorentzVector const &escat, Float_t *x,Float_t *y,Float_t *Q2)
{
  Float_t gamma = 2.*atan(Epzh/pth);
  //Float_t theta = TMath::Pi() - escat.Theta();
  Float_t theta = escat.Theta();
  *y = tan(gamma/2.)/(tan(theta/2.) + tan(gamma/2.));
  *Q2 = 4*ebeam.E()*ebeam.E()/tan(theta/2.)/(tan(theta/2.) + tan(gamma/2.));
  //*y = sin(theta)*(1-cos(gamma))/(sin(gamma)+sin(theta)-sin(theta+gamma));
  //*Q2 = 4.*escat.E()*escat.E()*sin(gamma)*(1.+cos(theta))/(sin(gamma)+sin(theta)-sin(theta+gamma));
  *x = *Q2/cme/(*y);
}
```

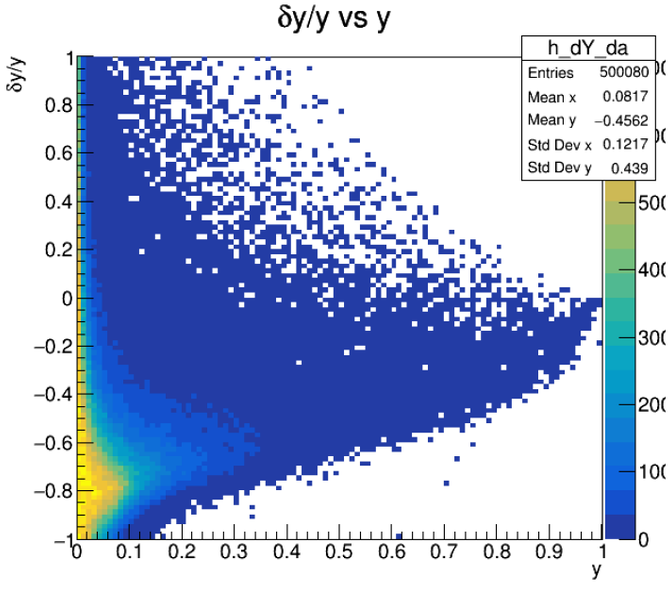


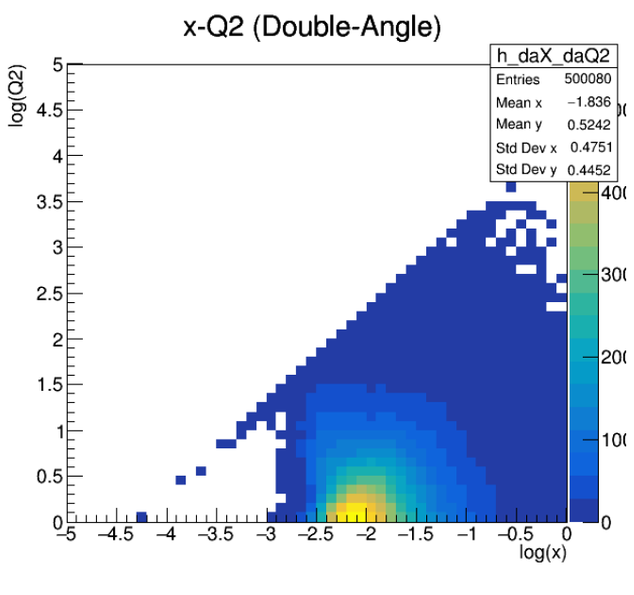




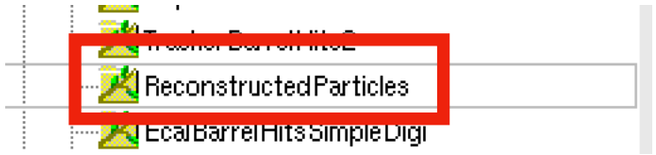
Truth x, y, Q2 using Lorentz vectors from *mcparticles2*



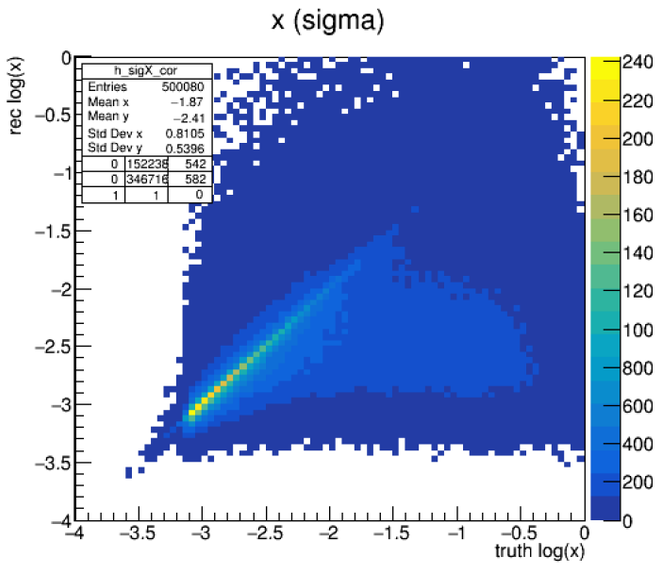


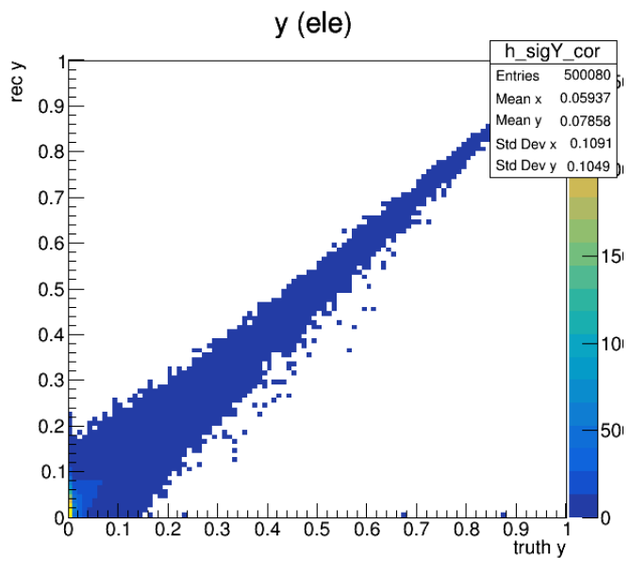


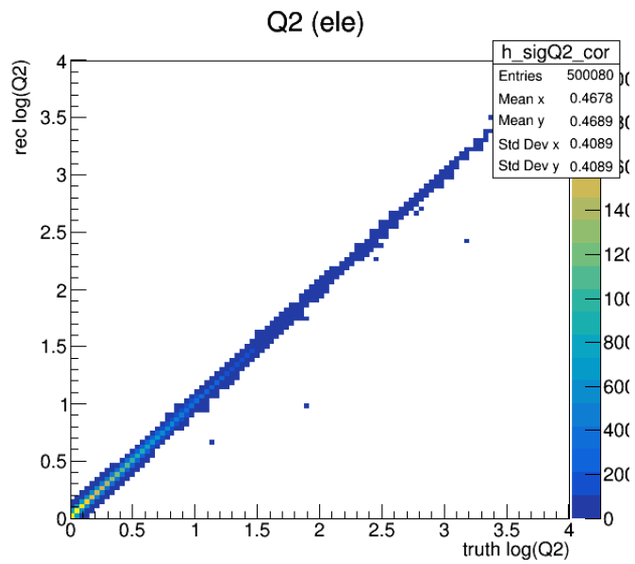
Sigma



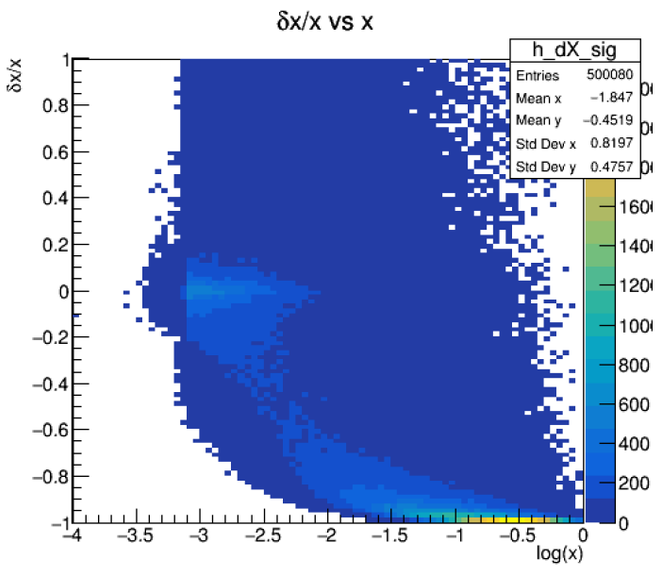

```
// sigma method
void GetKinematics_sigma(Float_t Epzh, Float_t cme, TLorentzVector const &escat,
    Float_t *x,Float_t *y,Float_t *Q2)
{
  Float_t Epz = escat.E() - escat.Pz();
  *y = Epzh/(Epzh+Epz);
  *Q2 = escat.Pt()*escat.Pt()/(1. - *y);
  *x = *Q2/cme/(*y);
}
```

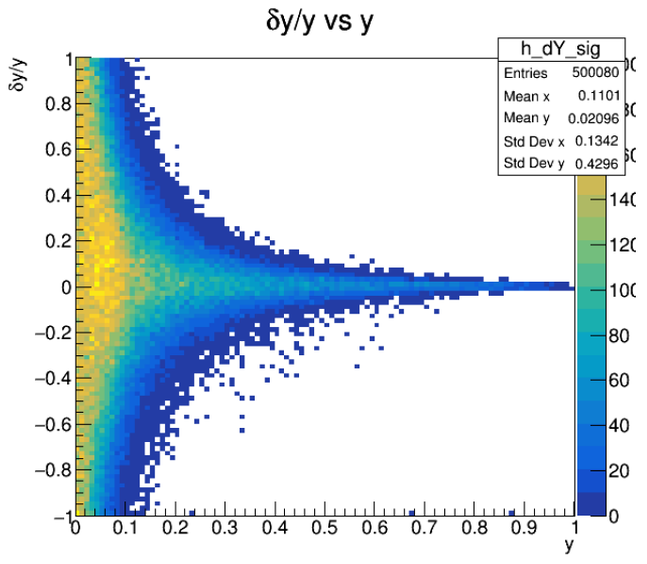


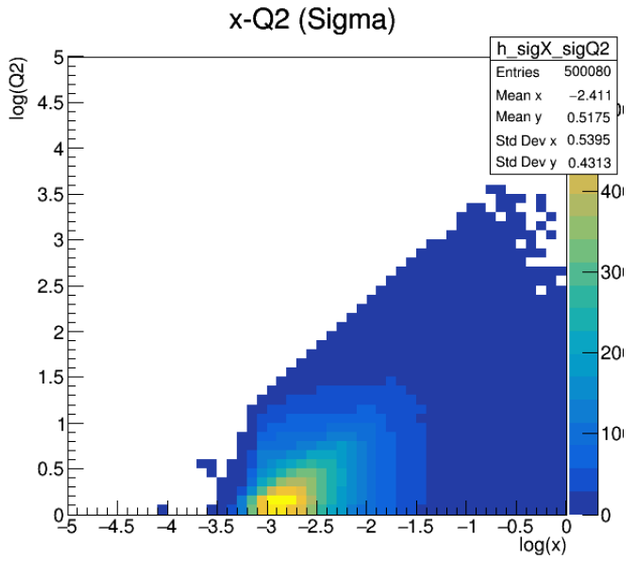




Truth x, y, Q2 using Lorentz vectors from *mcparticles2*

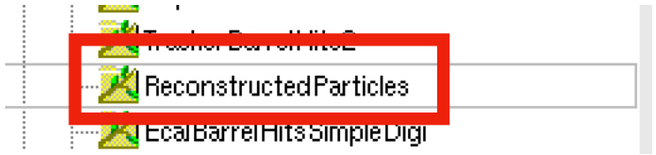


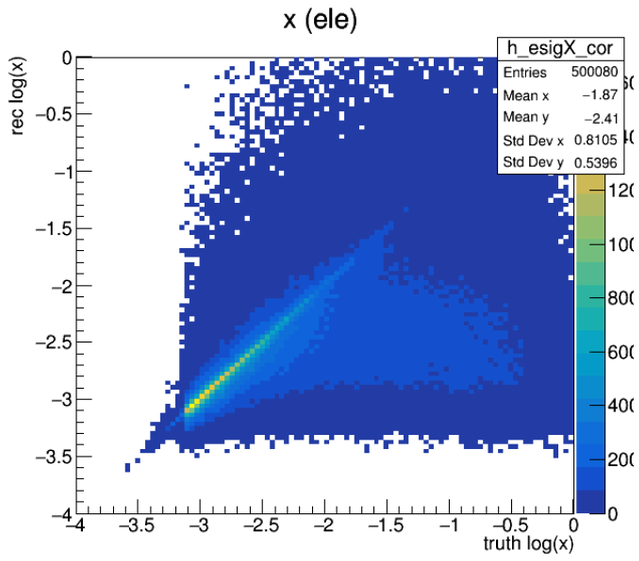


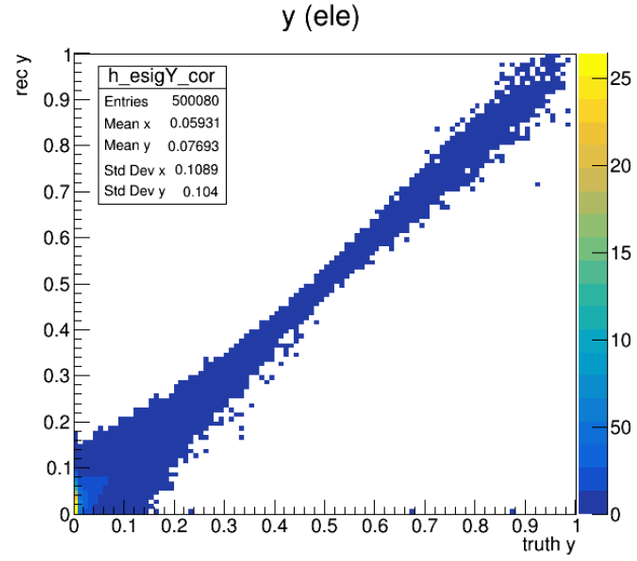


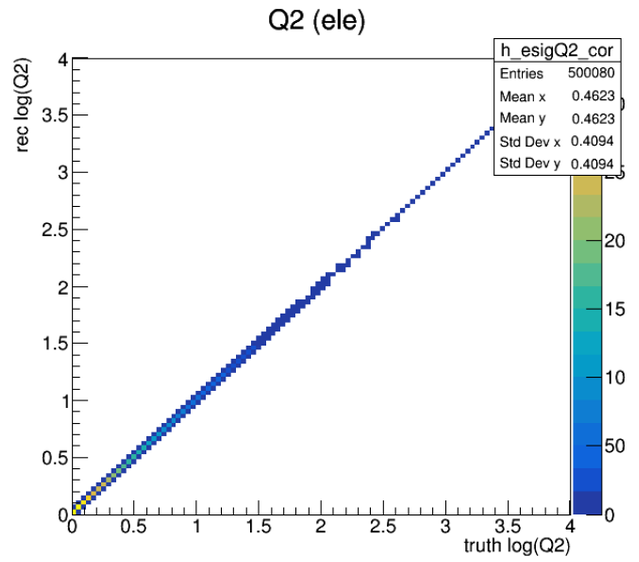
e-Sigma

```
// e-sigma method  x from sigma, Q2 from e
void GetKinematics_esigma(Float_t Epzh, Float_t cme, TLorentzVector const &escat,
    Float_t x,Float_t Q2,Float_t *y)
{
  Float_t Epz = escat.E() - escat.Pz();
  *y = Q2/cme/x;
}
```

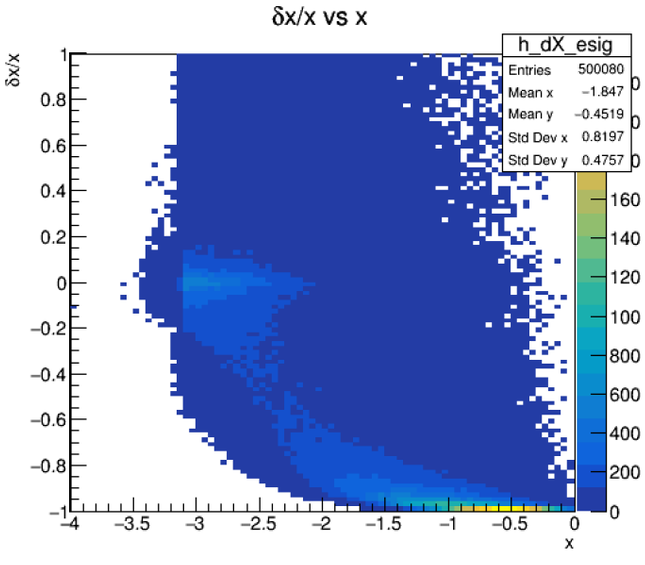


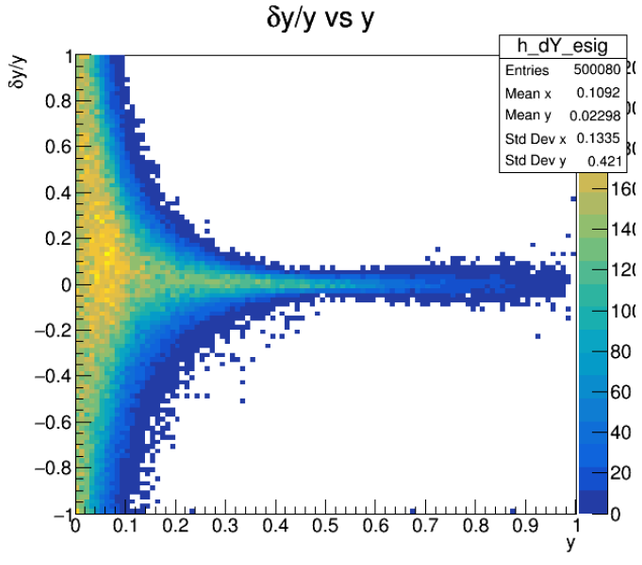


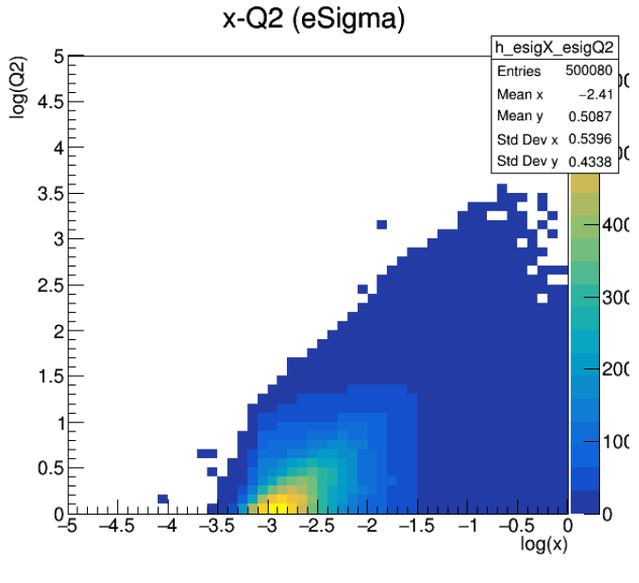




Truth x, y, Q2 using Lorentz vectors from *mcparticles2*

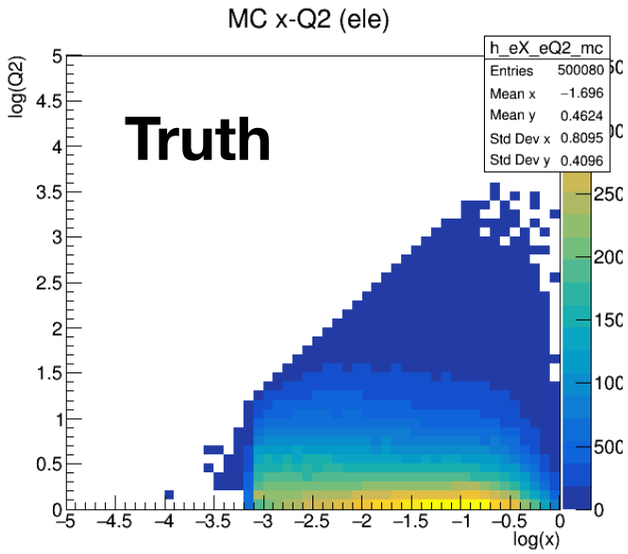


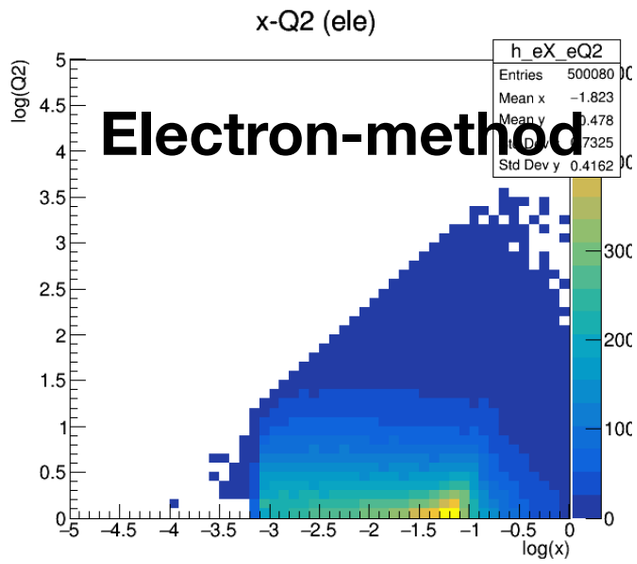


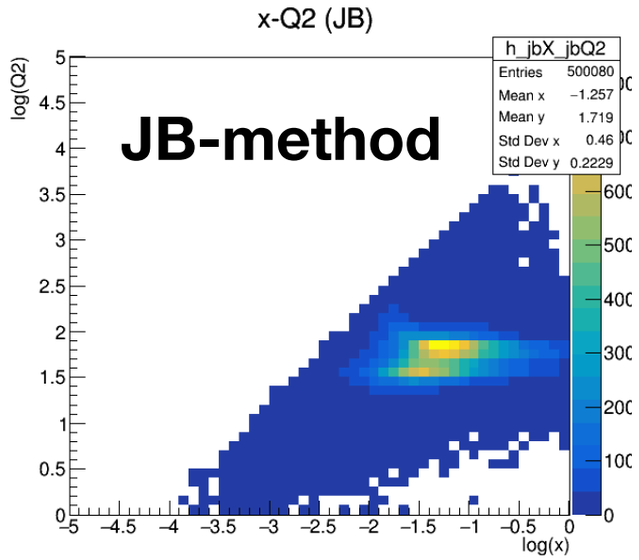


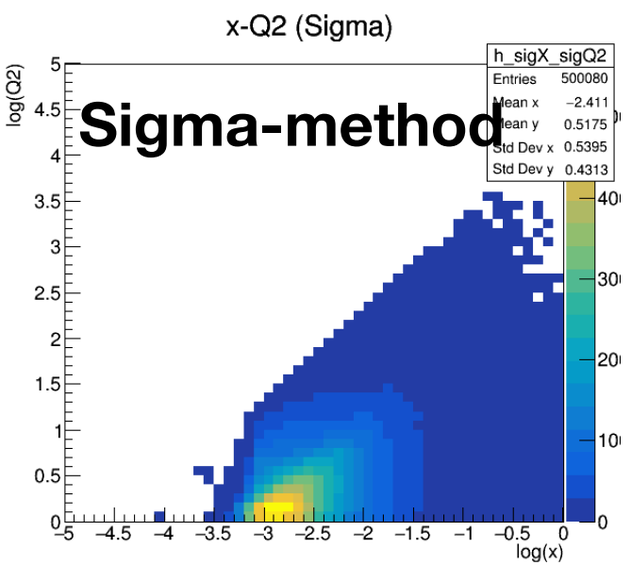
Kinematics reconstruction

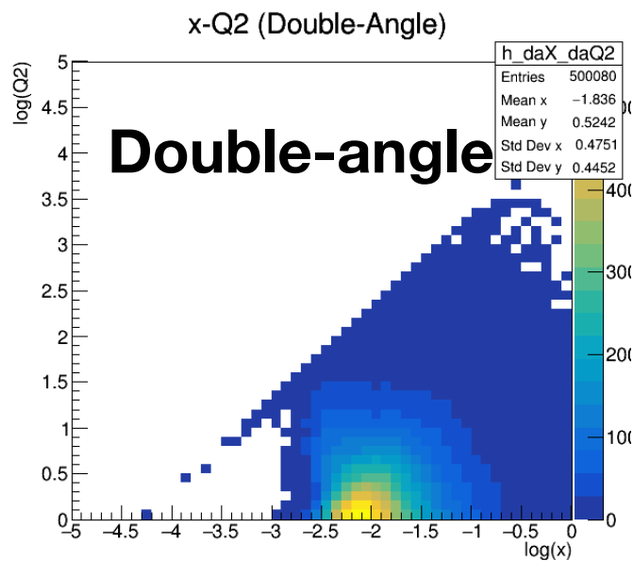
Truth x, y, Q2 using Lorentz vectors from *mcparticles2,* others using *ReconstructedParticles*

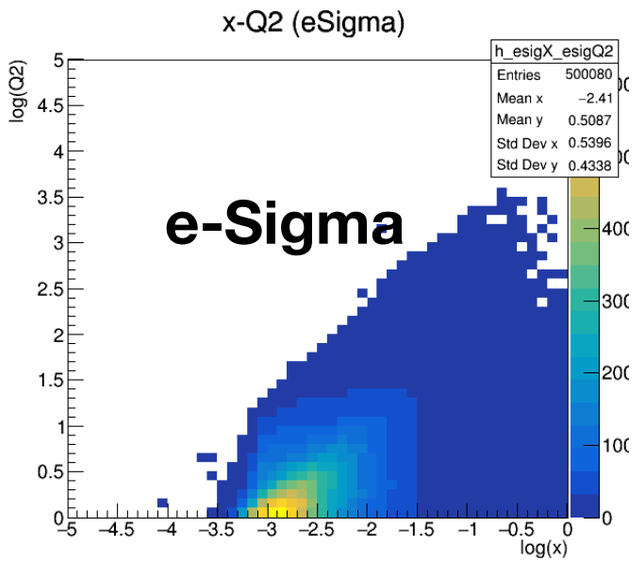












Reconstructed x / truth x

By Ting Lin

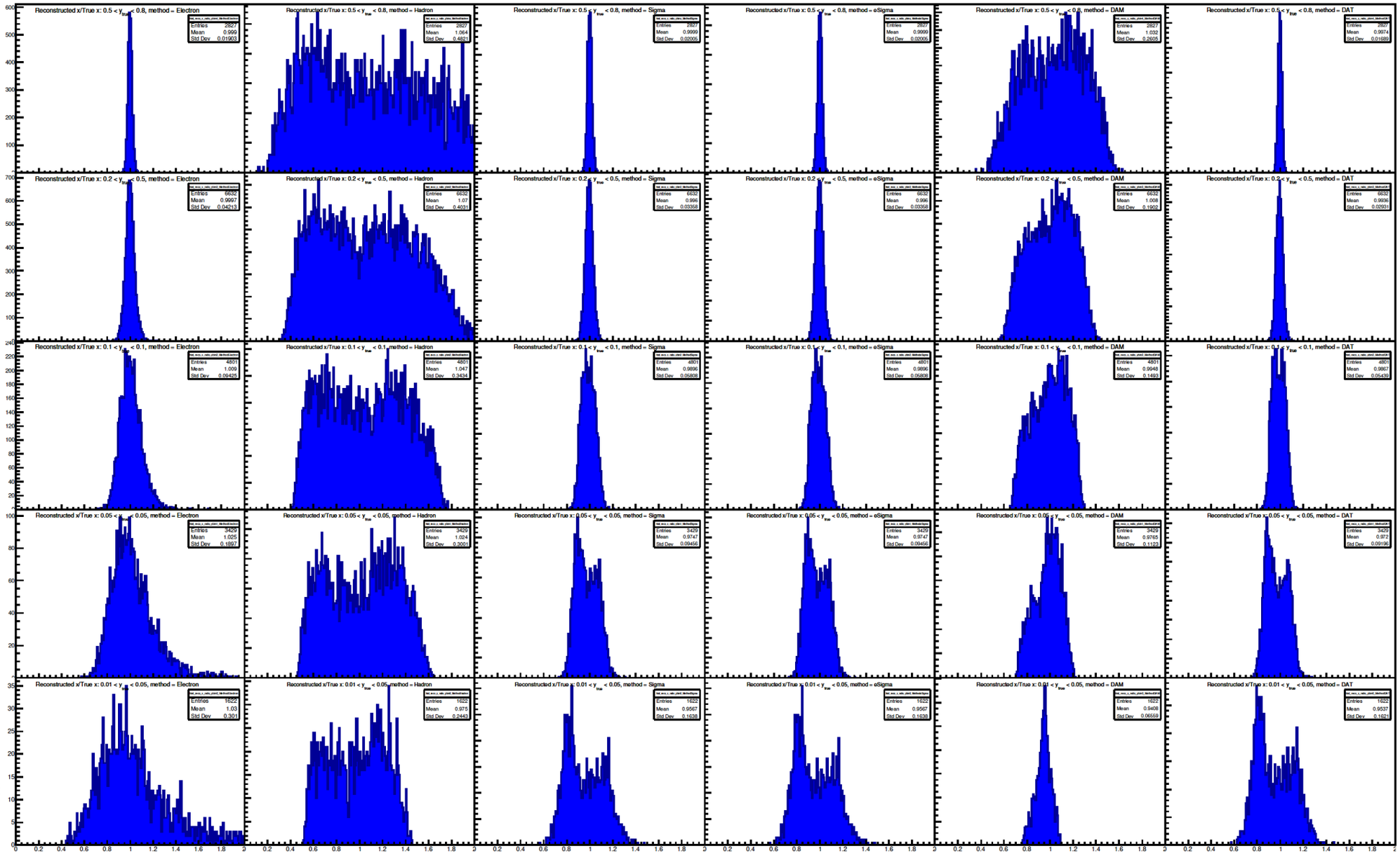
0.5 < y < 0.8

0.2 < y < 0.5

0.1 < y < 0.2

0.05 < y < 0.1

0.01 < y < 0.05



Electron **J-B** **Sigma** **e-Sigma** **D-A** **D-A pT**

Reconstructed y / truth y

By Ting Lin

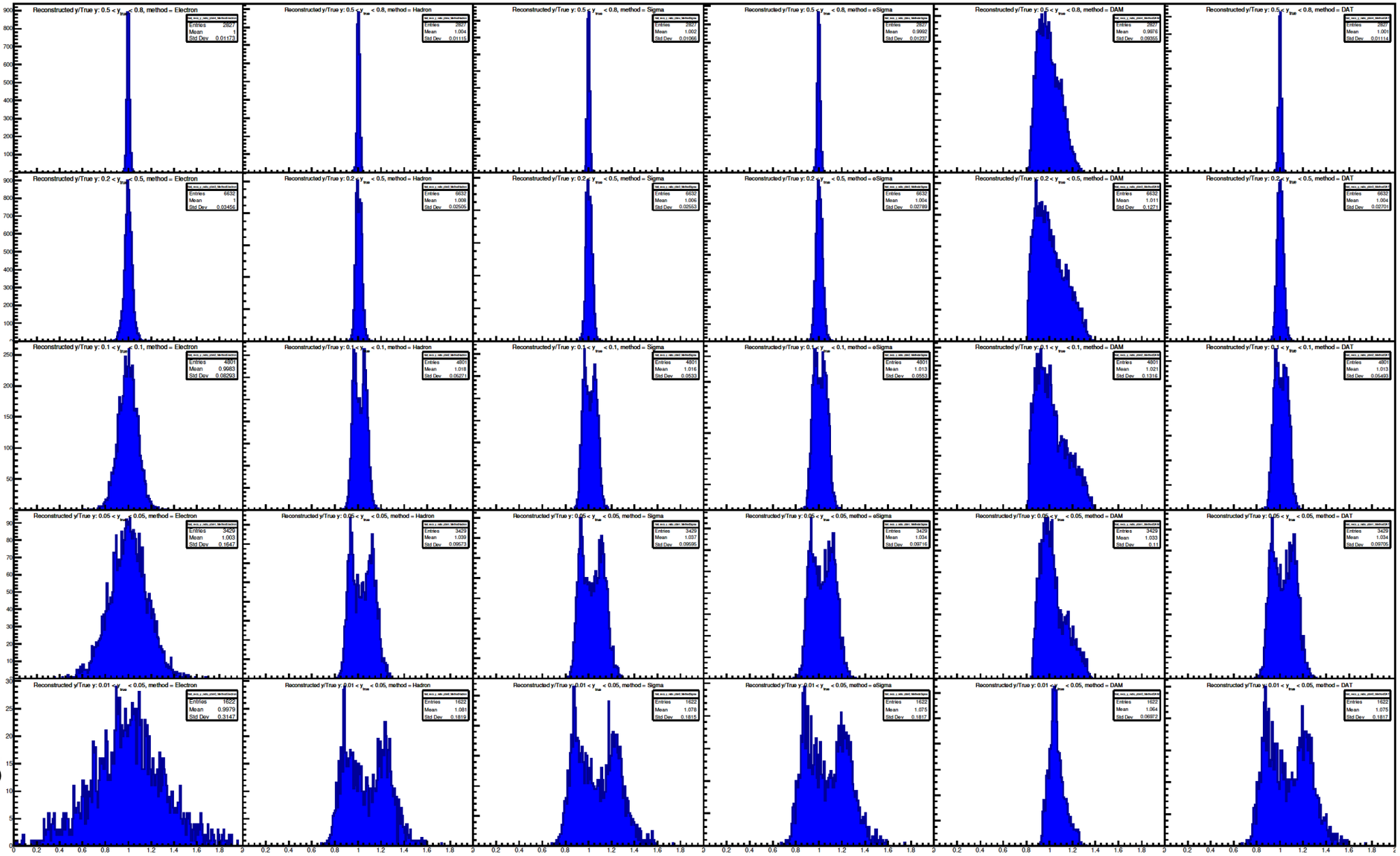
0.5 < y < 0.8

0.2 < y < 0.5

0.1 < y < 0.2

0.05 < y < 0.1

0.01 < y < 0.05



Reconstructed Q2 / truth Q2

By Ting Lin

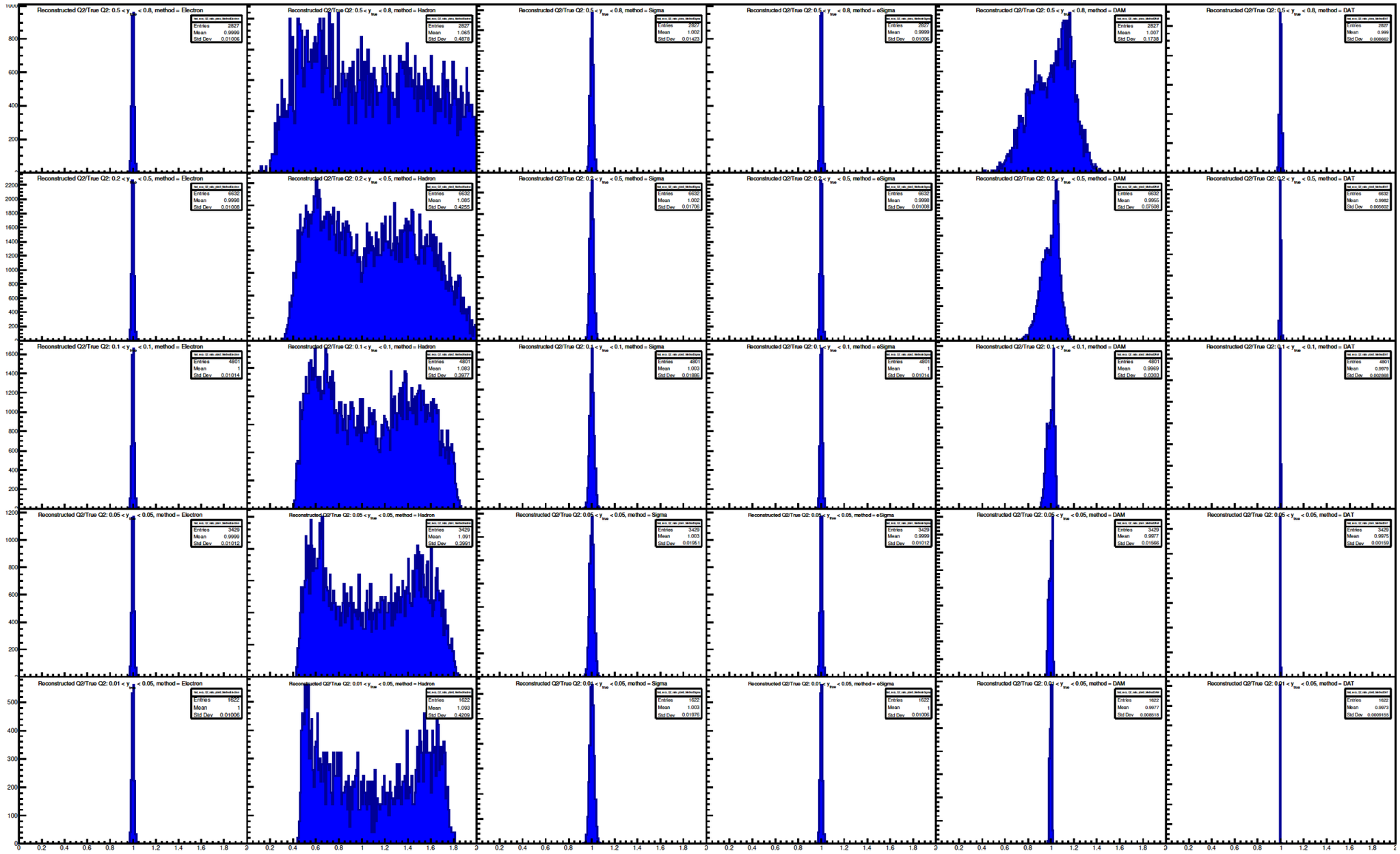
0.5 < y < 0.8

0.2 < y < 0.5

0.1 < y < 0.2

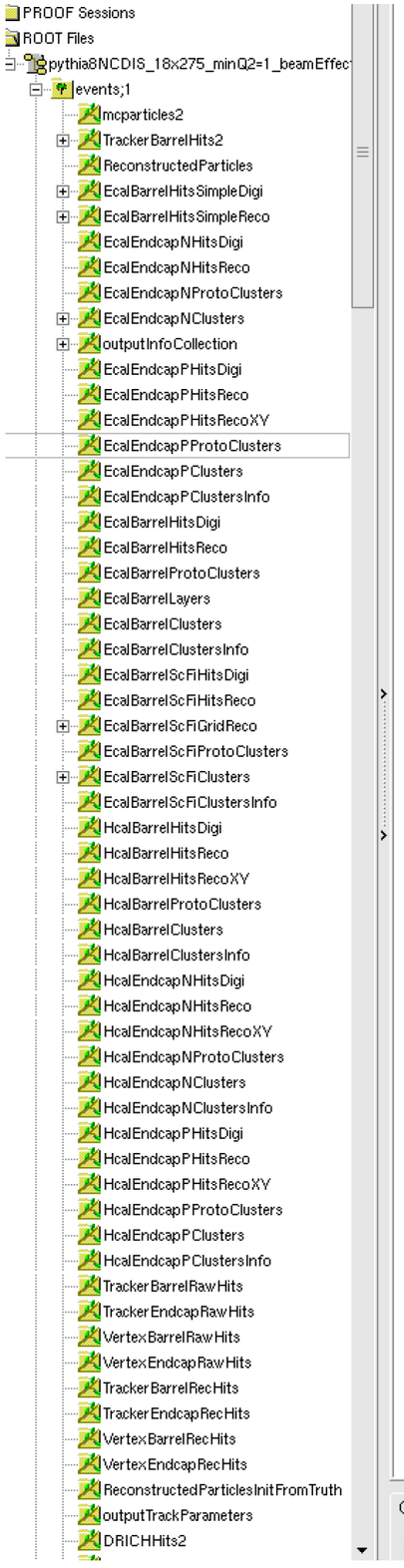
0.05 < y < 0.1

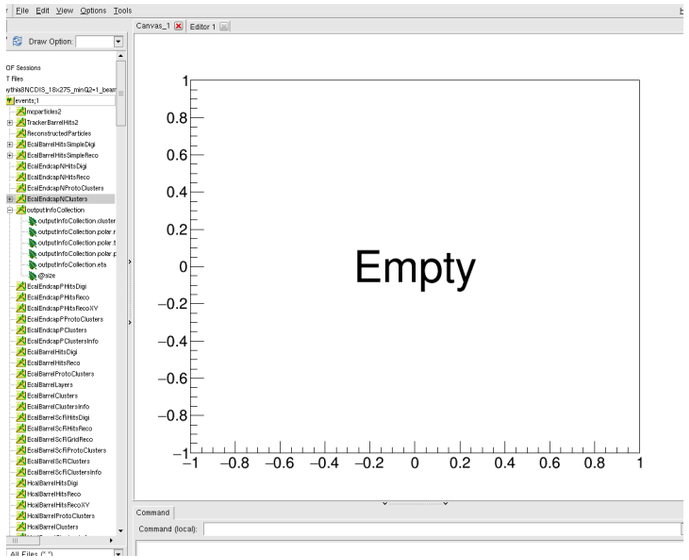
0.01 < y < 0.05

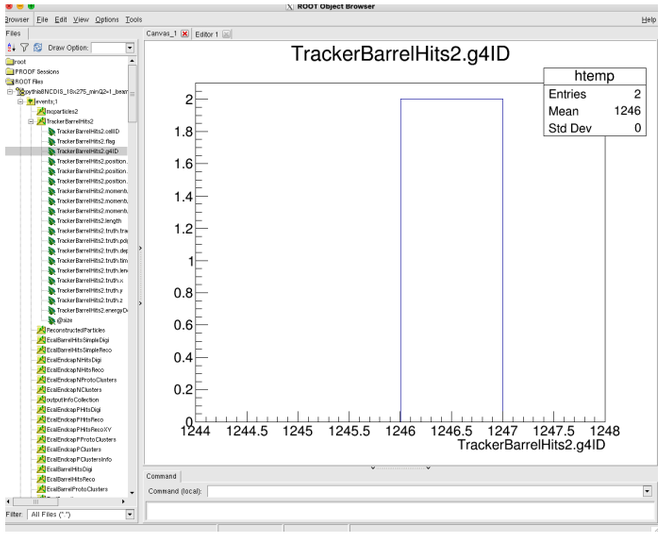


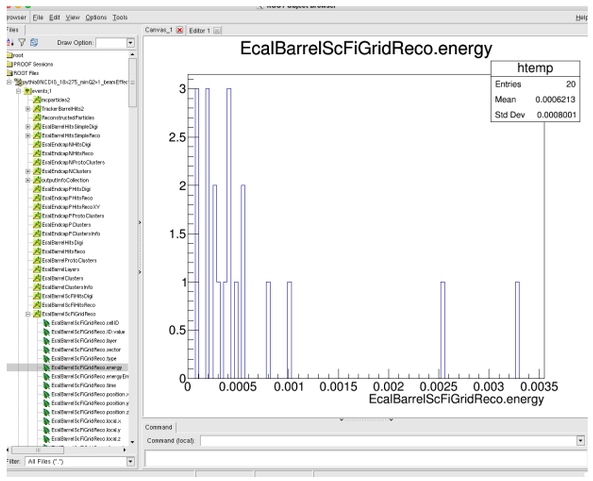
Electron J-B Sigma e-Sigma D-A D-A pT

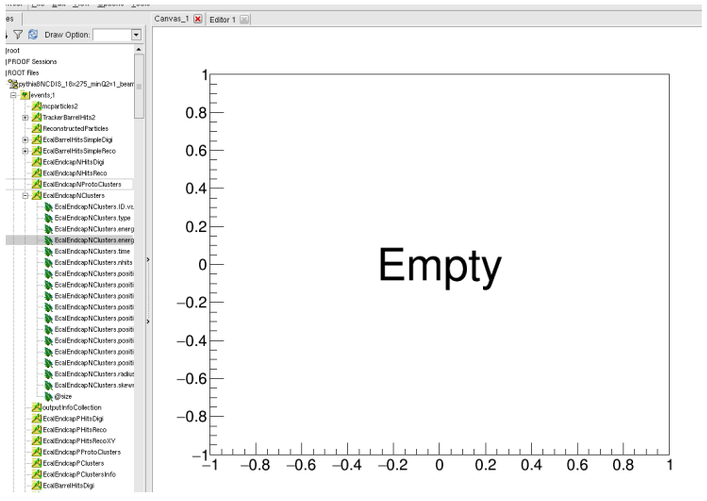
Other branches

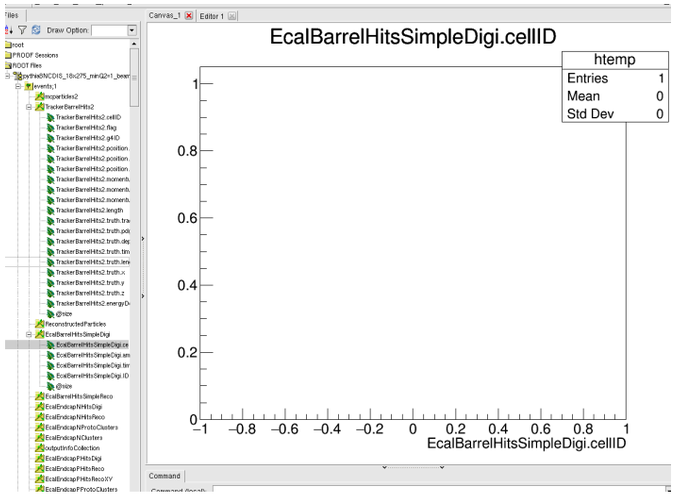












Most of other branches are (almost) empty, will they be filled?

Summary

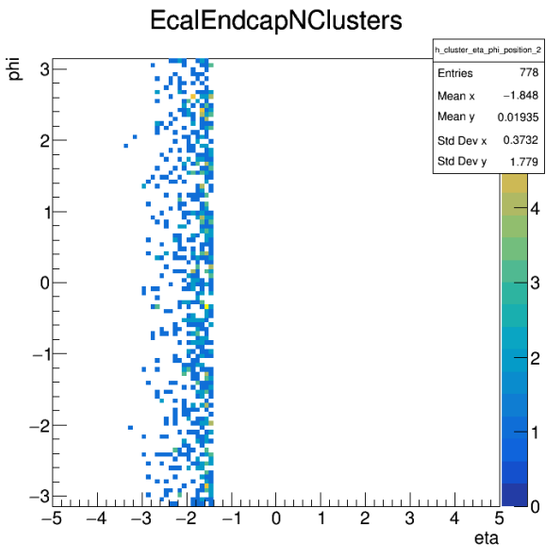
- Looked into ATHENA simulation files (Reconstruction_analysis)
  - Fully filled branches: mcparticles2 and ReconstructedParticles
  - Energy, acceptance, etc, are not reflected in ReconstructedParticles
  - Most of other branches are not (fully) filled
    - Initial state transverse momentum is not negligible for kinematics reconstruction. re-derive formulas or boost/rotate out system pT ??

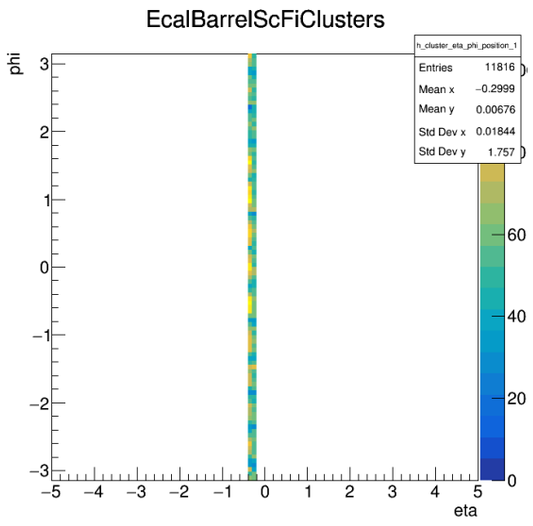
References:

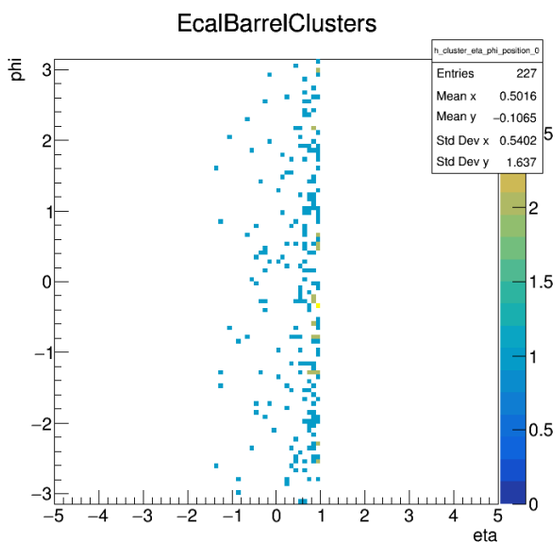
- EIC Tutorial page: https://eic.phy.anl.gov/tutorials/eic_tutorial/part5/reconstruction_analysis
- Wouter's Tutorial at (7/29) SIDIS Meeting
- Miguel's slides (6/28) and code (different input files, DIS (v2) vs. JETS(v1))
- Paul's HERA kinematics talk (5/24)

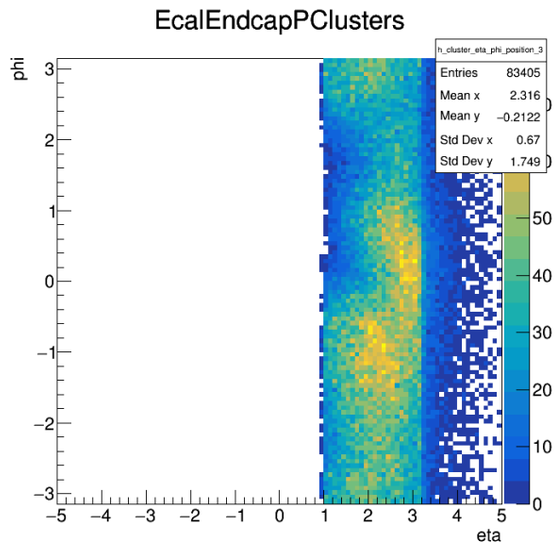
Backup

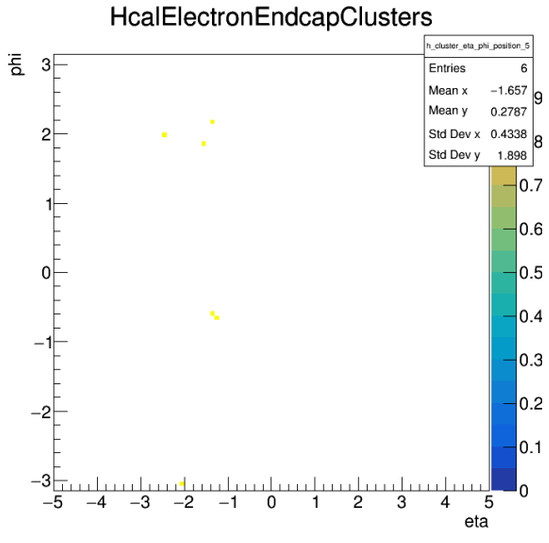
- How to use the calorimeter info? Directly use Clusters?
- Very low activity (< 1) on most of sub-calorimeter systems
- Narrow eta bands on EcalBarrelSciFi and HcalBarrel

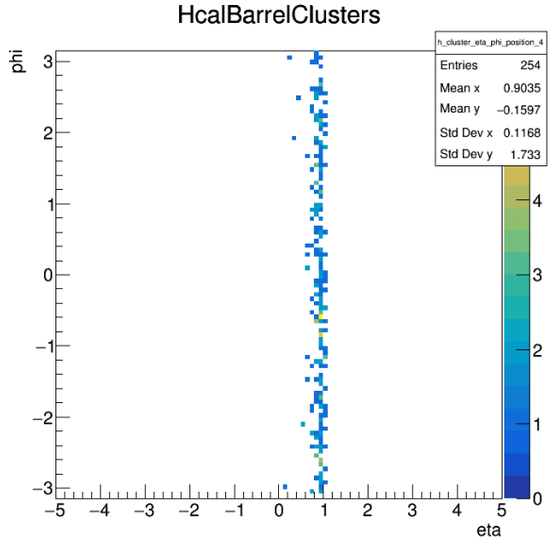


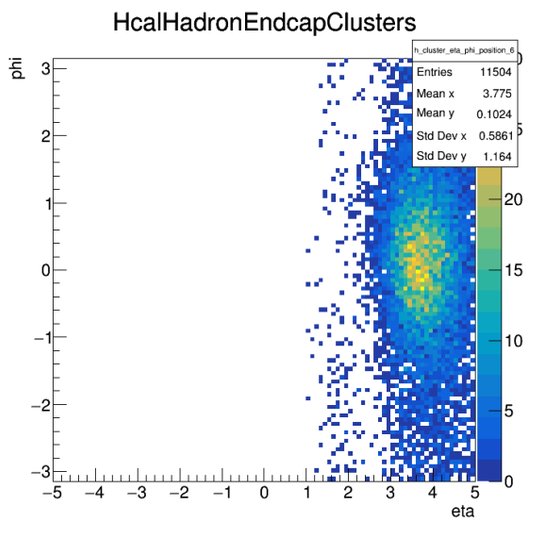






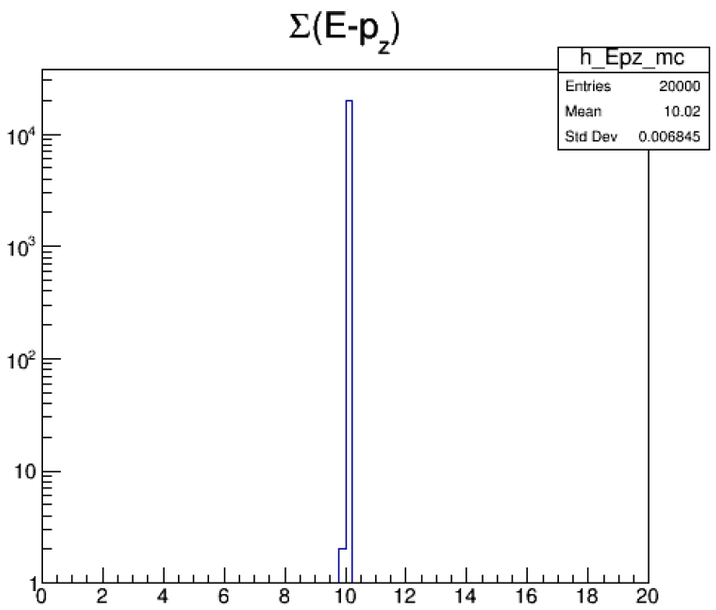


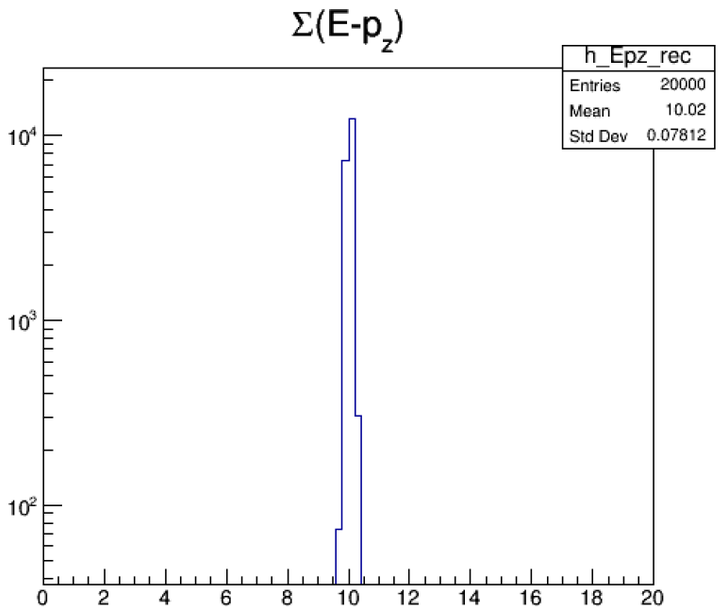


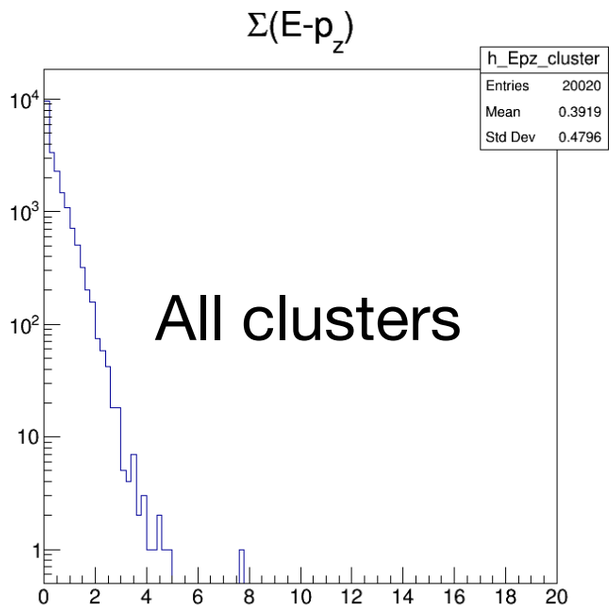


Σ(E-pz)

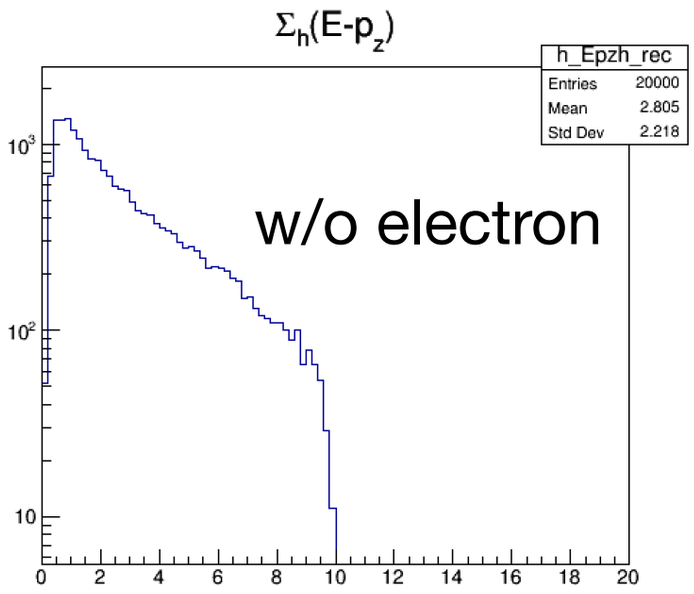
Electron missed ??



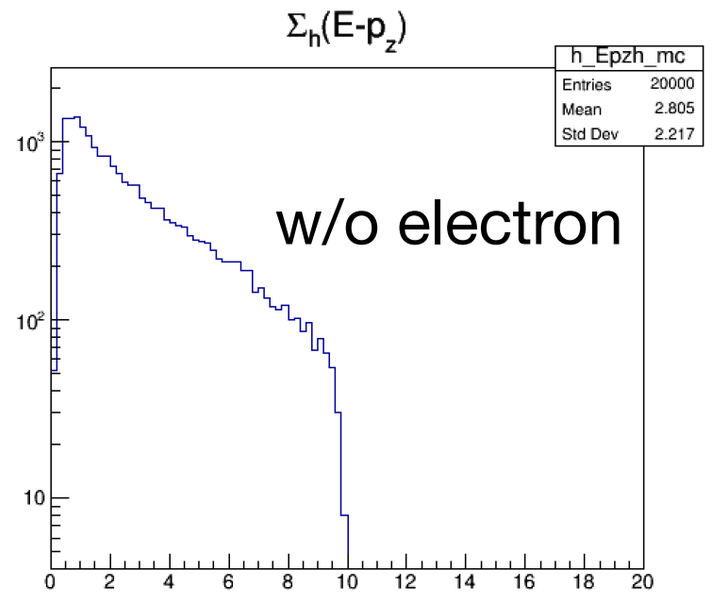




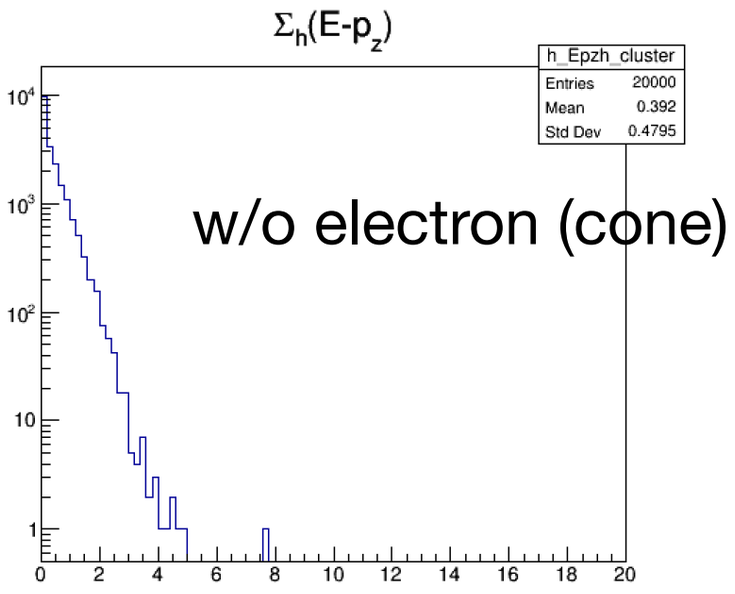
mcparticle2



ReconstructedParticle

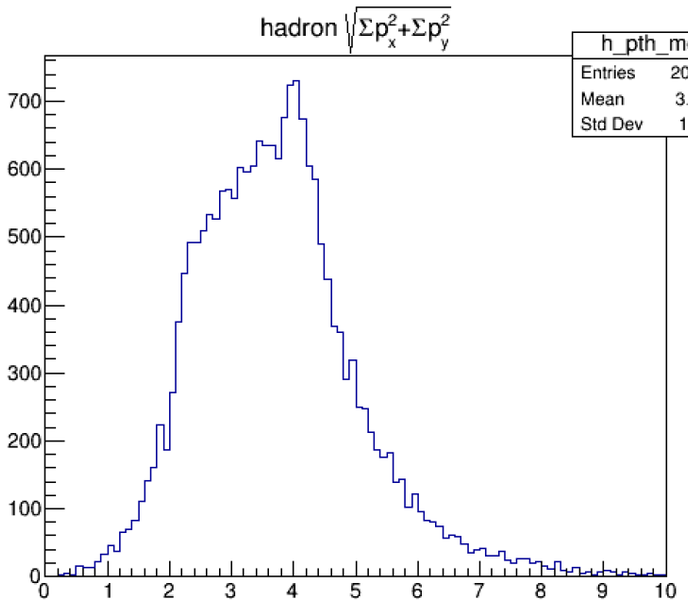


EcalEndcapNClusters and etc

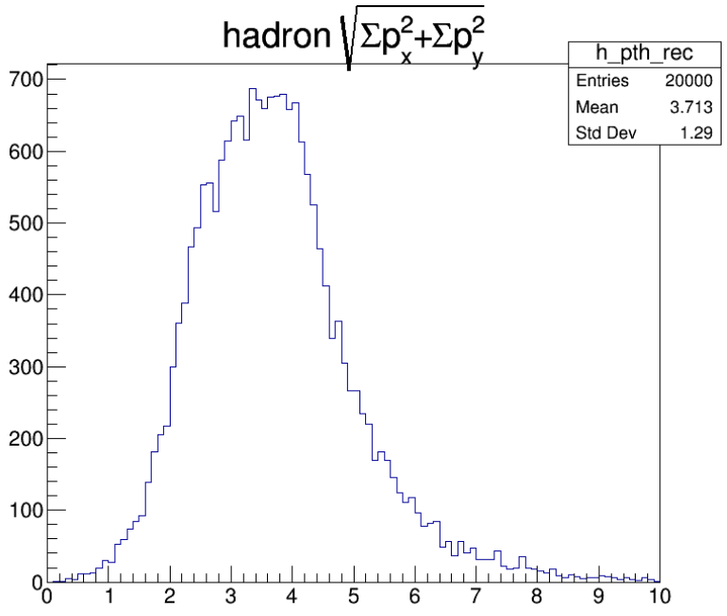


Hadron $\sqrt{\Sigma p_x^2 + \Sigma p_y^2}$

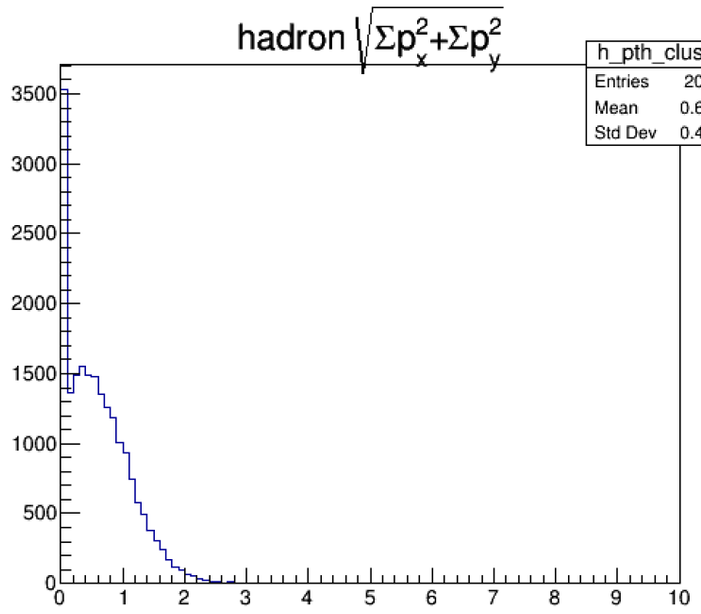
Some hadrons missed ??



mcparticle2



ReconstructedParticle



EcalEndcapNClusters
and etc

- How to use the calorimeter info? Directly use Clusters?
- Very low activity (< 1) on most of sub-calorimeter systems
- Scattered Electron seems not recorded by Ecal