UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

Comparison of x, y, Q^2 reconstruction methods

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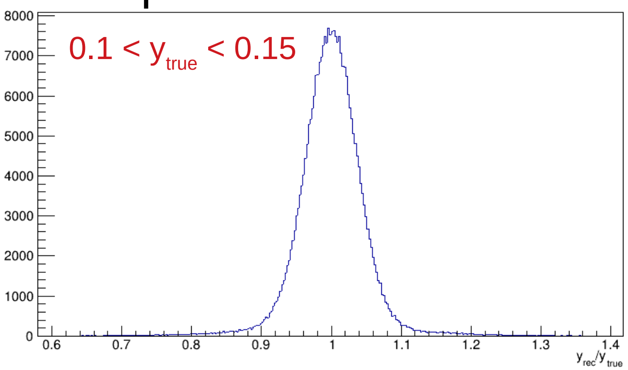
Introduction

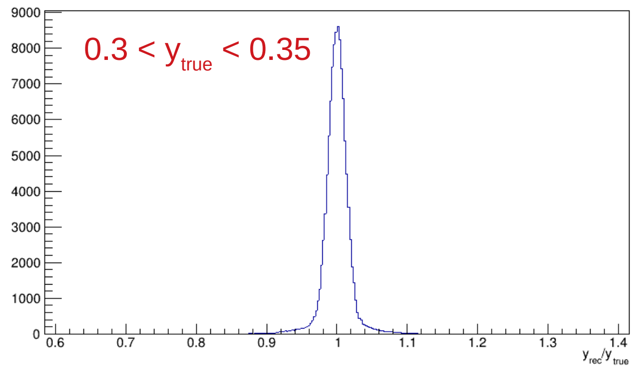
- Aimed to create plots that clearly show the performance of different reconstruction methods (e.g. electron method, JB method)
- Reconstructed kinematic variables from EICSmear output:
  - Electron, JB, Double Angle, Σ and e-Σ methods
- Wrote values to tree and produced plots detailing distribution of reconstructed values (x_{rec}/x_{true}, y_{rec}/y_{true}, Q^2_{rec}/Q^2_{true})
- Working on implementation for full simulation output → problems arise:
  - Need to account for crossing angle in reconstruction methods
  - Initial state QED radiation present?

*Available at
https://github.com/JeffersonLab/dis-reconstruction

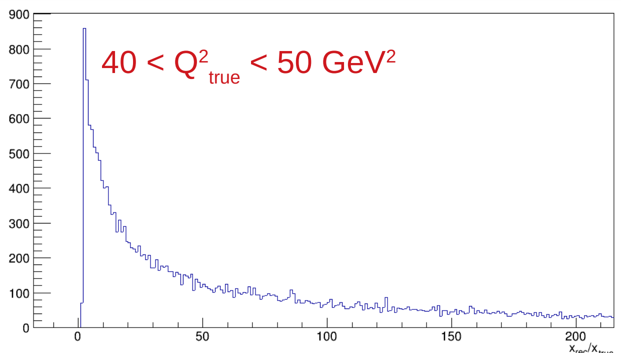
EICSmear implementation

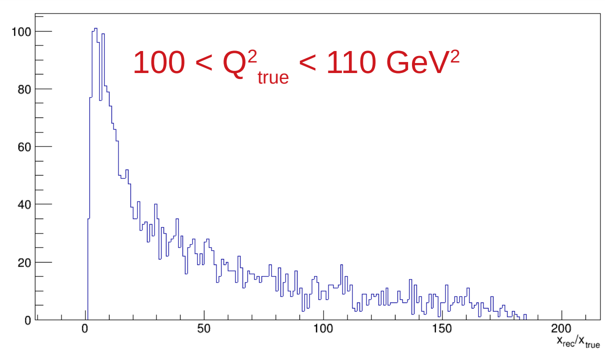
- Used Barak's DIS reconstruction code* as a starting point → Added Σ and e-
- Σ methods
- Extracted x, y, Q^2 , found x_{rec}/x_{true} etc
- Calculated standard deviation of x_{rec}/x_{true} etc at various x, y, Q2 values and plotted in a suitable form





Electron method (E from ECAL)
$0 < x_{true} < 0.5$, $2 < Q^2_{true} < 200$ GeV^2
Note: Can apply x and Q^2 cuts as desired





JB method
$0 < y_{true} < 1$, $0 < x_{true} < 0.5$
Note 2: These plots are for example purposes → don't expect JB to work well everywhere!

Plots generated from EICSmear output for smearing according to YR detector matrix of 18x275 e-p events (from pythia6)

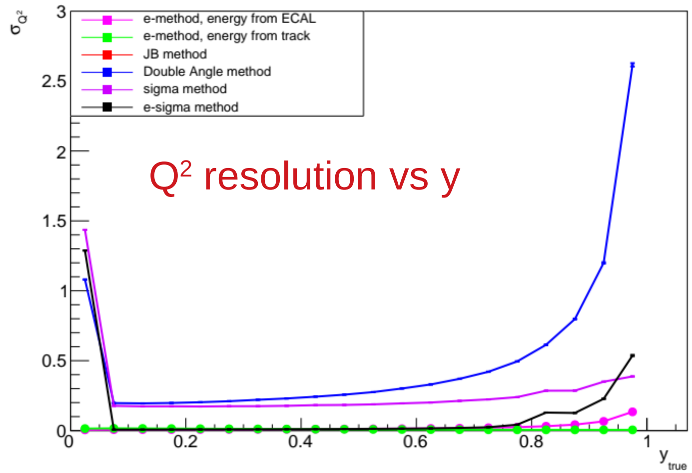
EICSmear implementation

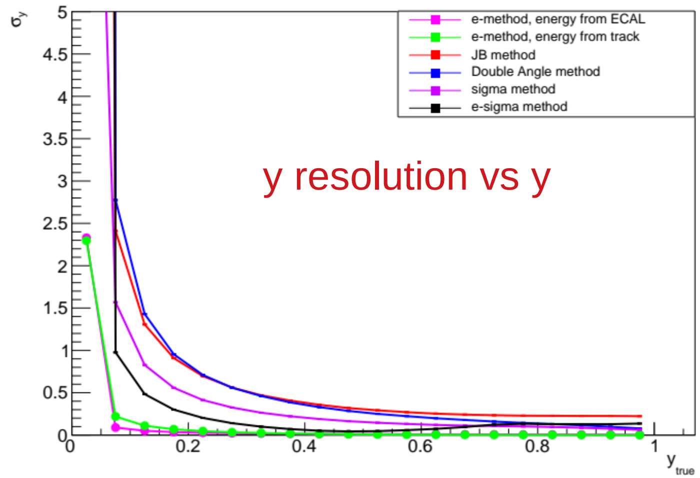
- Clearly while a Gaussian fit would work well for certain methods for certain x, y, Q^2 cuts, other methods do not fare so well
- Current approach is to take the standard deviation of the values w.r.t. mean, could alternatively take std dev w.r.t. 1
- Histogram mean values also of interest

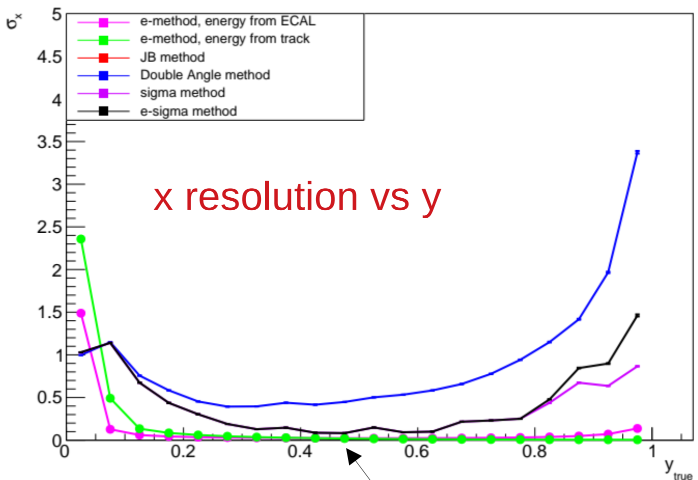
- Additionally, the current EICSmear implementation for hadrons mixes smeared calorimeter and tracking information → this can cause unusual behaviour
  - For consistency could try doing $p_z = E\cos(\theta)$, or $E = \mathrm{sqrt}(p^2 + m^2)$ (and either neglect m or use π mass) to use only information from either calorimeters or tracks

*For Matrix Smeared YR Pythia6 output

Resolution plots*



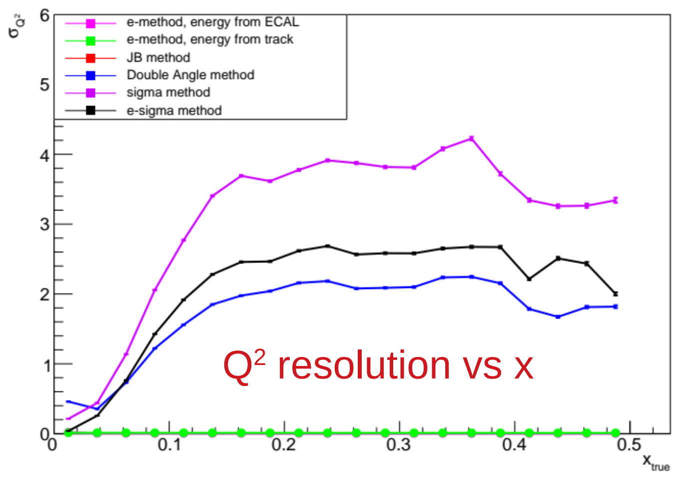


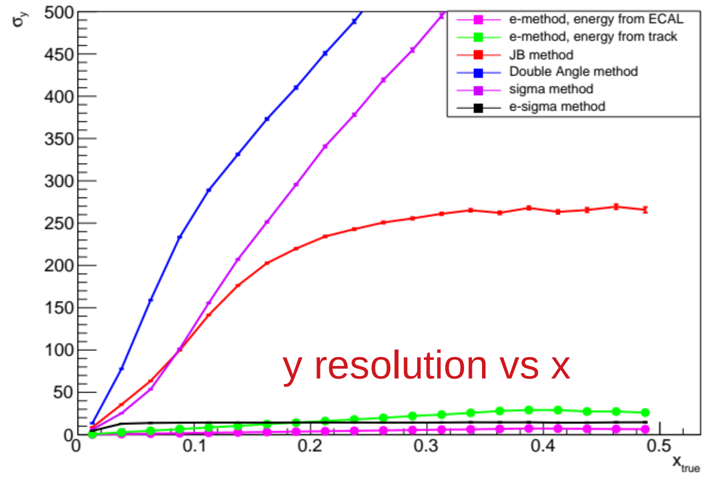


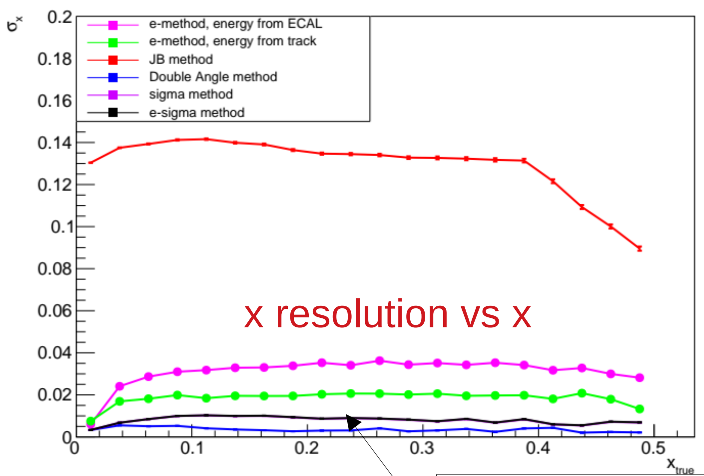
X resolutions still being investigated

- Cuts:
  - $0 < y_{true} < 1$
  - $0 < Q^2_{true} < 200\ \text{GeV}^2$
  - $0 < x_{true} < 0.5$

Resolution plots*







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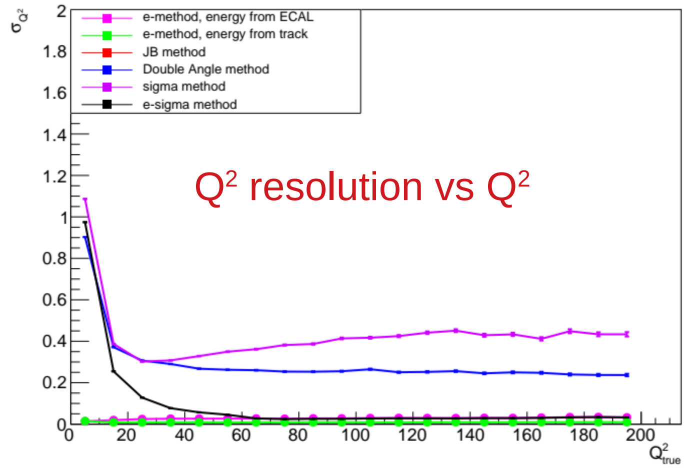
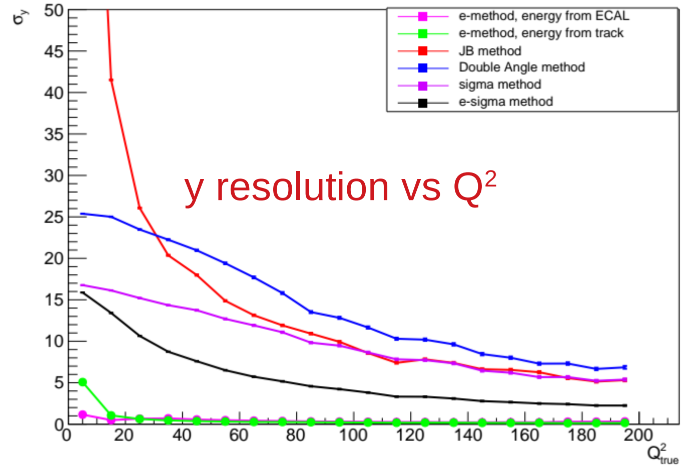
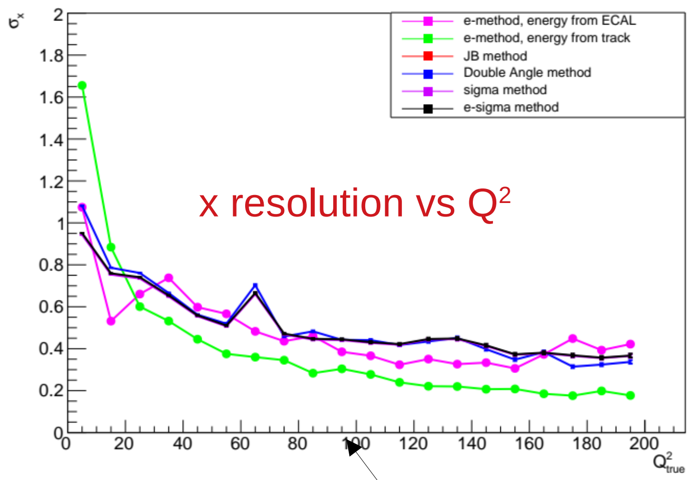






X resolutions still being investigated

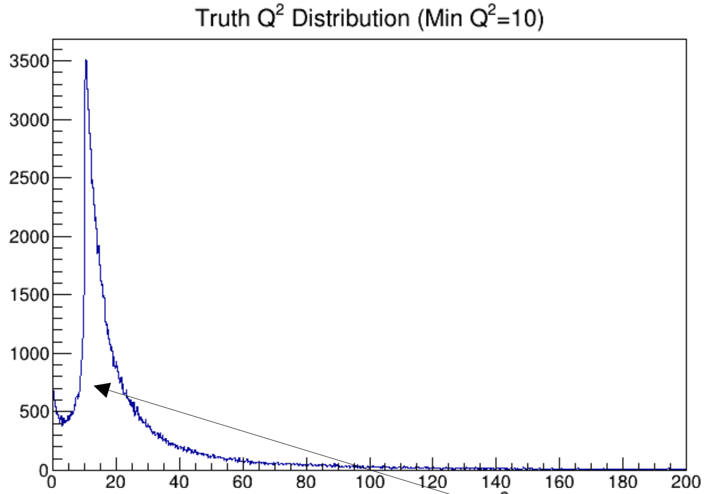
- Cuts:
  - $0 < y_{true} < 1$
  - $0 < Q^2_{true} < 200$ GeV^2
  - $0 < x_{true} < 0.5$

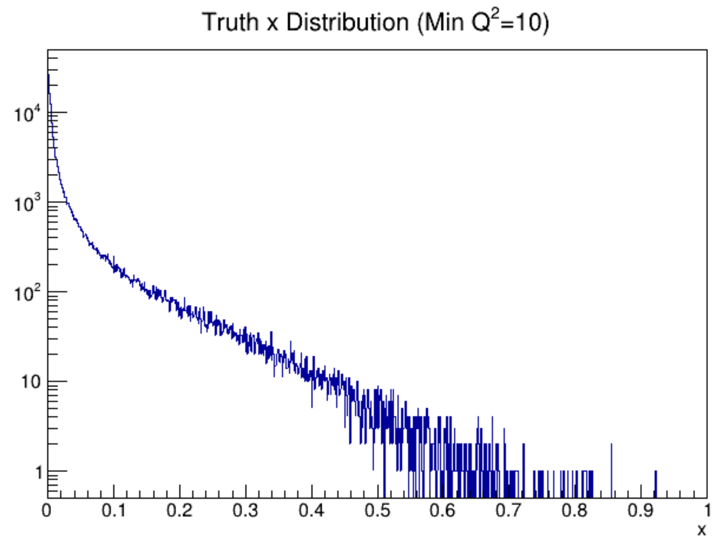
- Electron method tends to perform the best (excluding at low y)

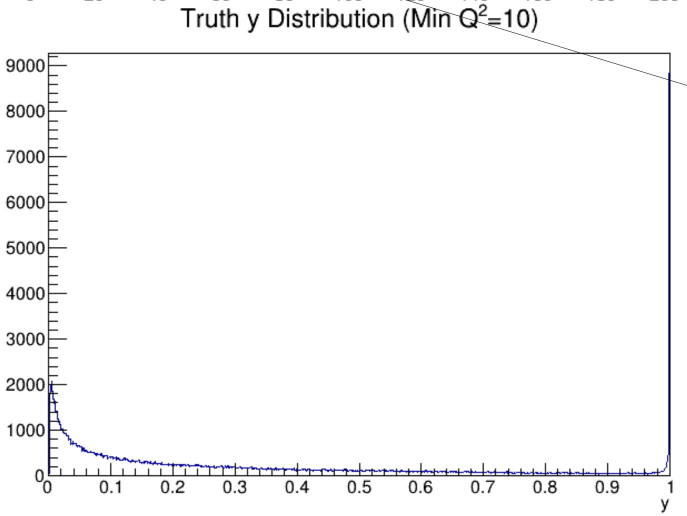
- Expect methods using hadron information to improve with input optimisations

Full Simulation Output

- Currently implementing for full simulation reconstructed output files available on S3
  - Strange behaviour when reconstructing x, y, Q^2 for reconstructed output files:







- Crossing angle?
- ISR and FSR (FSR flag on, ISR possibly?)

Files S3 path = "/eictest/ATHENA/RECO/acadia-v1.0-alpha/DIS/NC/18x275/minQ2=10/"

Reconstruction with 25 mRad crossing angle

- The presence of a crossing angle should not present any problems when reconstructing from 4 vectors:

$$Q^2 = -q^2 \qquad x = \frac{-q^2}{2p \cdot q} \qquad y = \frac{p \cdot q}{p \cdot e}$$

- However once we begin reconstructing by JB etc, the presence of the crossing angle will begin to affect reconstruction
  - → boost to head on frame
- Discussion with software working group would be beneficial for this

Summary

- Have a plot format for viewing x, y, Q^2 reconstruction performance
  - Tested with EICSmear YR matrix smeared Pythia 6 output
- Implementing for Full simulation output
  - Problems encountered reconstructing from MC truth information

Next Steps

- Understand/resolve problems reconstructing truth information (full sim)
- Investigate optimised hadron reconstruction and electron ID
- Implement reconstruction methods such that they work with 25mRad crossing angle
- Produce benchmark plots that compare reconstruction methods for various kinematic cuts