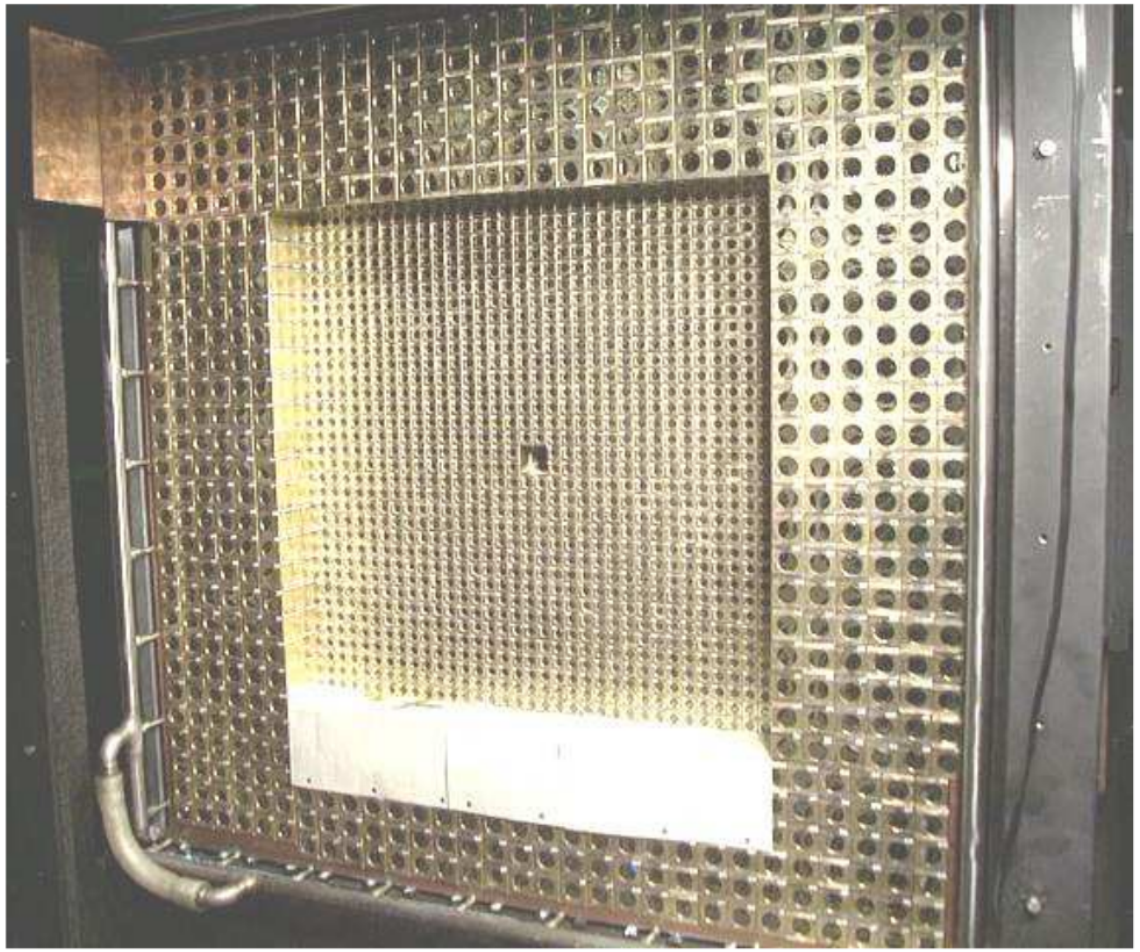
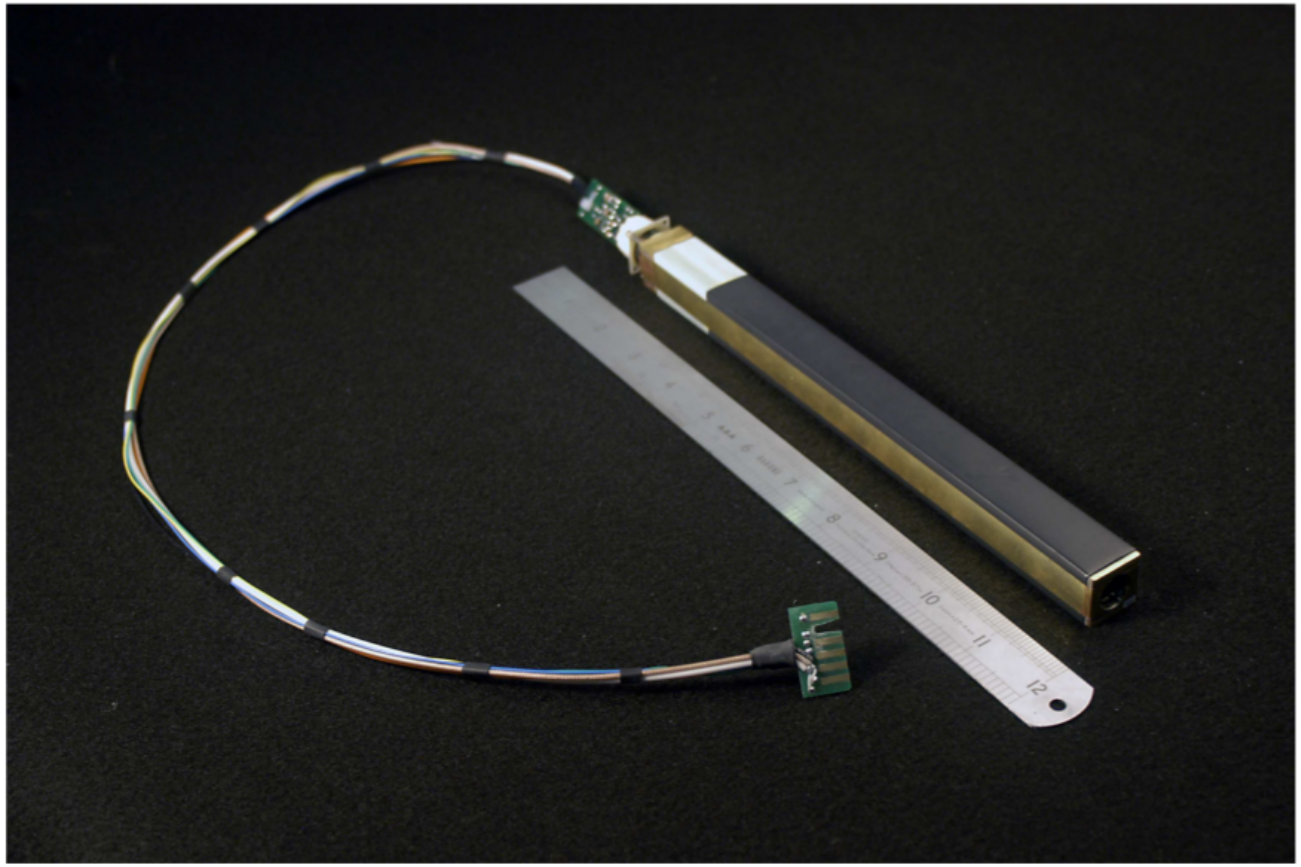
# HyCal geometry

- Chao Gu has put the brass face place and more realistic materials around the modules in the simulation

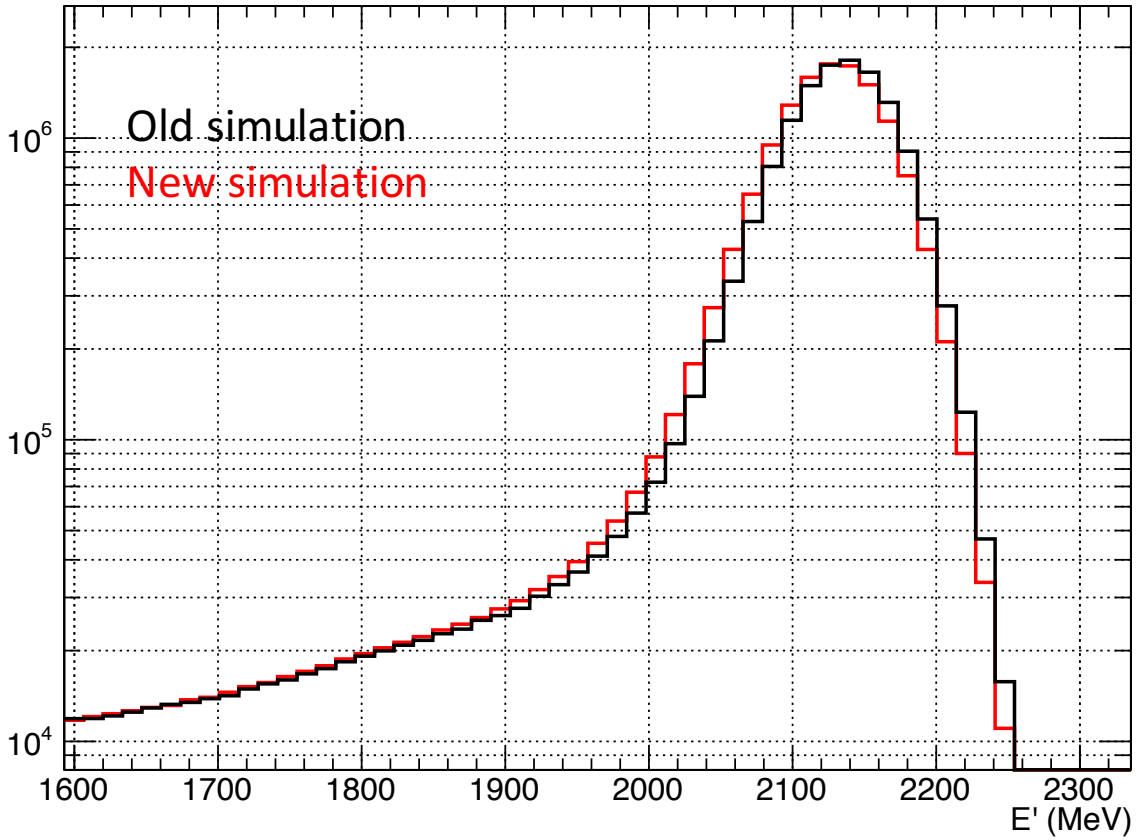




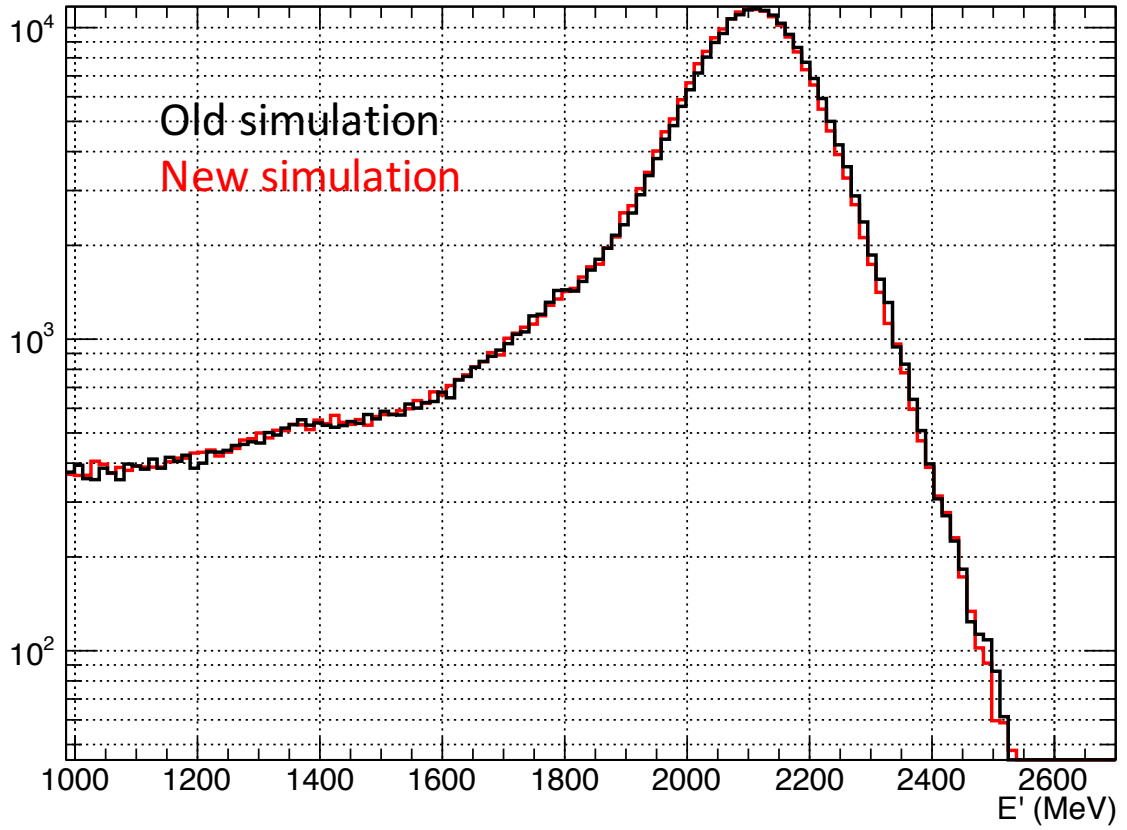
# Spectrum comparison

The major impact is the shift of the elastic peak, which can be shifted back by calibration

spectrum for $0.90 < \theta < 1.10$ deg

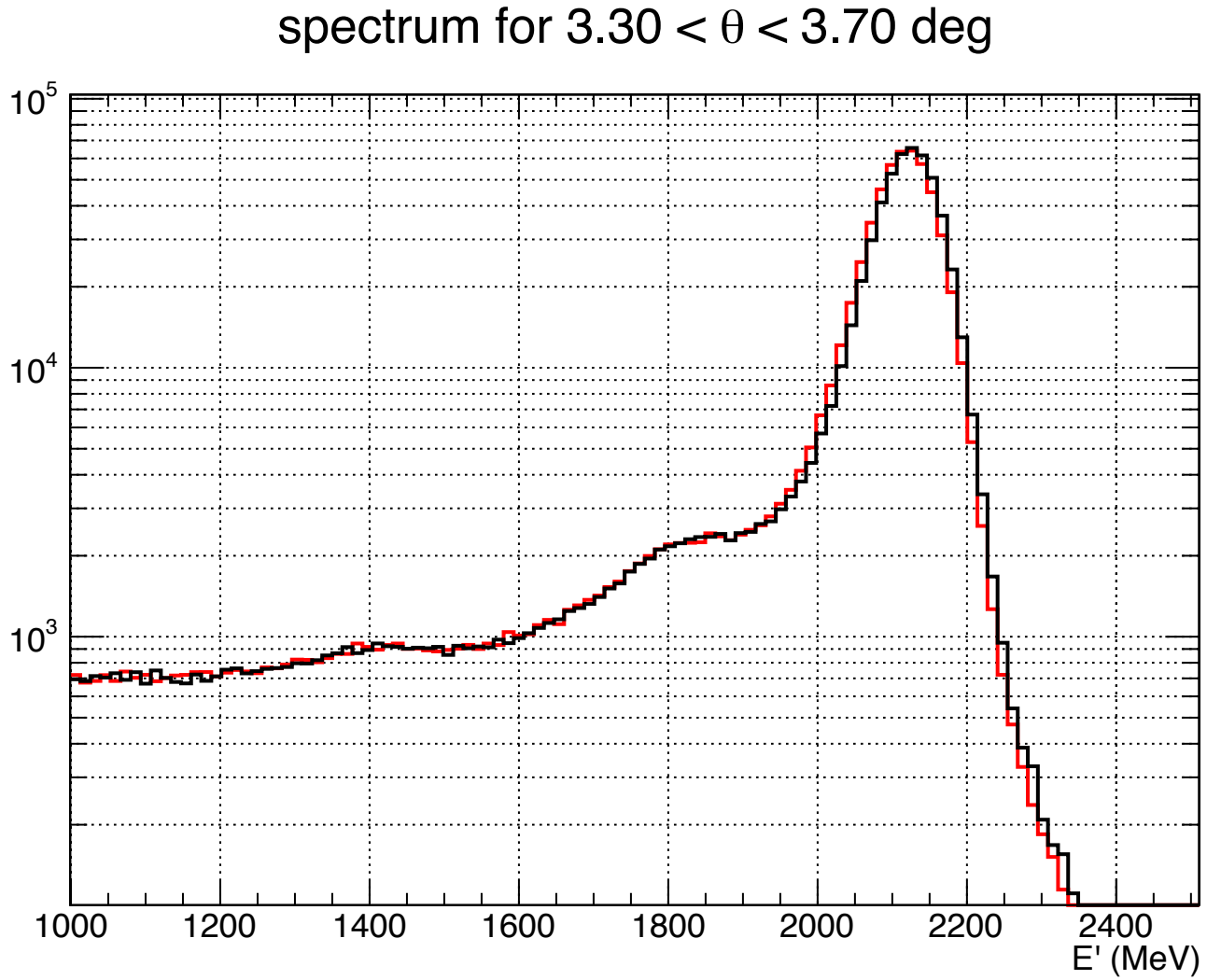



spectrum for $4.70 < \theta < 5.20$ deg

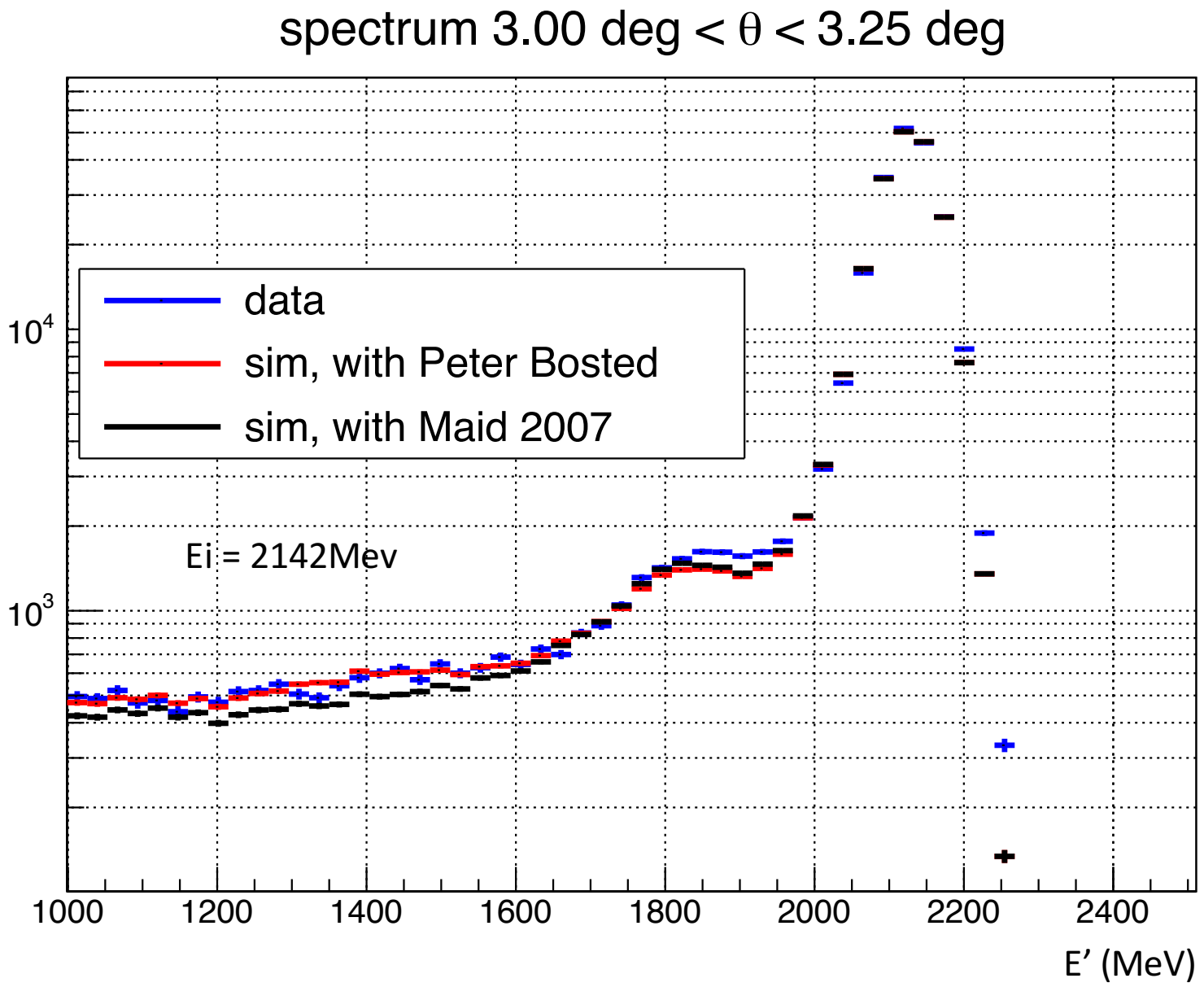


# Spectrum comparison

The major impact is the shift of the elastic peak, which can be shifted back by calibration



# Inelastic ep cross section comparison



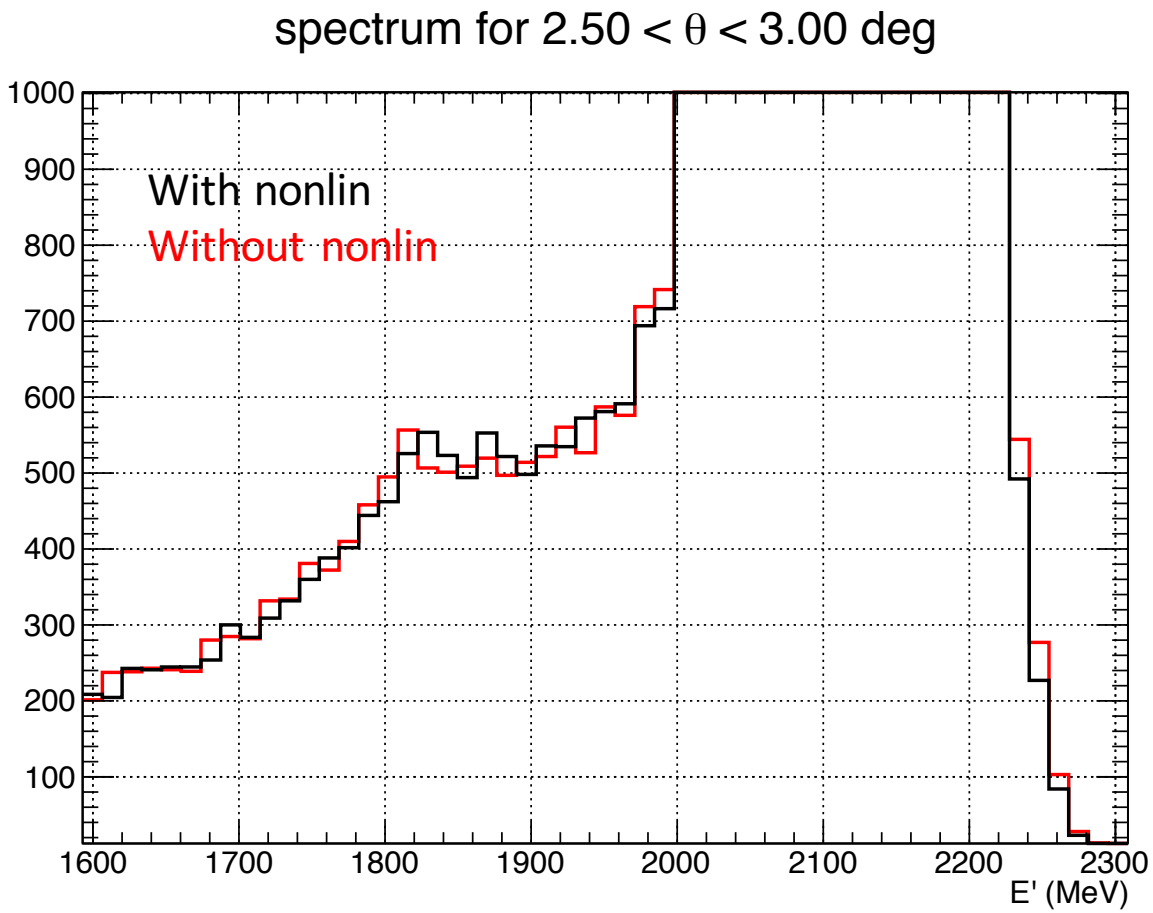
# Non-linearity in data and simulation

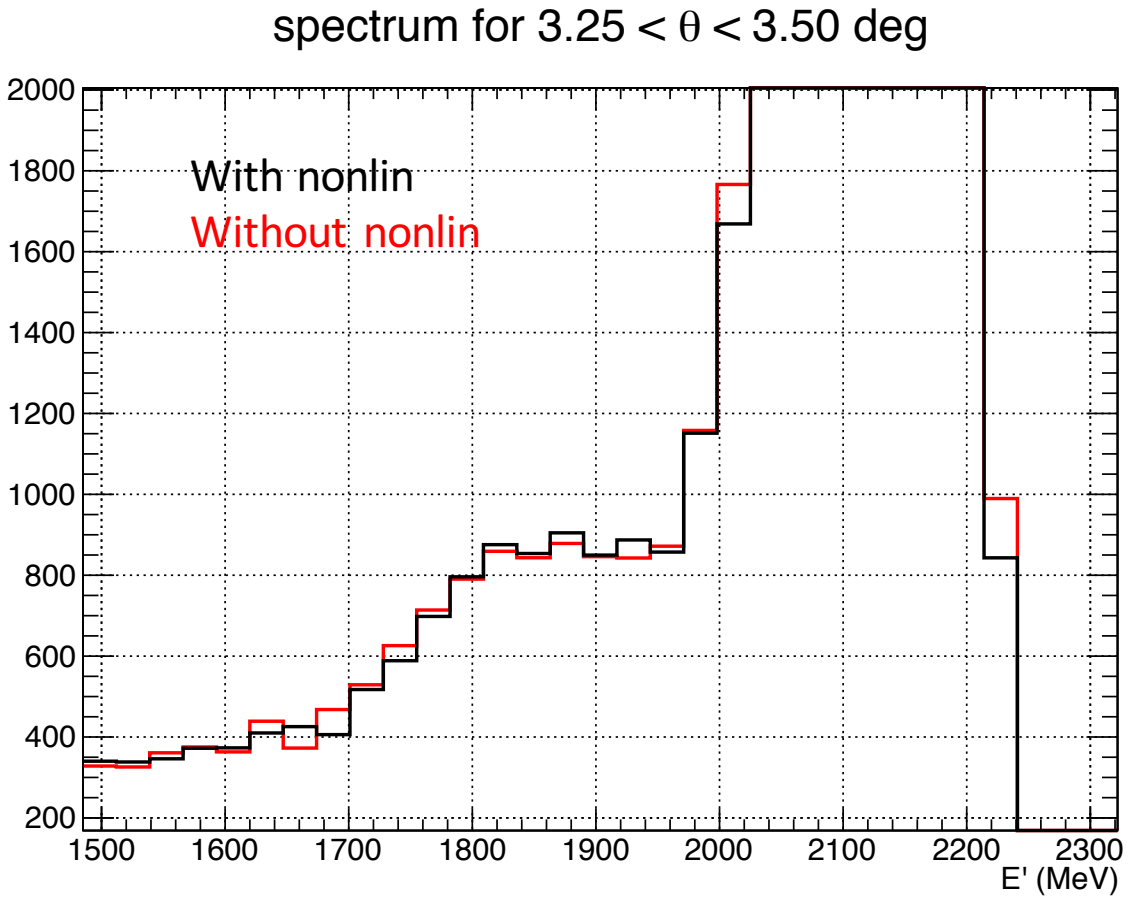
- Formula we use for the non-linearity correction:

$$E_{corr} = \frac{E_m}{1 + \alpha(E_m - E_{cali})}$$

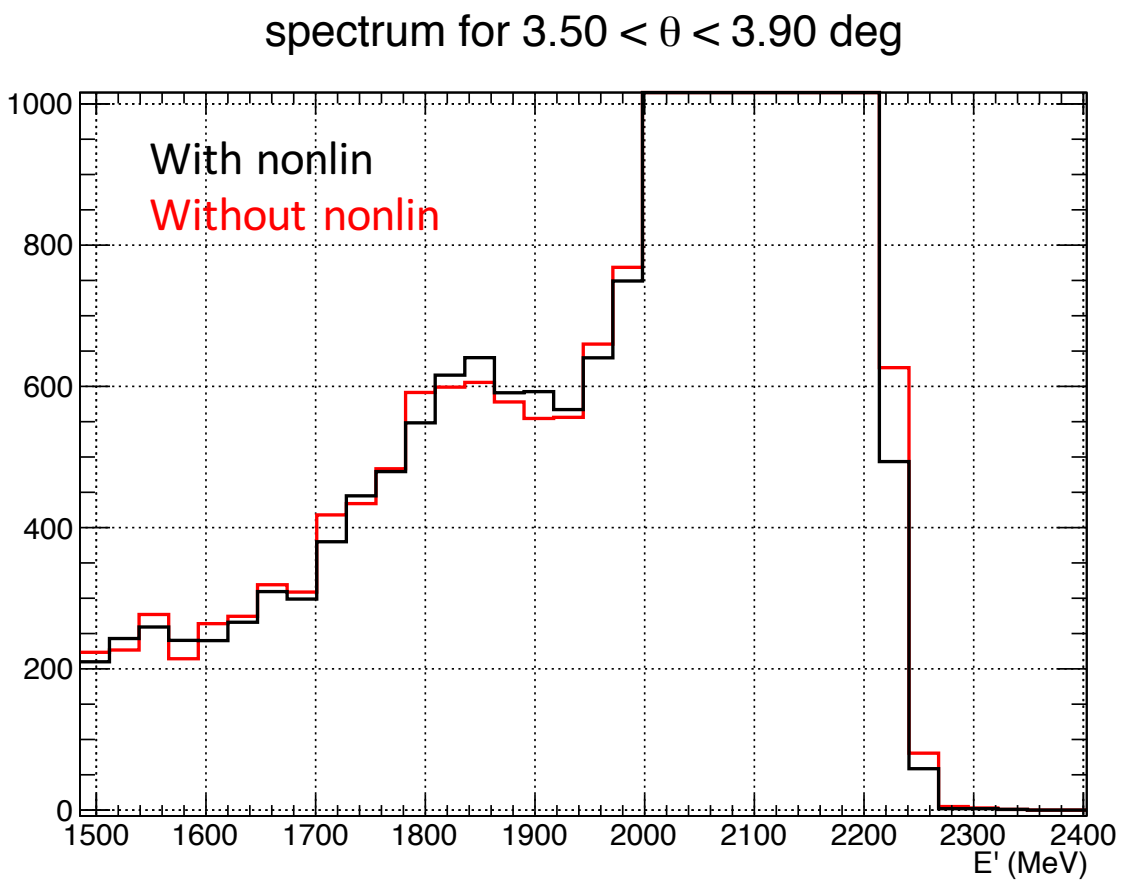
- For data, we calibrate to the ep elastic peak ($E_{cali} = E_{ep}$)
- If $\alpha$ is positive: energy spectrum squeezed toward the calibration point;
- 100% of the PWO modules and 75% of the LG modules have positive $\alpha$ in data
- All modules have positive $\alpha$ in the simulation
- The non-linearity behavior is not yet properly taken cared of in the simulation

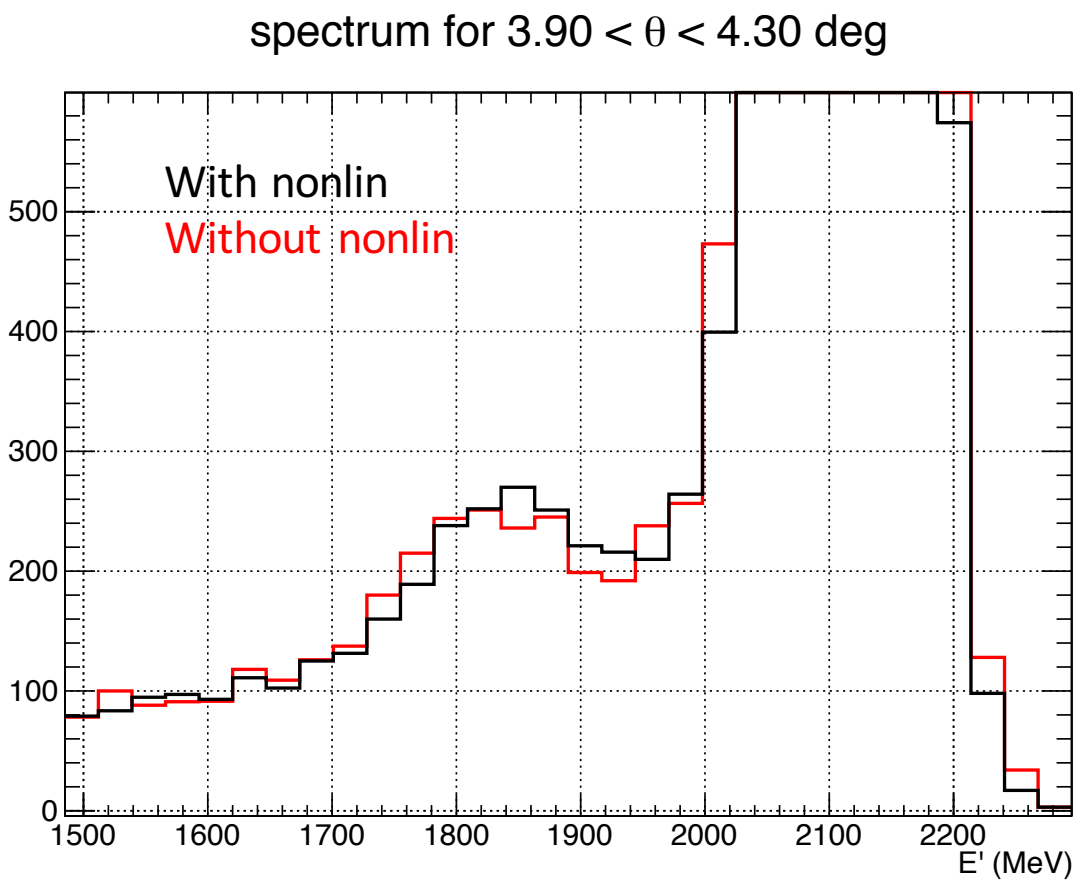
# Data non-linearity behavior



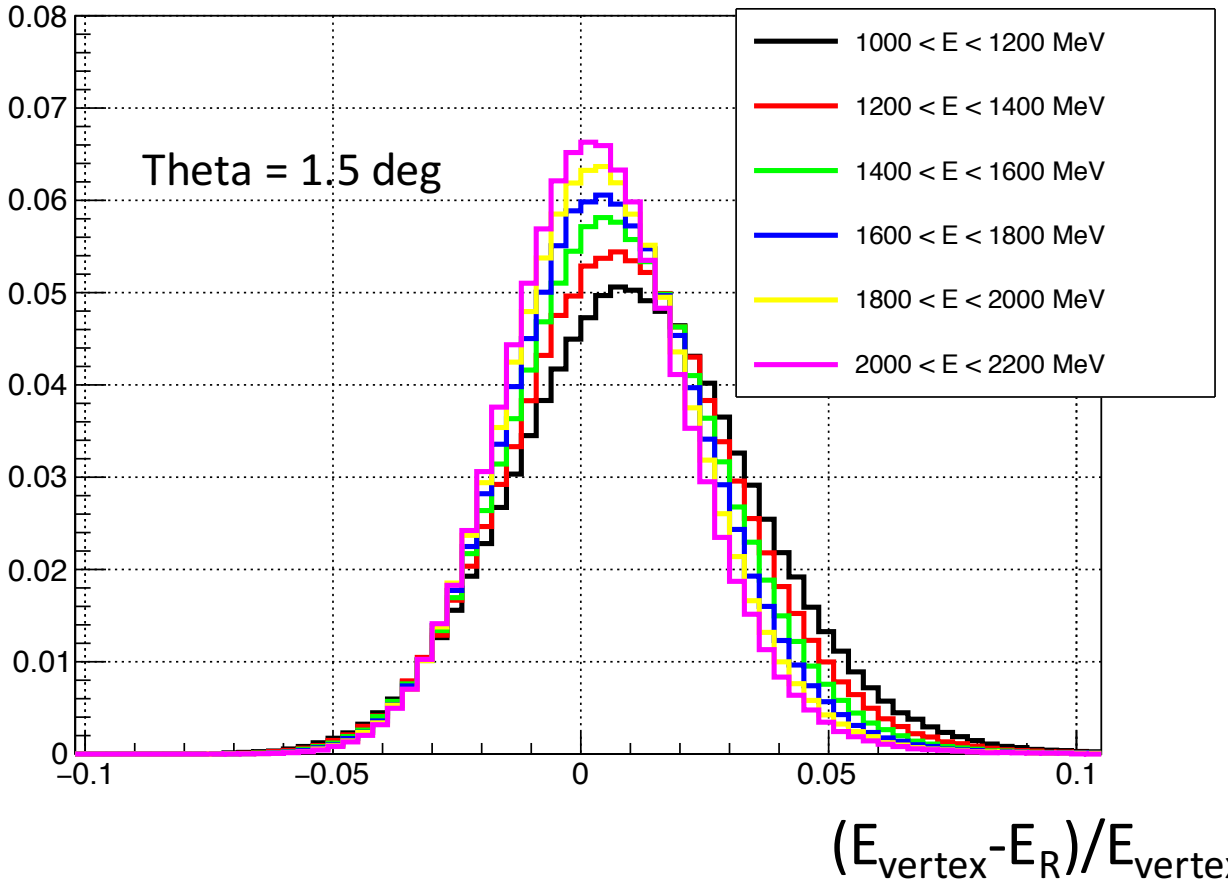
# Data non-linearity behavior

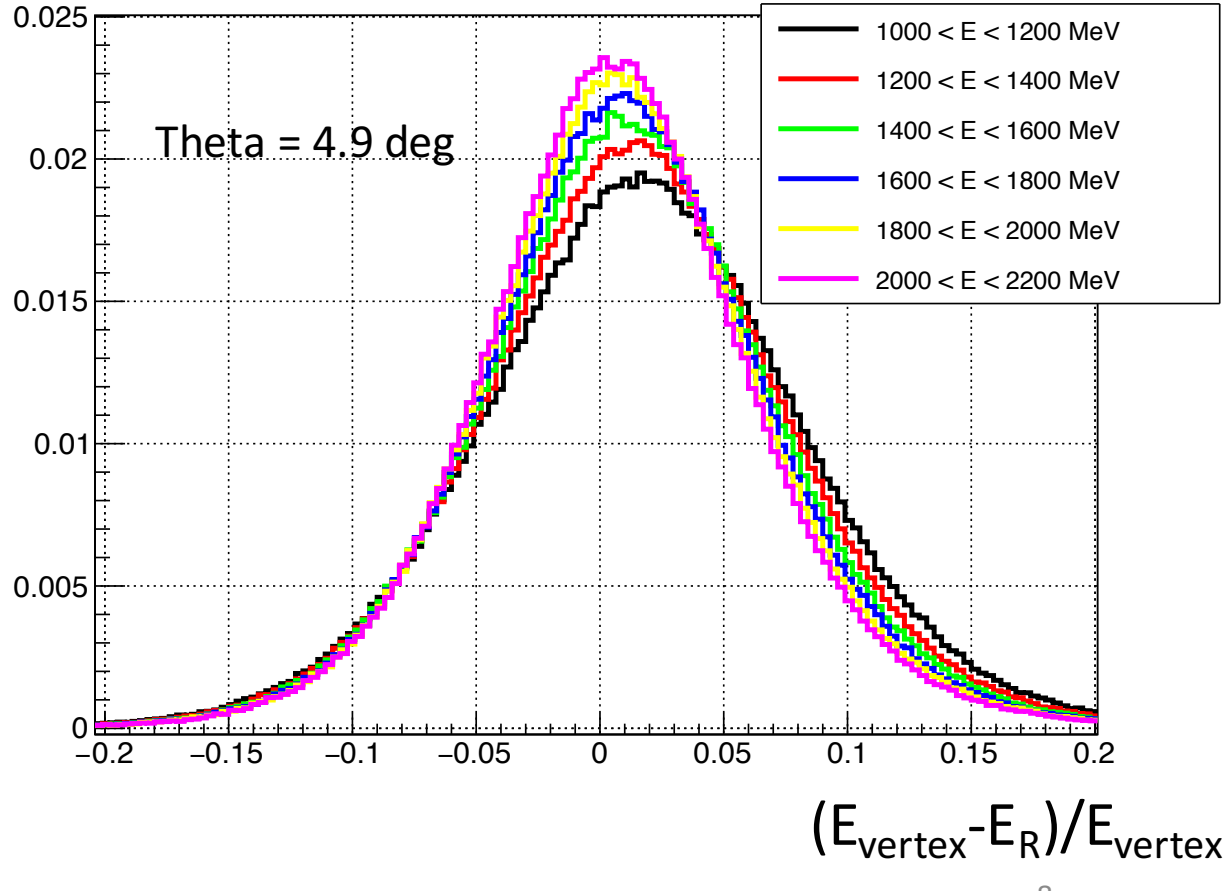


# Non-linearity in simulation

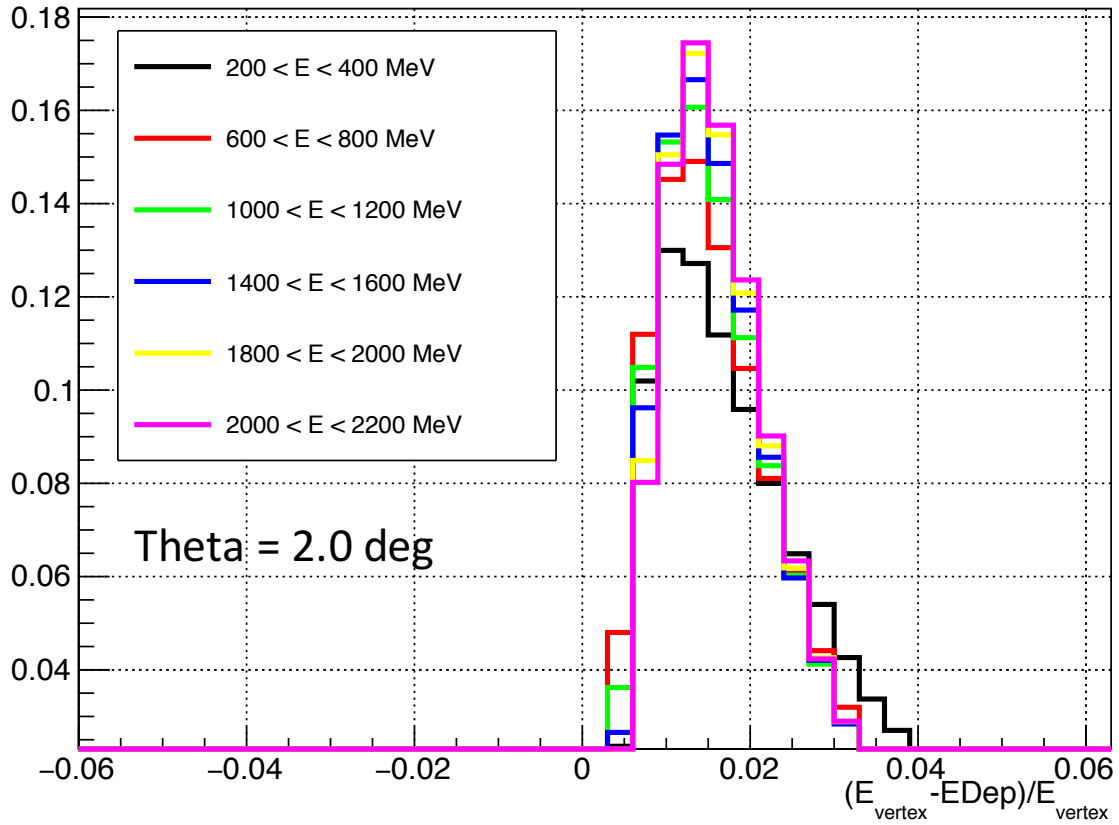
- Similar non-linearity behavior also exists in the simulation, but it is not fully corrected

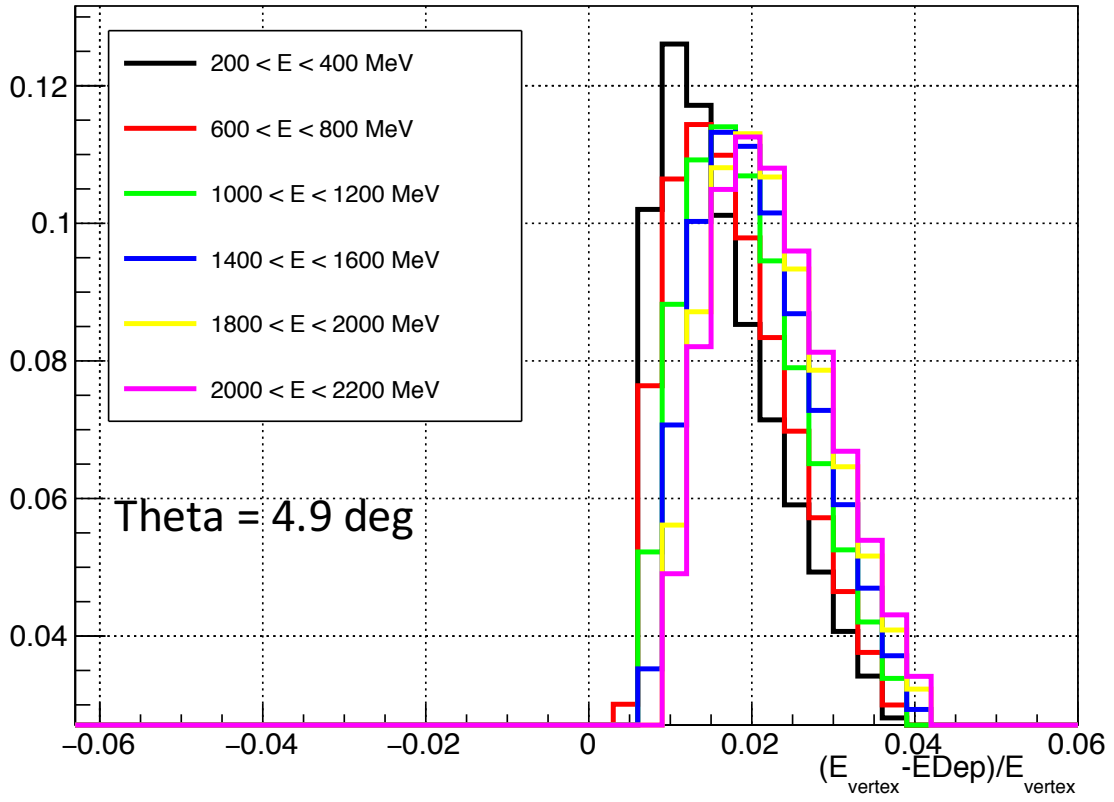


# Non-linearity in simulation

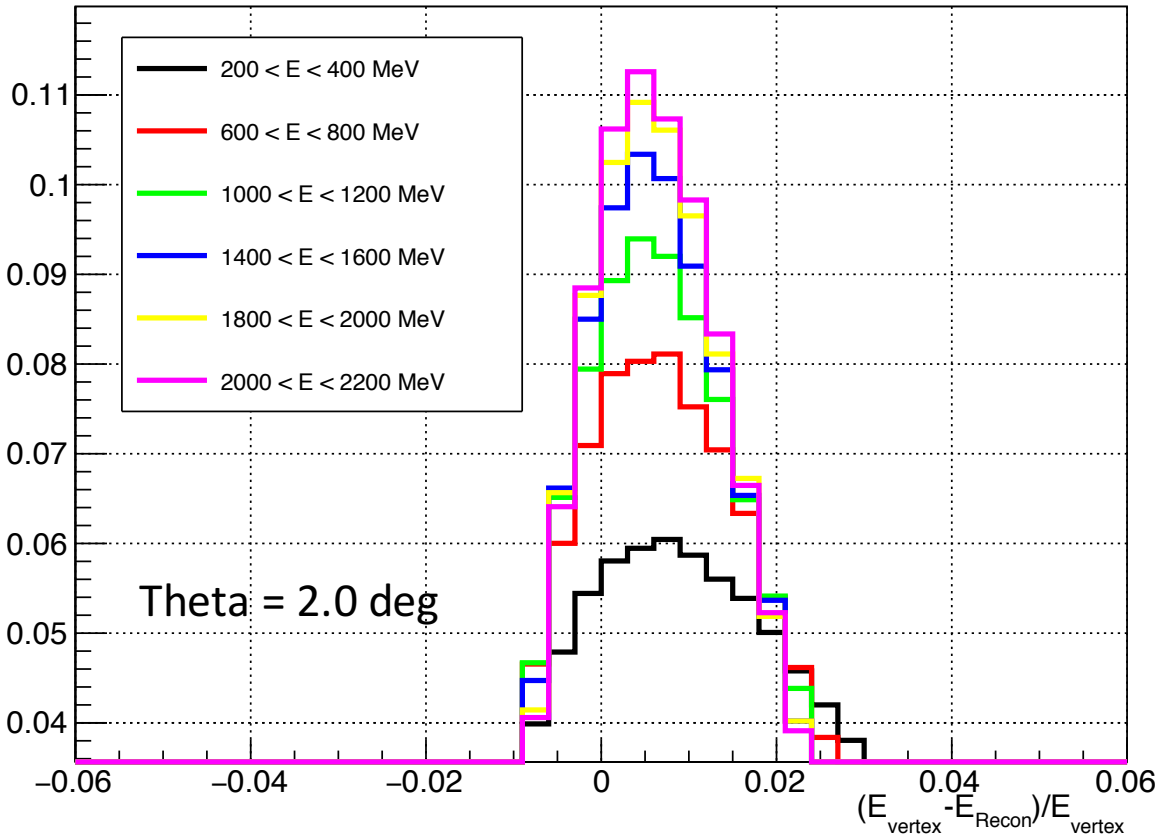
- If we look at the total energy deposition in HyCal from the simulation, no strong non-linearity behavior observed
- In fact, low energy particle deposition more of its energy into HyCal than higher energy ones
- So non-linearity can only come from, threshold cut and clustering in simulation

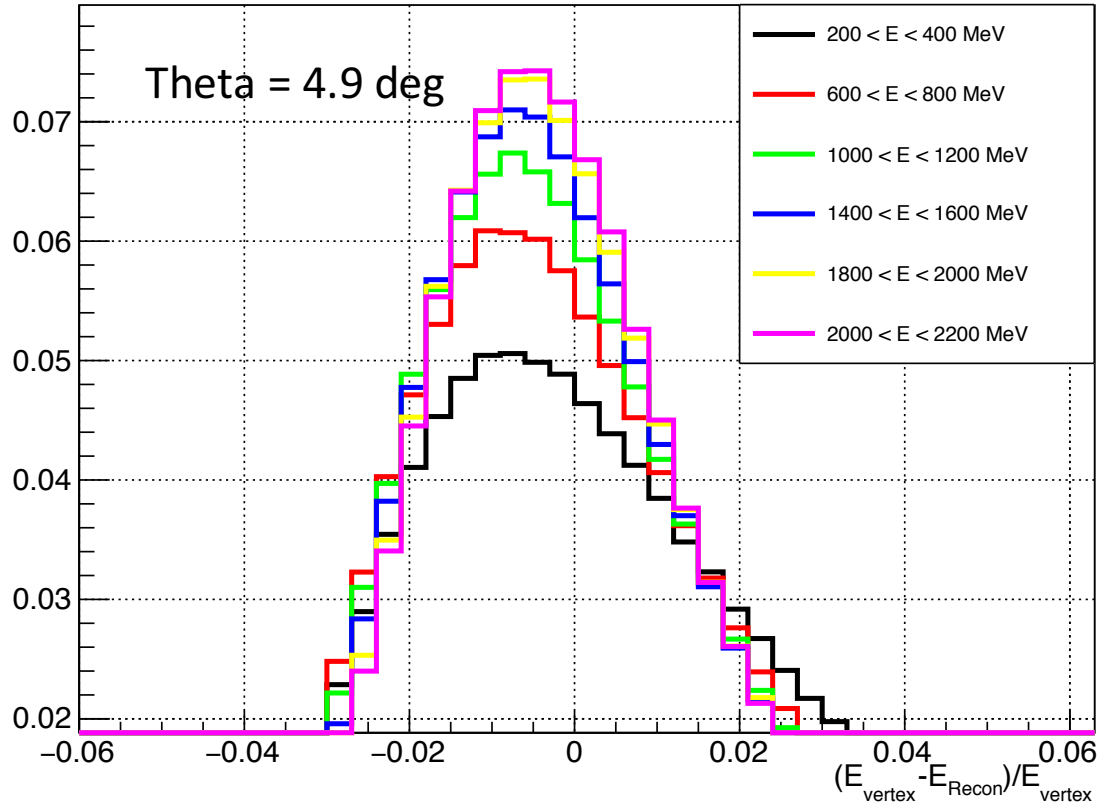


# Non-linearity in simulation

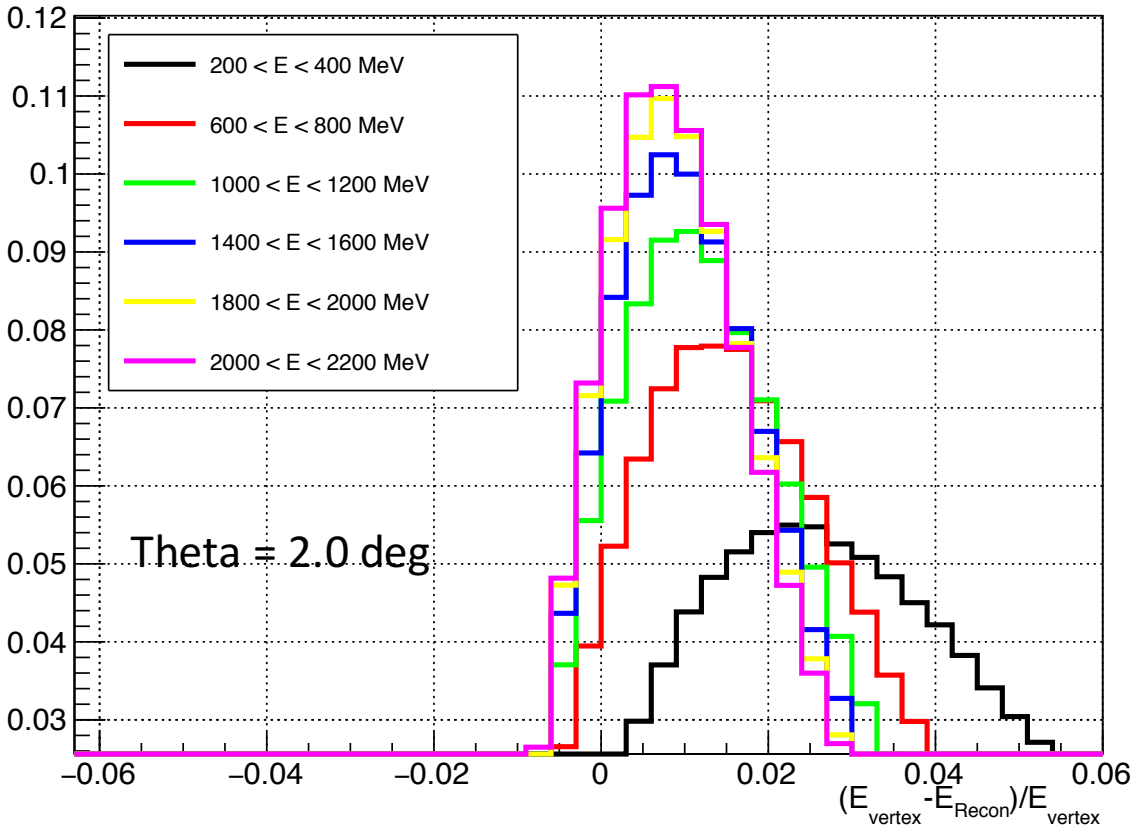
- Using 5 x 5 algorithm
- No Gaussian smearing for the energy deposition
- No pedestal smearing, and pedestal cut set to be 1 ADC

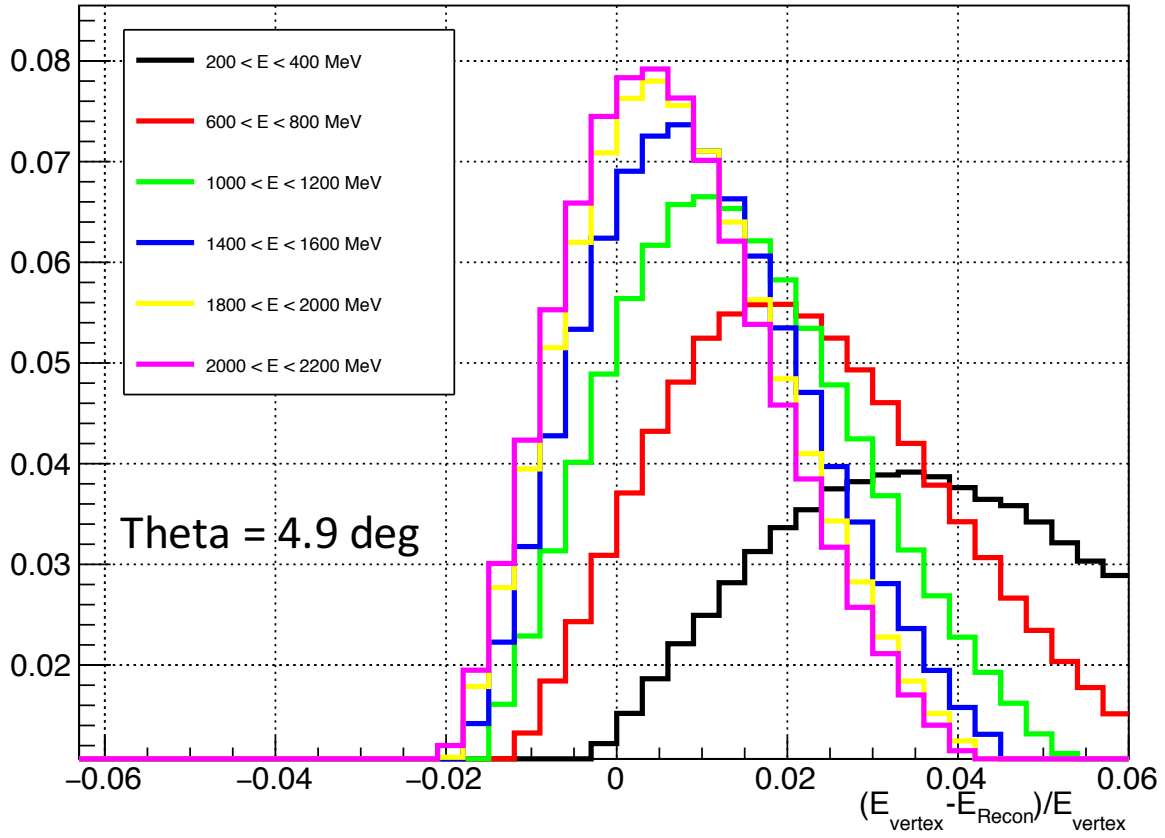


# Non-linearity in simulation

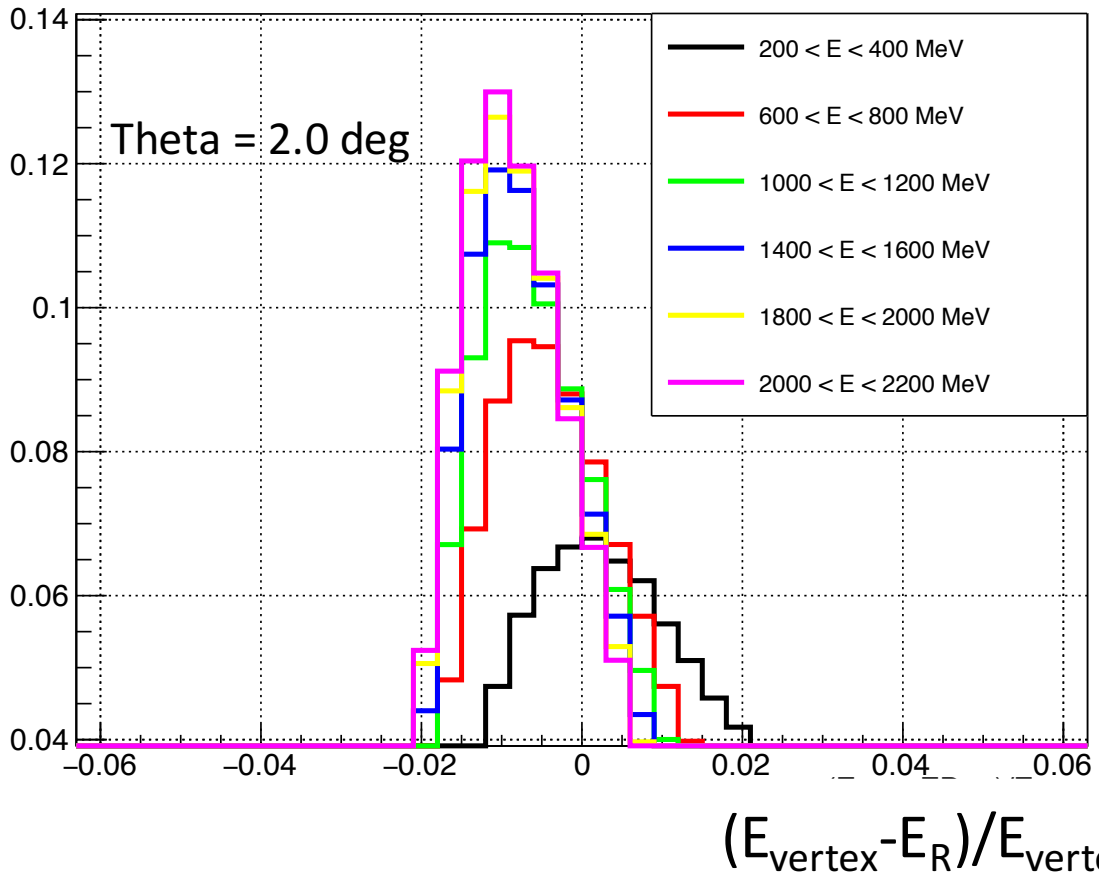
- Using 5 x 5 algorithm
- No Gaussian smearing for the energy deposition
- No pedestal smearing, and pedestal cut set to be 5 sigma of pedestal width (typical 5 ~ 15 ADC)

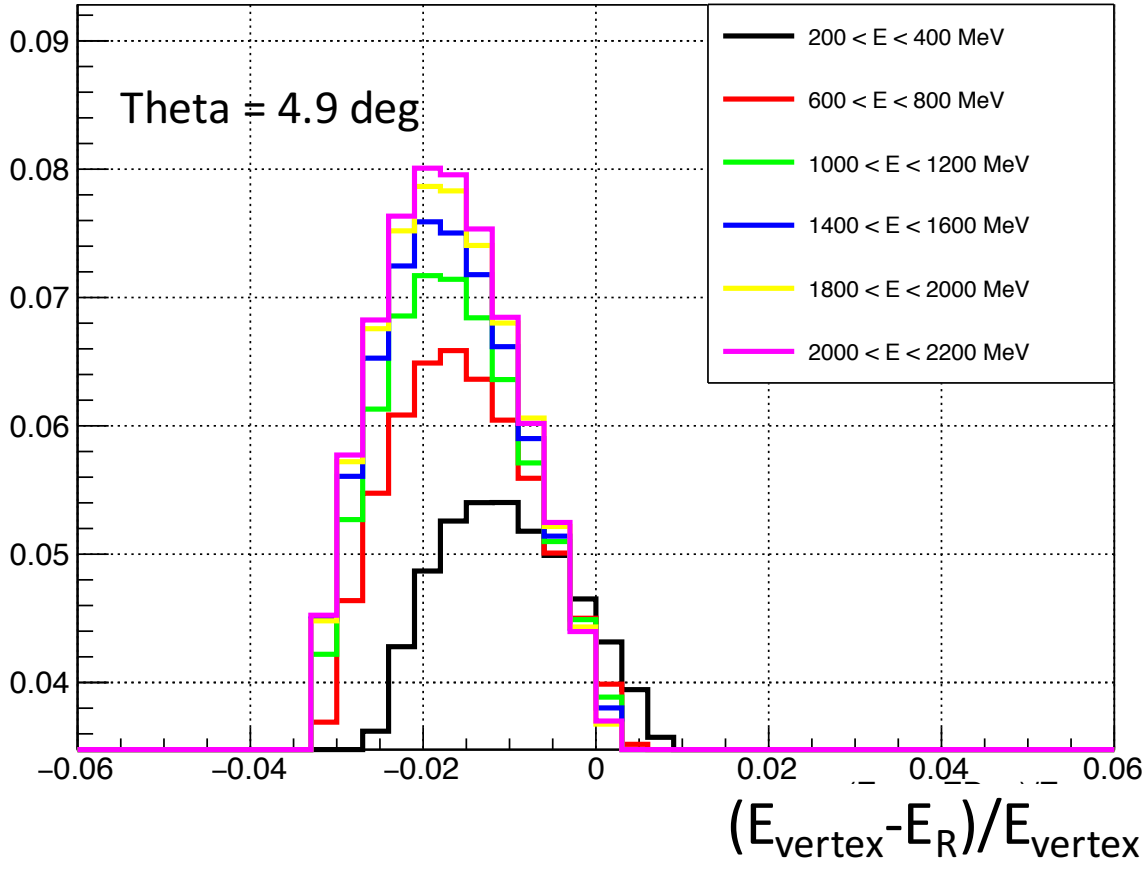


# Non-linearity in simulation

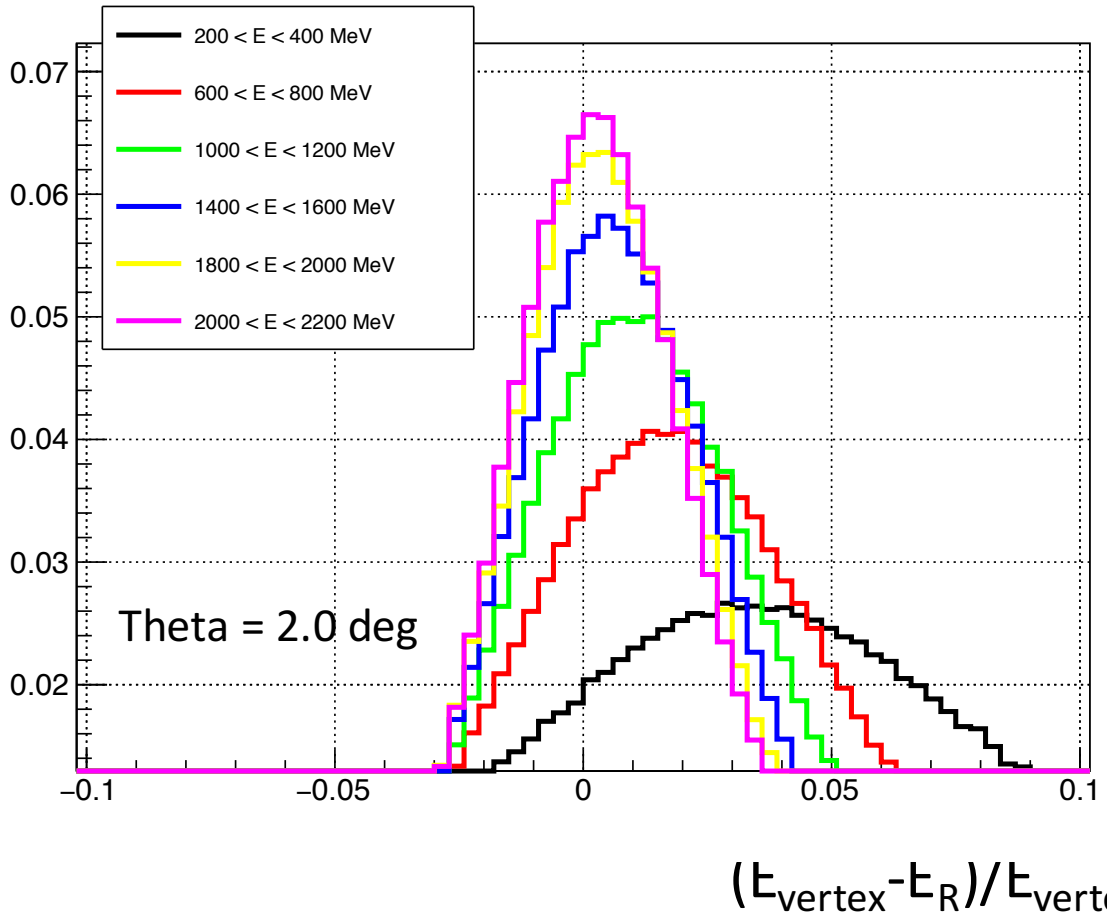
- Using Prad island algorithm
- No Gaussian smearing for the energy deposition
- No pedestal smearing, and pedestal cut set to be 1 ADC

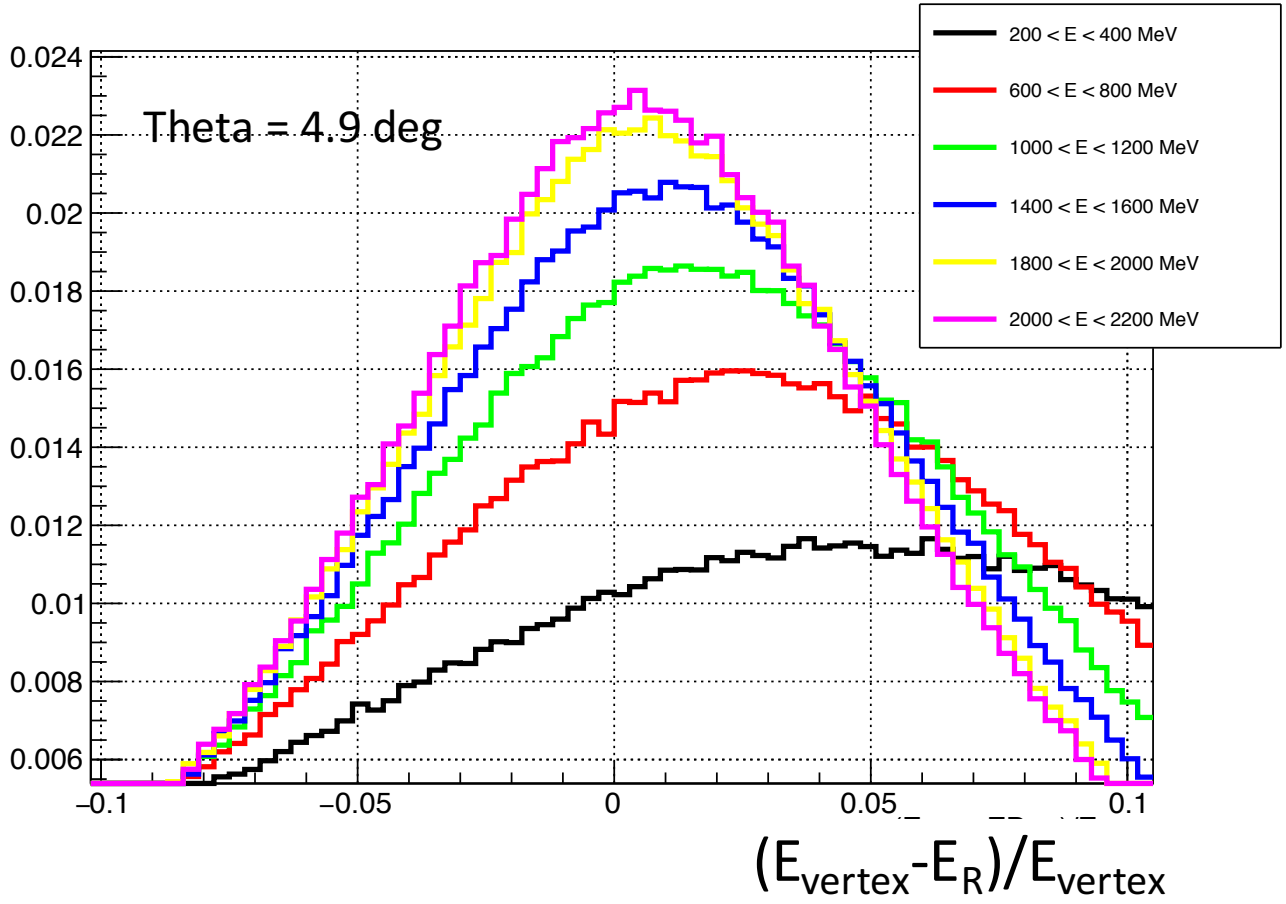


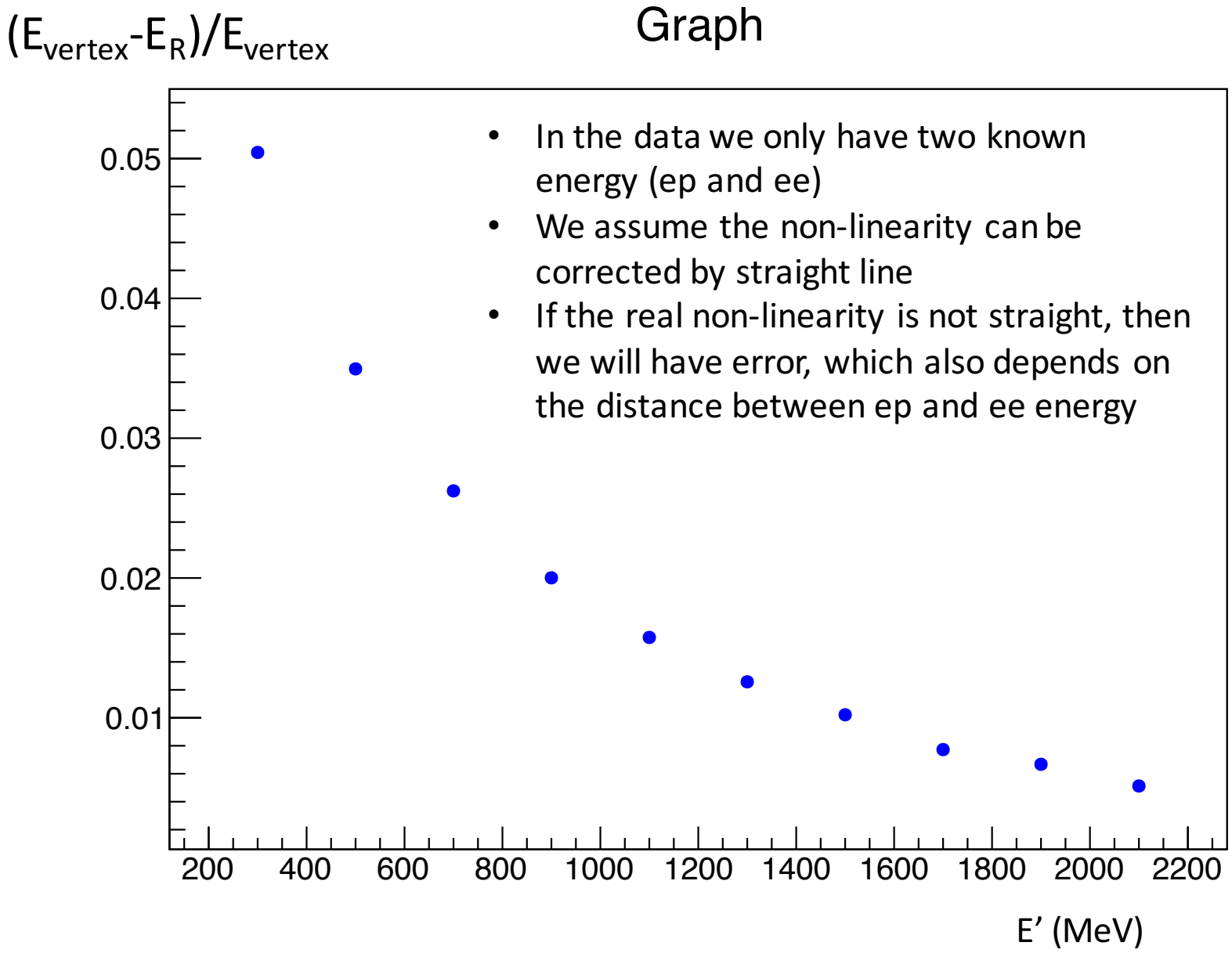
# Non-linearity in simulation

- Using Prad island algorithm
- with Gaussian smearing for the energy deposition
- with pedestal smearing, and pedestal cut set to be 5 sigma of pedestal width (typical 5 ~ 15 ADC)



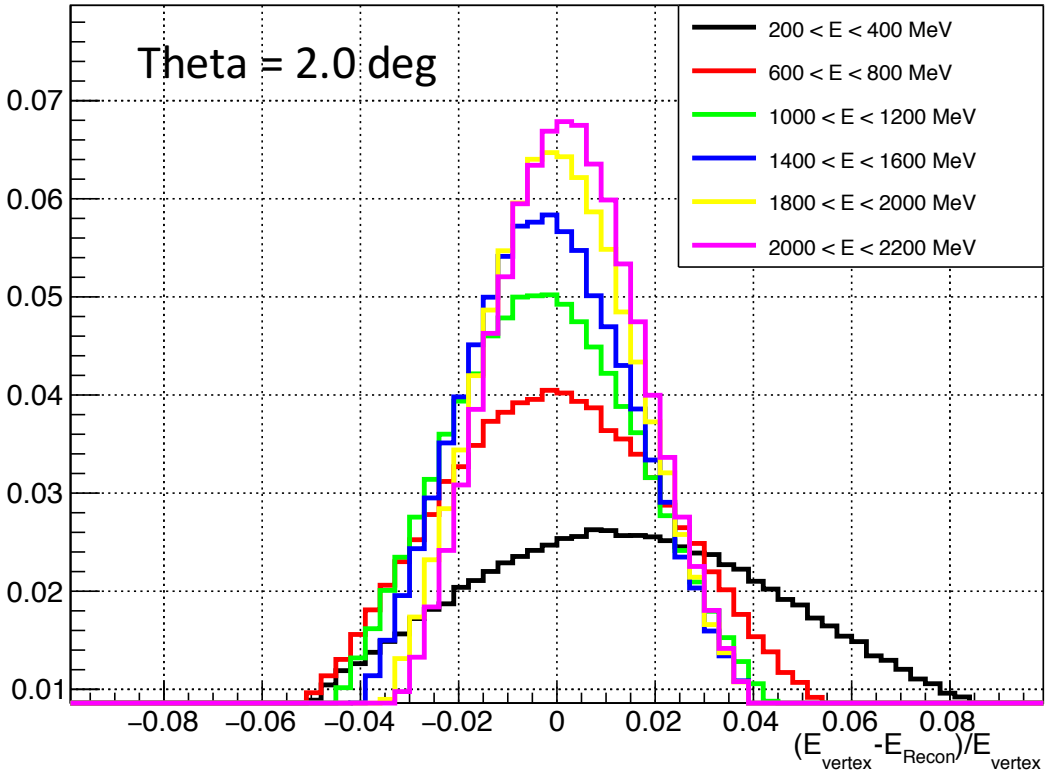



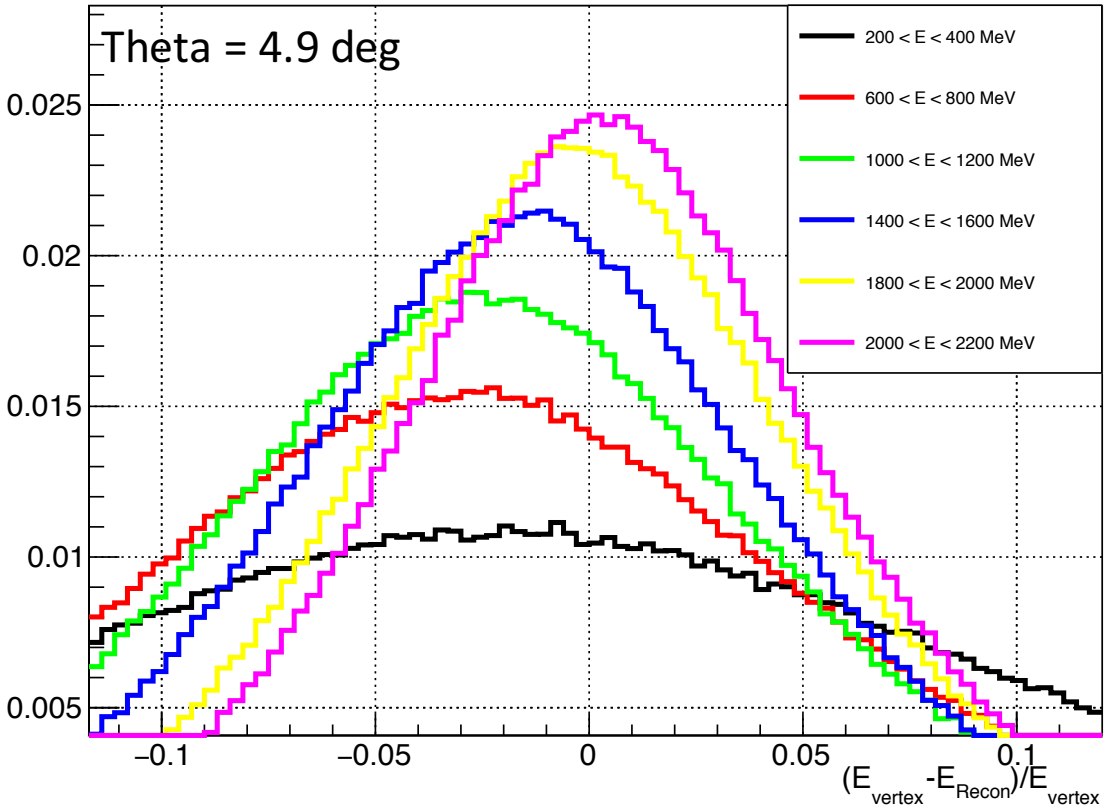
# Non-linearity in simulation



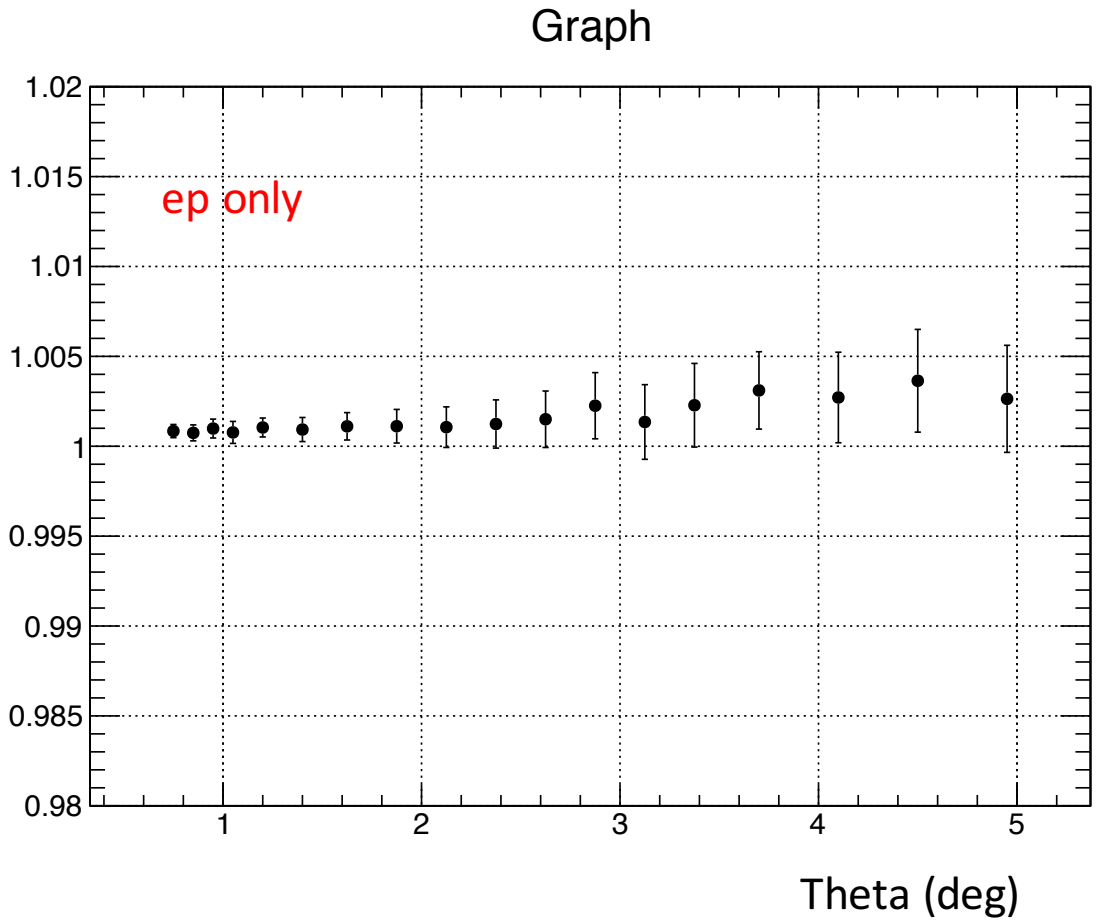
# Non-linearity in simulation

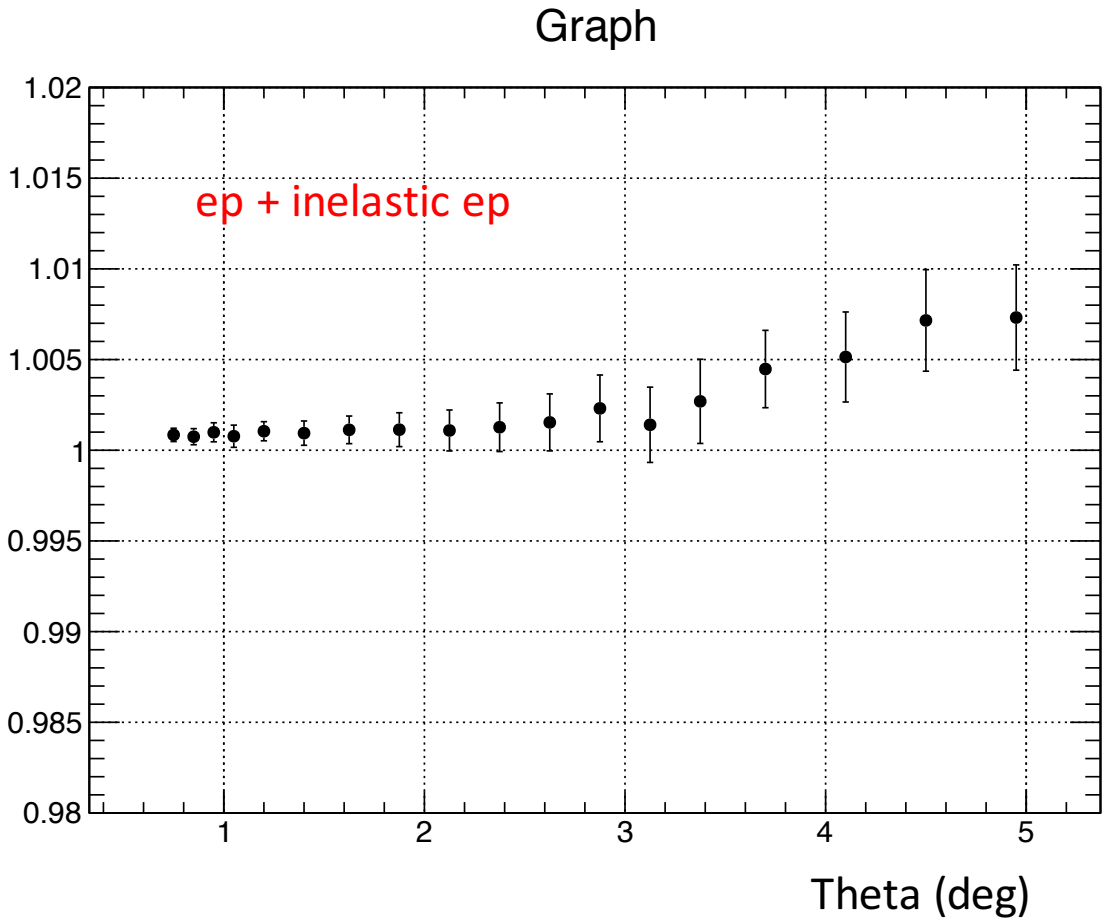
- Using Prad island algorithm
- with Gaussian smearing for the energy deposition
- with pedestal smearing, and pedestal cut set to be 5 sigma of pedestal width (typical 5 ~ 15 ADC)
- After non-linearity correction in the same way as for the data



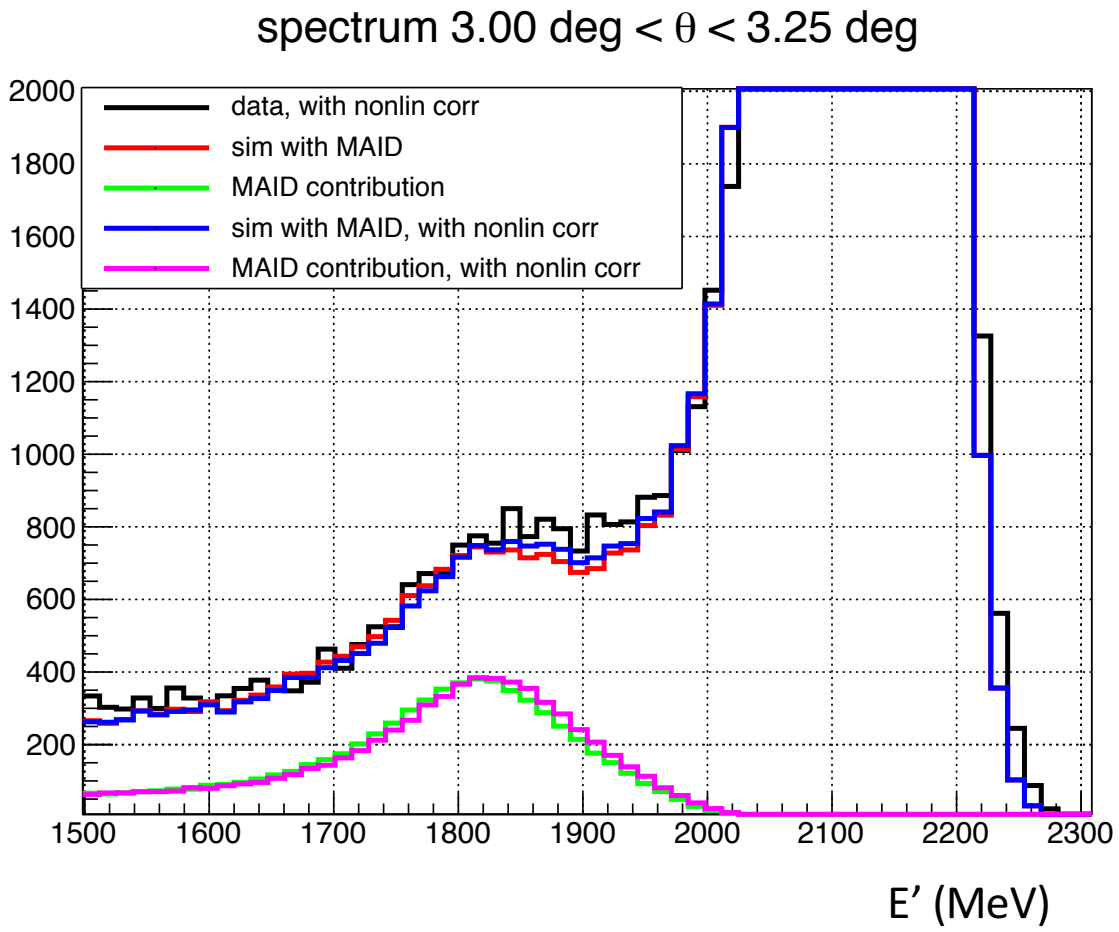



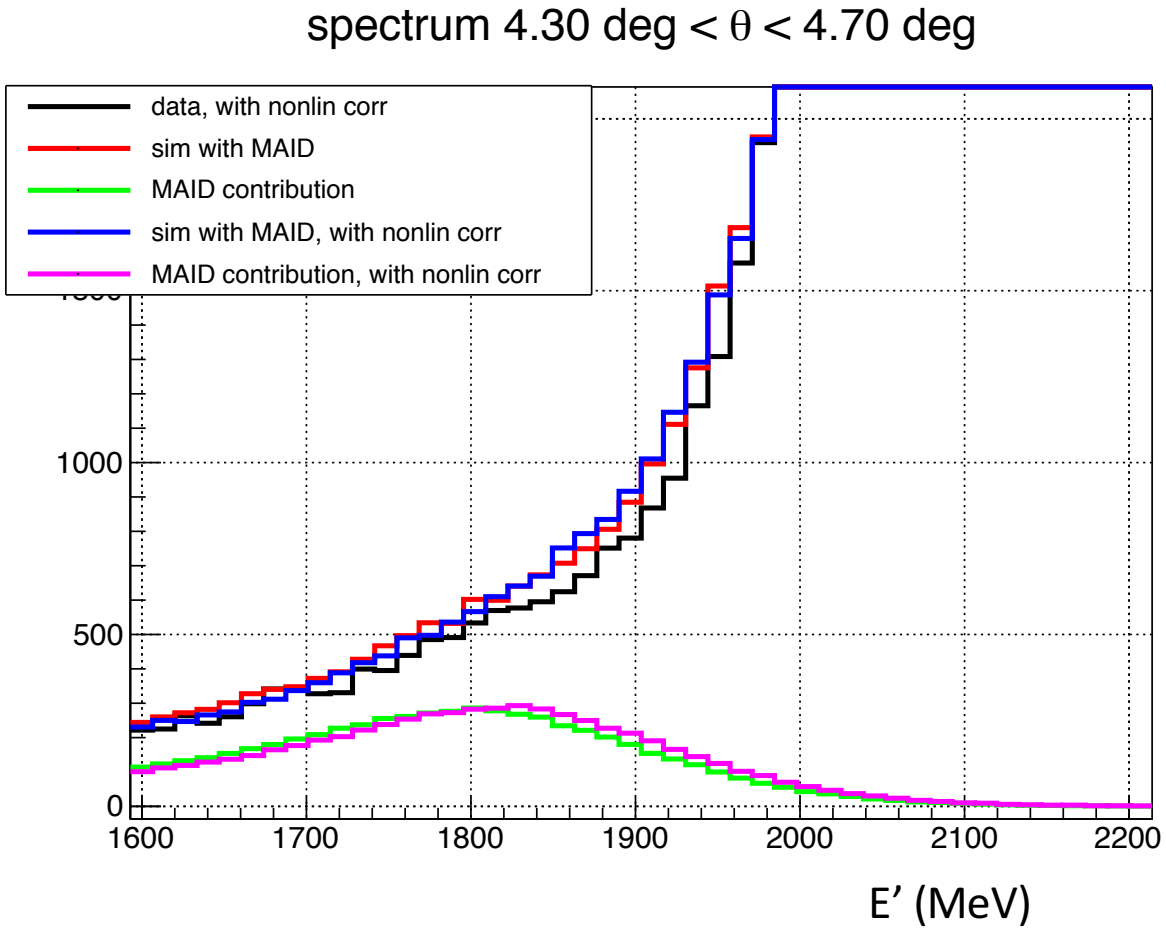
# Ep yield with nonlin correction / ep yield without nonlin correction



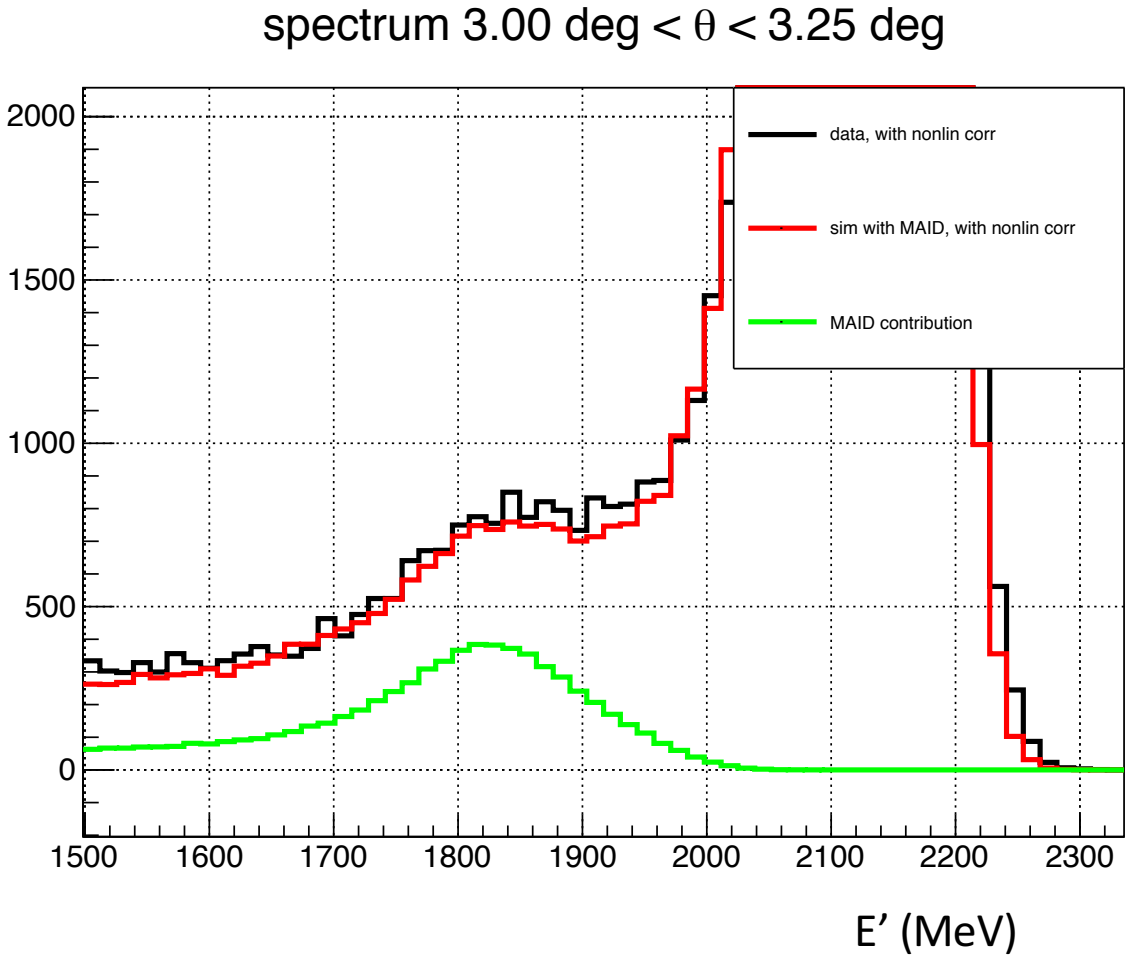
# Spectrum comparison

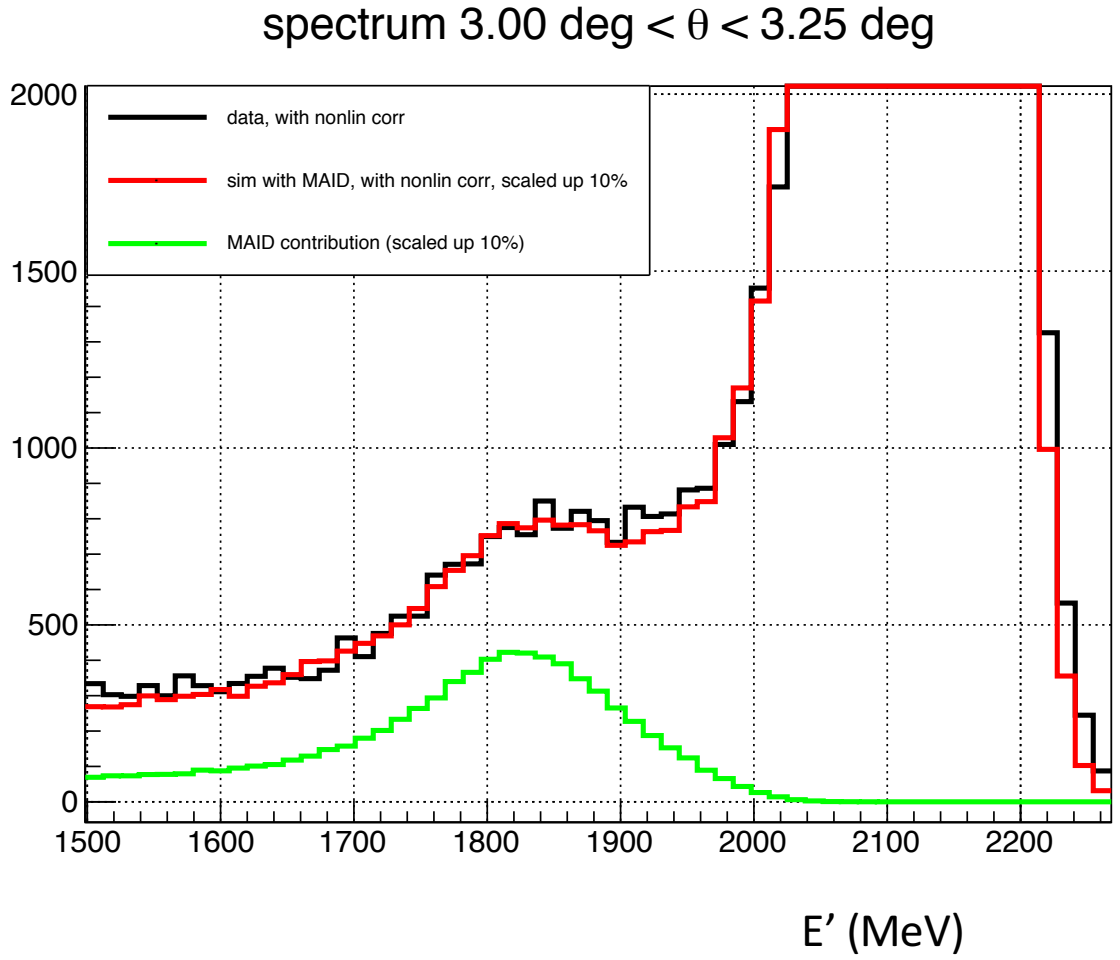


# Spectrum comparison

The shift may be taken cared of by non-linearity correction, but for all angle, inelastic ep in the data is more than that in the simulation



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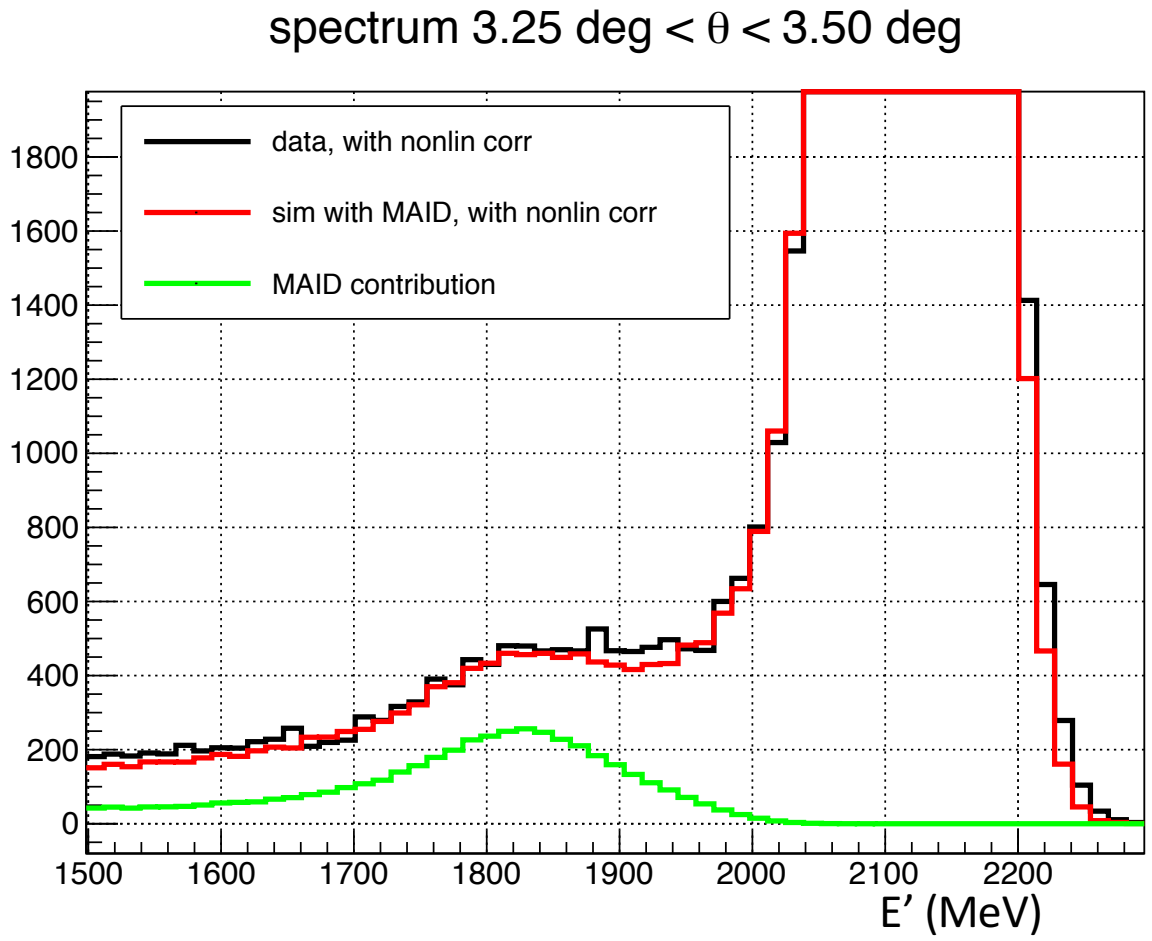


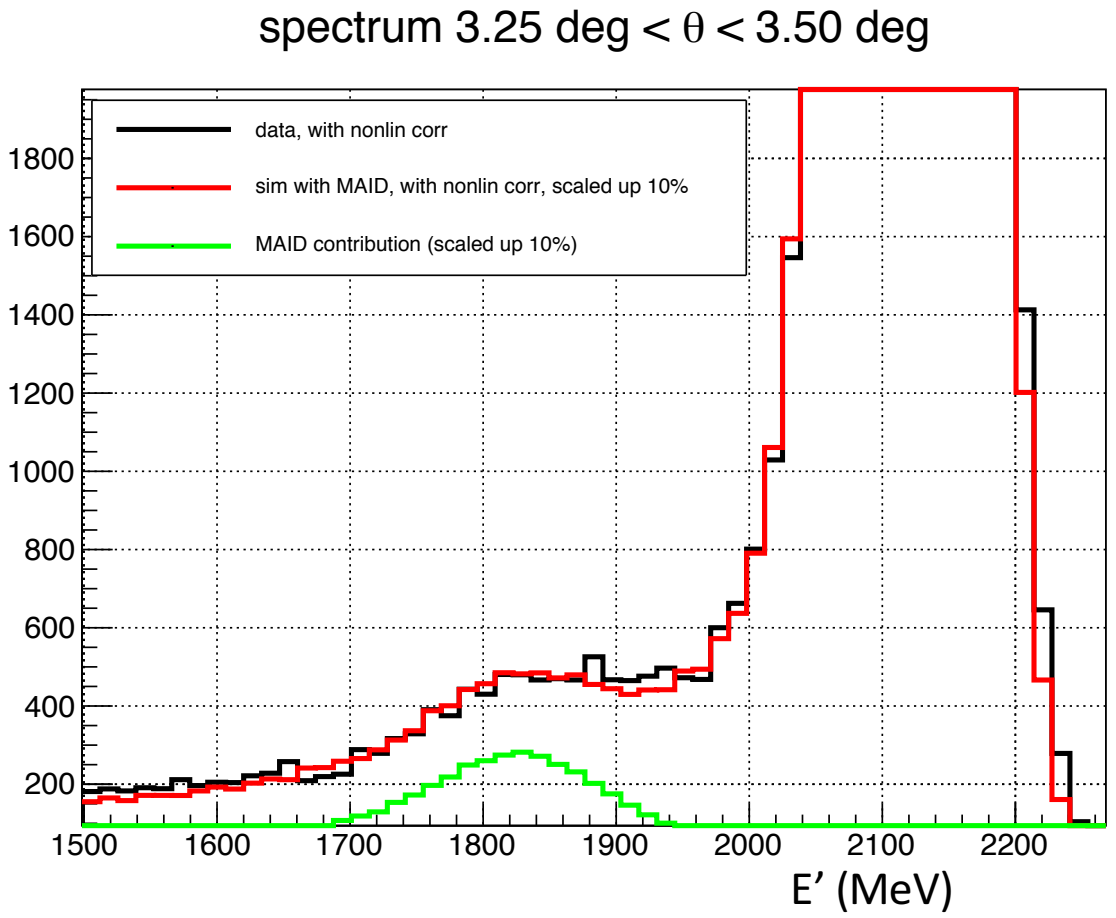

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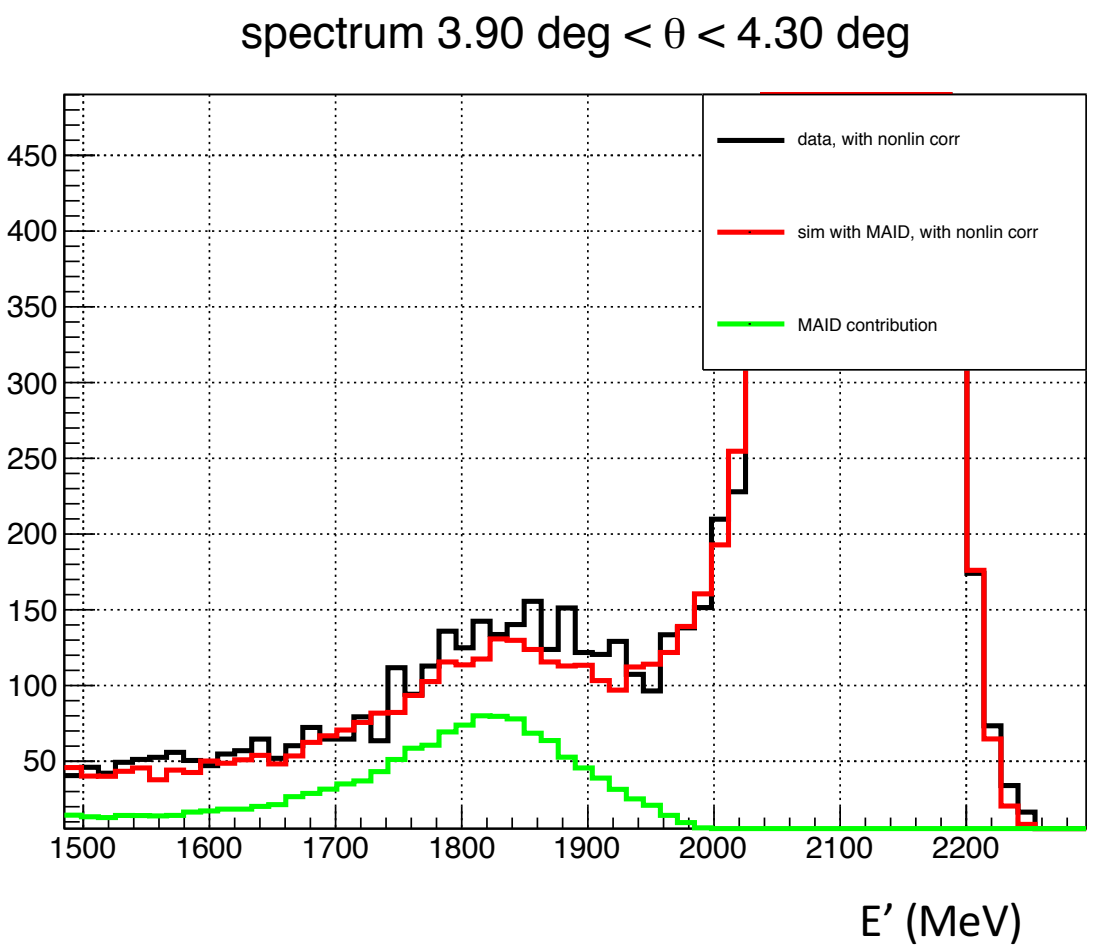


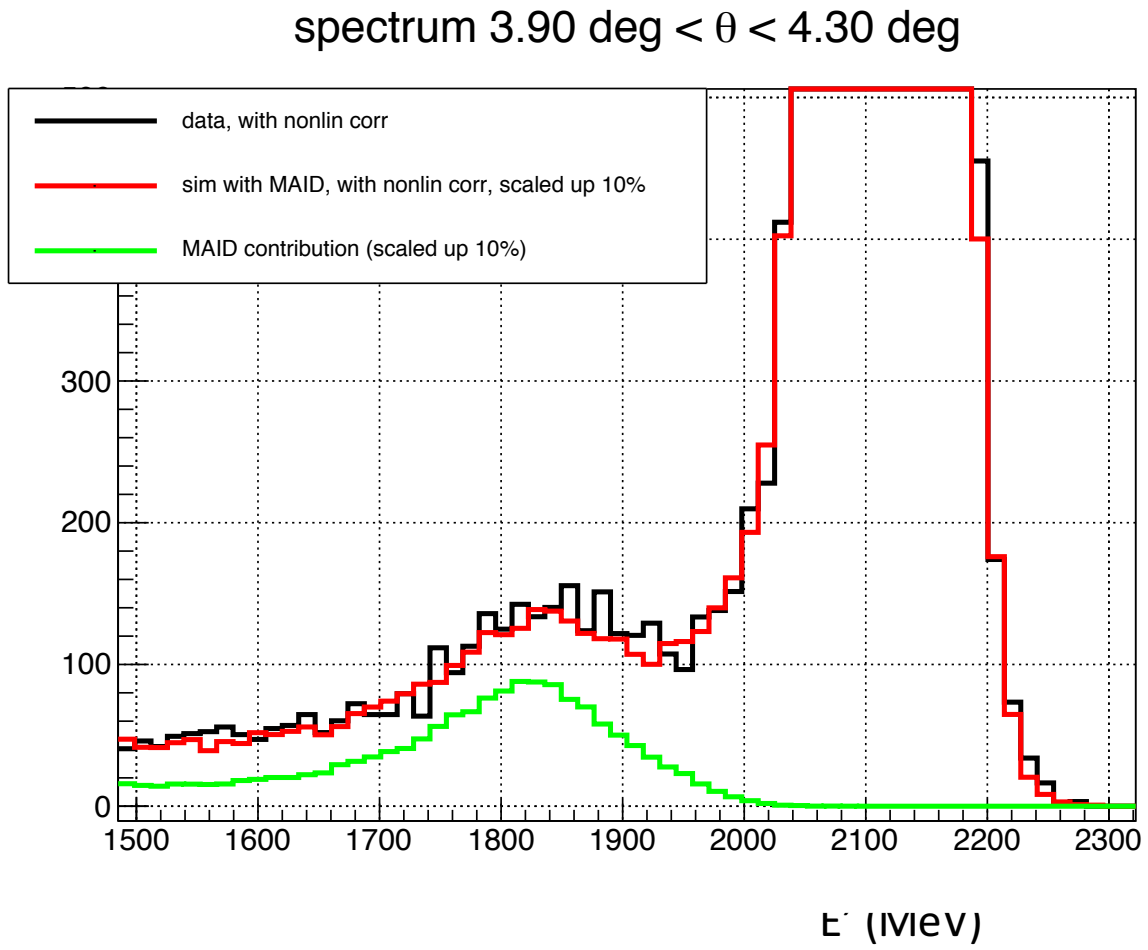

$(ep/ee)_{sim}/(ep/ee)_{data}$