

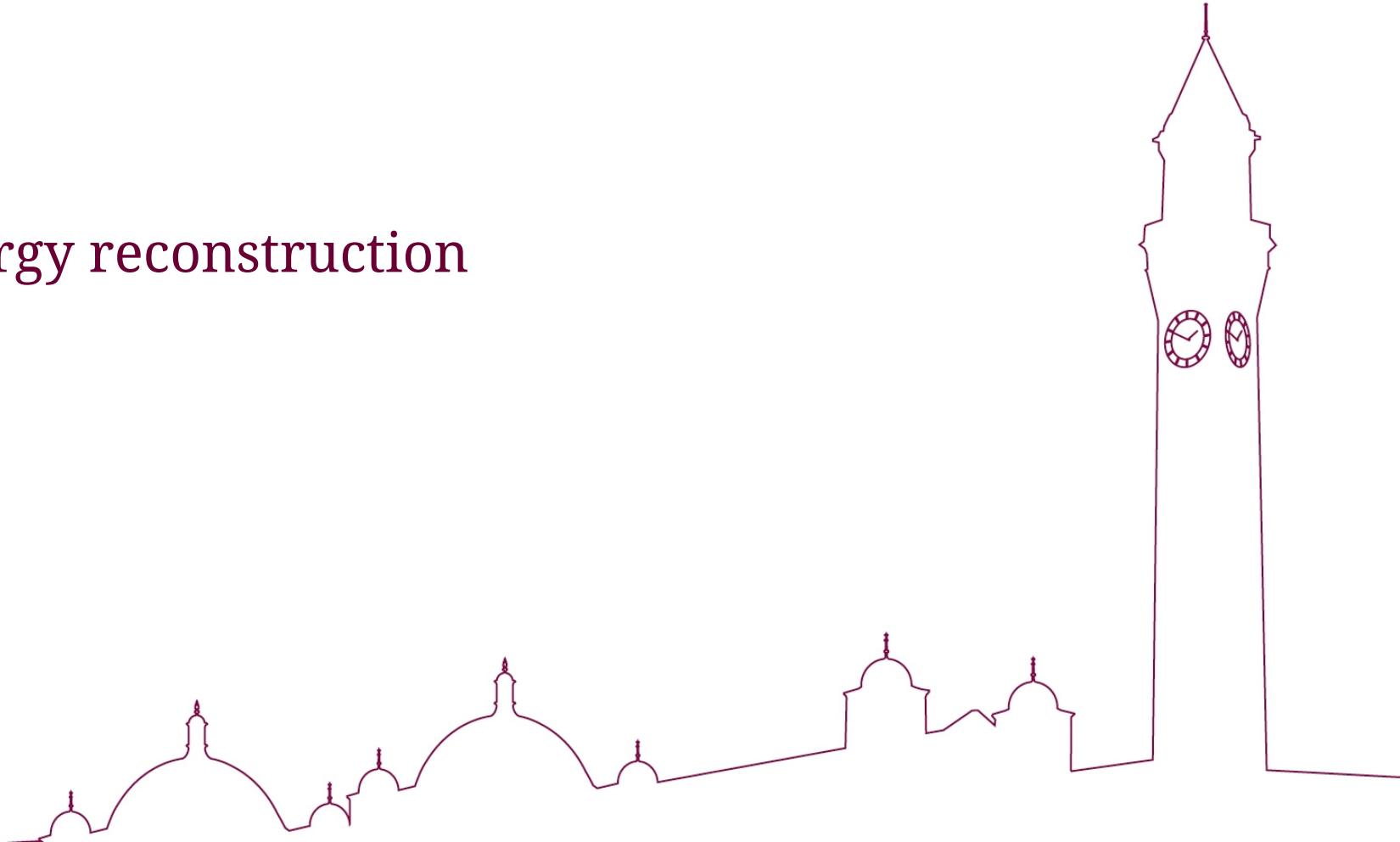


UNIVERSITY OF
BIRMINGHAM

SCHOOL OF
PHYSICS AND
ASTRONOMY

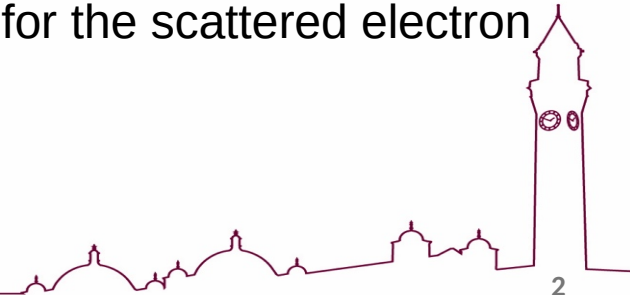
Electron energy reconstruction

S. Maple



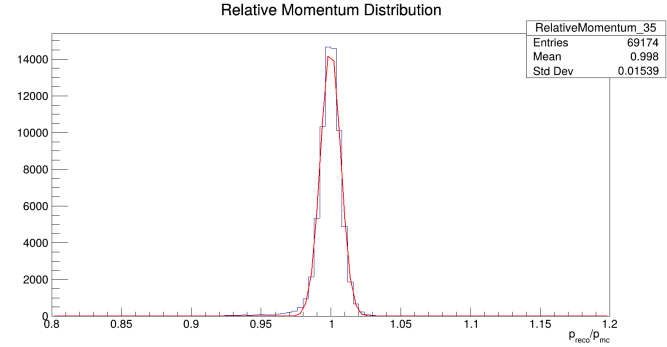
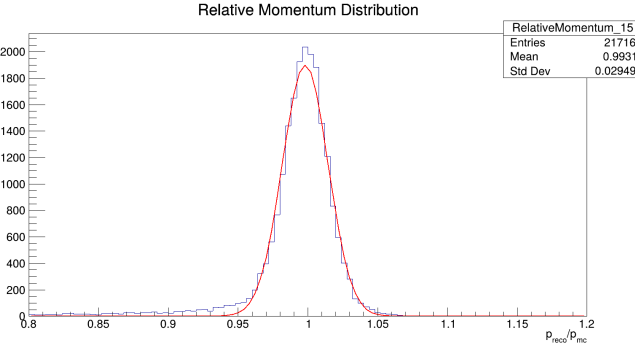
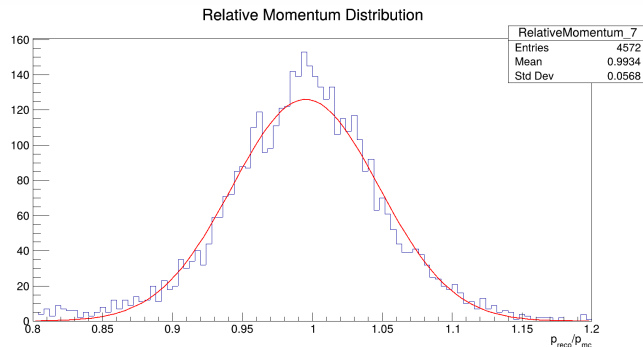
Overview

- When retrieving an energy from ReconstructedParticles/ReconstructedChargedParticles, by default we get the energy by the track momentum
- Generally the track momentum resolution is very good – but it degrades somewhat with increasing momentum, and degrades significantly with increasing dip angle (larger pseudorapidities) due to the decreasing lever arm
- For electrons we have a very good ECAL in the backwards direction – it's been known for some time that this is what we will be using for electron energy reconstruction, but I've not yet seen a clear evaluation of how much improvement we would expect
- ECCE had some success when combining track and ECAL info for the scattered electron
→ let's see for ePIC



Methodology

- Single electron simulations from 26.02.0 simulation campaign
 - 1, 2, 5, 10, 20 GeV
 - Can get away with single particle simulations because electrons are usually isolated
 - Newer campaign available – will update plots, but don't expect major changes
- Evaluate electron energy resolution with both tracker only and ECAL only, at fixed momenta, as a function of pseudorapidity
 - Single gaussian fit of $p_{\text{rec}}/p_{\text{true}}$ over full range (would like to update to fit over limited range used in tracking resolution plots $\rightarrow 2\sigma$)



Tracking only, 10GeV

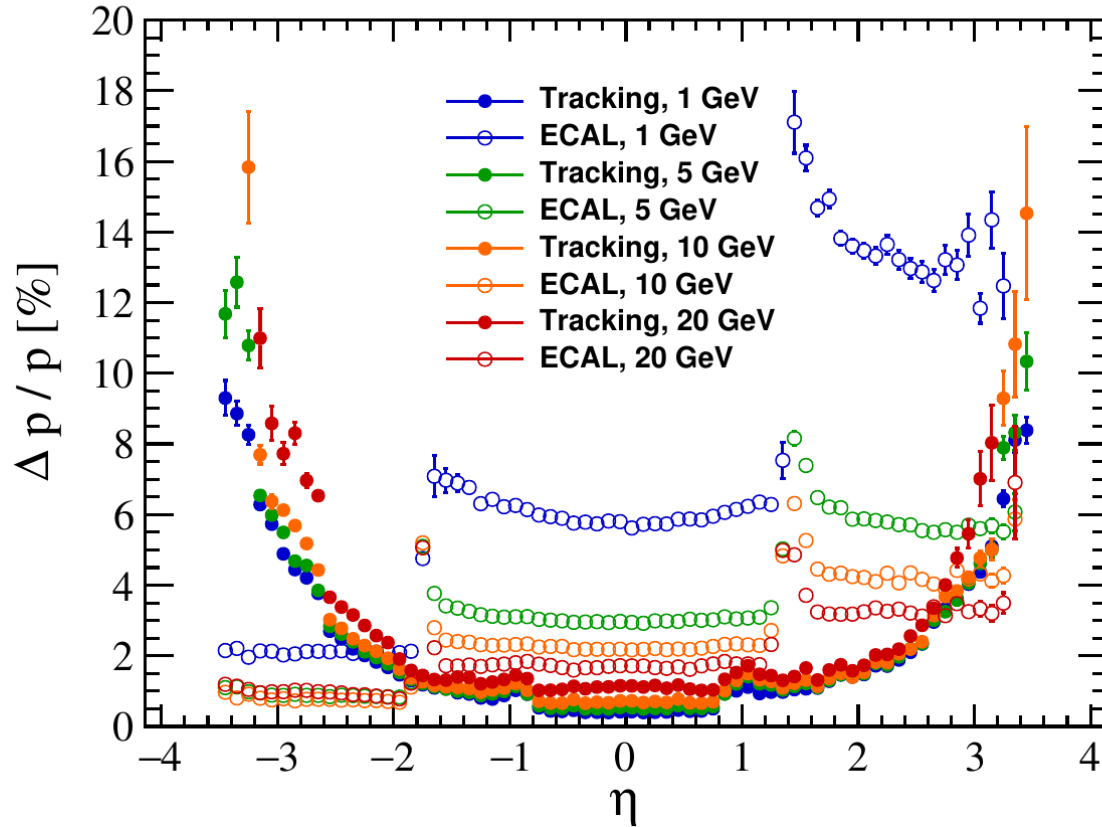
Methodology

- Write out resolutions as tables
- C++ header written with class that:
 - Reads each table
 - When given electron candidate's ECAL energy, track momentum, and track pseudorapidity, linearly interpolates to estimate of track and ECAL resolution at that η
 - Measured ECAL energy used to estimate ECAL resolution, measured track momentum used to estimate track momentum resolution
 - Returns inverse variance weighted average of the two energies $\rightarrow$ “combined” energy estimate

$$E_{combined} = \frac{E_{\text{trk}}/\sigma_{\text{trk}}^2 + E_{\text{ECAL}}/\sigma_{\text{ECAL}}^2}{1/\sigma_{\text{trk}}^2 + 1/\sigma_{\text{ECAL}}^2}$$

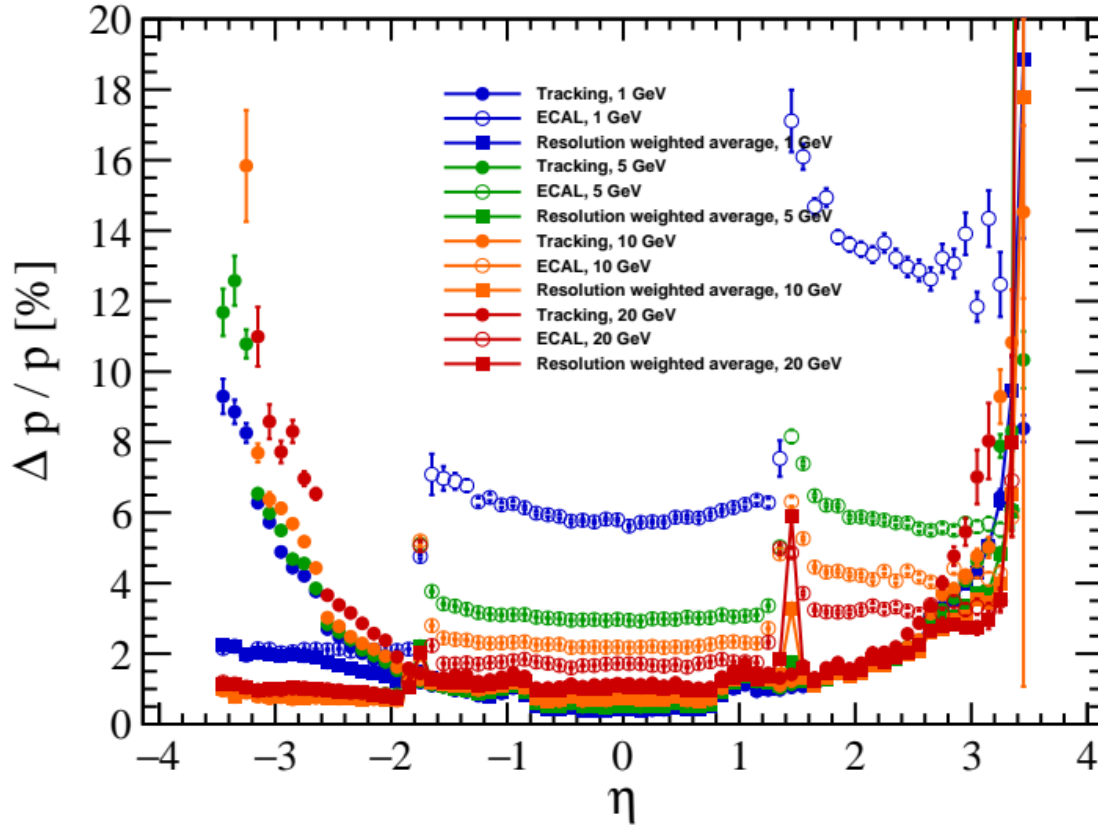
- ... then analyse the electron energy resolution using same method as before
 - **Not** just estimating the uncertainty on the combined quantity as $\sigma_{E_{combined}} = \left(\frac{1}{\sigma_{\text{trk}}^2} + \frac{1}{\sigma_{\text{ECAL}}^2} \right)^{-1/2}$.

Resolution vs η – no combination

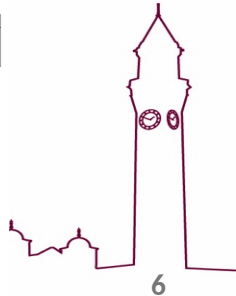
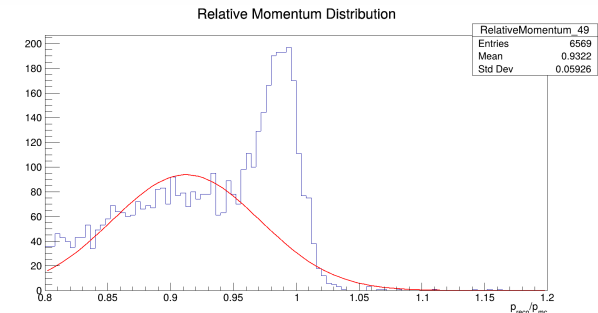


- Electron resolution from tracking detector degrades with increasing pseudorapidity (as expected)
- ... but gives better resolution over much of the central region
- EEEMCAL gives significantly better resolution for $\eta < \sim -2.5$

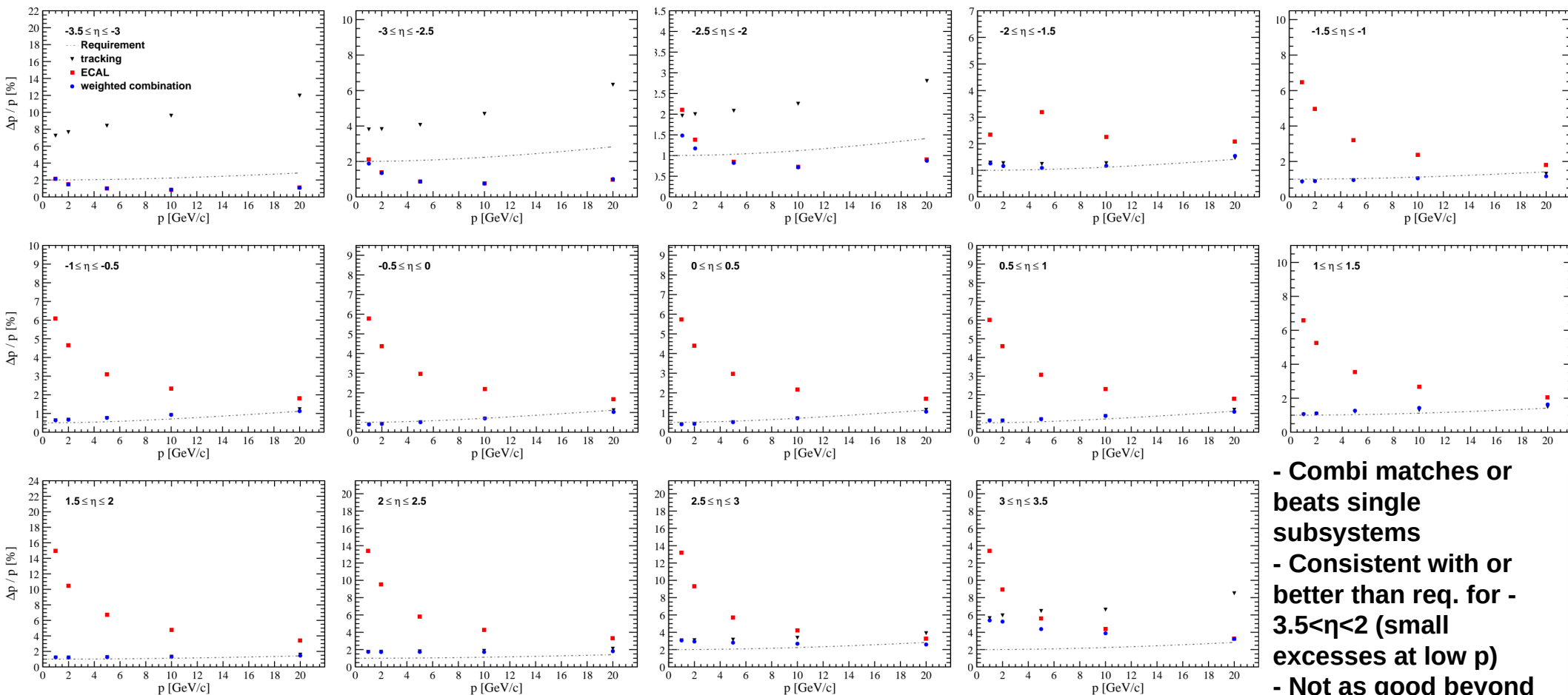
Resolution vs η – with combination



- Resolution weighted average typically follows resolution of best performing subdetector
- If the resolution of the two subdetectors are comparable, then can improve by up to factor of $\sim 1/\sqrt{2}$
- Spike at η from fit not matching distribution due to calorimeter transition $\rightarrow$ strict E/p requirement may help necessary here ($E/p > 0.9$)



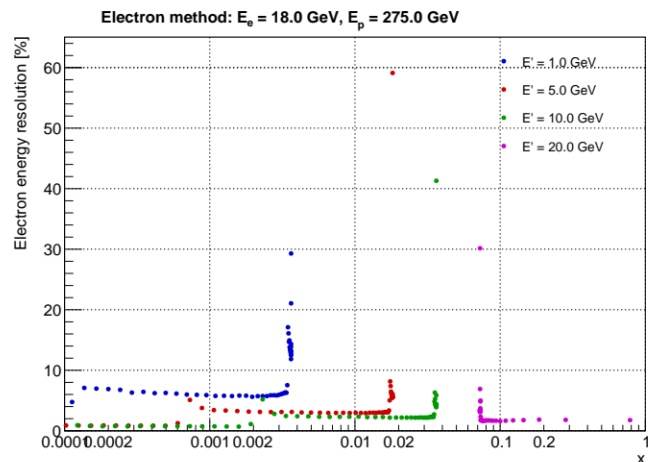
Resolution vs p in coarser η bins (compared to tracking req.)



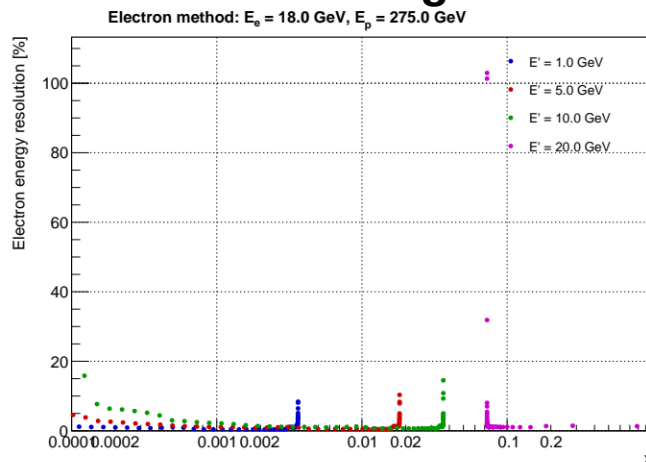
- Combi matches or beats single subsystems
- Consistent with or better than req. for - $3.5 < \eta < 2$ (small excesses at low p)
- Not as good beyond this → but very few electrons expected

Energy resolution vs x , Q^2 (18x275)

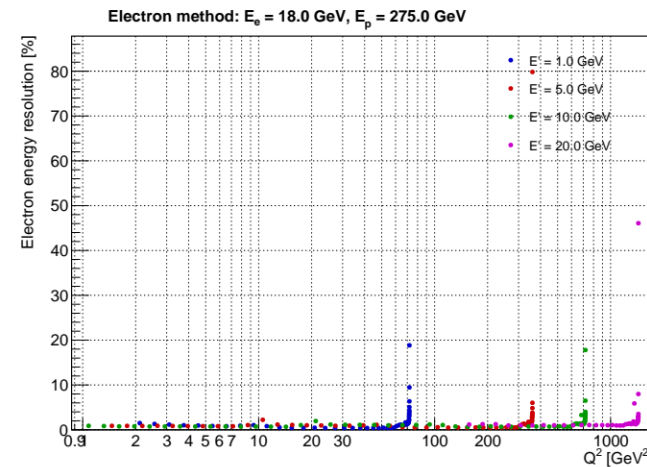
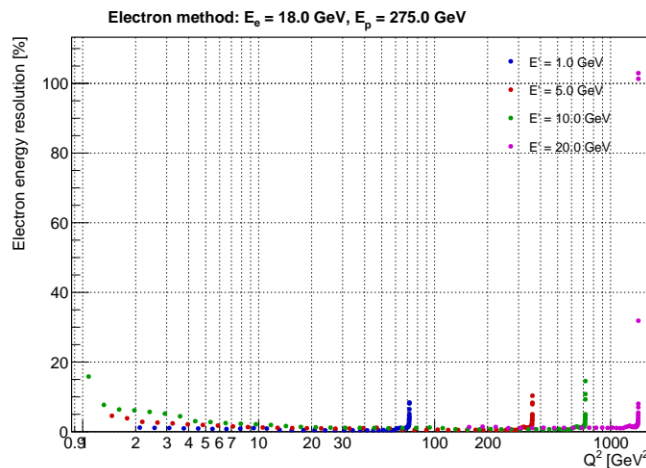
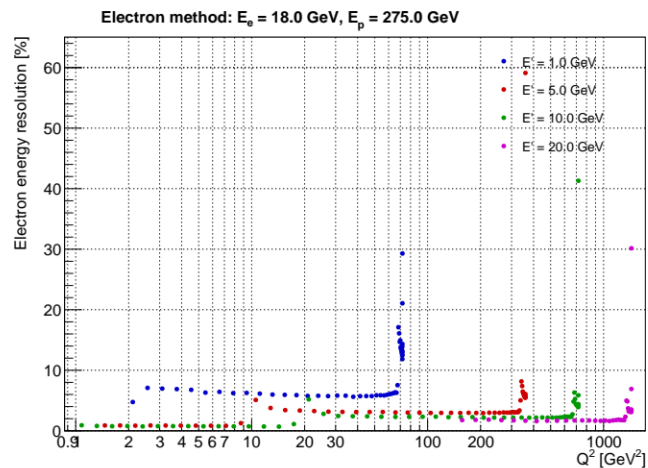
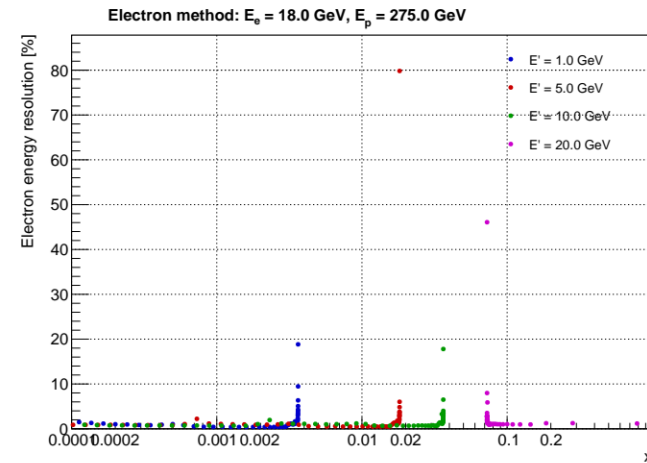
ECAL



Tracking



Combined



Summary

- We've largely been using the tracking detector for reconstructing electrons to this point as, by default, we use the tracker for charged particles
- Tracking becomes challenging at small angles from the beamline → ECAL can provide better performance here
- If we use the tracking and calorimeter information simultaneously, we can match or improve the performance of the best subsystem
- This makes the challenging tracking requirements for the electron endcap region achievable

