ECAL Studies – Sampling Fraction (Redux)

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Introduction

- Leo recently pushed new code into the repository

- Included a new value of the Sampling Fraction from Francisco (Reco/SiPMHitFinder.fcl) for both ECAL and MuID (SF = 2.852)
  - Francisco used a similar technique as I had in my previous checks, i.e.,

  Compare Sum(E of all reco Hits in event) in single particle sample w/ starting E of particle
    - He used single photons between 0.25-0.75 GeV
    - The default value had been 2.726 – what went in was a SF ~ 5% higher (i.e., 2.852), but when I was discussing this issue with him, he realized that his definitions were such that they implied that SF was actually ~ 5% lower than the default (i.e., 2.618)! (in backup)

  - I am checking with single electrons (distributed around a mean of 3 GeV)
    - (a) look at all recoHits/Clusters in event – very simple – just look at all hits in event
    - (b) We can also use E/p of electron, but that needs backtracker information to associate clusters to electron, so relies on other software (I had shown this last month, so will not repeat it here)

Quick recap of what I showed last month

- Plots in the next three slides are Profile plots

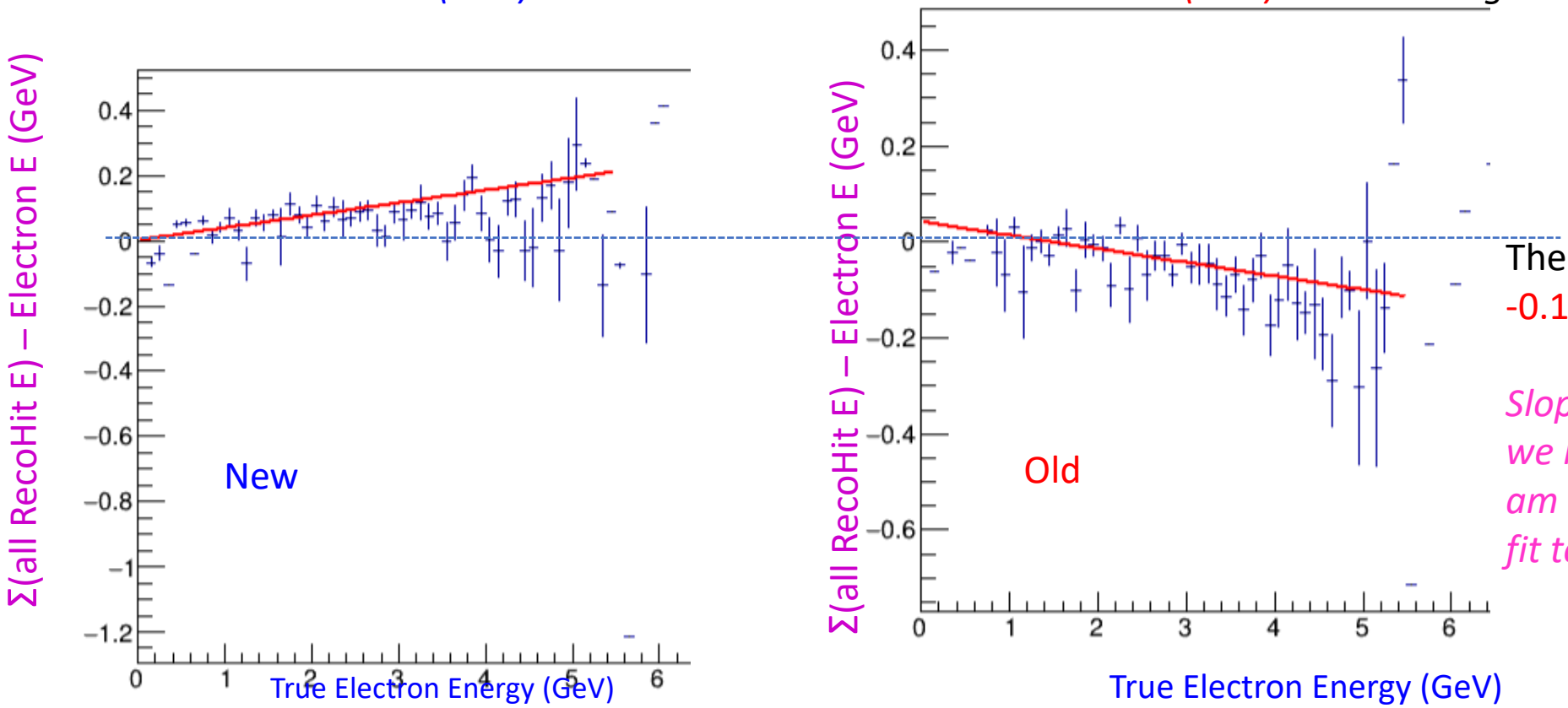
- I use single electrons, starting at the center of the TPC, and pointed along the beam direction
  - In these three slides I use 1000 events where the electron momentum was distributed according to a Gaussian with mean = 3 GeV and sigma = 1 GeV

New (2.852) vs. Default (2.726) SF: *RecoHits plots*

Slope/Intercept: 0.0383/0.0011 -0.0283/0.042

Reco Hit Energy

Calculated residual
at 3 GeV: *+0.116 (GeV)* *-0.043 (GeV)* *- this change is +5%*



The residual at 5 GeV changes from -0.1 GeV to +0.19 GeV, i.e., +5.8%

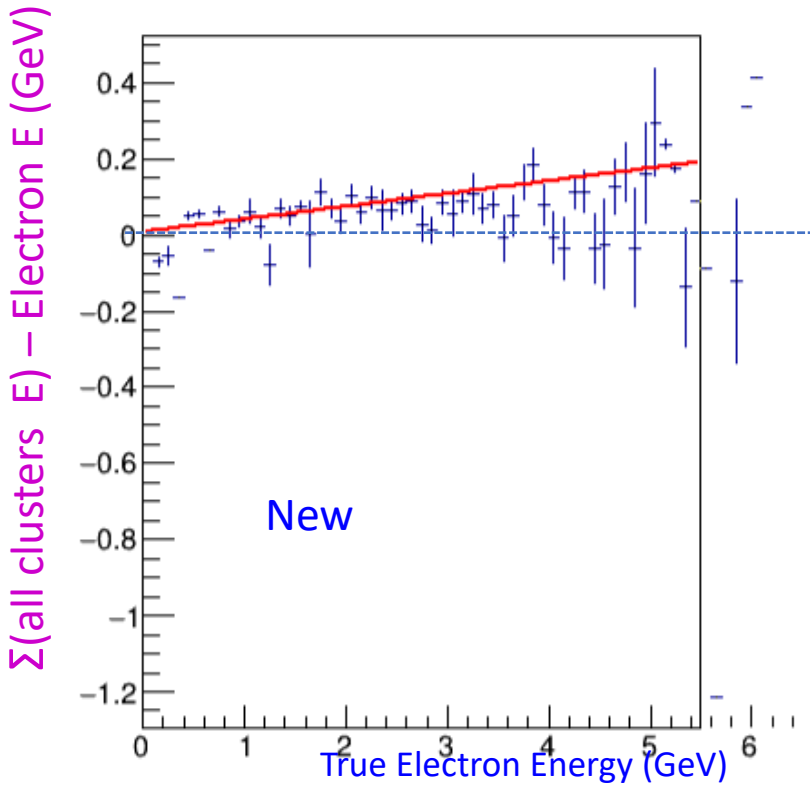
Slope of fit gives the impression that we might be over-correcting, but I am not sure. Was expecting the new fit to be flatter.

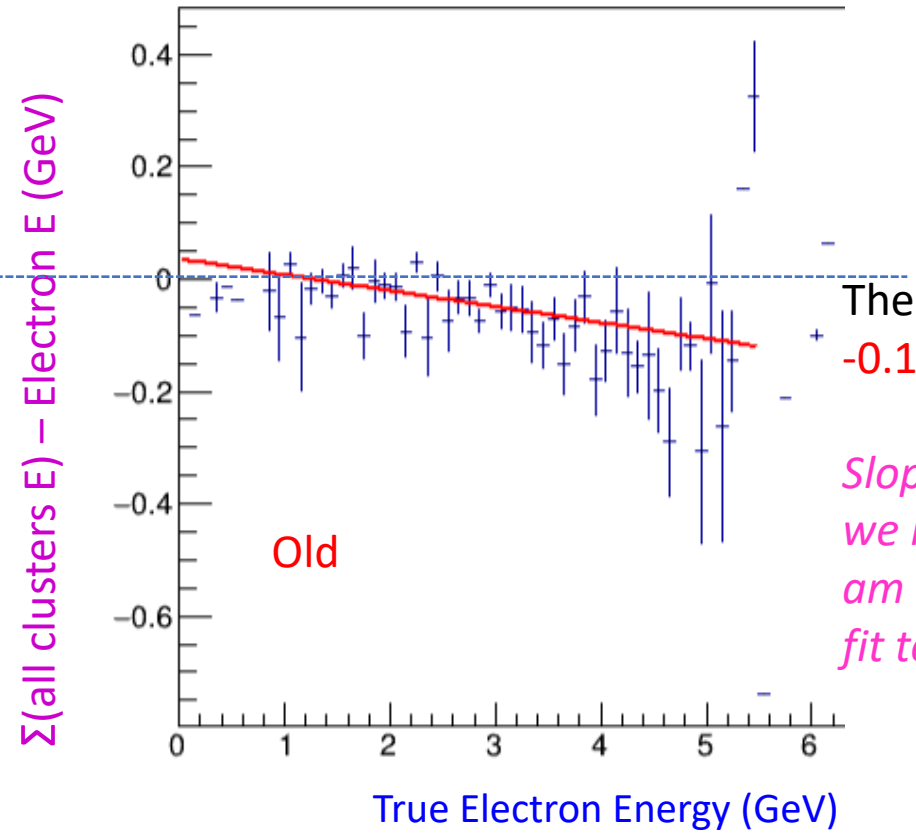
New (2.852) vs. Default (2.726) sampling fractions: *All Clusters in event*

Slope/Intercept: 0.0336/0.0079 - 0.0284/0.0357

Clusters Energy

Calculated residual at 3 GeV: *+0.109 (GeV)* *-0.0495 (GeV)* *- this change is +5.3%*





The residual at 5 GeV changes from -0.11 GeV to +0.18 GeV, i.e., +5.8%

Slope of fit gives the impression that we might be over-correcting, but I am not sure. Was expecting the new fit to be flatter.

Fit profile plots for allRecoH, allCluster – Ad-hoc Mean value of SF (=2.789)

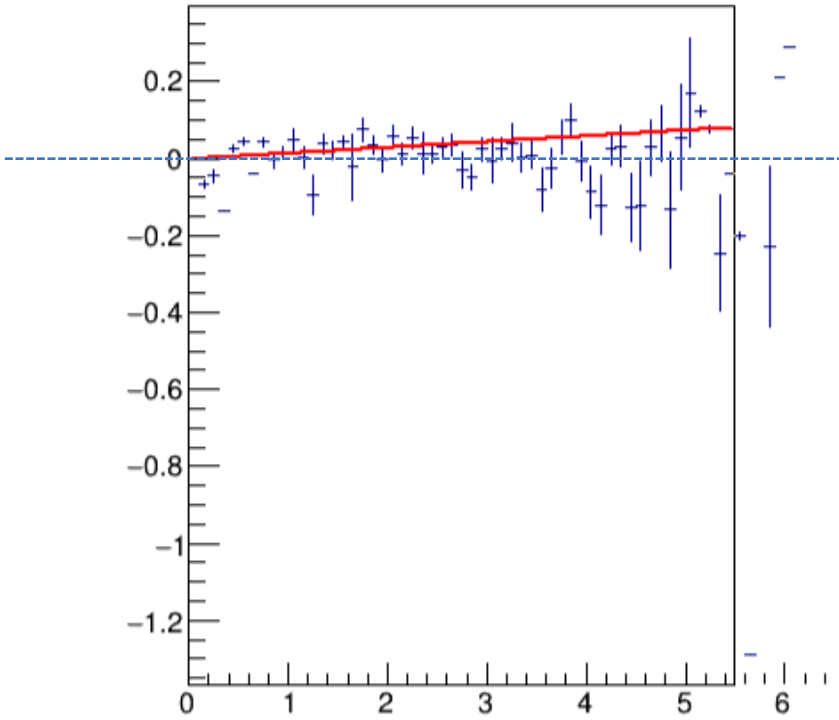
X-axis: True electron Energy, Y-axis: Residuals (all<Sim/Reco/Clus>E – electron E)

0.015/-0.00252

Reco

Calculated Residual@E = 3 GeV:

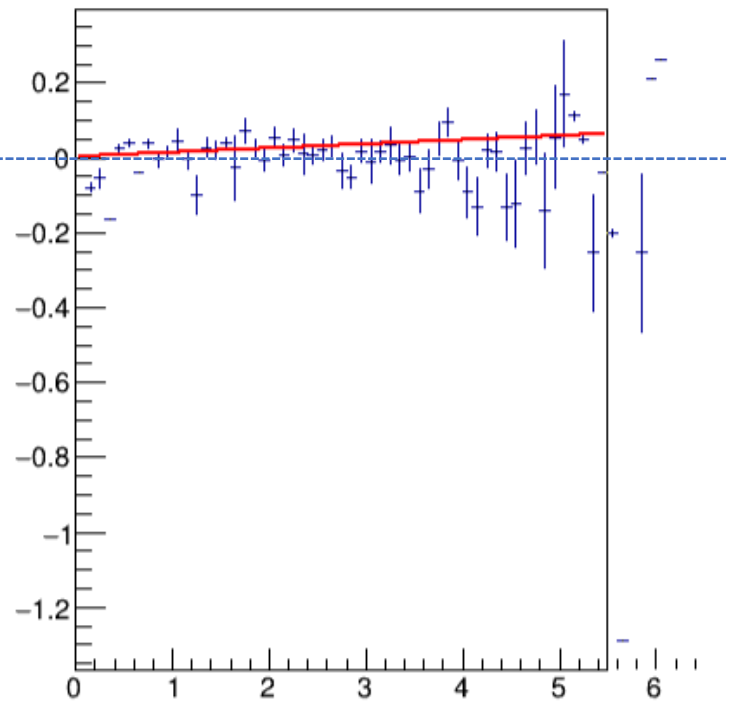
+0.043



0.0112/0.0022

Clusters

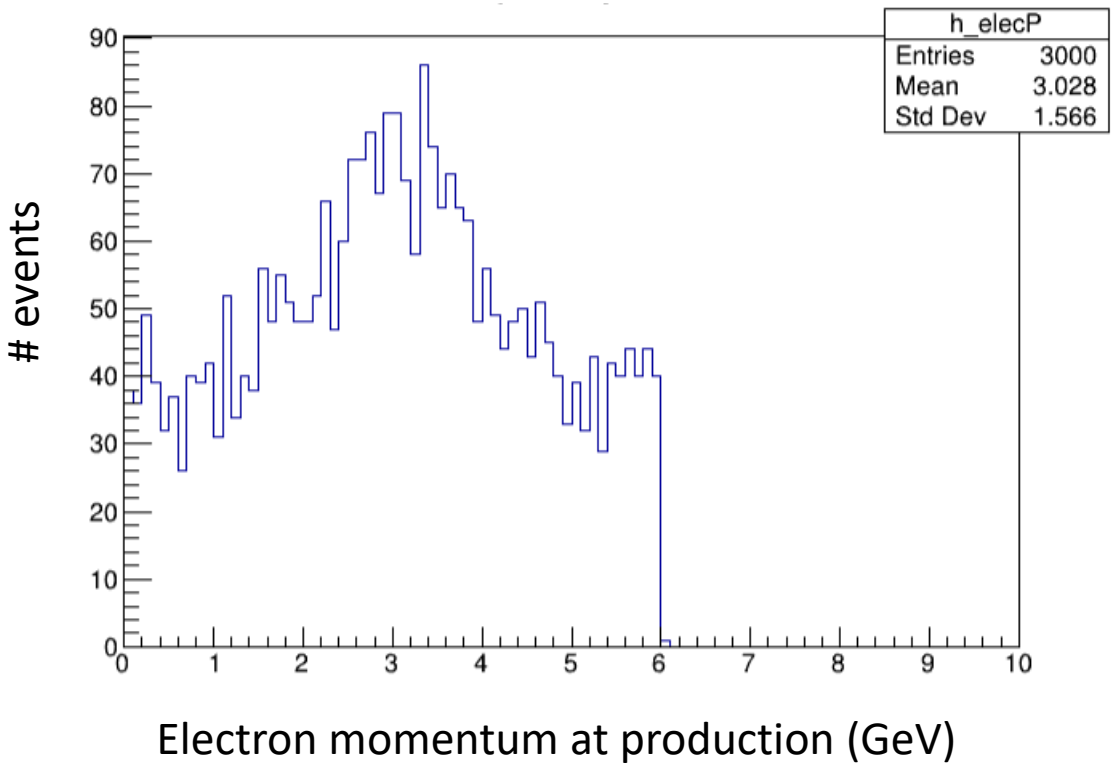
+0.036

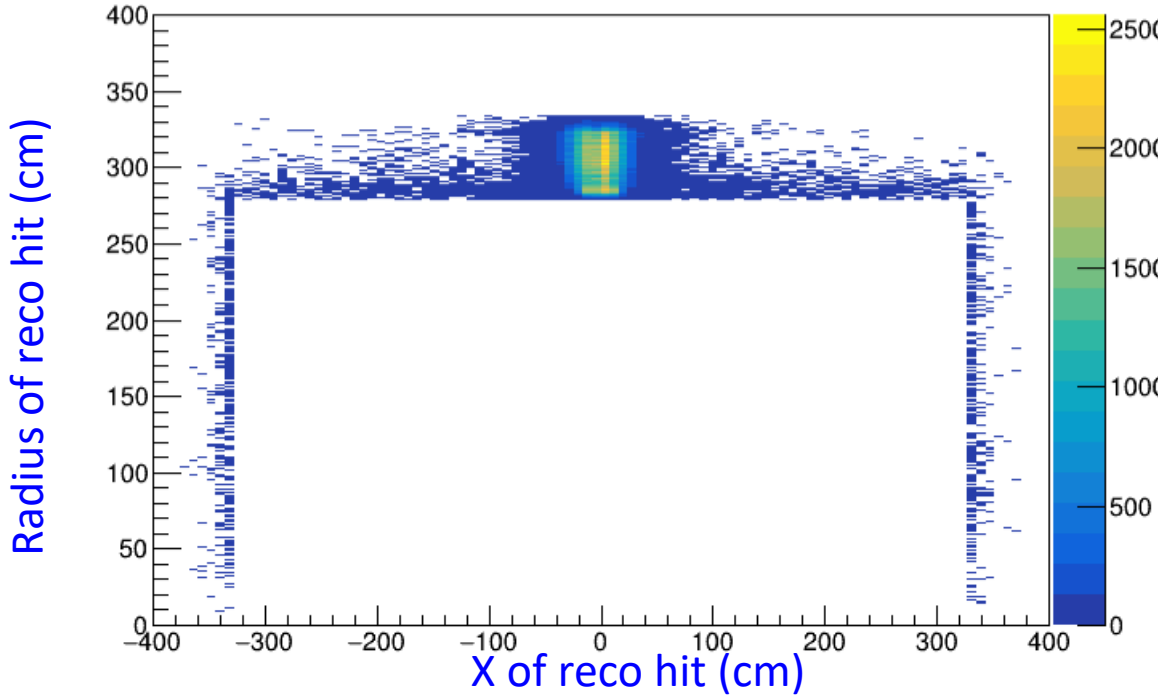


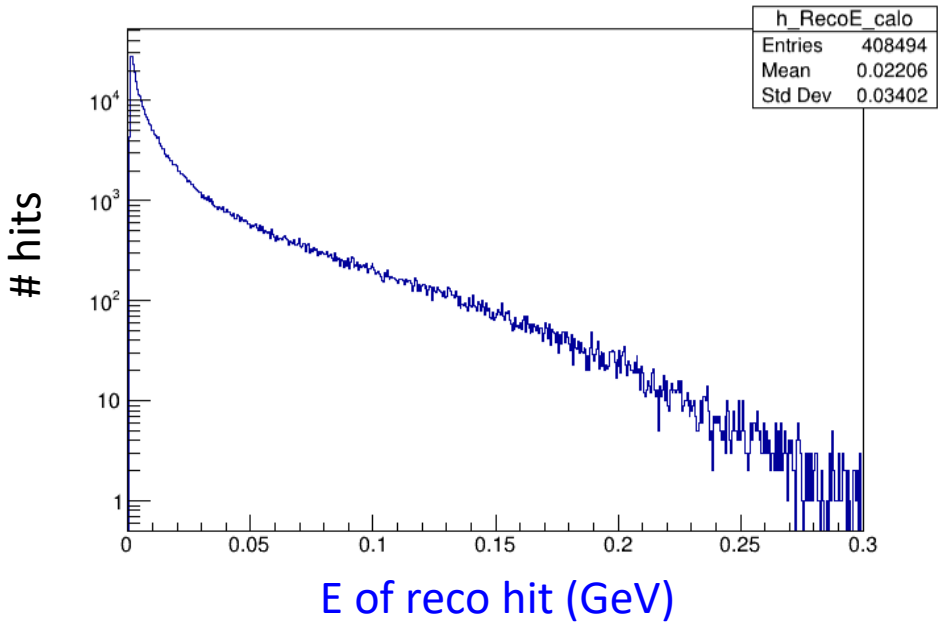
New work

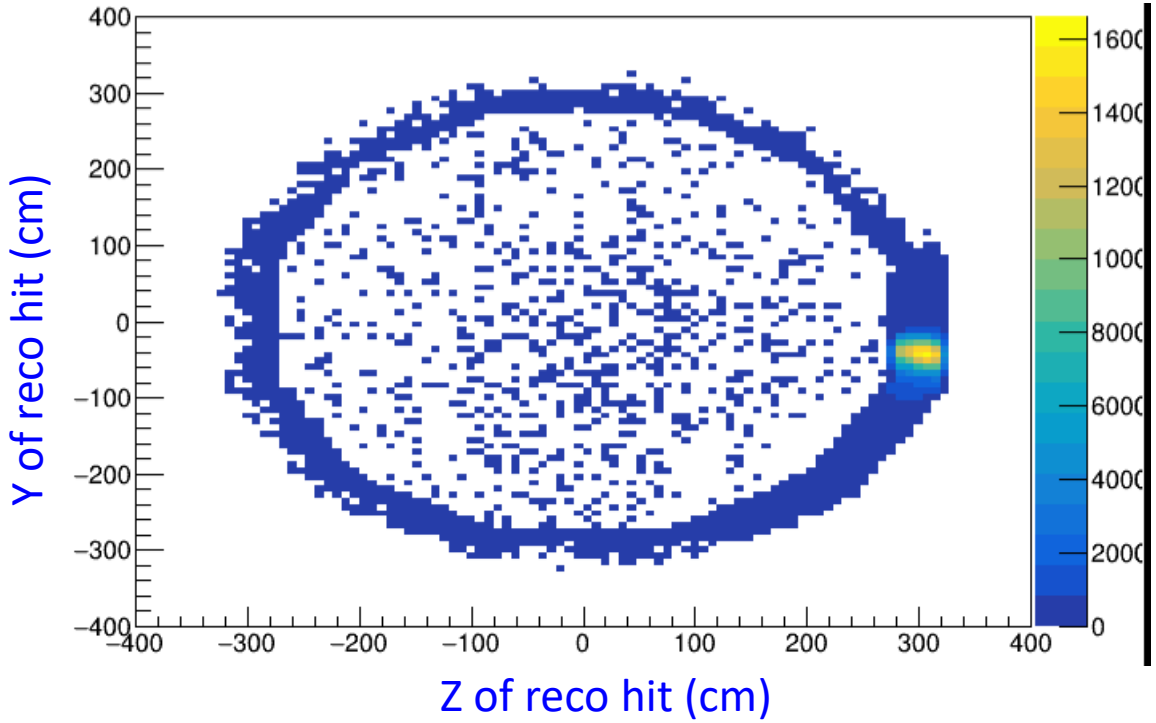
- Made more single electrons with *SF = 2.789* (ad-hoc mean value)
  - Original 1K events – <electron E> = 3 GeV – Gaussian σ = 1 GeV
  - New 2K events – Uniform distribution between 0-6 GeV

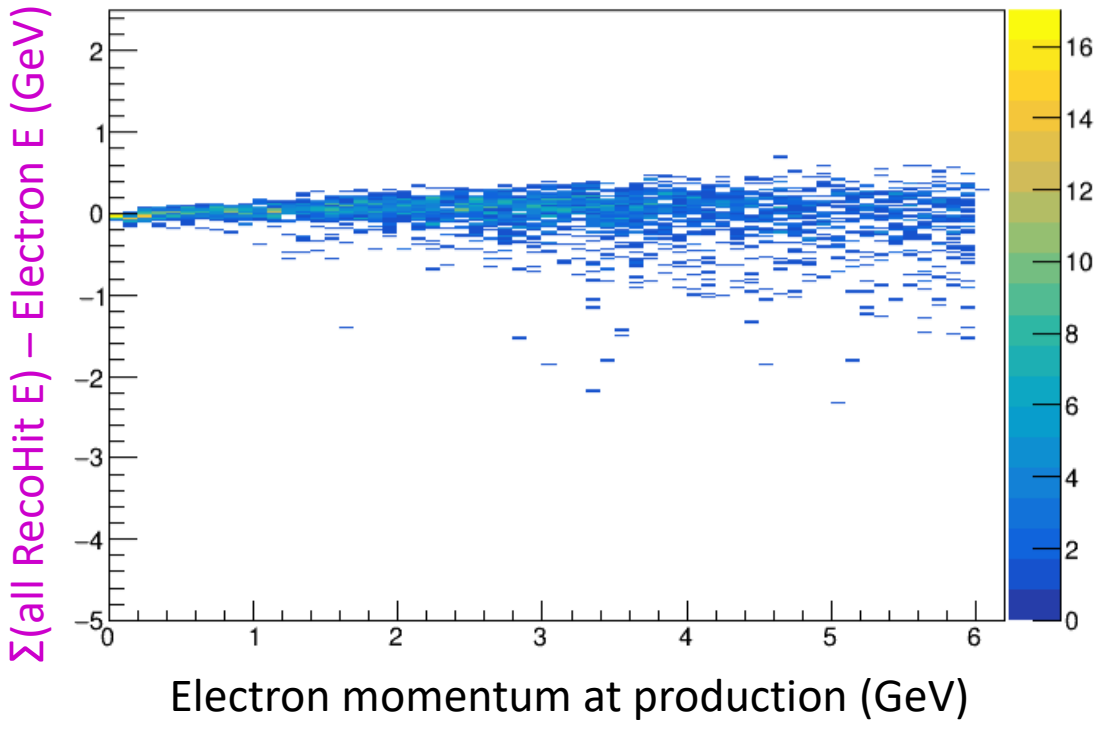
- Separate fits in different electron energy regions


h_elecP
Entries 3000
Mean 3.028
Std Dev 1.566
events
Electron momentum at production (GeV)


Radius of reco hit (cm)
X of reco hit (cm)


h_RecoE_calo
Entries 408494
Mean 0.02206
Std Dev 0.03402
hits
E of reco hit (GeV)

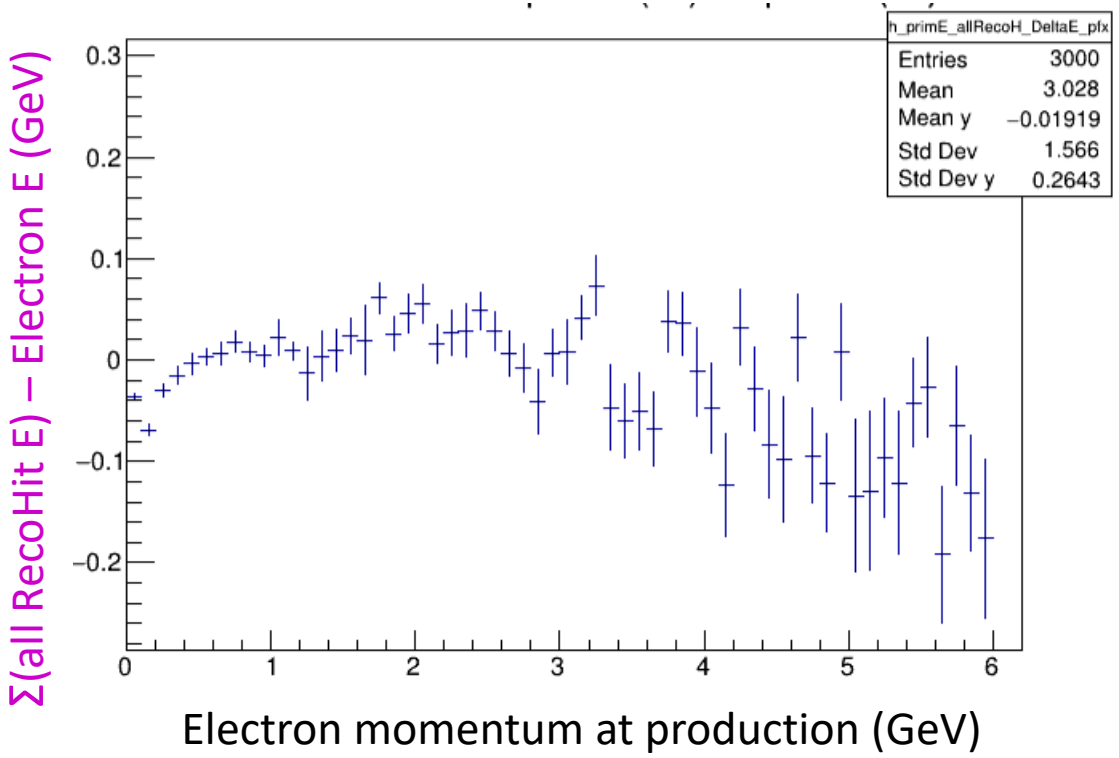

Y of reco hit (cm)
Z of reco hit (cm)

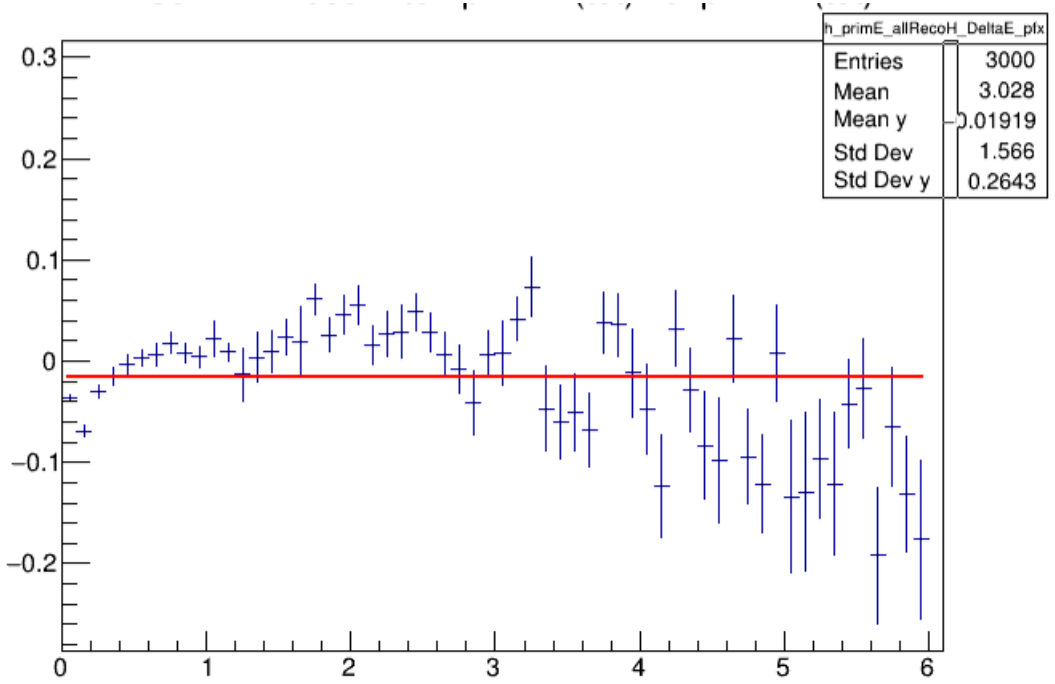


Francisco made a similar plot for his photon sample,
took the Y-projection, and fit with a Double Gaussian,
and took the mean of the core Gaussian to determine the correction to the default Sampling Fraction (see backup)

Not sure if it is such a good idea since the Y-projection averages over all energies, and the double gaussian fit can hide a "multitude of sins". Also, why only consider mean of the core? What is the wider Gaussian telling us?

X-profile plot

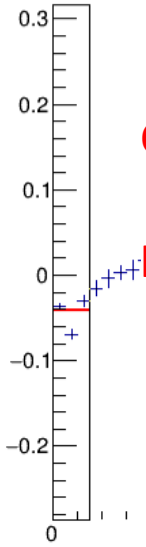




Fit with a straight line:

Chi2/Ndof: 325/59

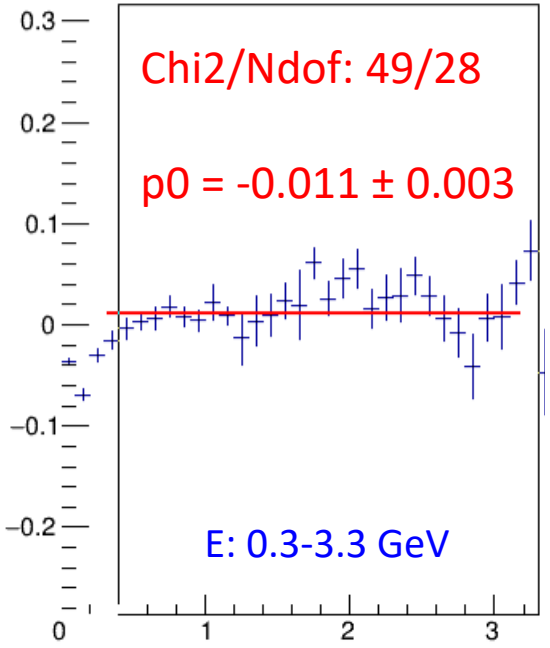
p0 = -0.0157 ± 0.0019



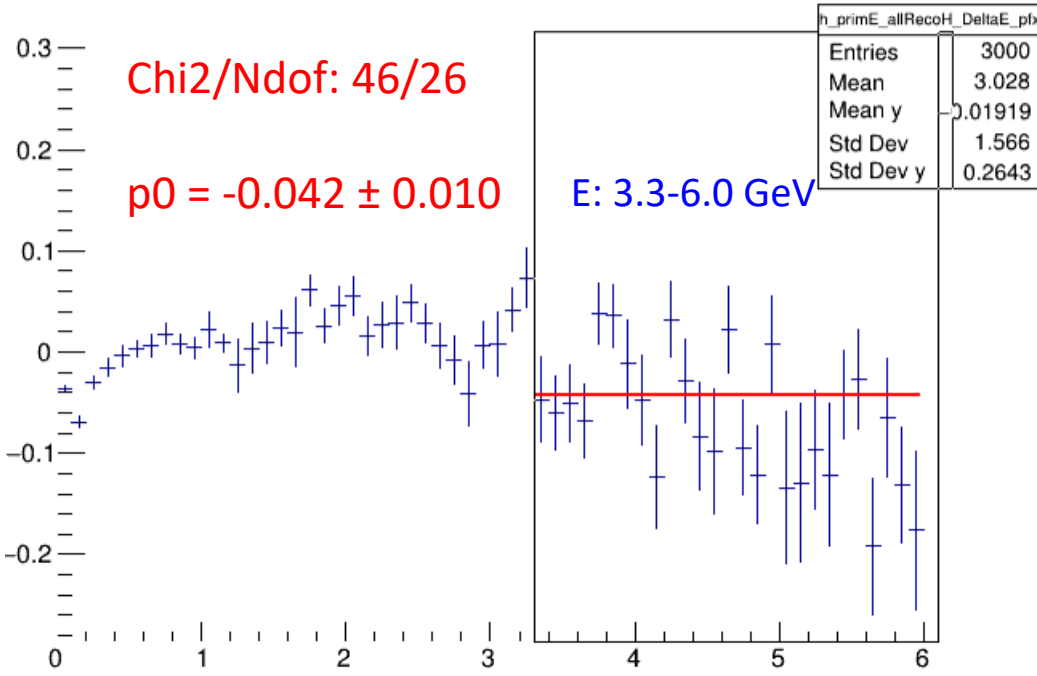
Chi2/Ndof: 24/2

p0 = -0.041 ± 0.003

E: 0-0.3 GeV



Poly1 fit gives:
Chi2/Ndof: 37/25
p0: 0.11 ± 0.05
p1: -0.035 ± 0.012

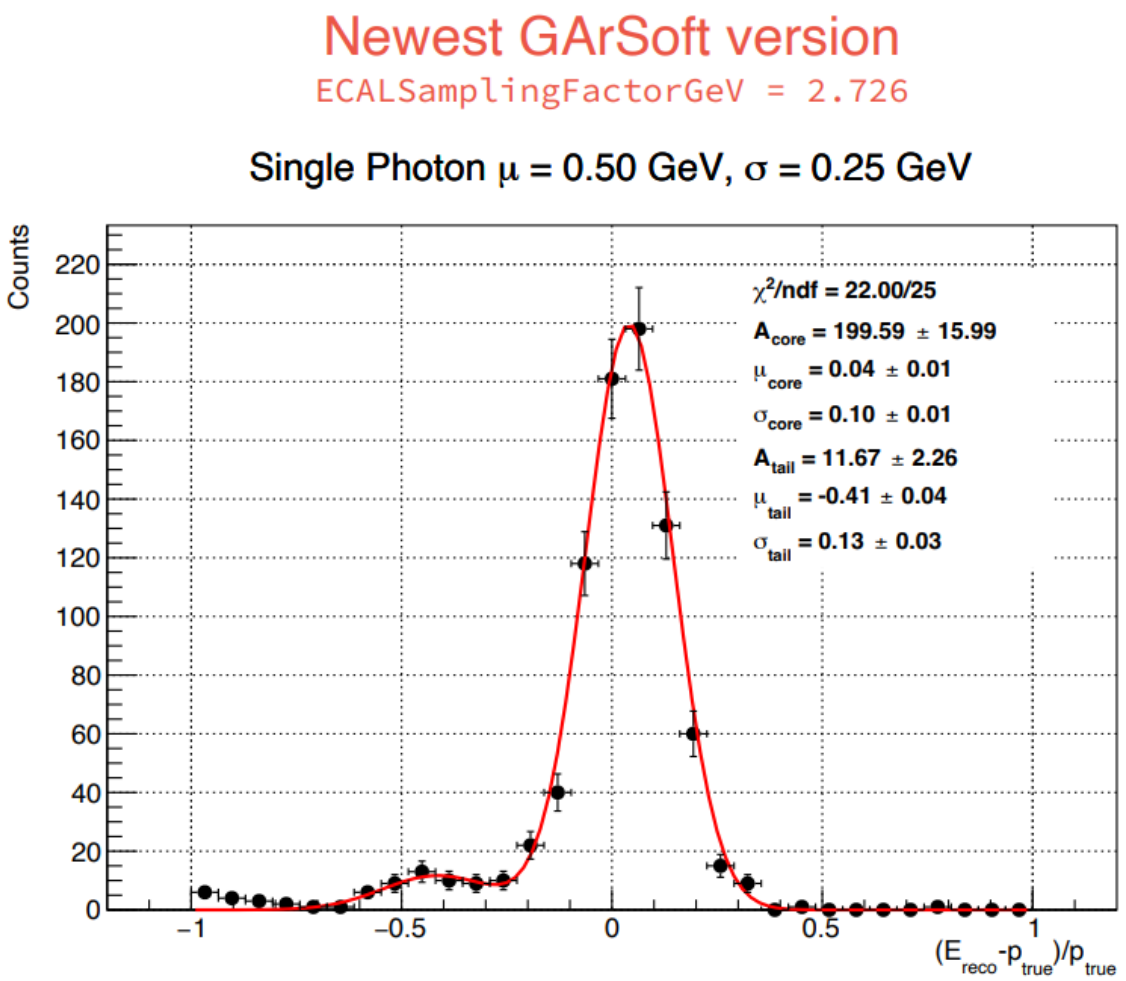


Conclusion

- There must be material in front of the CALO – probably explains the lower value in the 0.0 – 0.3 GeV bin.
  - Not sure why the highest energy bin is low – “leakage” out the back? The CALO is ~ 10 X_0 , so that shouldn’t be an issue?

- A better way to do it could be to use Geant and see how much energy is deposited in the lead absorber and how much in the scintillator

Francisco's plot



Since the core's mean is > 0, he claims that the E of reco hits is too large. But what is the bump at ~ -0.4?

If we just take the mean of the plot (without fitting), what conclusion would we draw?

New (2.852) vs. Default (2.726) SF: *SimHit plots are unchanged – as expected*

Slope/Intercept: -0.6329/-0.0043 -0.6395/0.01502

Sim Hit Energy

Calculated residual at 3 GeV: *-1.903 (GeV)* *-1.90 (GeV)*