ECAL Energy Calibration Updates

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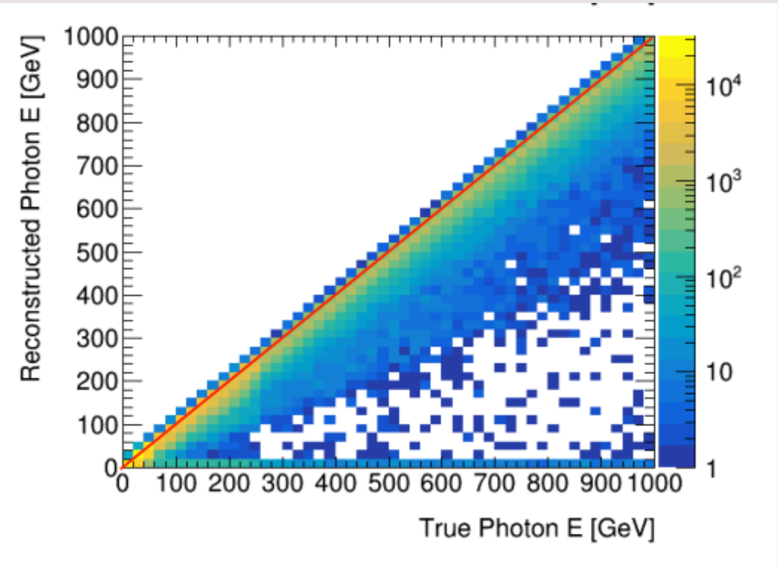
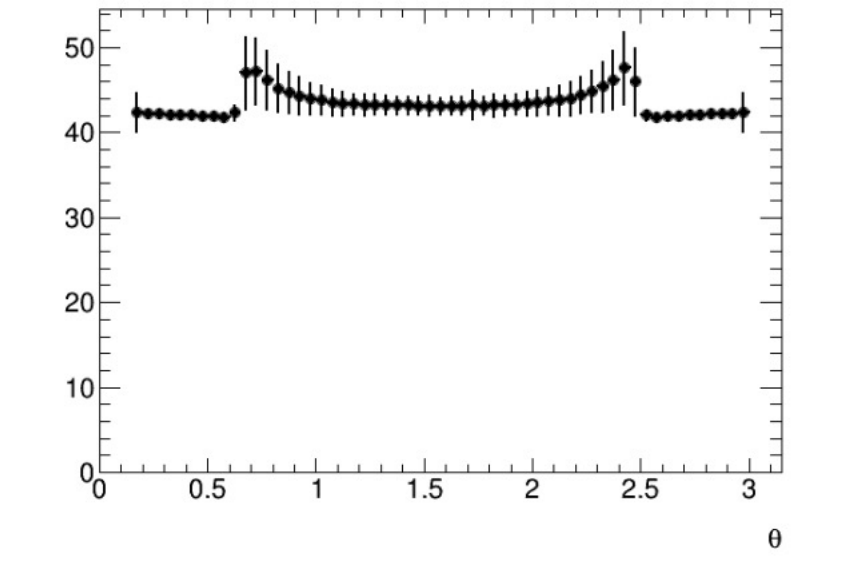
Rose Powers (Yale/FNAL)

Review of the Problem

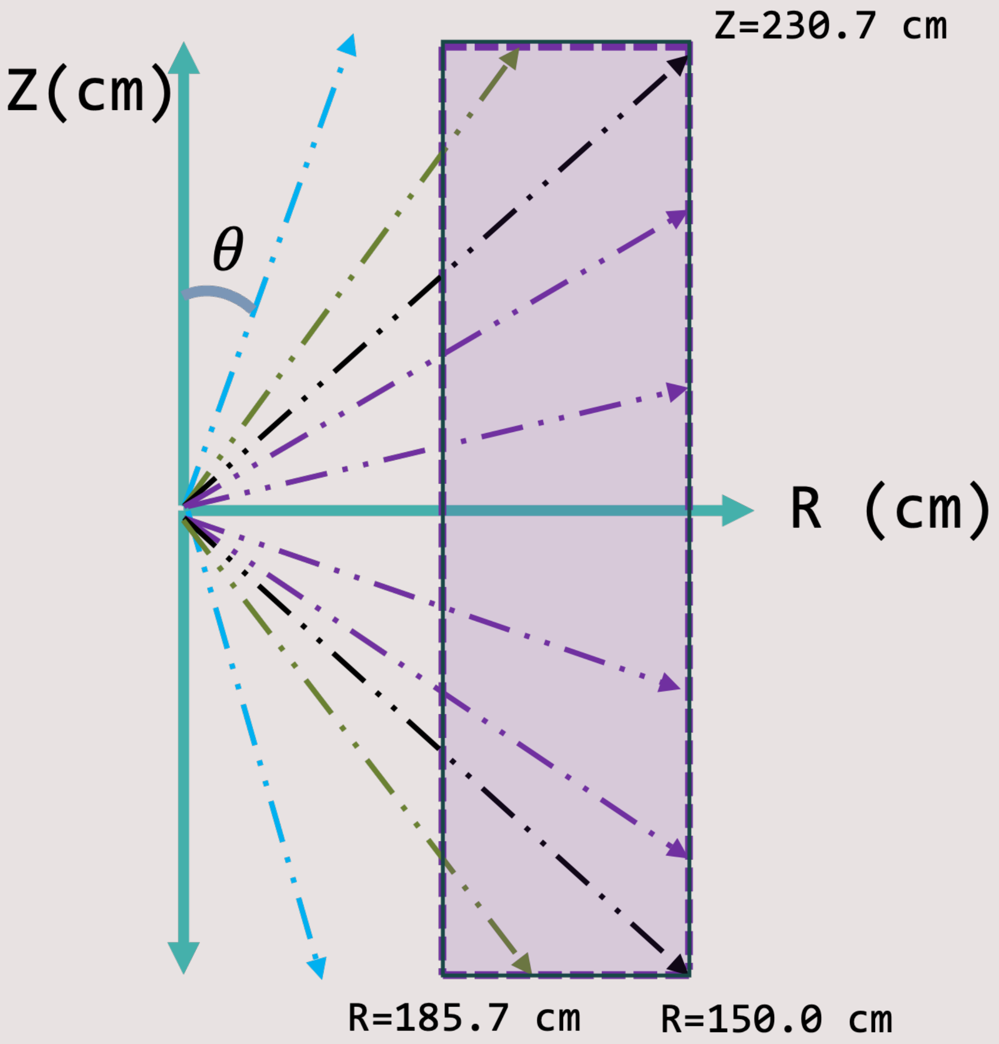
- Experiencing poor photon resolution and globally underestimated E_reco
- Tova confirmed non-uniform **theta-dependence** of E_truth/E_reco (see her super helpful plots below)
- Conclusion: we need a theta-dependent calibration at the clustering/reco stage





A First-Principles Approach

- Angular dependence originates from the solenoid geometry
- With the assumption that photons begin showering in the magnet, use trig to find a model for angular-dependent energy loss
- First: determine how many **radiation lengths** (X_0) of solenoid material photons see
- Three regions:
  - + Doesn't interact with solenoid (bounded by inner R-limit)
  - + Bounded by z-limit
  - + Bounded by outer R-limit



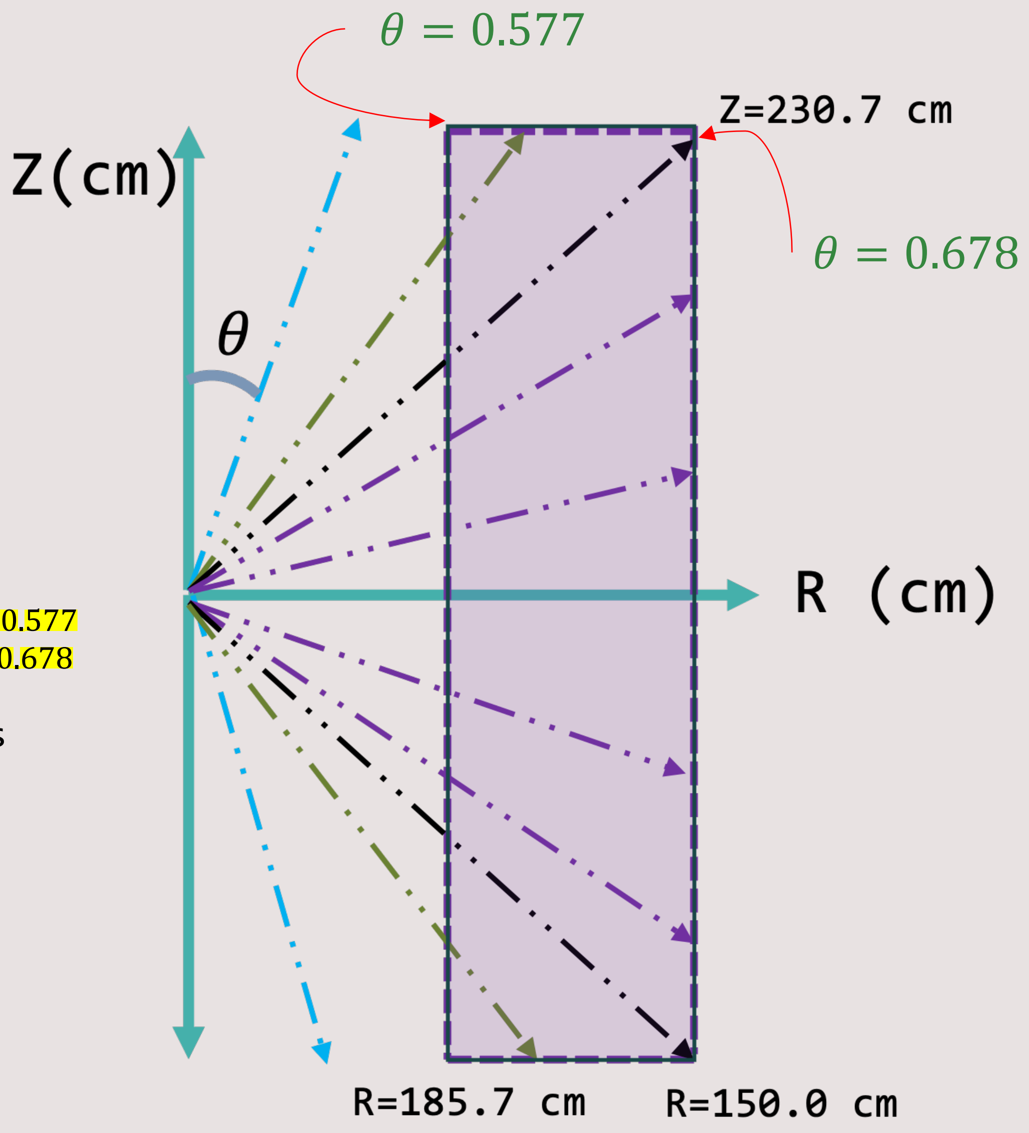
Piecewise Energy Loss

- Assumptions:
  - + Photons fired from the origin
  - + X_0 in Al ~ 8.897 cm
  - + Pair production and Brem dominate energy loss
  - + $E(N)=E_0 2^{-N}$ (where N is # of rad lengths)
- $N(\theta) =$

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

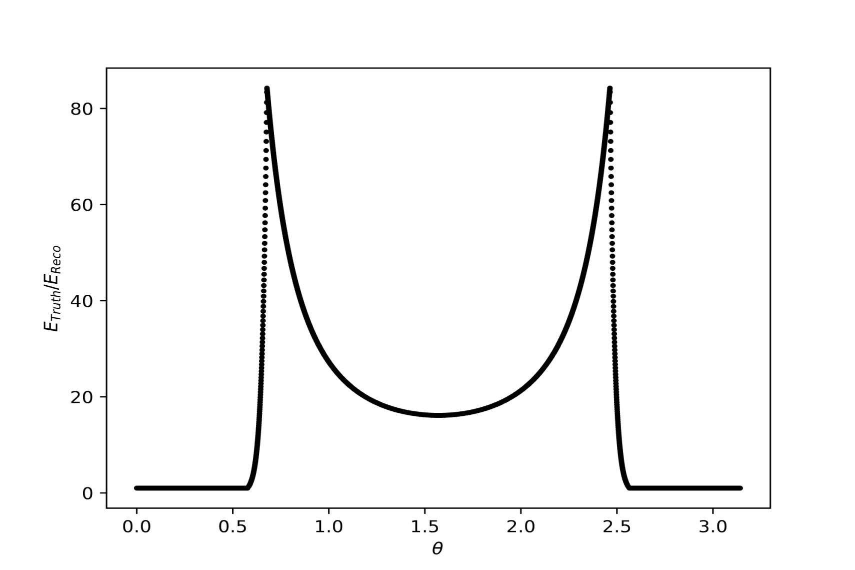
- Then we expect to model our ratio of E_{true} to E_{reco} as

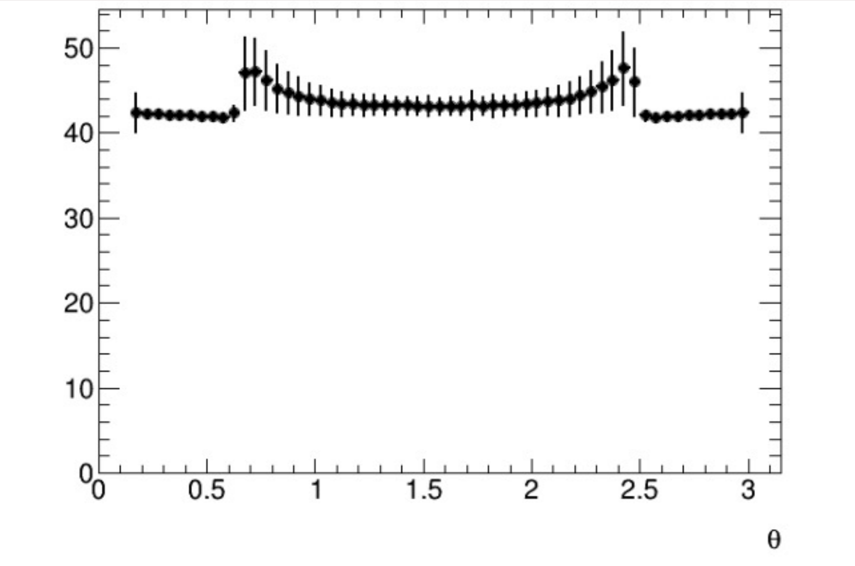
$$\frac{E_{truth}}{E_{reco}} = 2^{N(\theta)}$$



Expected ratio

- Plotting this function for values of theta between 0 and pi returns a familiar shape
- Obviously not scaled correctly
- However, it looks like this may be the correct functional form





Fitting to our data

- For further convincing, dividing by 10 and shifting to combat the underline ~40x offset factor gives us back almost the same distribution (see below)
- Plan: reproduce the E_t/E_r profile for the latest photon sample (which should take care of the constant offset) and then fit to our custom function
- A simple calibration model: multiply reconstructed energy by our ratio function