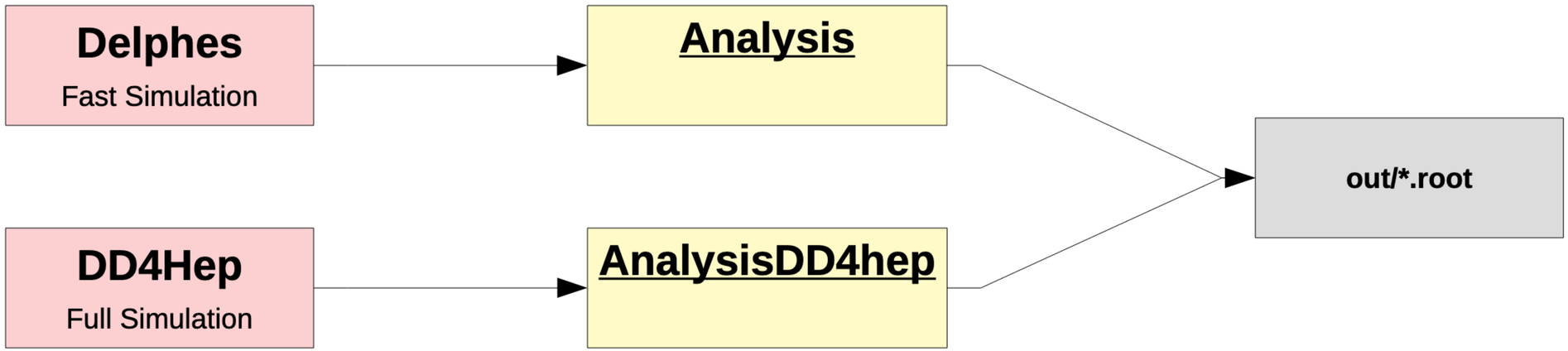
SIDIS Full Simulation Analysis

Analysis Module

- Full simulation analysis module added: https://github.com/c-dilks/largex-eic/tree/fullsim
- Pull request submitted (up to date, to be merged into main easily)



Example macro (analysis_fullsim.C)

```
R__LOAD_LIBRARY(Largex)

#include "Analysis.h"
#include "AnalysisDD4hep.h"

void analysis_fullsim(
    TString infiles="file.list", /* single root file or file list */
    Double_t eleBeamEn=18, /* electron beam energy [GeV] */
    Double_t ionBeamEn=275, /* ion beam energy [GeV] */
    Double_t crossingAngle=0, /* crossing angle [mrad] */
    TString outfilePrefix="test.root" /* output filename prefix*/)
{

  AnalysisDD4hep *ana = new AnalysisDD4hep(eleBeamEn,
                                           ionBeamEn,
                                           crossingAngle,
                                           outfilePrefix);

  // Using a list of multiple files
  ana->AddFiles(infiles);

  // To run over a single root file
  // ana->AddFile(infiles);

  ana->AN->writeSimpleTree = true;

  // Set scatt. electron cuts
  ana->SetEleEnergyThreshold(eleBeamEn * 0.1);  // default is 10% of beamE
  ana->SetIsoCut(0.1);         // default is 10%
  ana->SetIsoConeRadius(1.0); // default is 1.0

  ana->process_event();

}
```

Input can be a list of output files or a single root file

Write a simple tree output

Histograms: pi+, p-, K+, K- final state added (default)

Electron ID cuts

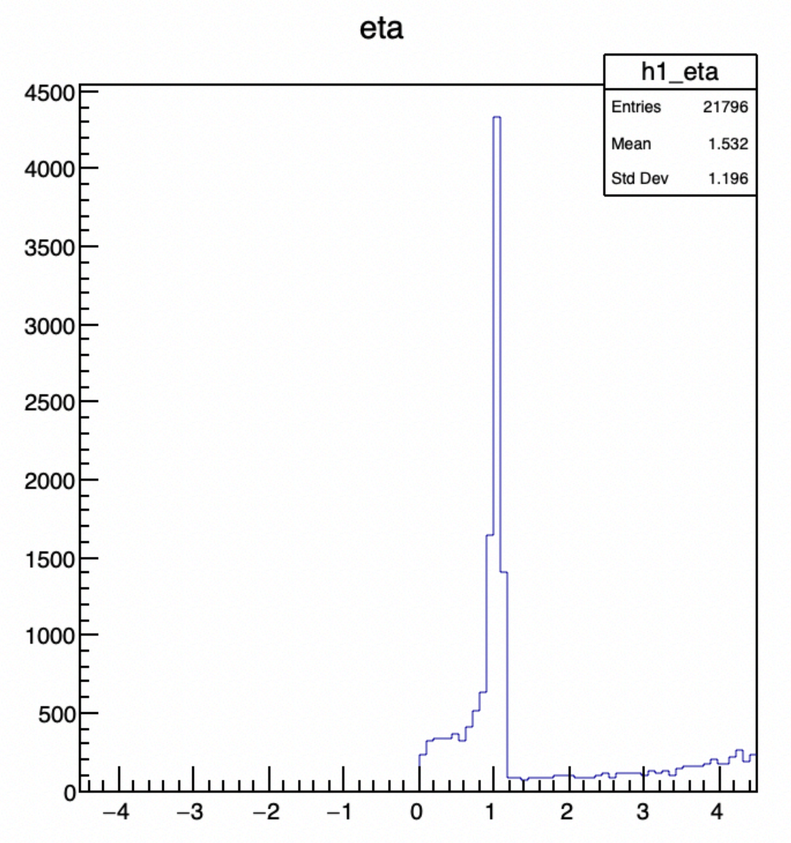
Scattered Electron Identification

- Using the calorimeters + isolation cut
- Minimum energy for the cluster
- Isolation criteria (default: E_cone < E_e * 0.1 with the cone R = 1.0)

*** Cuts can be adjusted:**

```
void SetEleEnergyThreshold(double e_threshold_) { fEThreshold = e_threshold_; }
void SetIsoConeRadius(double r_ ) { fIsoR = r_; }
void SetIsoCut(double isocut_ ) { fIsoCut = isocut_; }
```

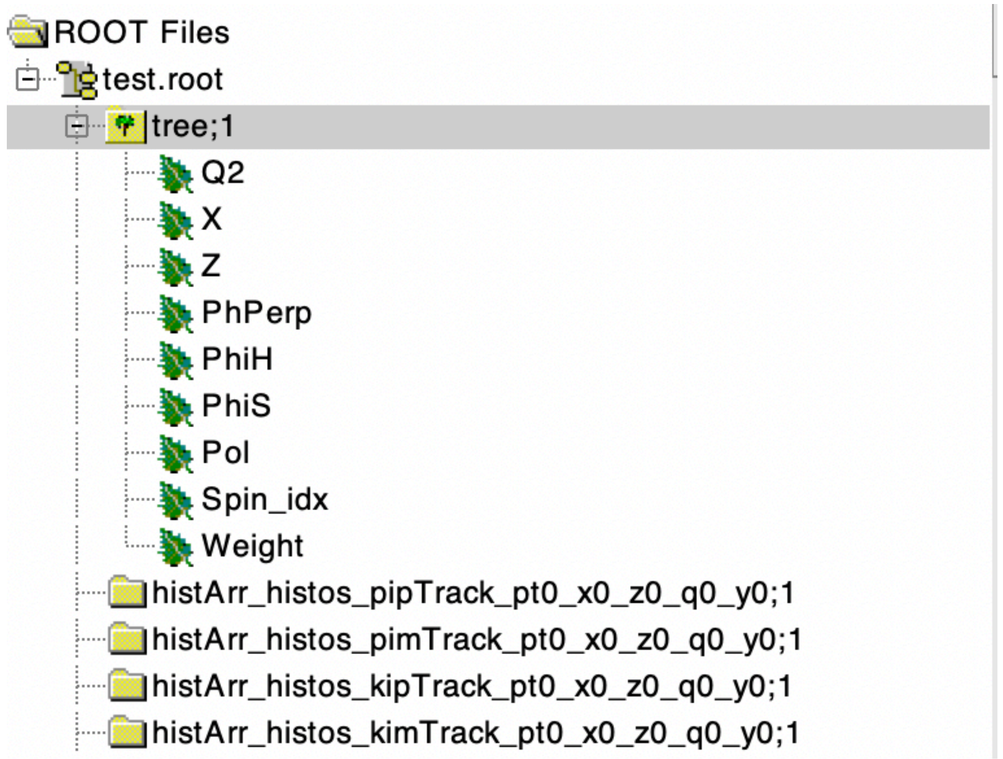
Scattered Electron Identification

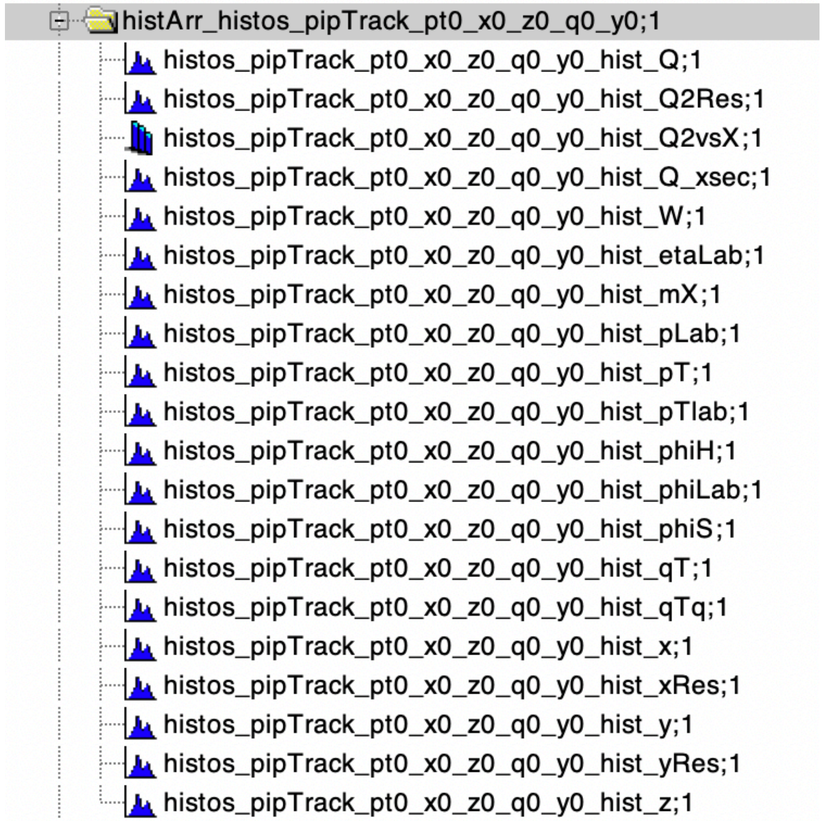


- About 3% events failed to find a scattered electron (5x41 GeV)
- Mostly eta around 1.0
- Issues seems to be identified(track reconstruction) and resolved: https://eicweb.phy.anl.gov/EIC/benchmarks/reconstruction_benchmarks/-/issues/64

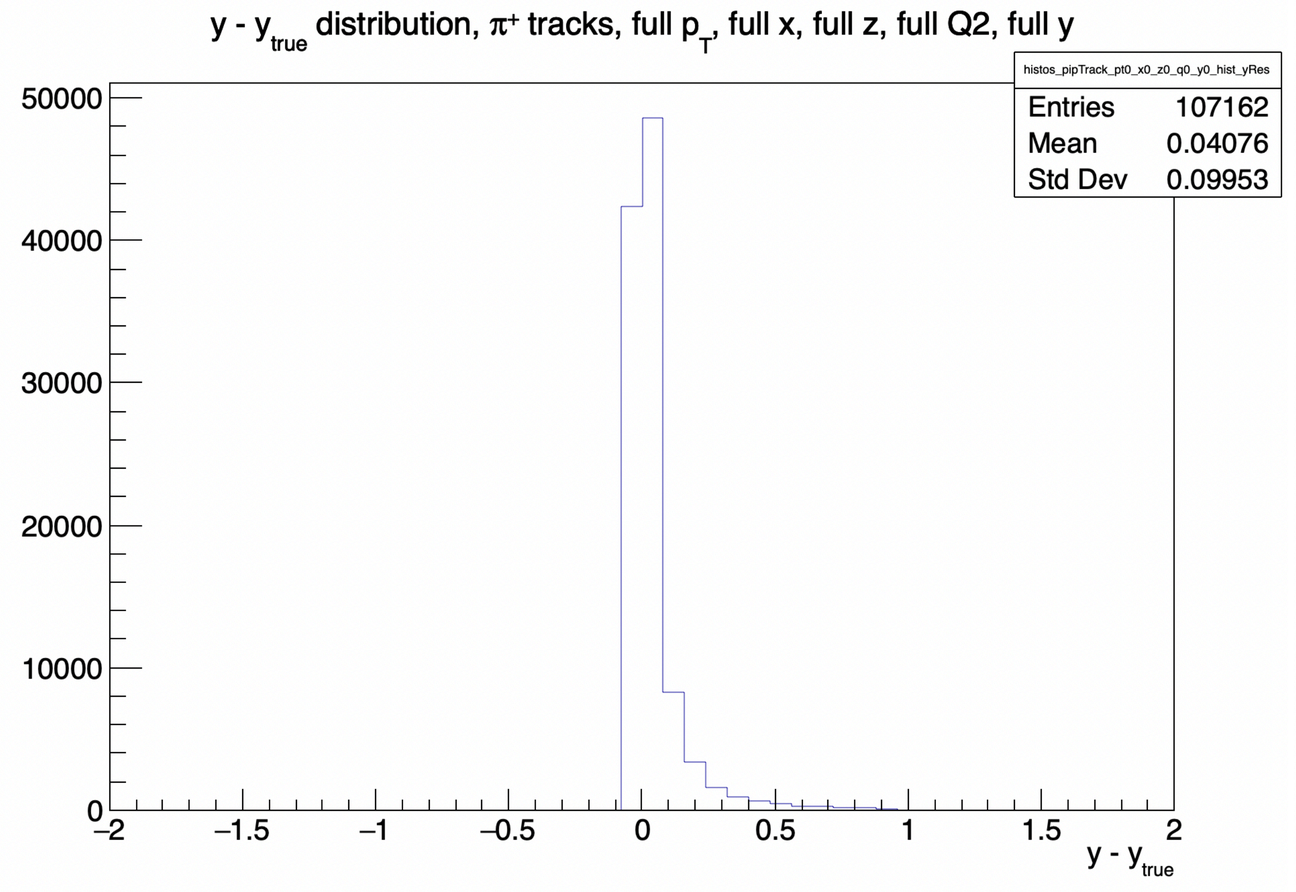
Outputs

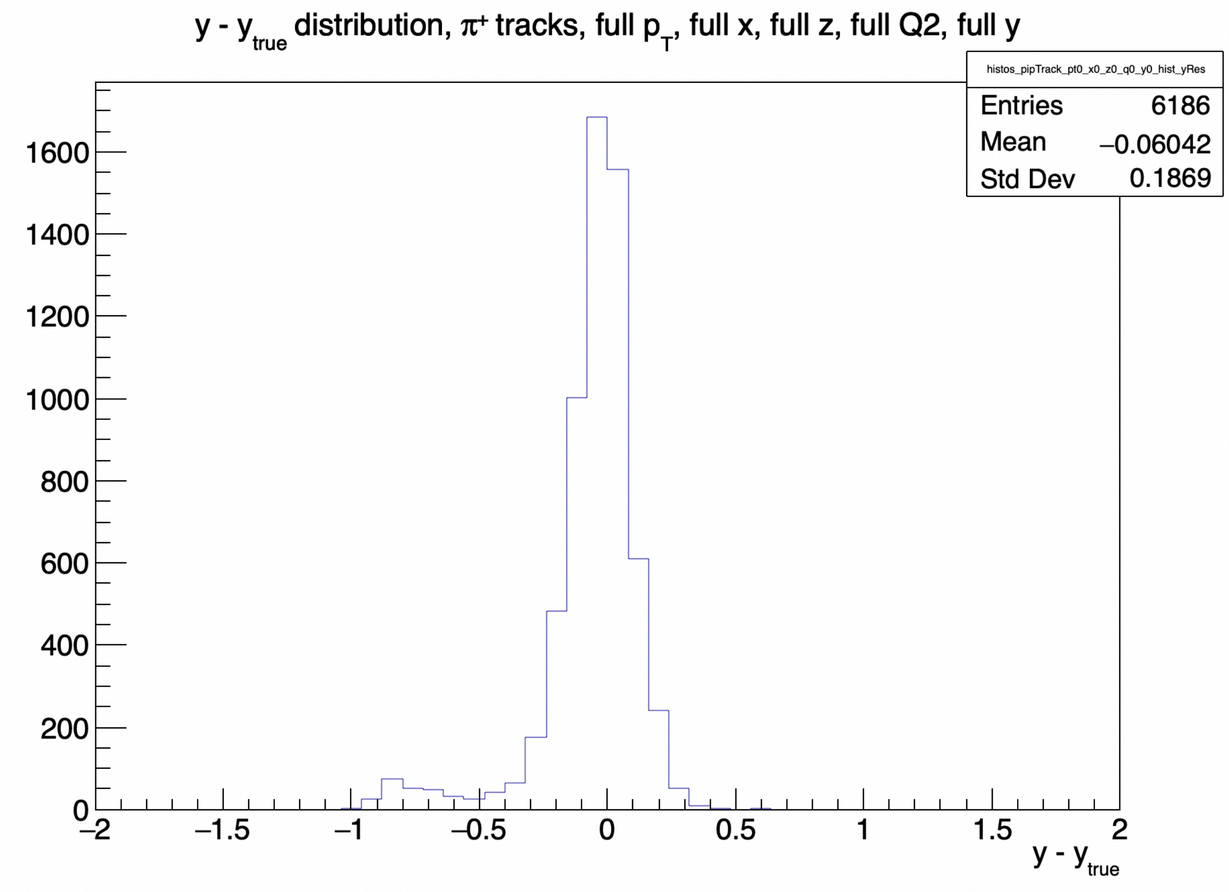
- Share the same output structure as Delphes analysis
- Simple tree output (basic kinematic variables) and histograms for each final state hadron





Example outputs (compare with Delphes (5x41)





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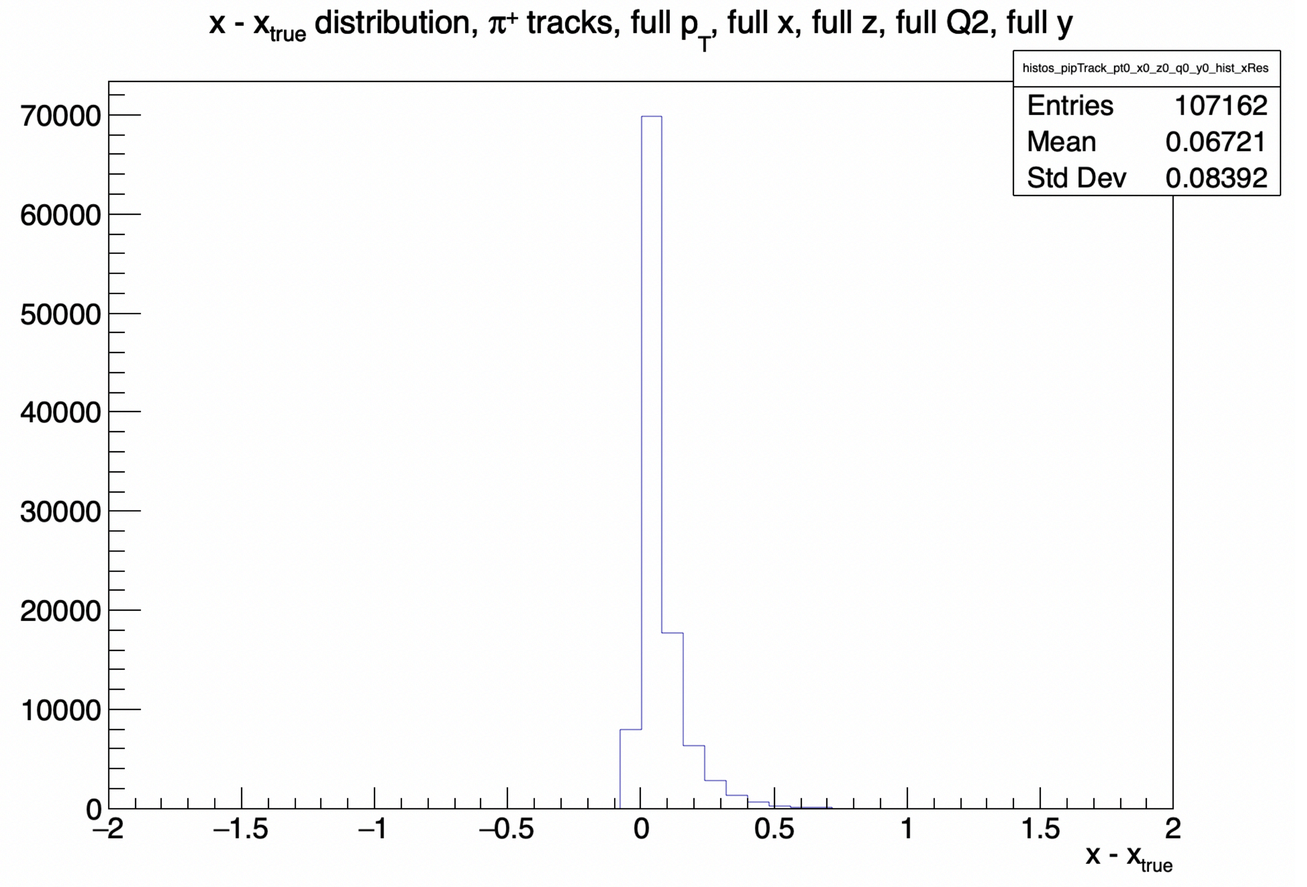

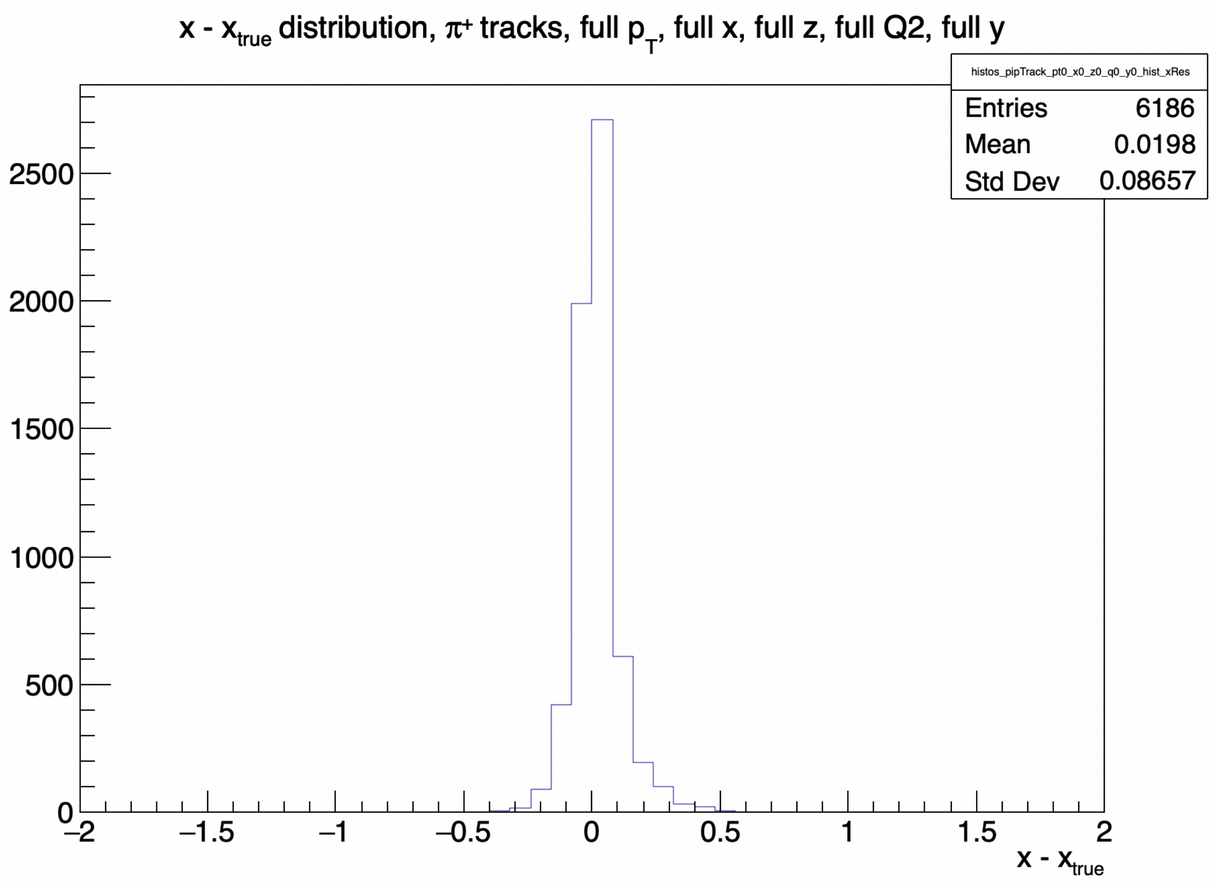

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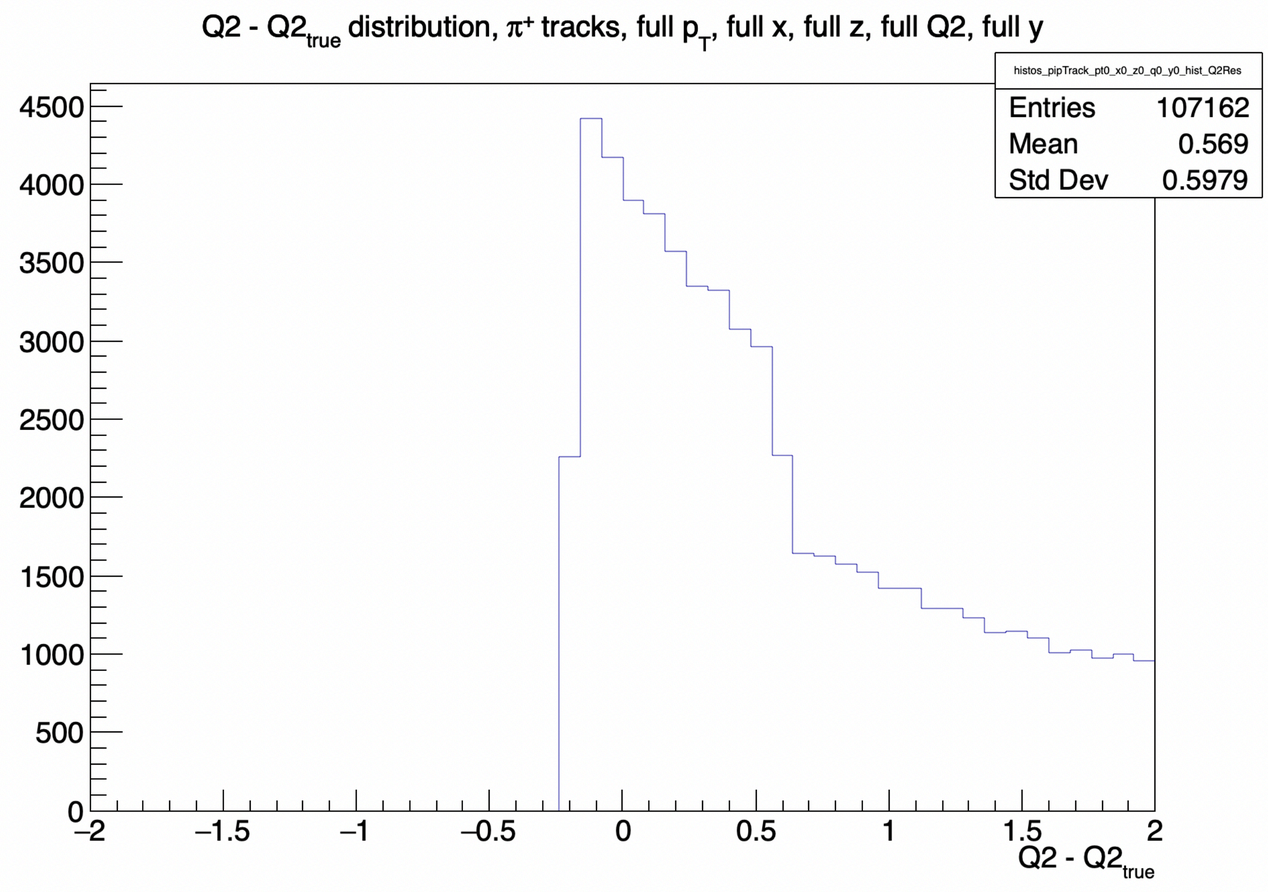

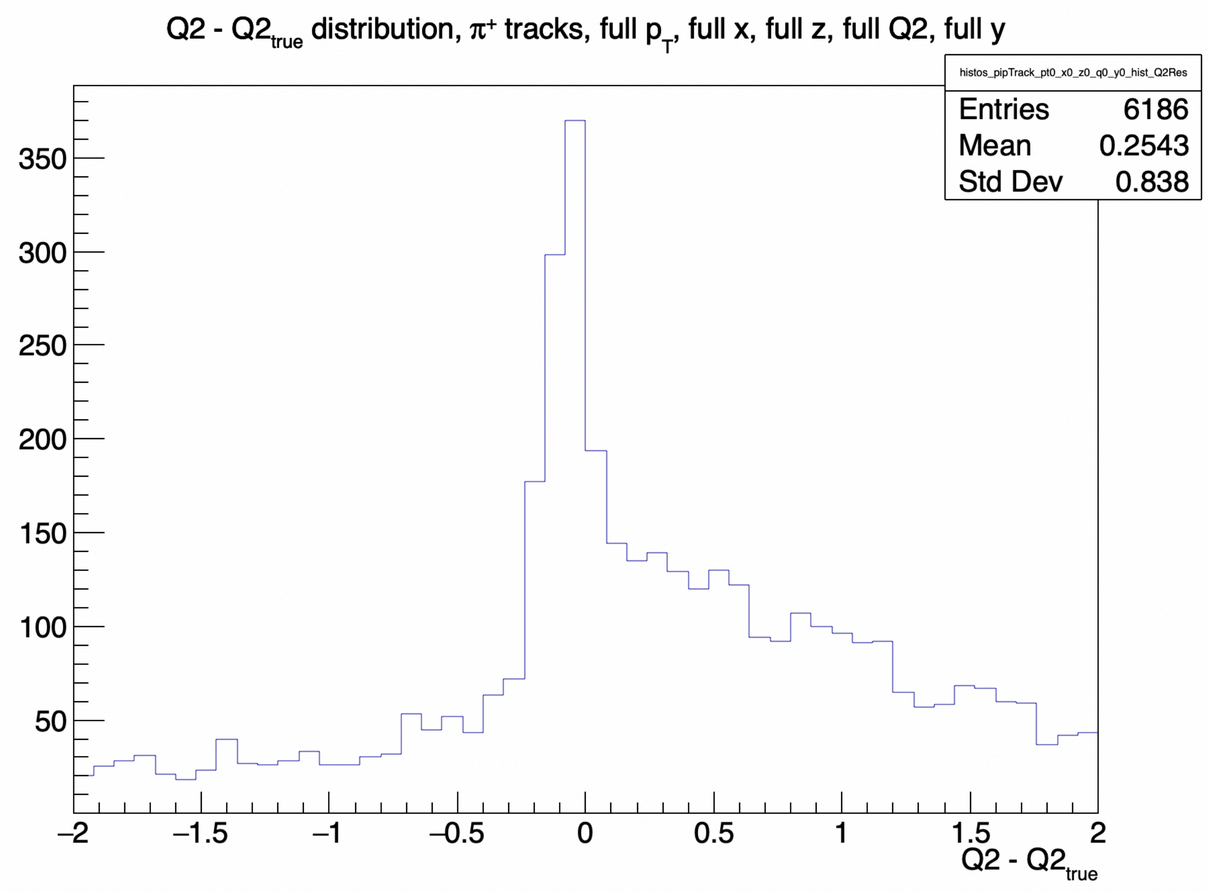

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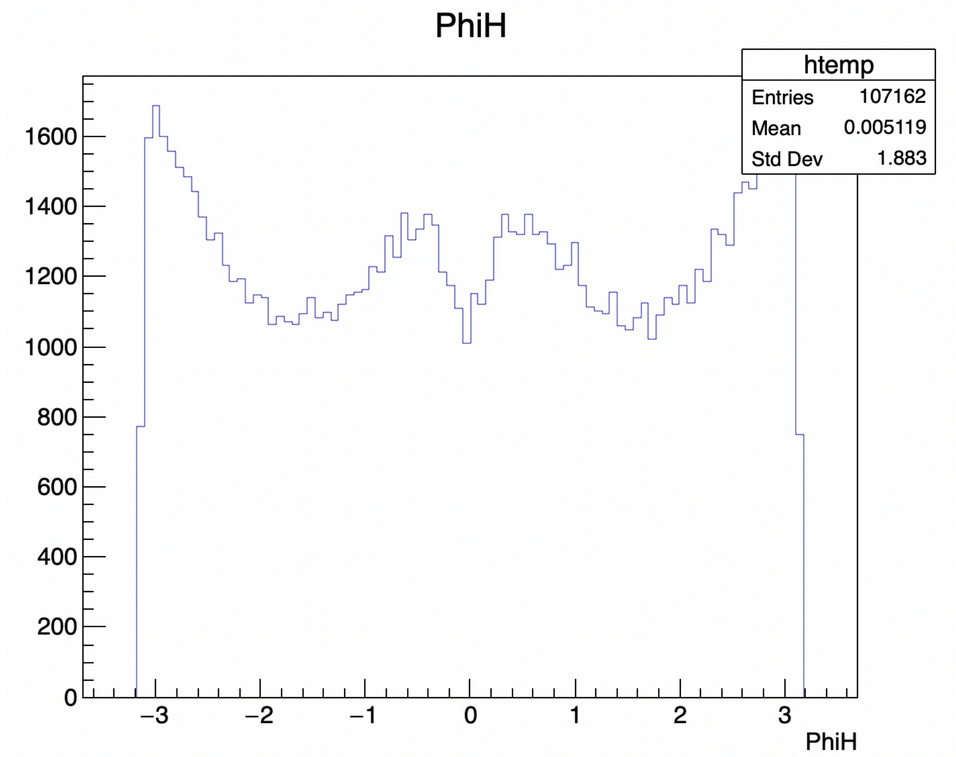

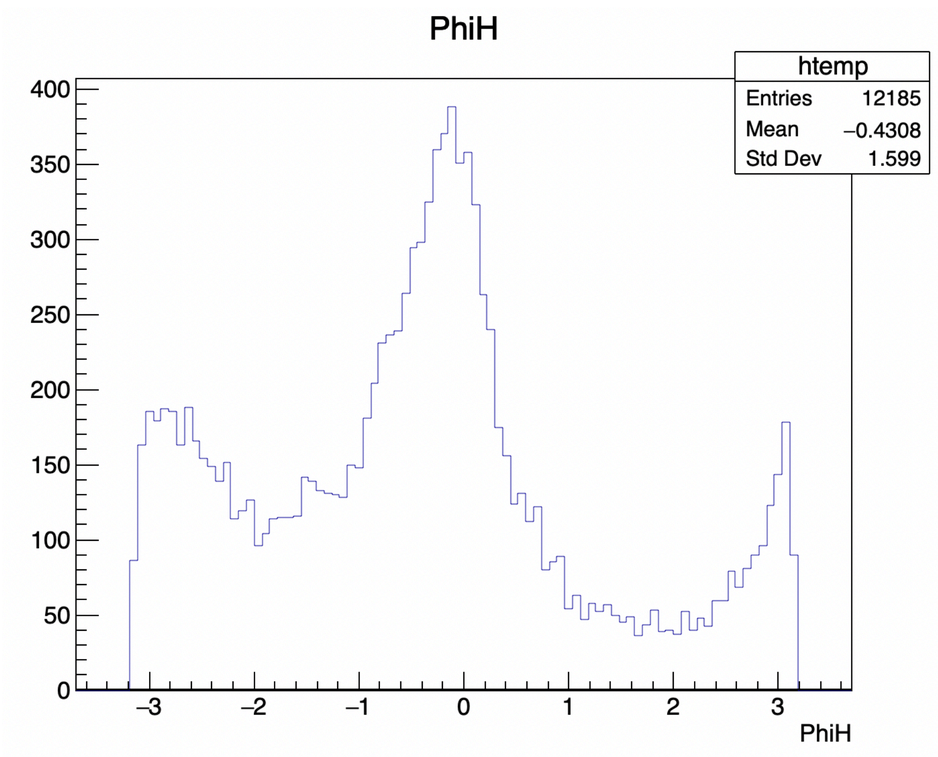

Not using the same coordinate system?

- Full simulation analysis module ready to be used
  - Further updates expected (PID parameterization, coordinates check), but should be able to get started doing some studies already (more detailed comparisons with fast simulations, asymmetry injection check with the full simulation, ..)
  - Simulation outputs are also expected to be reproduced occasionally, but running the analysis is fairly quick

https://github.com/c-dilks/largex-eic/issues/12

- [x] verify the output histograms
- [x] upload example running macros
- [ ] implement PID smearing
- [x] other hadron truth information (currently only have it for scattered electron)
- [x] fix hard-coded parameters (e.g. energy threshold for the scattered electron, better change to something like ~10% of the beam energy?)
- [ ] clean-up
- [ ] implement track-cluster matching (start with a simple projected distance check)