ECAL Energy Calibration Updates

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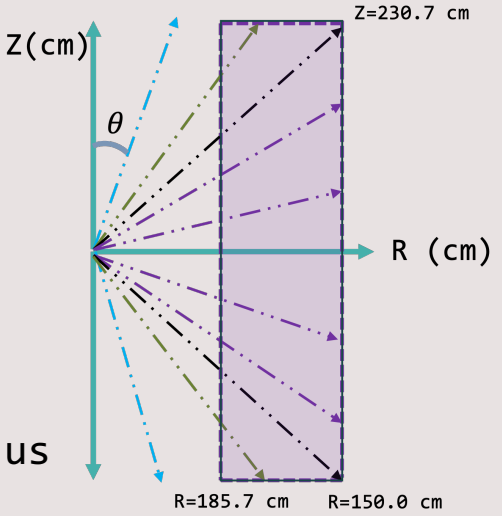
Review of the Problem

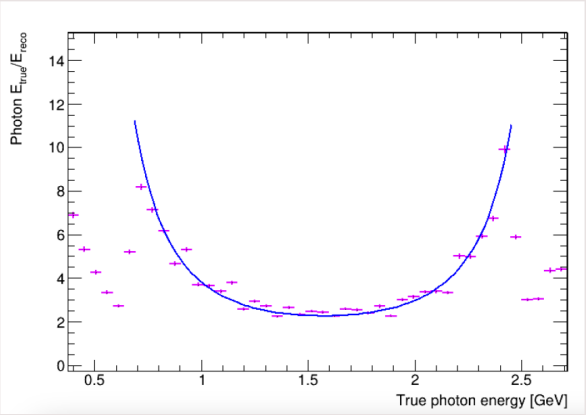
- Attempting an analytical theta-dependent calibration for photon energy

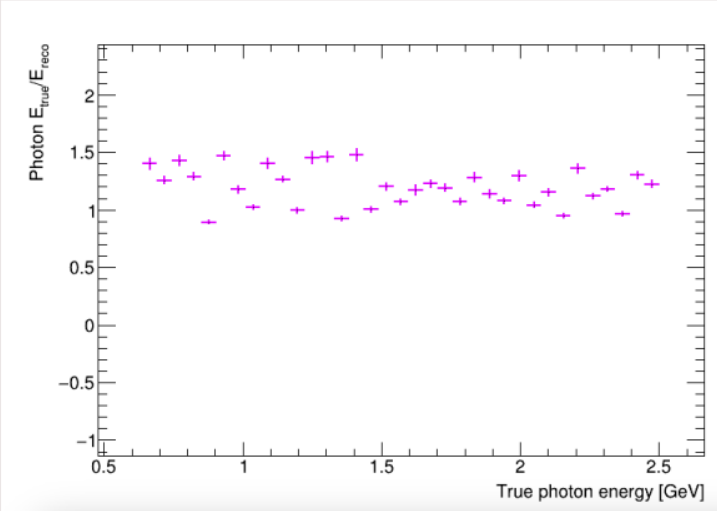
$$N(\theta) = \begin{cases} 0 & \theta < 0.577, \theta > \pi - 0.577 \\ 25.93|\sec\theta| - 16.86\csc\theta & 0.577 < \theta < 0.678, \pi - 0.678 < \theta < \pi - 0.577 \\ 4.01\csc\theta & 0.678 < \theta < \pi - 0.678 \end{cases}$$

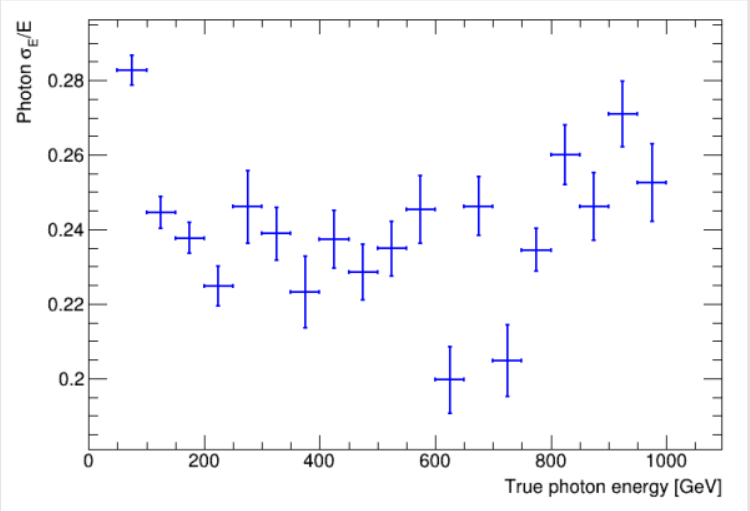
$$\frac{E_{truth}}{E_{reco}} = 2^{N(\theta)}$$



- Profiled over energy and fit this function in the barrel region, giving us a correction factor of ~0.14 (at right)
- Implemented the correction and saw improvement in the theta response
- However, the resolution fits were drastically worsened:

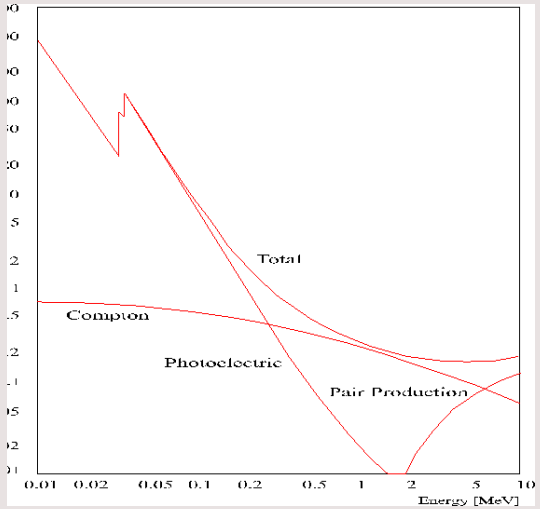






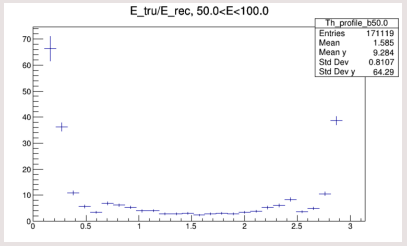
Revisiting Assumptions

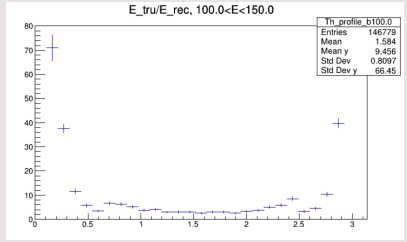
- Two simplifying assumptions were made when creating this analytic function:
  - + Energy loss proceeds via pair production (allowing us to use the 2^N energy loss model)
  - + Particles begin to shower right when they enter the magnet bulk
- The first assumption should be ok, given that PP dominates above 10 MeV
- However, it is the second assumption that might be giving us trouble
- Higher-energy photons especially may not start to shower for several radiation lengths, so N(θ) may have implicit energy dependence as well

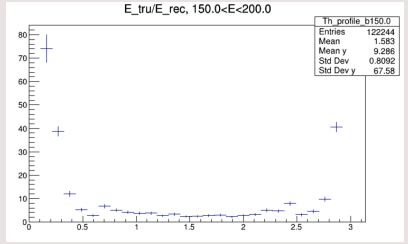


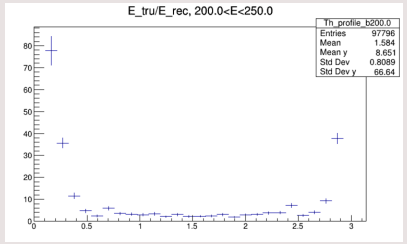
Energy Binned Profiles

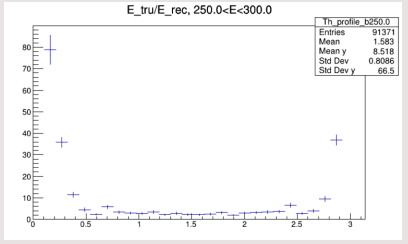
- Reproduced the E ratio profiles in each energy bin, indeed revealing energy dependence on the shape of the ratio
- (still have this issue in the forward regions but for now focusing on barrel)

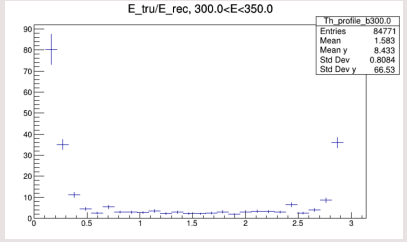


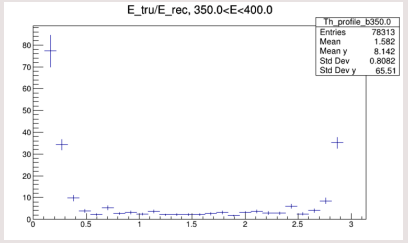


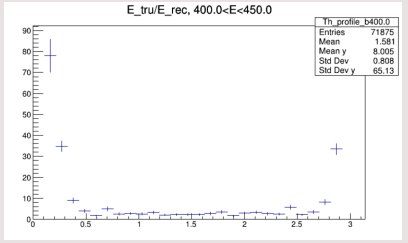


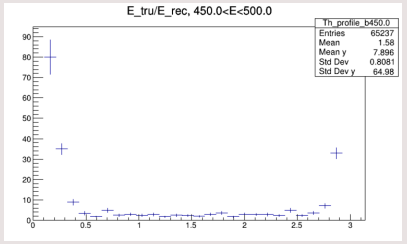


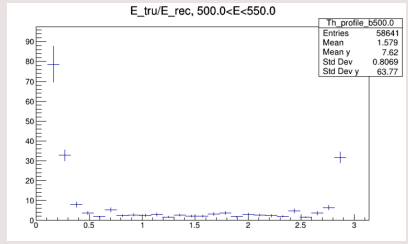


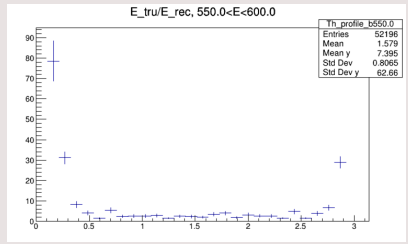


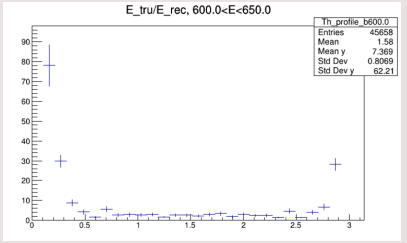


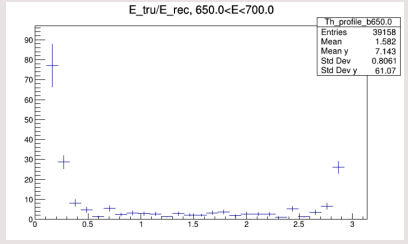


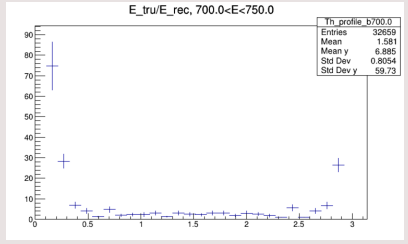


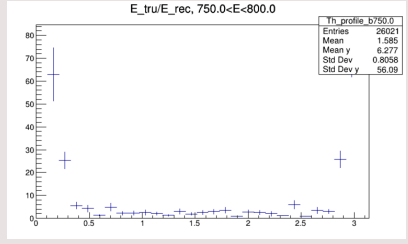


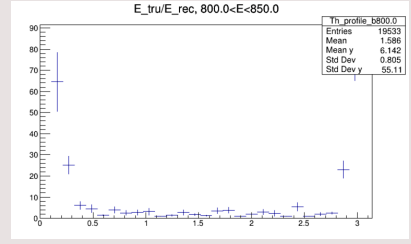


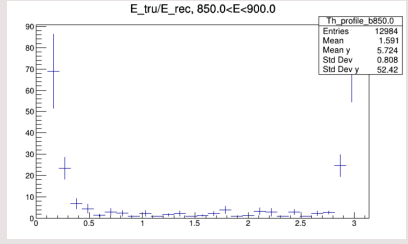


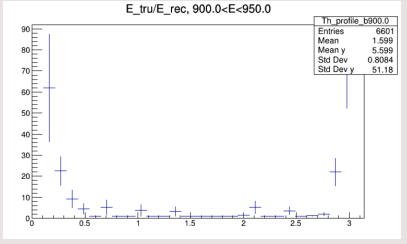






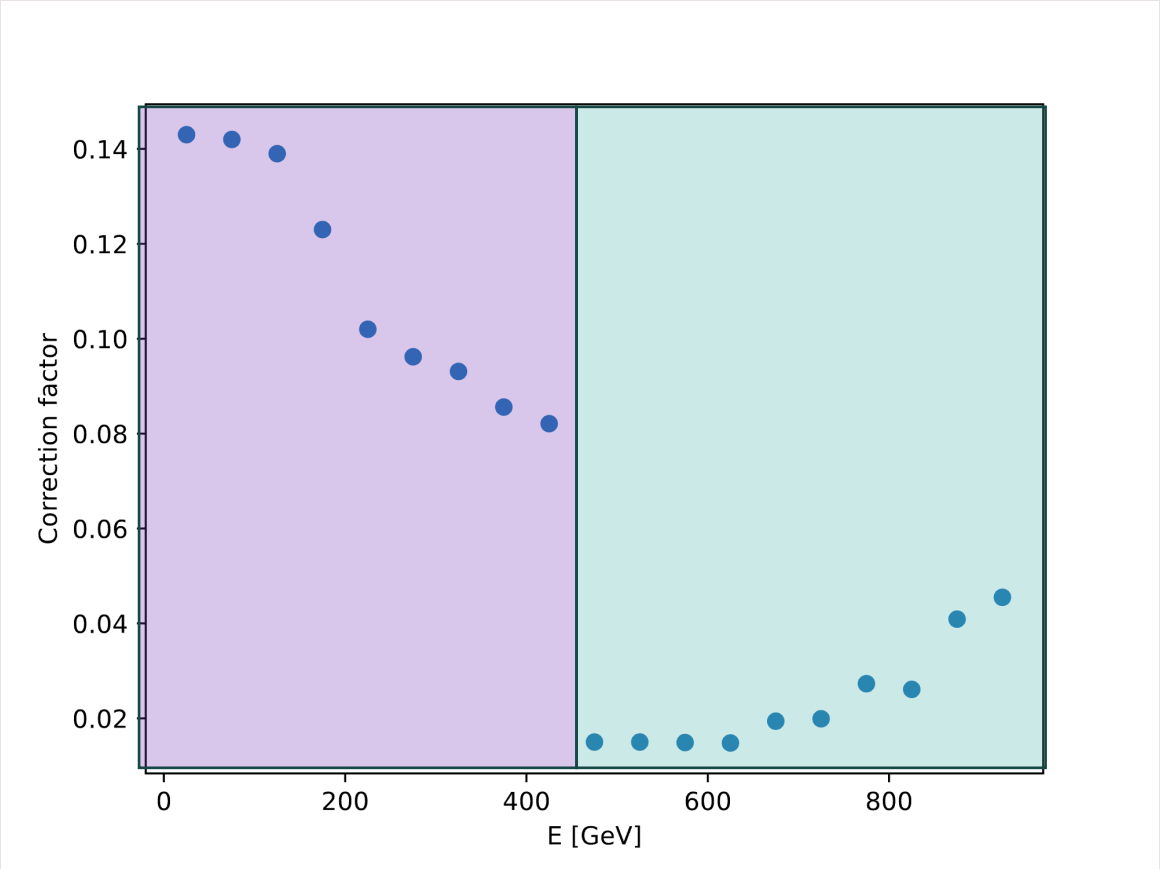






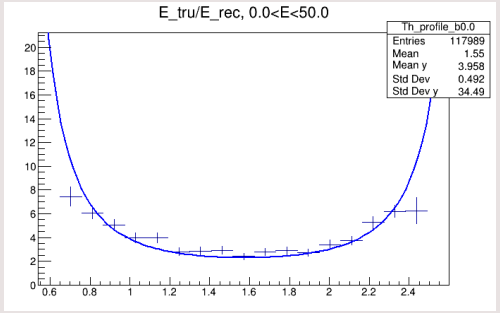
Fitting for Each Energy Bin

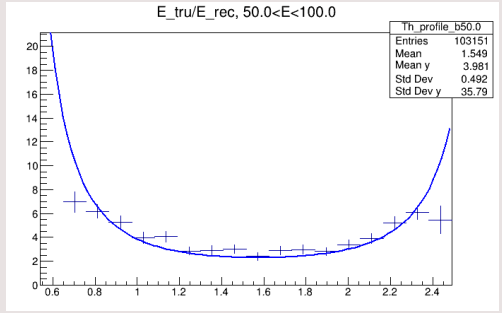
- Repeated the fit (in the barrel region) for each energy bin
- Correction constants show a clear delineation between two regions of energy

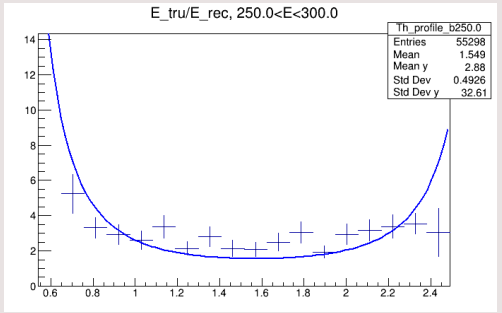


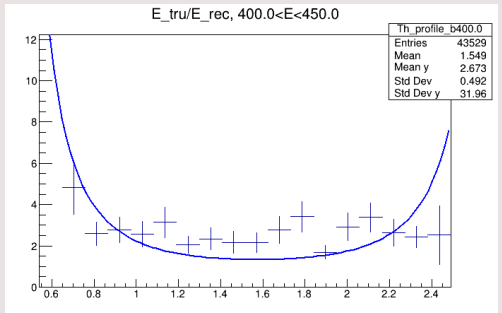
Higher-Energy Region Not Fitted Well

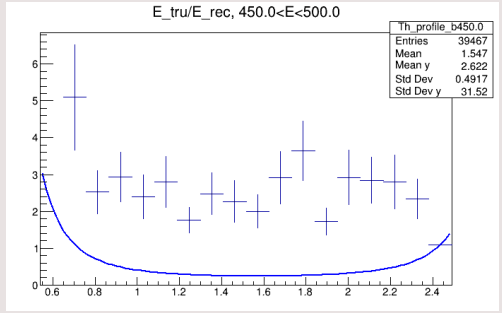
- Individual fits ok for E<450 GeV, not for E>450 GeV

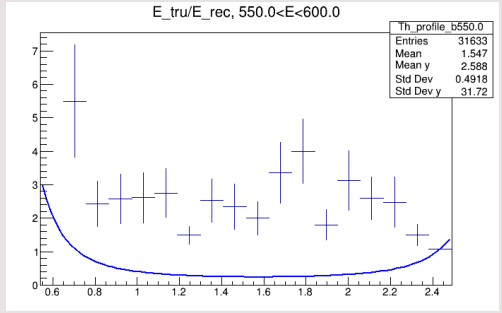












- **Conclusion:** ~450 GeV is where the immediate-showering assumption becomes prohibitively inaccurate

Next Steps

- The question now: is it worth doing an analytical calibration for lower energies and then trying a more descriptive binned calibration above 450 GeV?
  + Will try this and see how it affects resolution, etc
- Still need to address the forward regions
  + Multiple photons in each event? Nozzle showering?