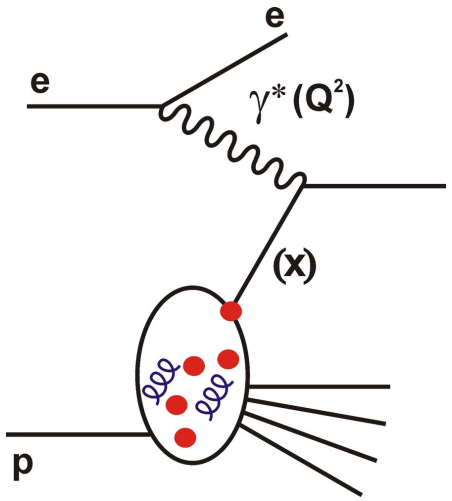
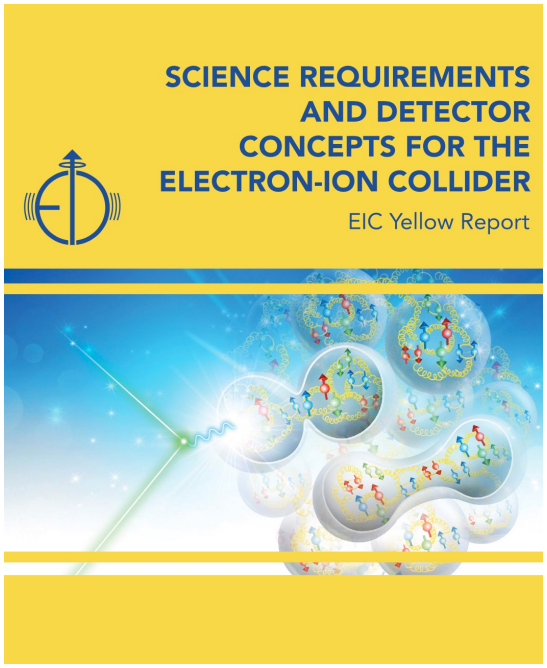
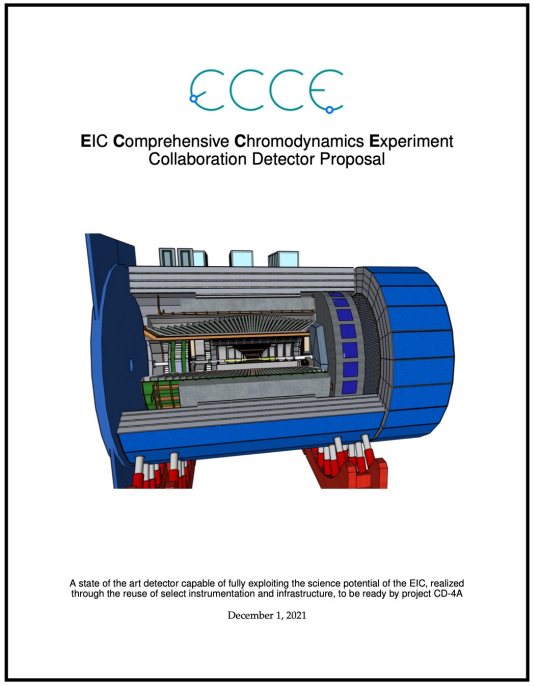
Inclusive Physics at EIC: and the UK



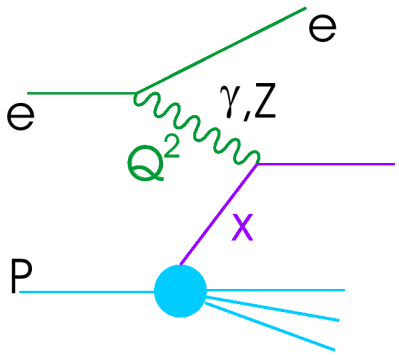
EIC-UK Discussion Meeting
7 December 2022

Paul Newman (Birmingham)

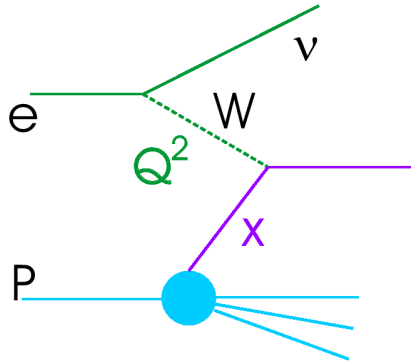




Inclusive Scattering Observables



Neutral Current:
ep → eX



Charged Current:
ep → νX

`Inclusive' refers to anything we can measure starting from the inclusive neutral and charged current processes

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

$$y = \frac{p \cdot q}{p \cdot e} \qquad Q^2 \simeq sxy.$$

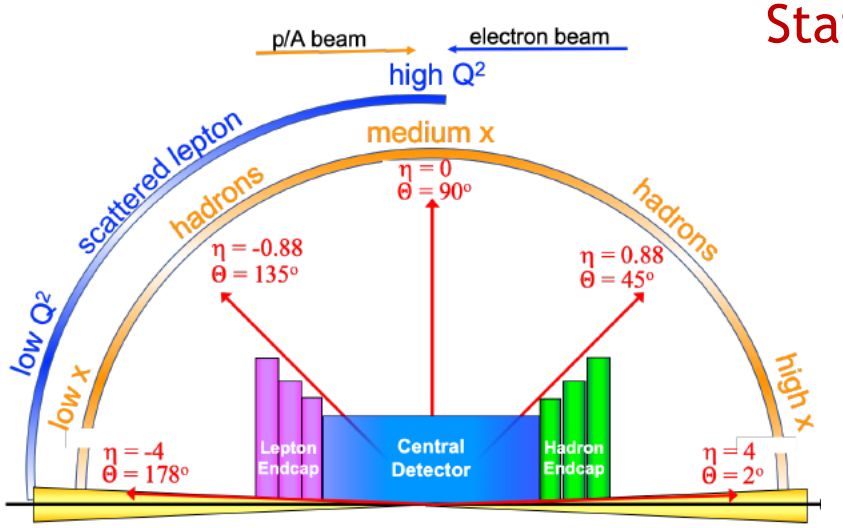
$$W^2 = (q+p)^2.$$

- x, Q^2 (via y, Q^2) can be reconstructed from any two of E_e, θ_e, E_h, θ_h

- Hadronic final state understanding also important for background rejection

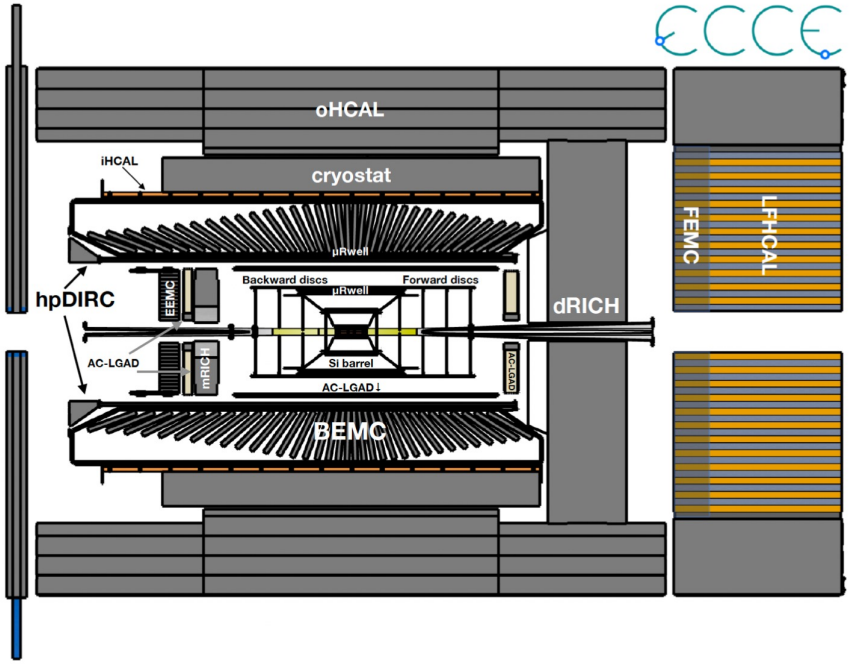
… starting point is electron identification & reconstruction, plus inclusive hadronic final state measurement.

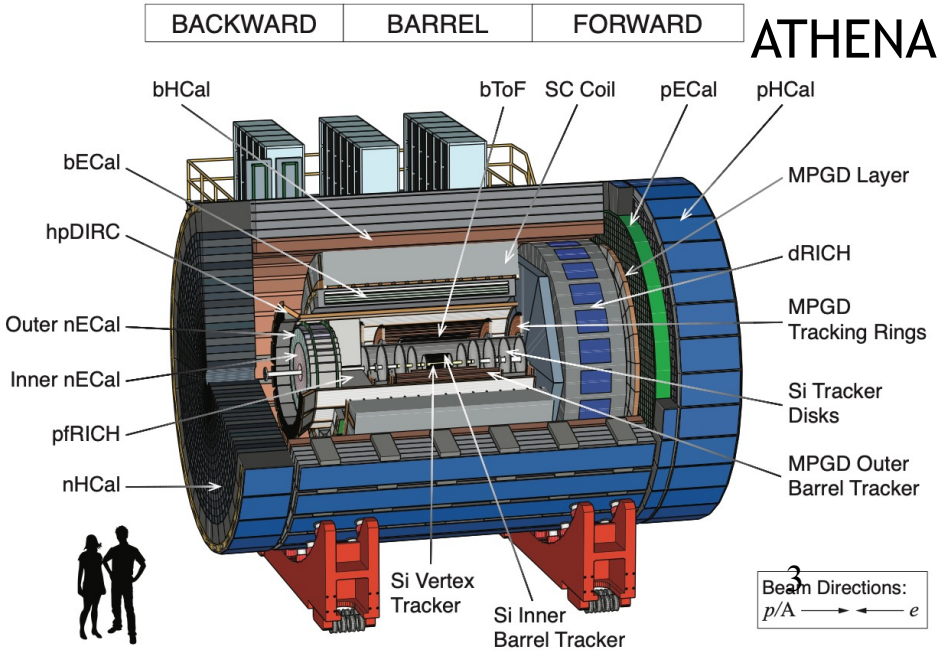
EIC detectors will be transformational



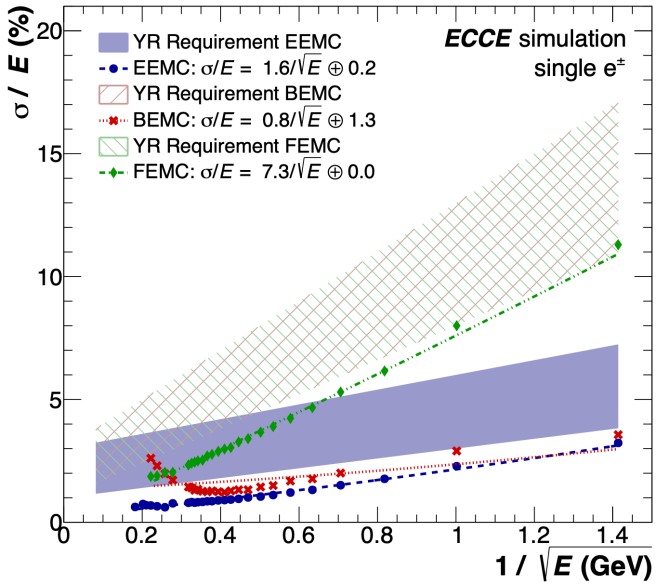
State-of-the-art detectors with:

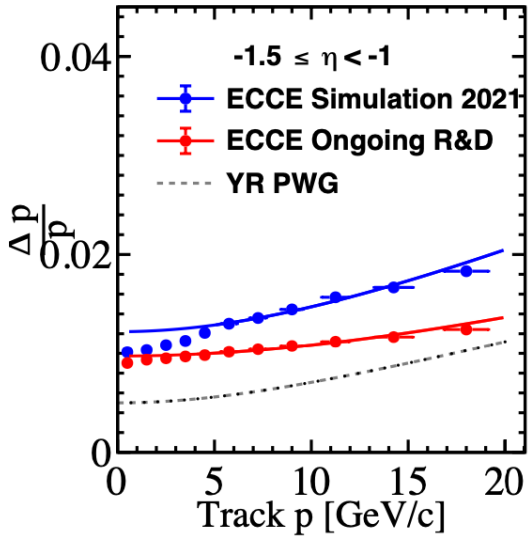
- Hermetic e, h coverage to $|\eta|$~4
- High tracking resolution (MAPS silicon)
- High precision ECAL (and HCAL)
- Strong emphasis on particle ID
- Strong emphasis on Forward / Backward beamline instrumentation

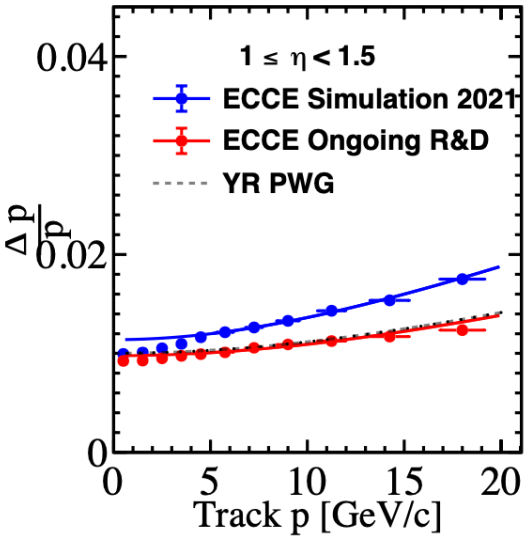




Early Performance Studies:

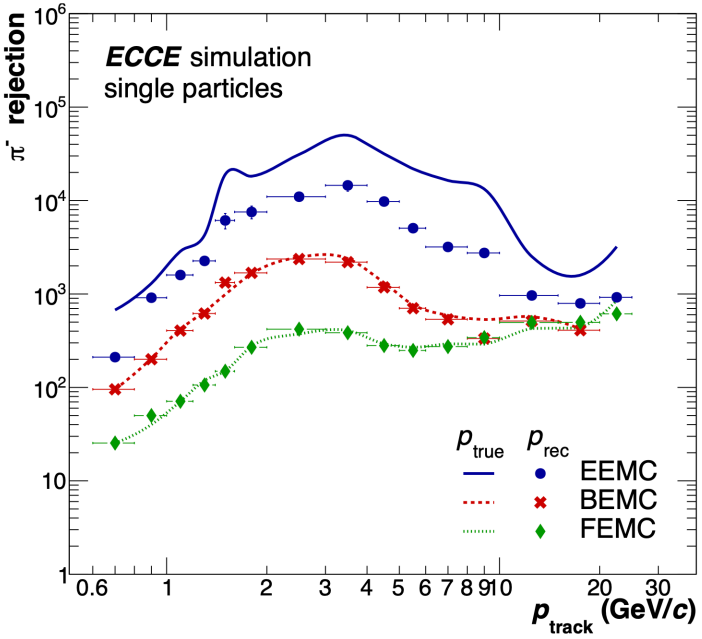






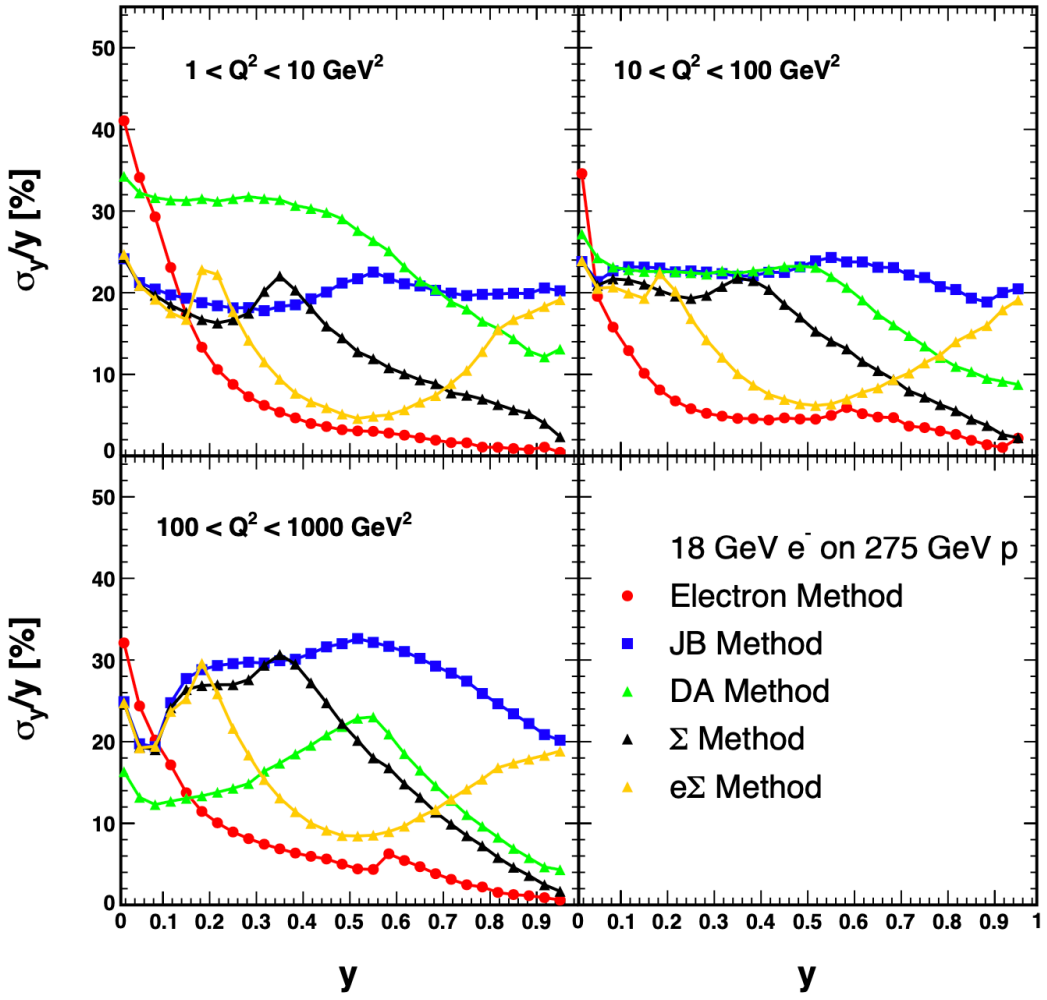
- Electron energy measurement with either tracker (low p_T) or ECAL (high p_T) is at ~1% level throughout measured range

- Photoproduction background to electron ID (from π^-) can be suppressed to < few% level using calorimeter alone, and to completely negligible levels when also including particle ID detectors.



Early Performance Studies

ATHENA



- First detailed assessment of relative performance of reconstruction methods throughout measured phase space

- Ongoing work on modernised using all information simultaneously (machine learning / kinematic fitting)

UK Contributions

ATHENA

Paul Newman - Convener
- Assessment of impact on proton and nuclear PDFs

Stephen Maple – Performance studies (kinematic reconstruction etc)

Tom Cridge, Lucian Harland-Lang, Robert Thorne
- Assessment of impact on proton PDFs

→ Publication plans?

ECCE

Claire Gwenlan - Convener
- Assessment of impact on proton PDFs

EPIC

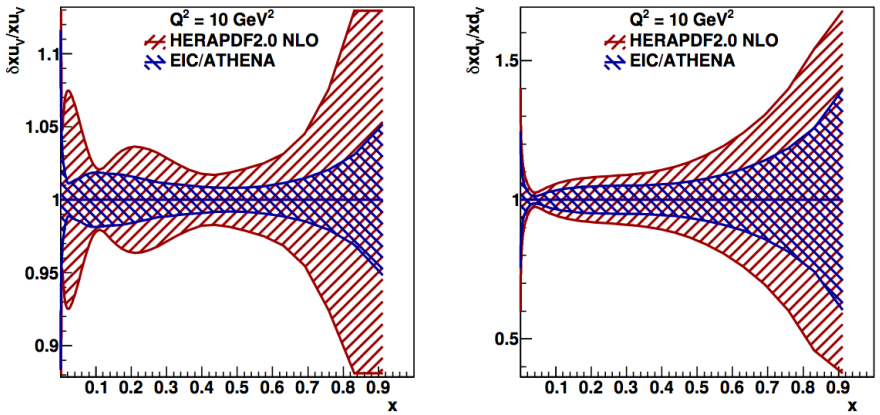
Glaire Gwenlan and Paul Newman
- Conveners

Stephen Maple - Simulation tests, Kinematic fitting studies

Matthew Hellen / George Williams
- Charged current (particle flow, Strange from s→c)

… getting up and running → testing simulated files and EICRECO
→ benchmarking detector designs (currently CALO)

Impact of EIC/ATHENA on PDFs

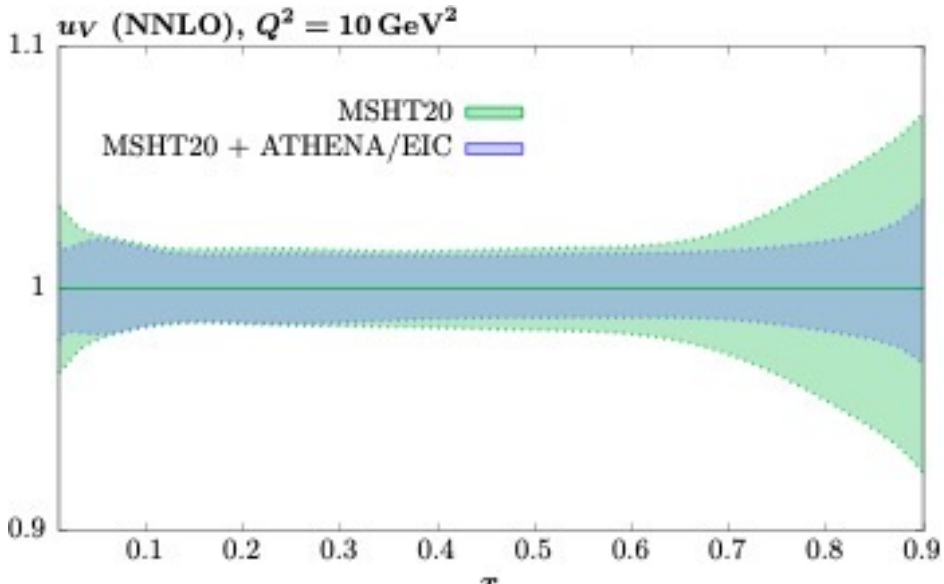


Fractional total uncertainties with / without EIC / ATHENA data included

- Relative to (HERA-only) HERAPDF2.0

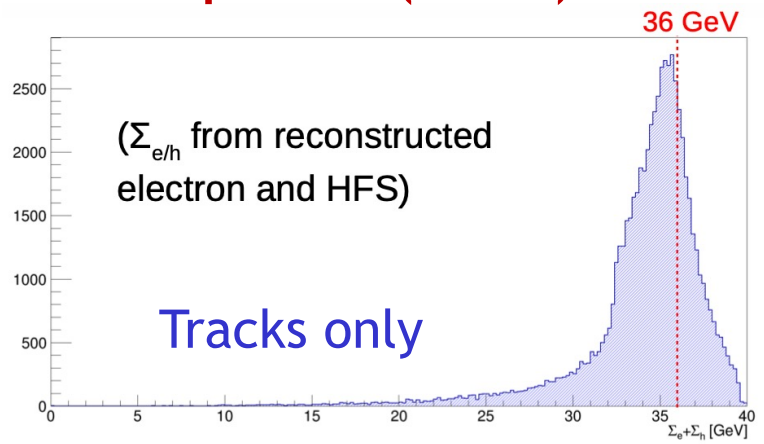
- Relative to MSHT20 Global Fit

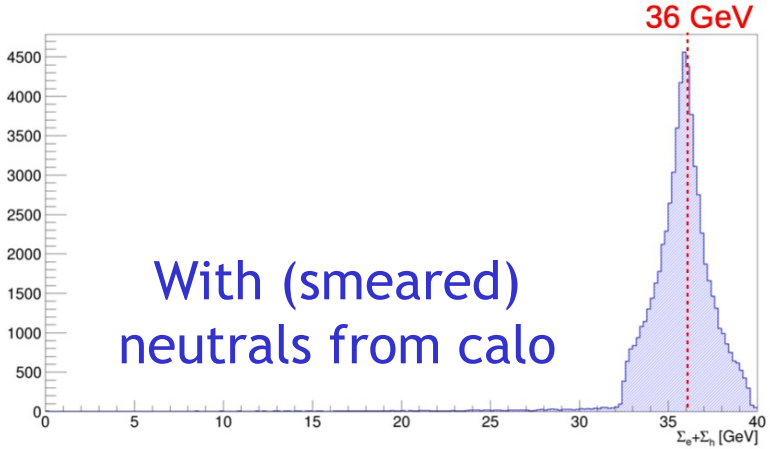
- Impact on Nuclear PDFs and sensitivity to low-x effects also studied



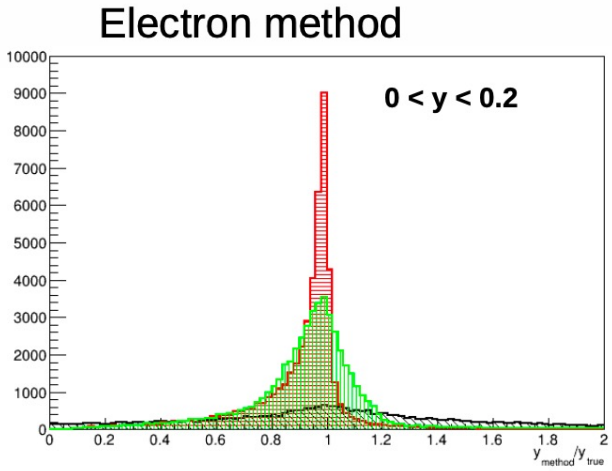
Testing EPIC Simulation and Developing EICRECO (Stephen Maple)

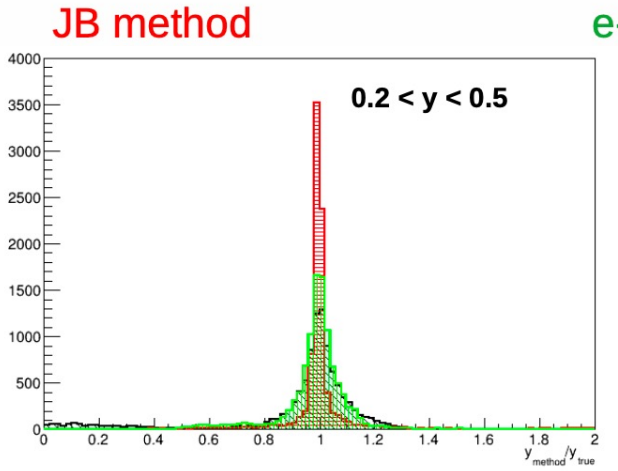
Total E-pz sum (= 2Ee)

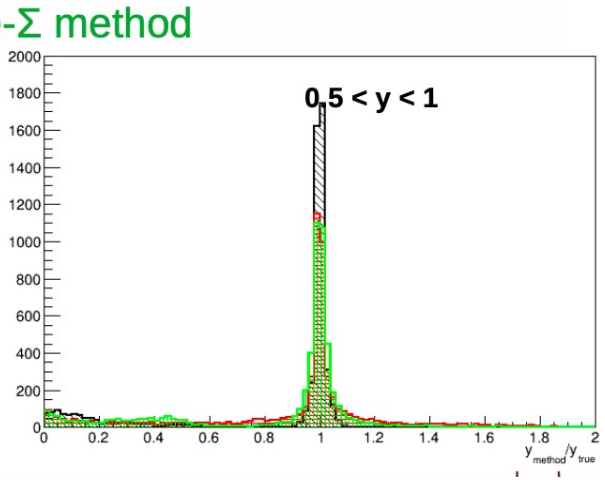




First look at impact on kinematic reconstruction …







… next attempt to develop particle flow algorithm

Next Steps

- Benchmarking increasingly detailed EPIC simulations, including performance understanding and main sources of systematics
→ fully simulate an inclusive measurement using MC, event-by-event

- Ongoing work / main current questions:

- What level of performance can be obtained in overall hadronic final state reconstruction (via energy flow algorithms)

- How much can we improve on NC kinematic reconstruction by trying novel machine learning or kinematic fitting methods

- Do we have ISR completely under control?

- What can we expect / learn from CC?

- What can we expect / learn from $Q^2 \rightarrow 0$ ('photoproduction') regime?