FEE Rate Analysis

Matt Solt

SLAC National Accelerator Laboratory

mrsolt@slac.stanford.edu

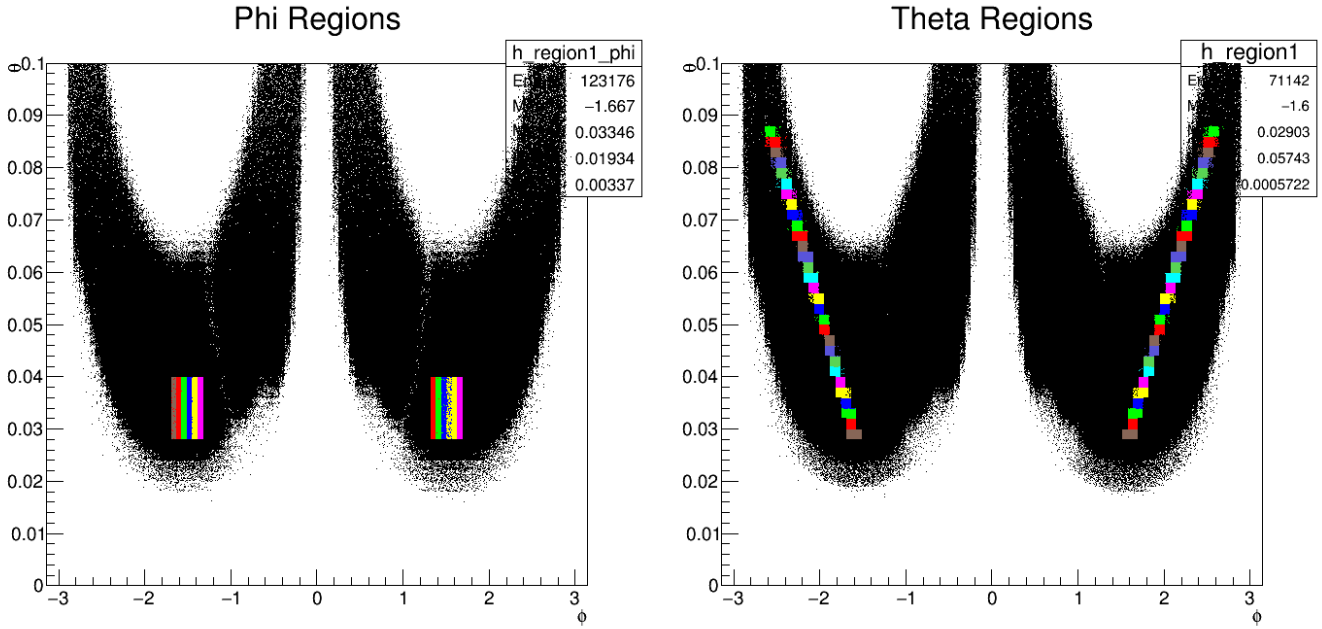
October 12, 2015

Introduction

- Pass2, V3 Detector, Singles1 Trigger
- FEE cuts - 10 ns timing window, 0.85-1.2 GeV energy cut, greater than 2 cluster size cut. All rates are matched
- FEE rates in different spherical (ϕ and θ) regions of detector. Comparison of data (tunsten and carbon targets) and MC.
- Calculations now include the electric form factor for tungsten
- Data - 5771, and 5779 (Carbon); MC - 3.4.0

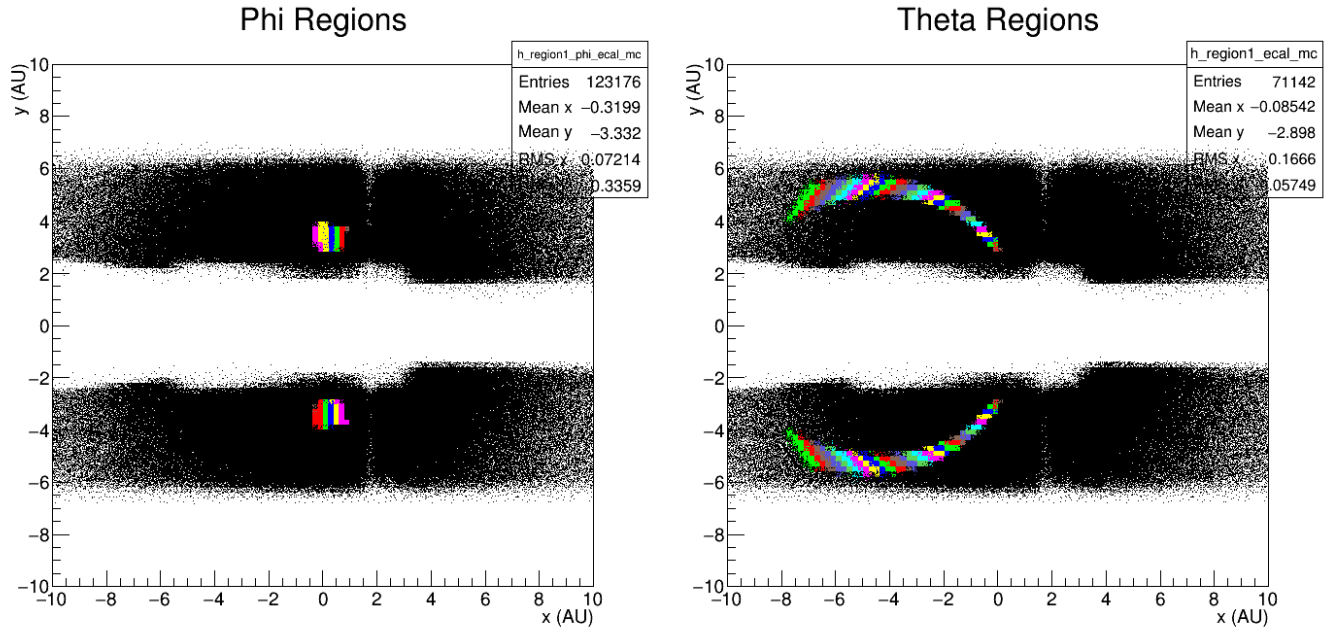
Region Definitions

- Definition of regions shown in the different colors. Black is not a part of any region
- ϕ regions (left): $\Delta\phi = 0.0666$, $0.028 < \theta < 0.040$
- θ regions (right): $\Delta\phi = 0.2$, $\Delta\theta = 0.02$



Region Definitions (Cont.)

- Definition of regions shown from previous slide in x-y coordinates
- ϕ regions (left) and θ regions (right)



Normalization and Total Rates

- Data normalized based on time (7200 s), current (50 nA), blind (0.1), and deadtime (0.85)
- Carbon run normalized based on (1800 s), current (30 nA), blind (0.1), deadtime (0.85)
- MC normalized based on time (calculated from file size), current (50 nA), and prescale (2^{11})

Calculations

- Mott cross section with form factor

$$\frac{d\sigma}{d\Omega}(E,\theta) = \frac{Z^2 e^4}{(4\pi\epsilon_0)^2 4E^2 \sin^4\frac{\theta}{2}} \left(1 - \beta^2 \sin^2\frac{\theta}{2}\right) |F(Q)|^2$$

- where $F(Q)$ is the electric form factor. For Tungsten it is

$$F(Q) = \frac{3\hbar}{(QR)^3} \left(\sin\frac{QR}{\hbar} - \frac{QR}{\hbar}\cos\frac{QR}{\hbar}\right)$$

- where R is the nuclear radius and Q is the positive transferred 4-momentum which is given in the high energy limit

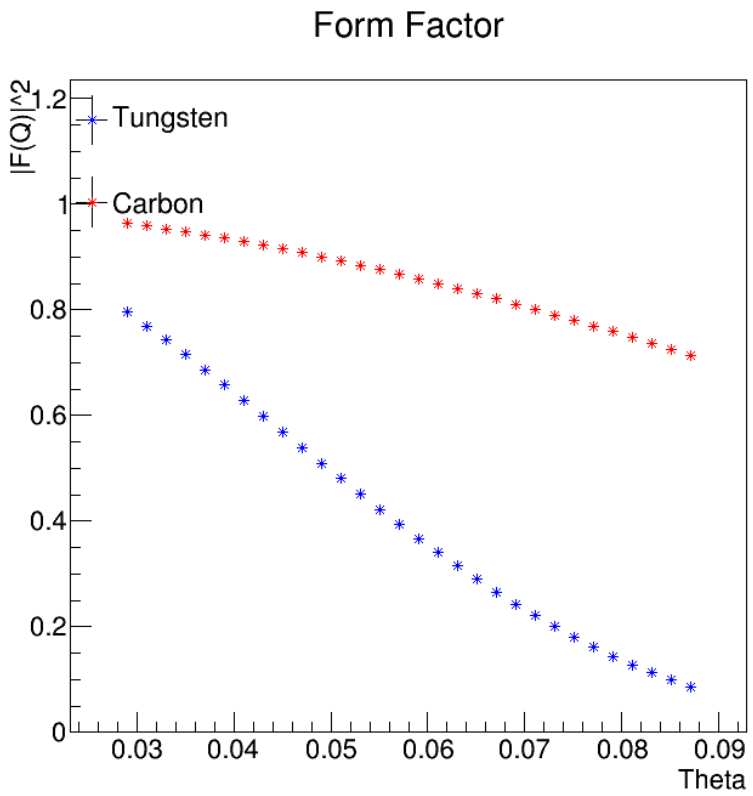
$$Q^2 = 4EE' \sin^2\frac{\theta}{2}$$

- where E' is the scattered electron energy

$$E' = \frac{E}{1 + \frac{2E}{M}\sin^2\frac{\theta}{2}}$$

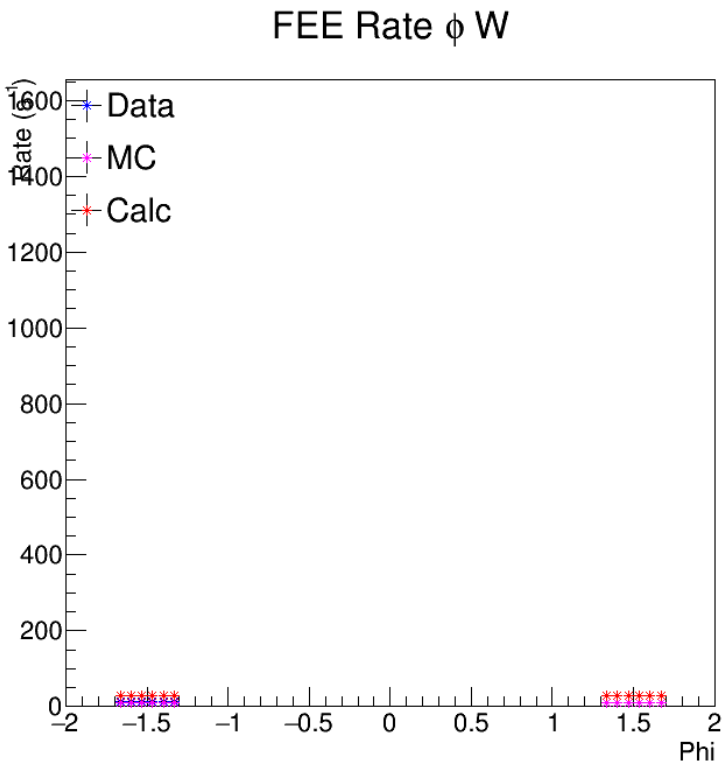
Form Factor

- Form Factor makes a big deal...



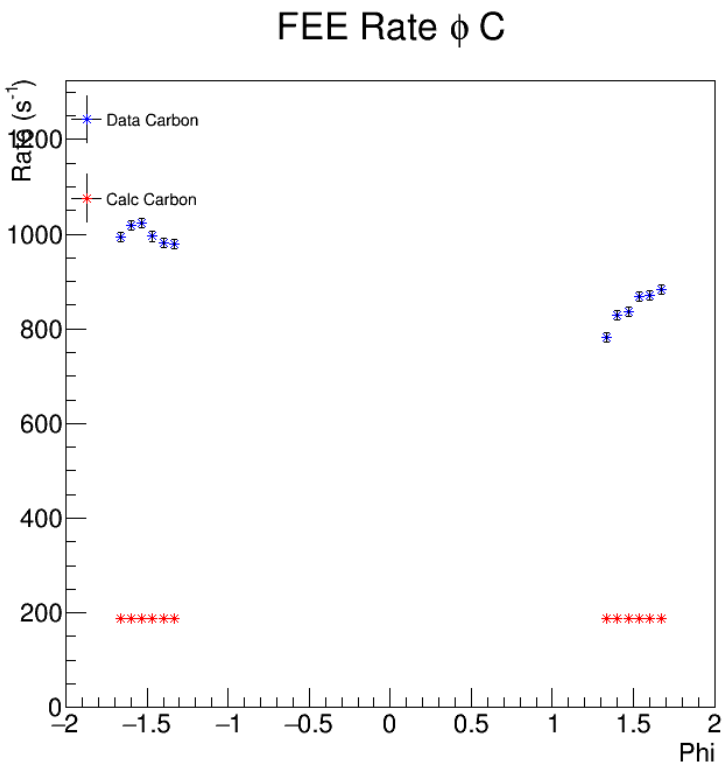
FEE Rate of ϕ Regions Tungsten

- Comparison of ϕ regions, should be constant



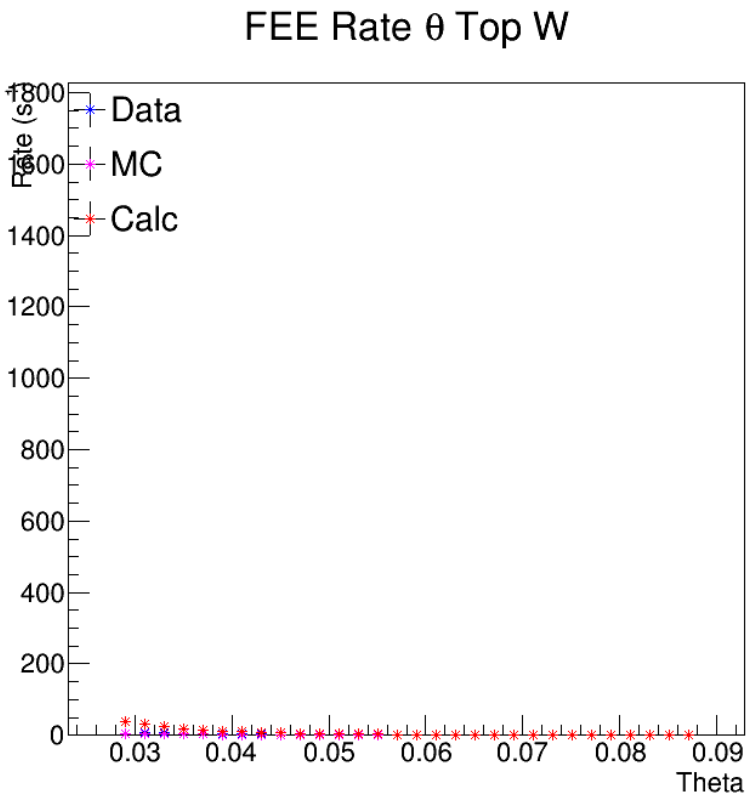
FEE Rate of ϕ Regions Carbon

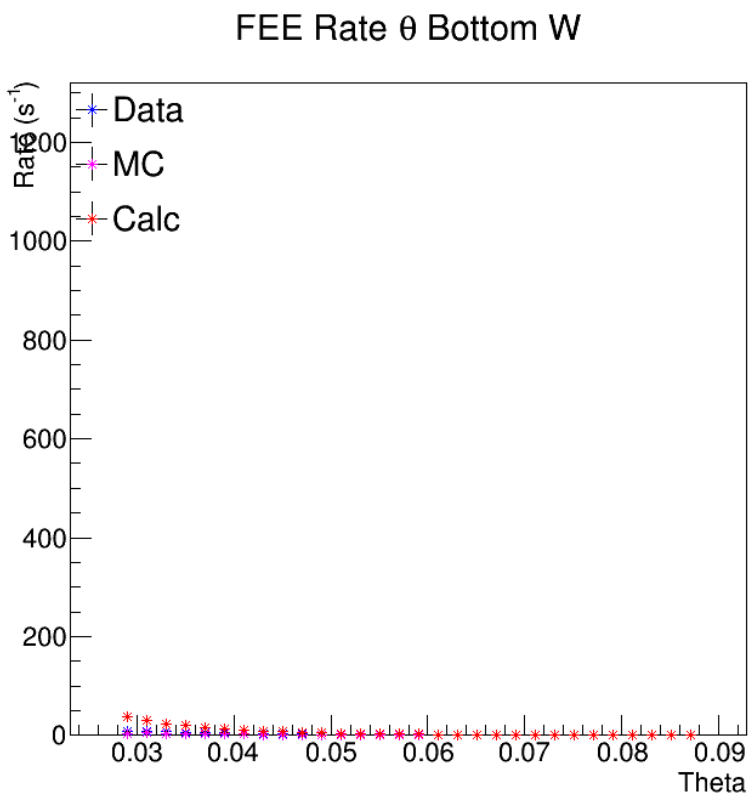
- Carbon is still a work in progress for a variety of reasons



FEE Rate of θ Regions Tungsten

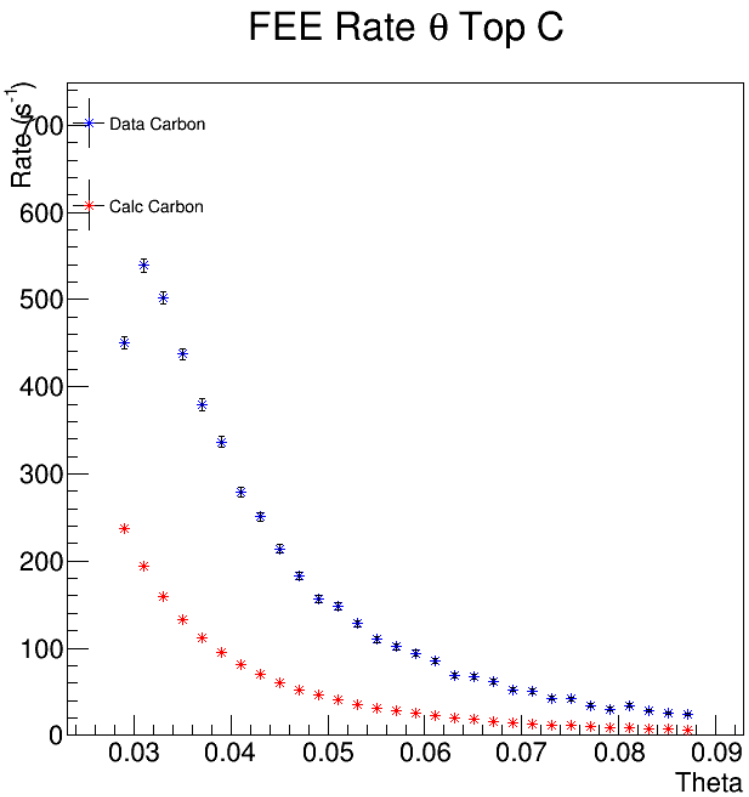
- Data matches calculation up to a factor of about 2

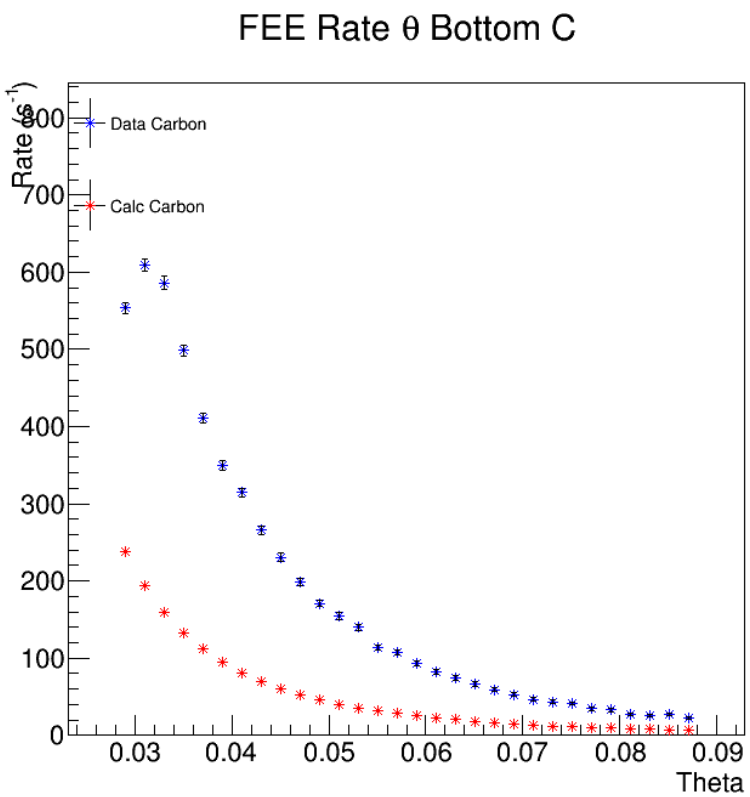




FEE Rate of θ Regions

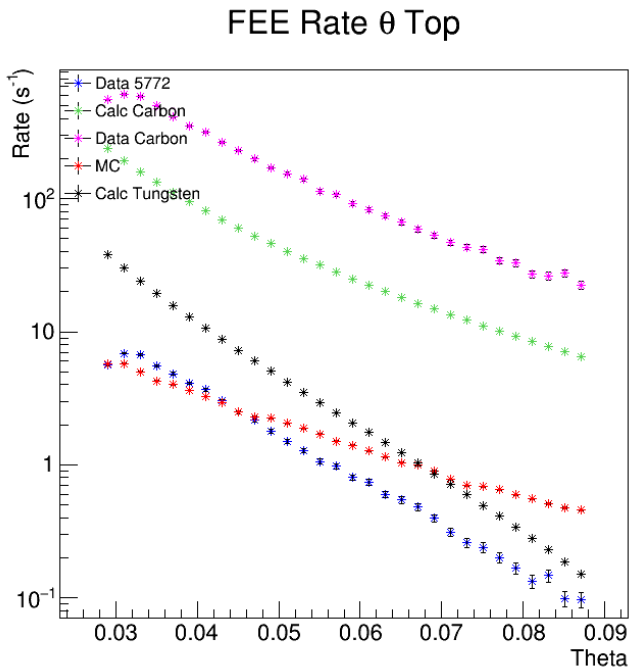
- Carbon is still a work in progress for a variety of reasons

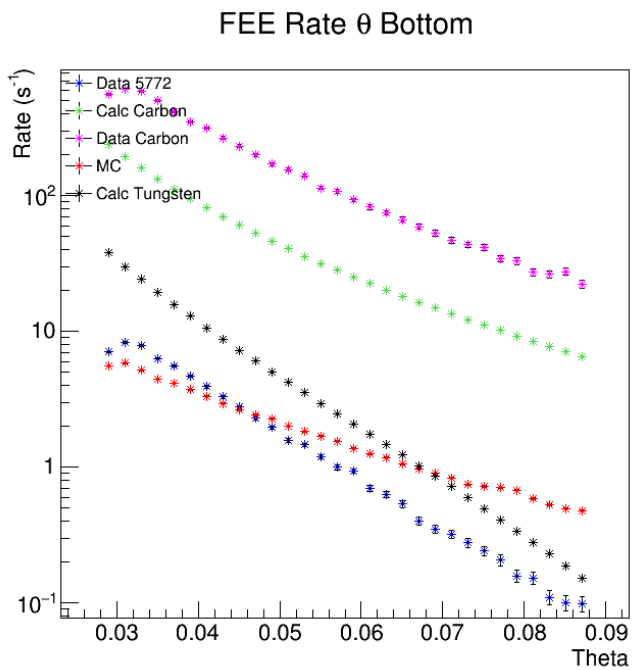




FEE Rates of Calculation Compared to Data or MC in θ

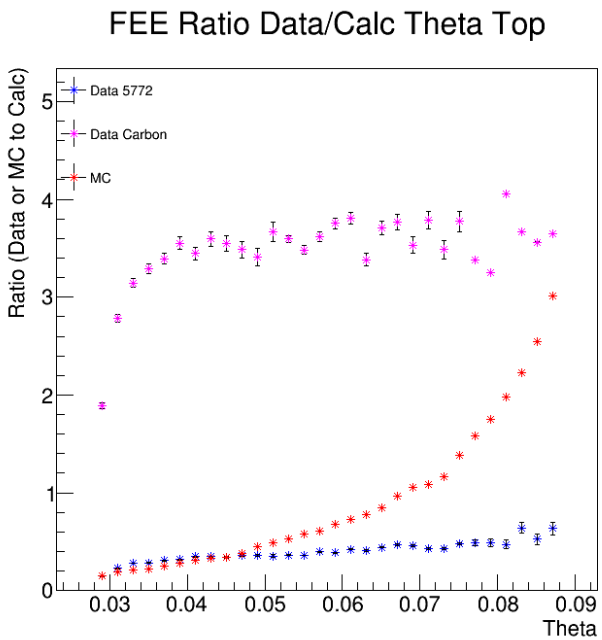
- Comparison of Calculation (Mott Scattering) Rates to Data and MC log scale
- MC and calcs have the similar slope and carbon run appears to match as well.
- Note: Calculation are off by an arbitrary factor

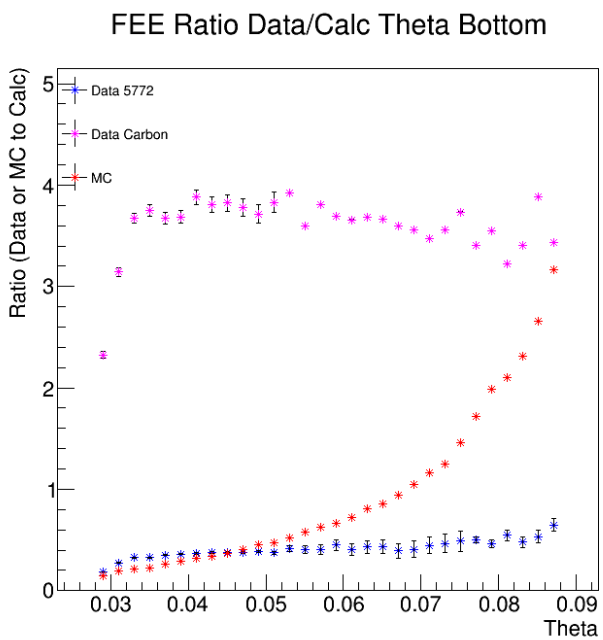




FEE Ratio of Calculation to Data or MC in θ

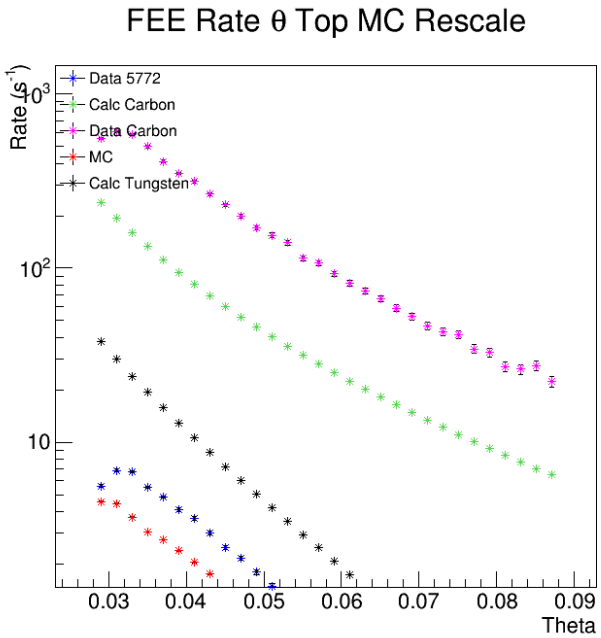
- Comparison of the ratios of Data and MC to Calculation (Mott Scattering): $\frac{\text{MC or Data Rate}}{\text{Calc Rate}}$
- Data matches the trend of calculations, MC does not.
- Note: Calculation are off by an arbitrary factor

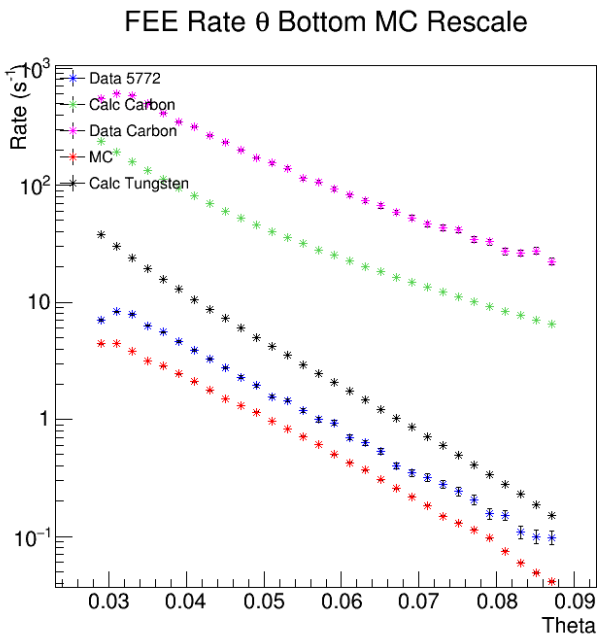




FEE Rates of Calculation Compared to Data or MC in θ. MC Corrected

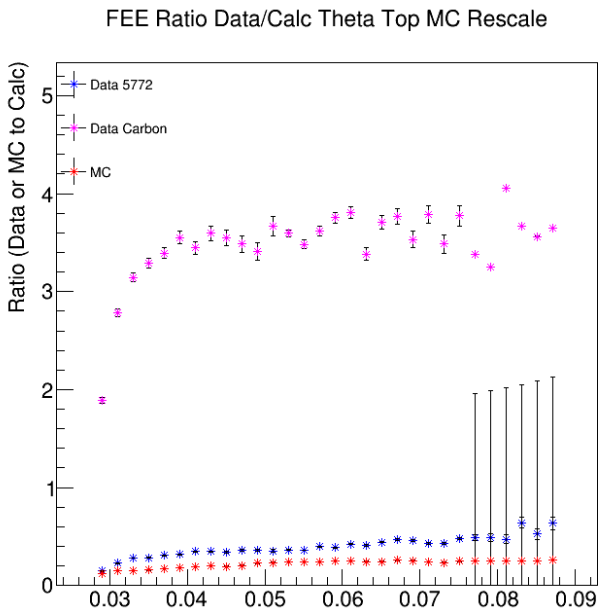
- Comparison of Calculation (Mott Scattering) Rates to Data and MC log scale
- MC is now corrected with form factor, MC seems to match
- Note: Calculation are off by an arbitrary factor

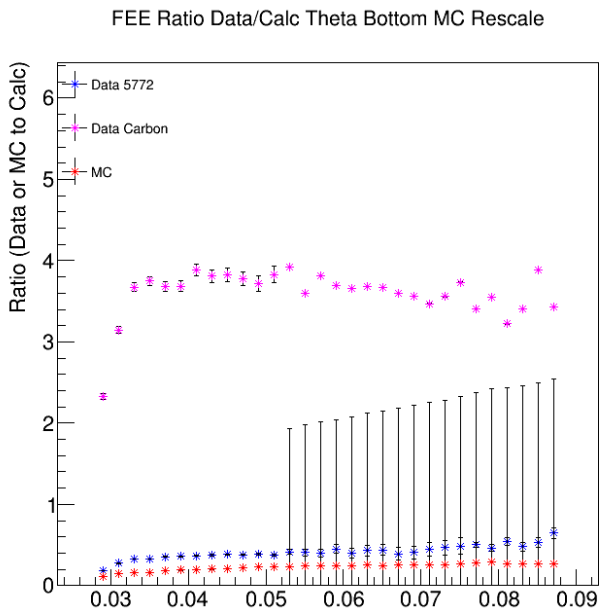




FEE Ratio of Calculation to Data or MC in θ. MC Corrected

- Comparison of the ratios of Data and MC to Calculation (Mott Scattering): $\frac{\text{MC or Data Rate}}{\text{Calc Rate}}$
- Data matches the trend of calculations, MC is corrected with form factor, and has a fairly constant ratio
- Note: Calculation are off by an arbitrary factor





Conclusions and Things to Do

- Form factor makes a large contribution and must be included in calculation
- Form factor corrects the shapes of both data and MC. MC form factor possibly incorrect at the generator level?
- In the near future: update for Pass3, extract measured cross sections, find factor of 2 discrepancy between data/MC and calculations, write up a note, and minor corrections in error bars and scales