Inelastic ep revisit

- Chao Gu has a program (used for the g2p experiment) that can generate inelastic ep inclusive cross section based on MAID 2007 model

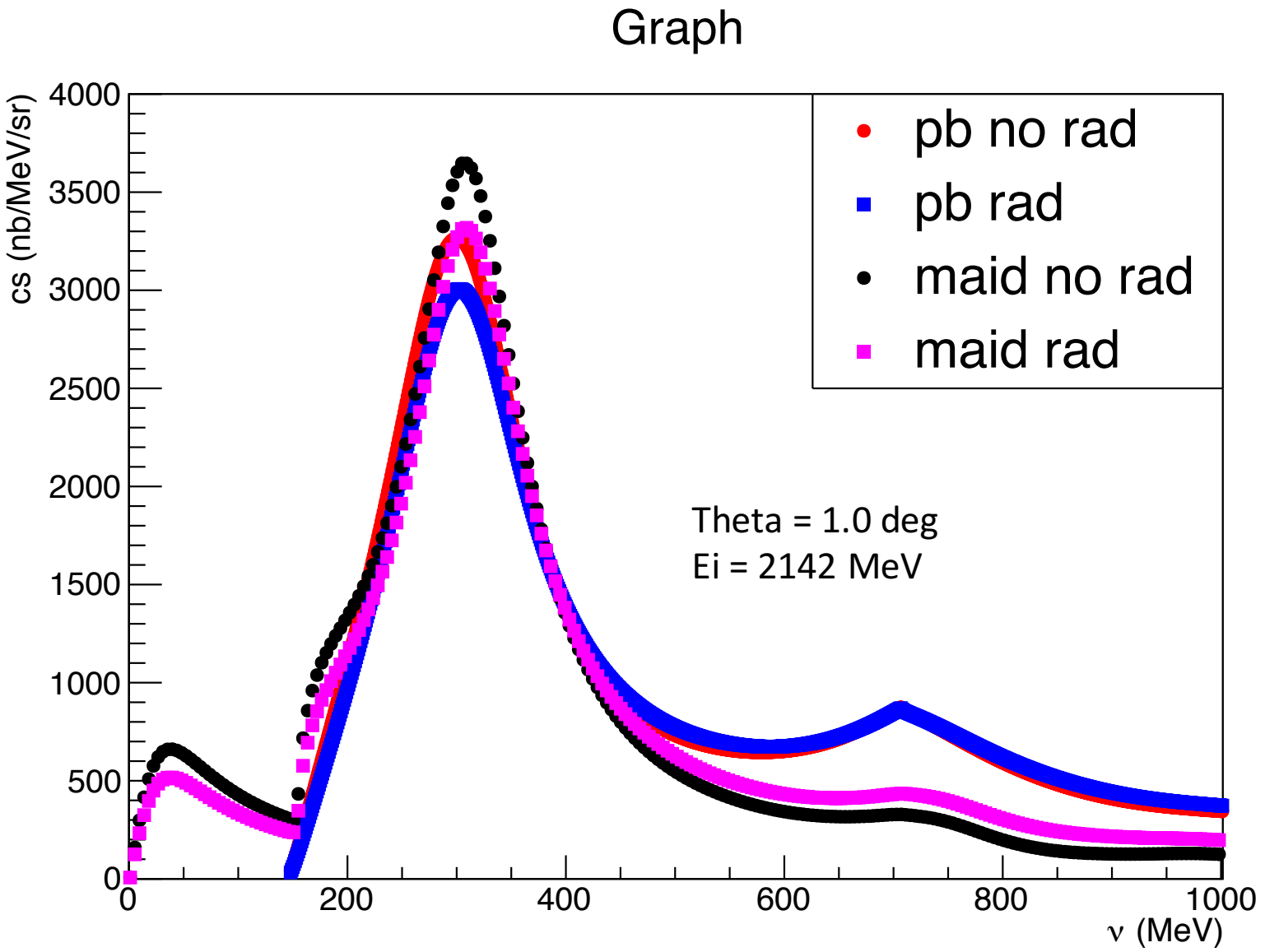
- Xuefei has helped me run the program and generate the Born cross section table

- I then run Chao Peng's program to get the internal radiated inelastic ep cross section

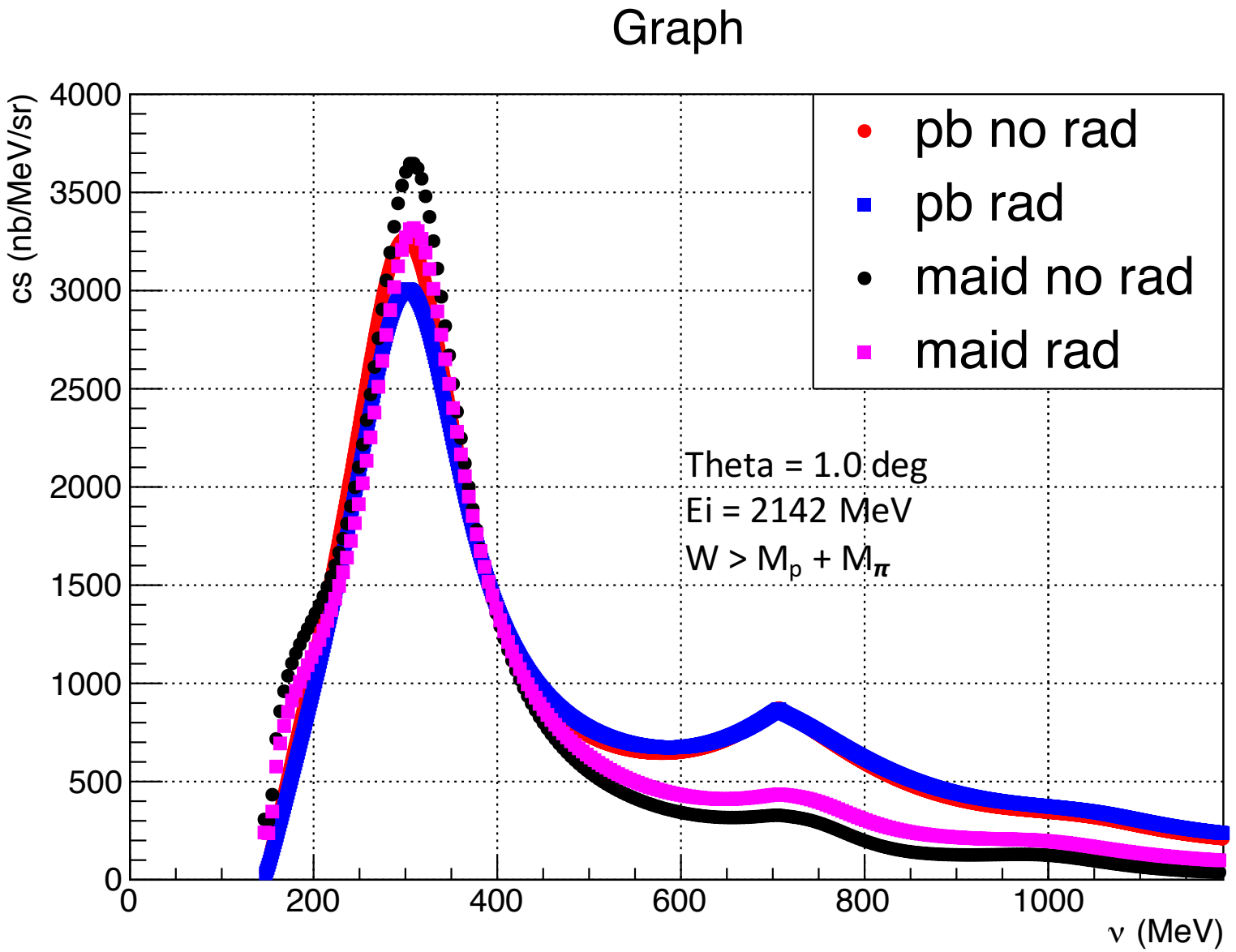
Inelastic ep cross section comparison

- Unlike the Peter Bosted model, which gives zero cross section below pion production threshold ($W > M_p + M_{\pi}$), MAID gives non-zero cross section

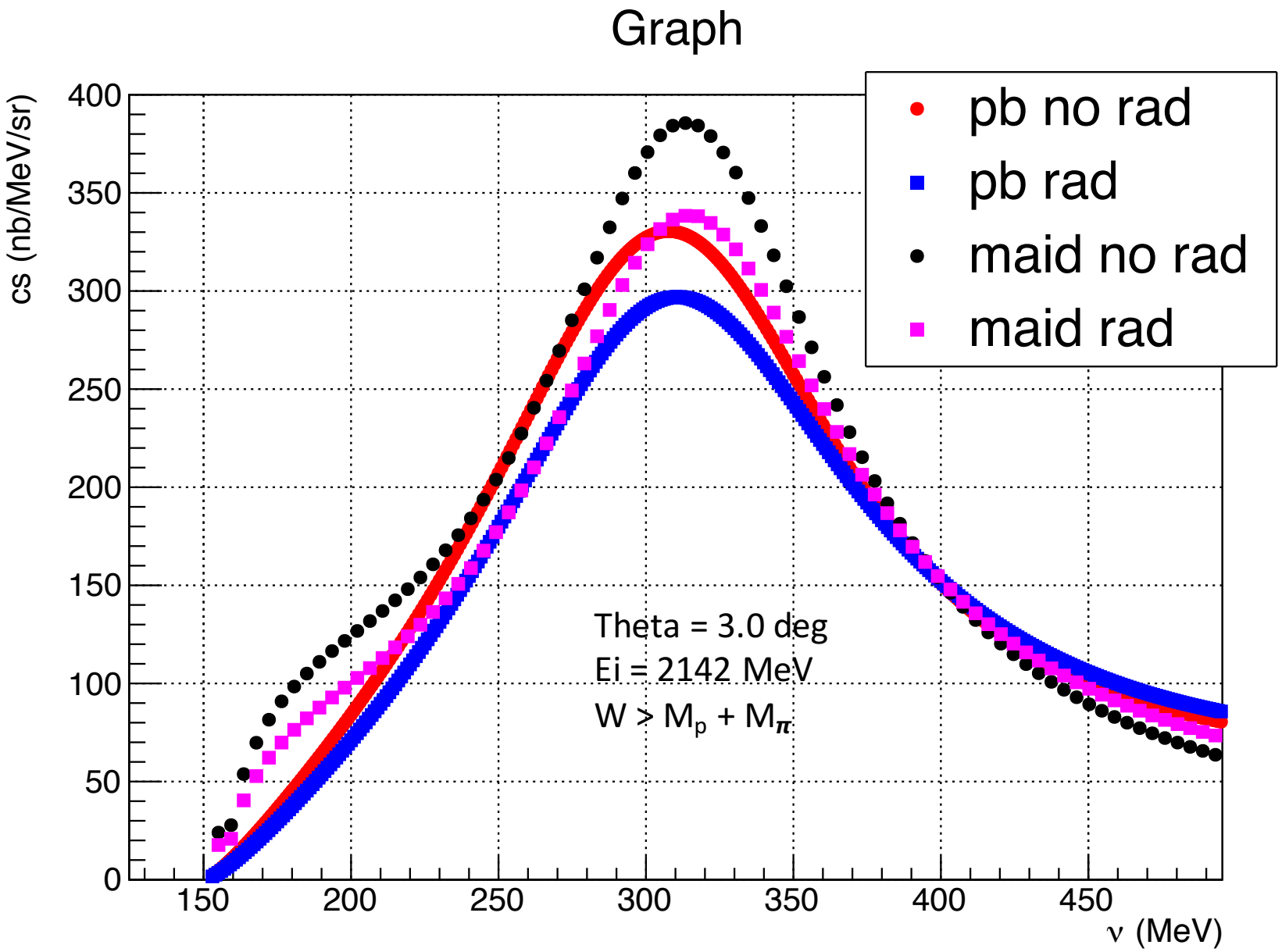
- Chao Gu suggest we need to apply the W cut on the cross section as MAID is only useable beyond the pion production threshold



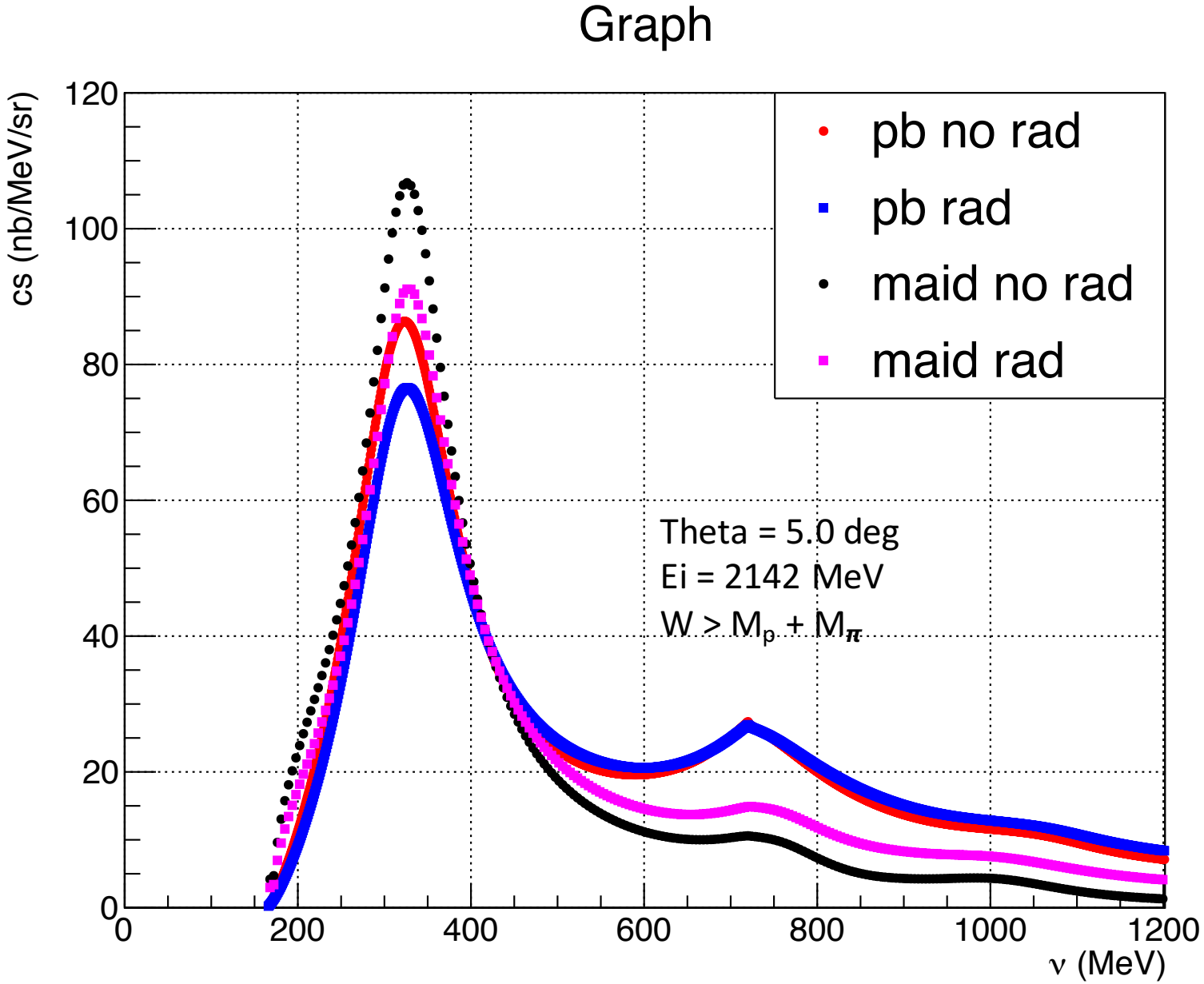
Inelastic ep cross section comparison



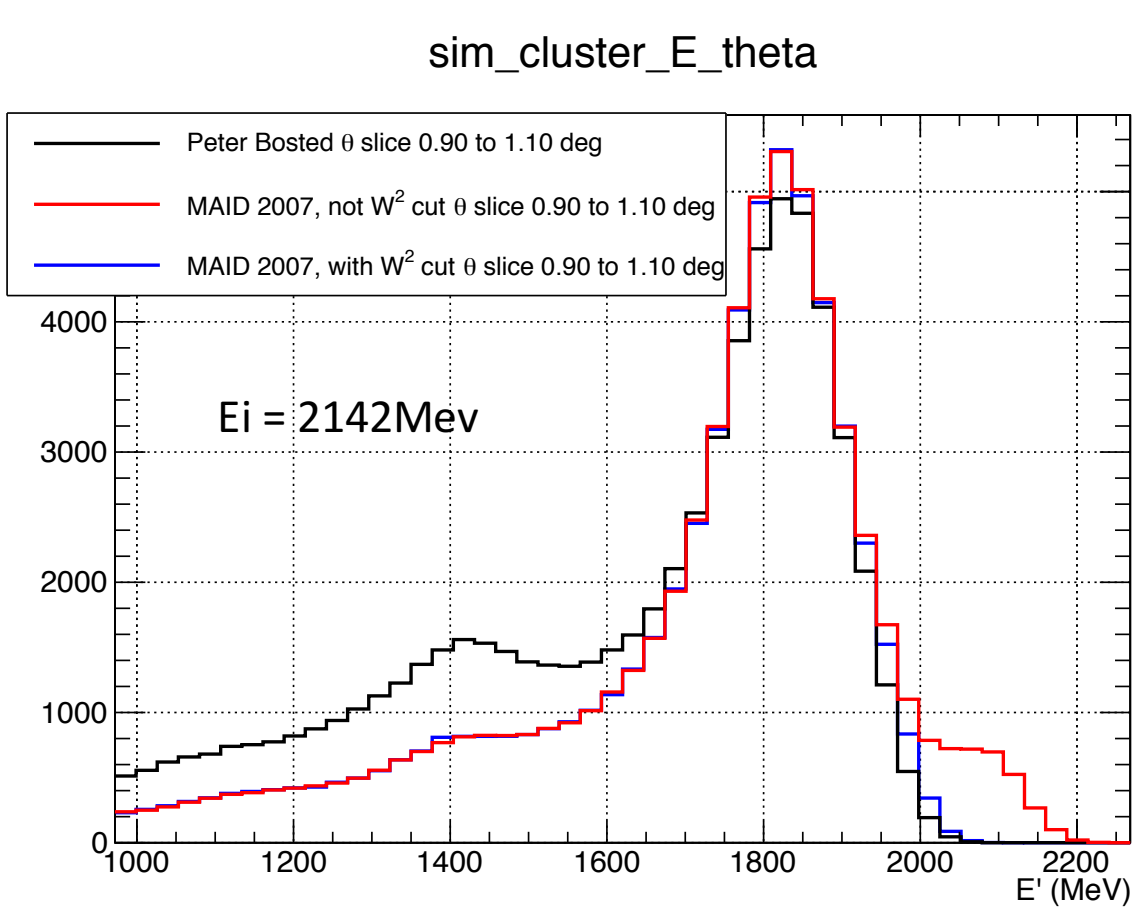
Inelastic ep cross section comparison

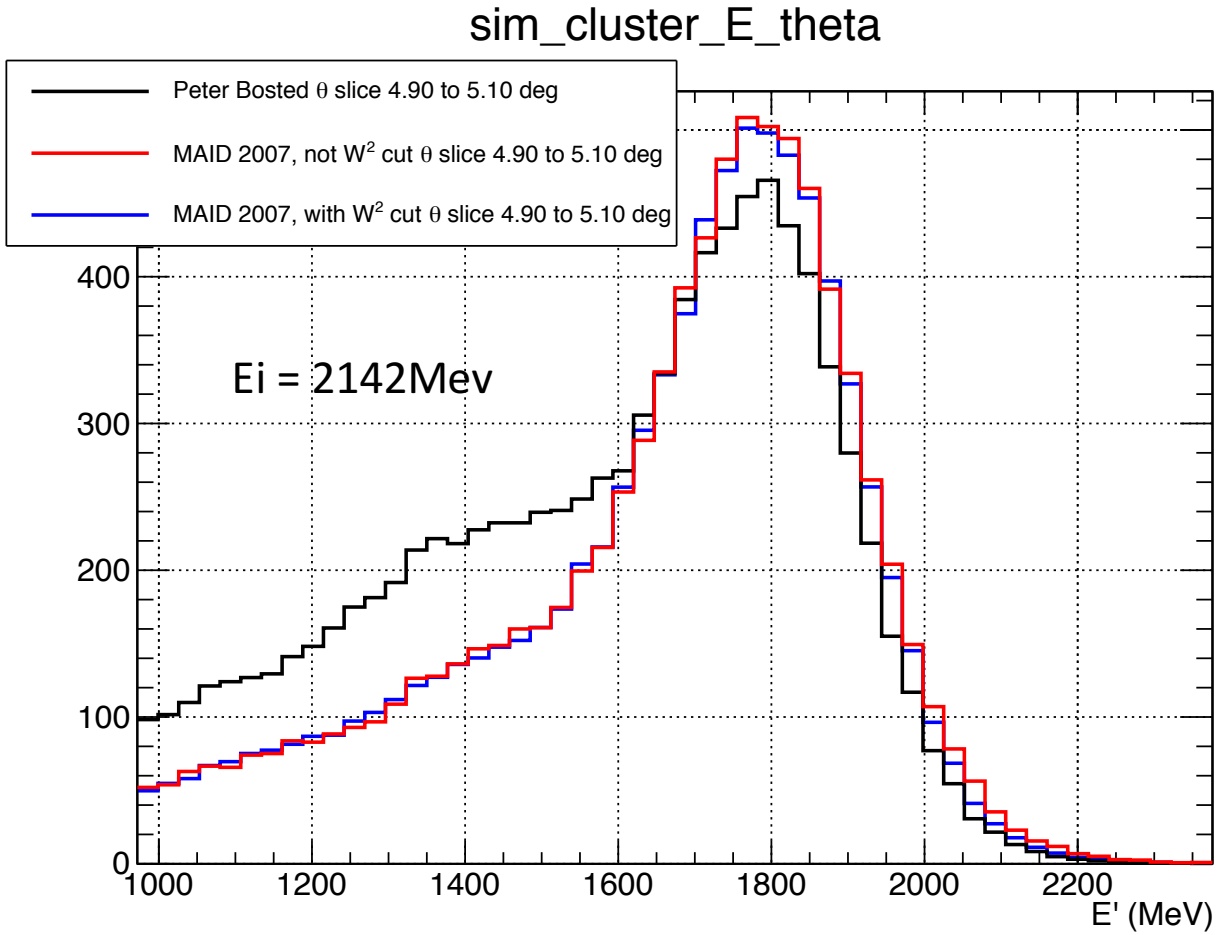


Inelastic ep cross section comparison

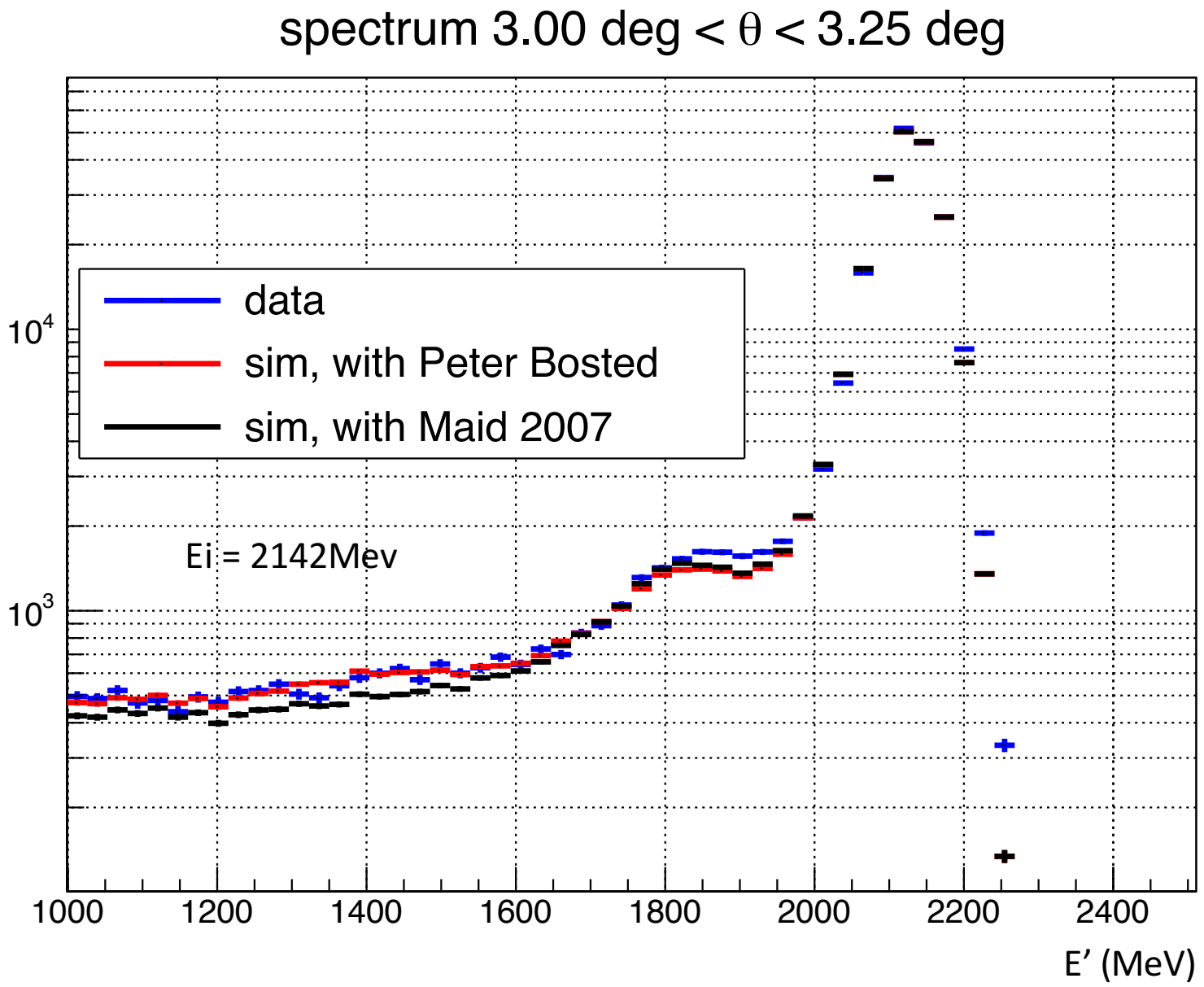


Inelastic ep cross section comparison



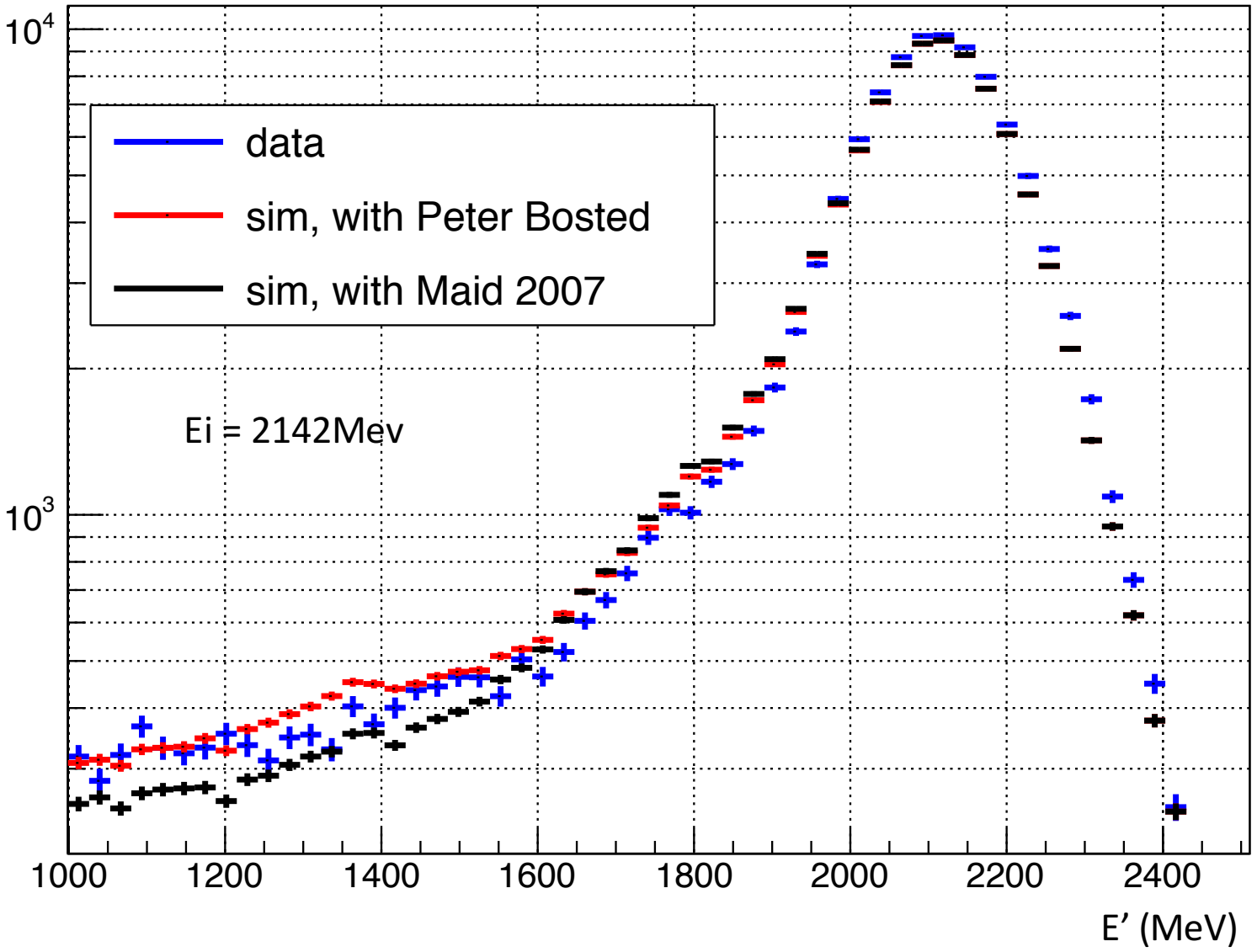


Inelastic ep cross section comparison



Inelastic ep cross section comparison

spectrum 4.70 deg < θ < 5.20 deg



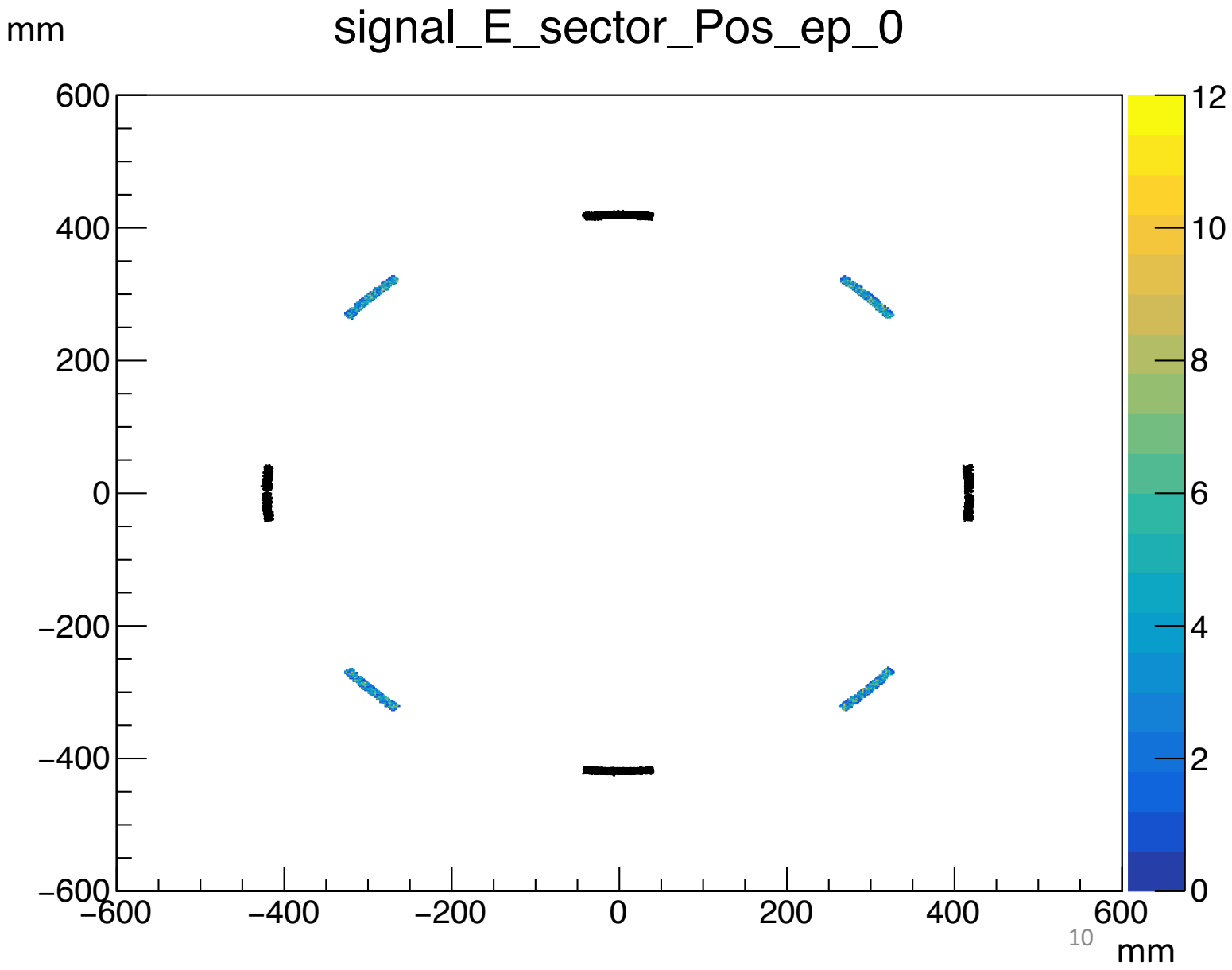
Inelastic ep cross section comparison

- For the first resonance peak region (1600 MeV < E’ < 2000 MeV), it seems that the simulation is less than the data in the PWO region but larger than the data in the LG region
- No necessary that the inelastic ep contribution is more in LG. For instance, it could be there is more energy leakage for LG in the simulation
- We can pick the same regions that are completely in either PWO or LG, but have the same theta angle. The ep and inelastic ep contribution must be the same

- In addition, the first resonance peak seems shifted slightly in either data or simulation

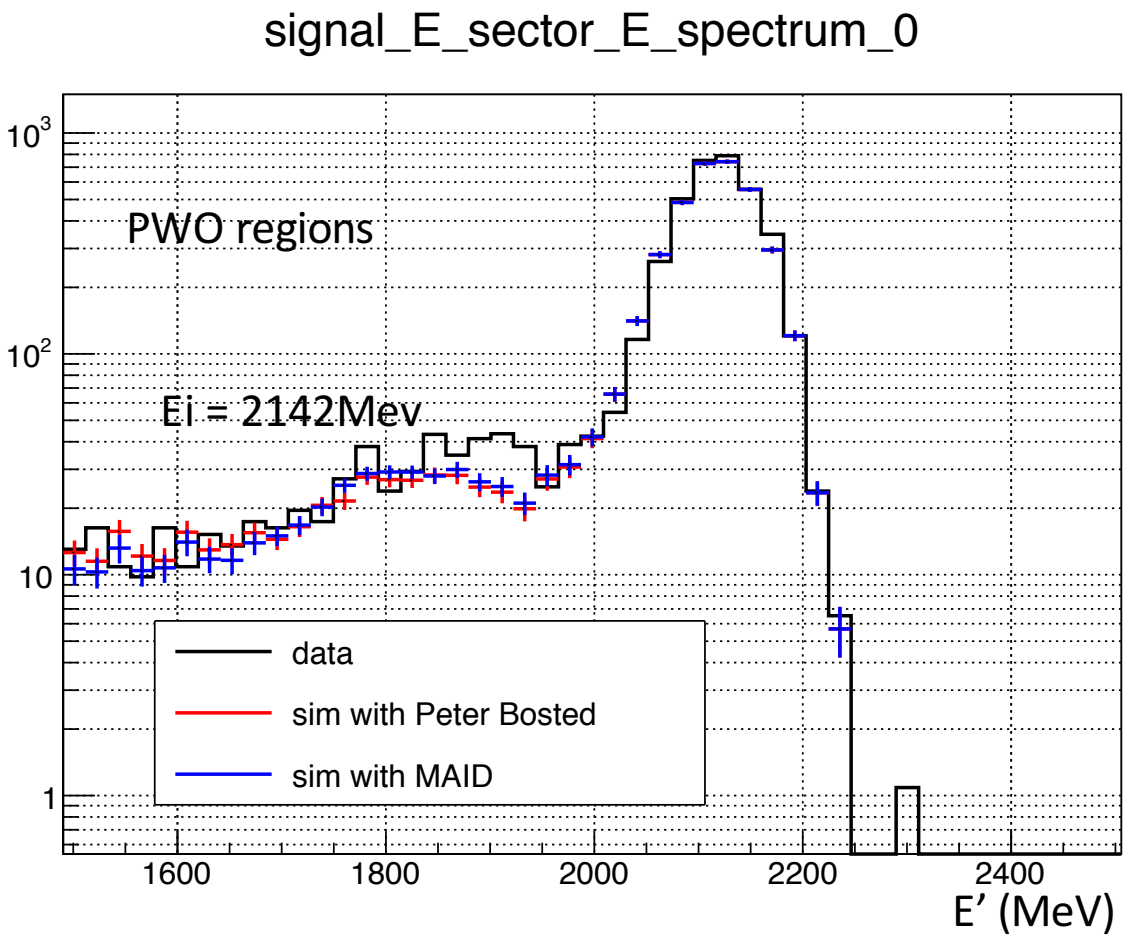
Inelastic ep cross section comparison

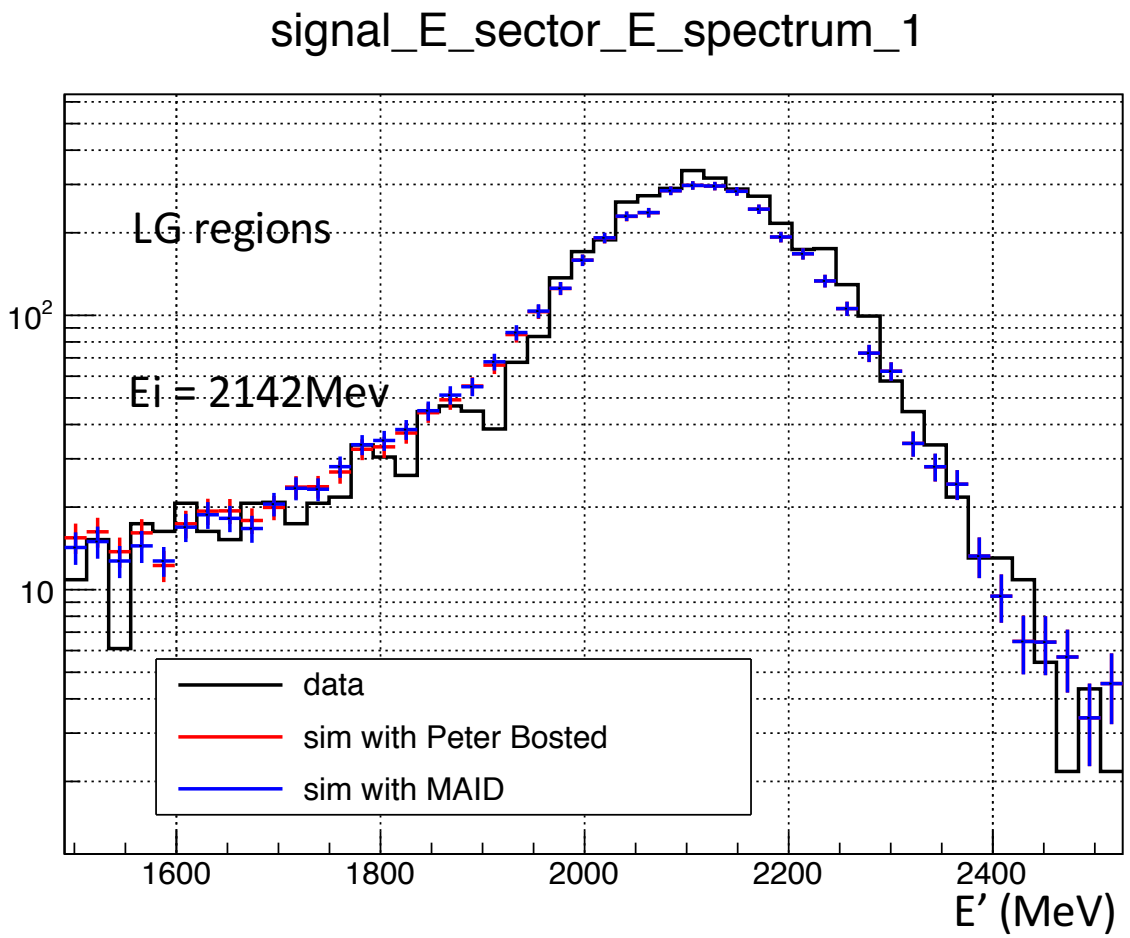
- Colored distributions are completely in PWO region
- Black distributions are completely in LG region
- 4.2 deg < theta < 4.3 deg



Inelastic ep cross section comparison

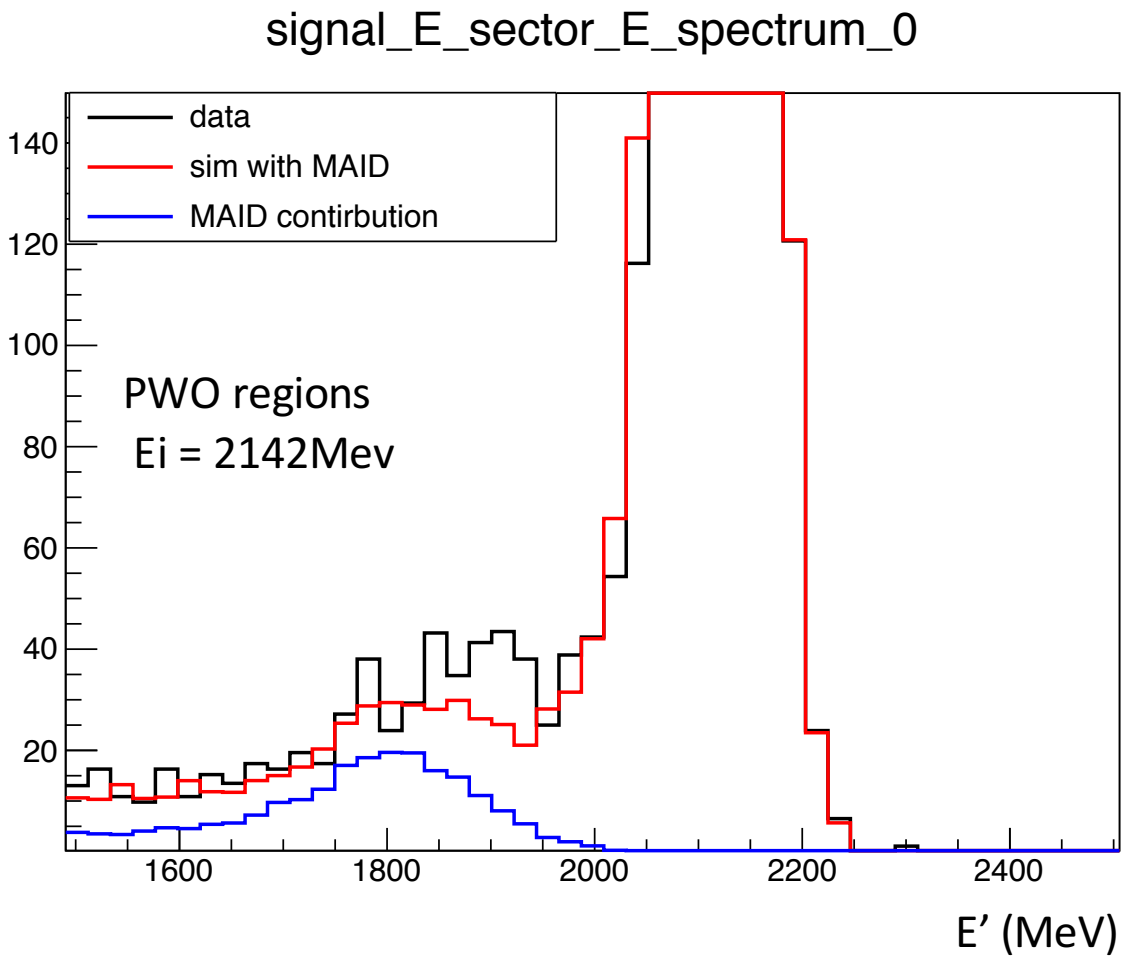
Same theta angle 4.2 ~ 4.3 deg

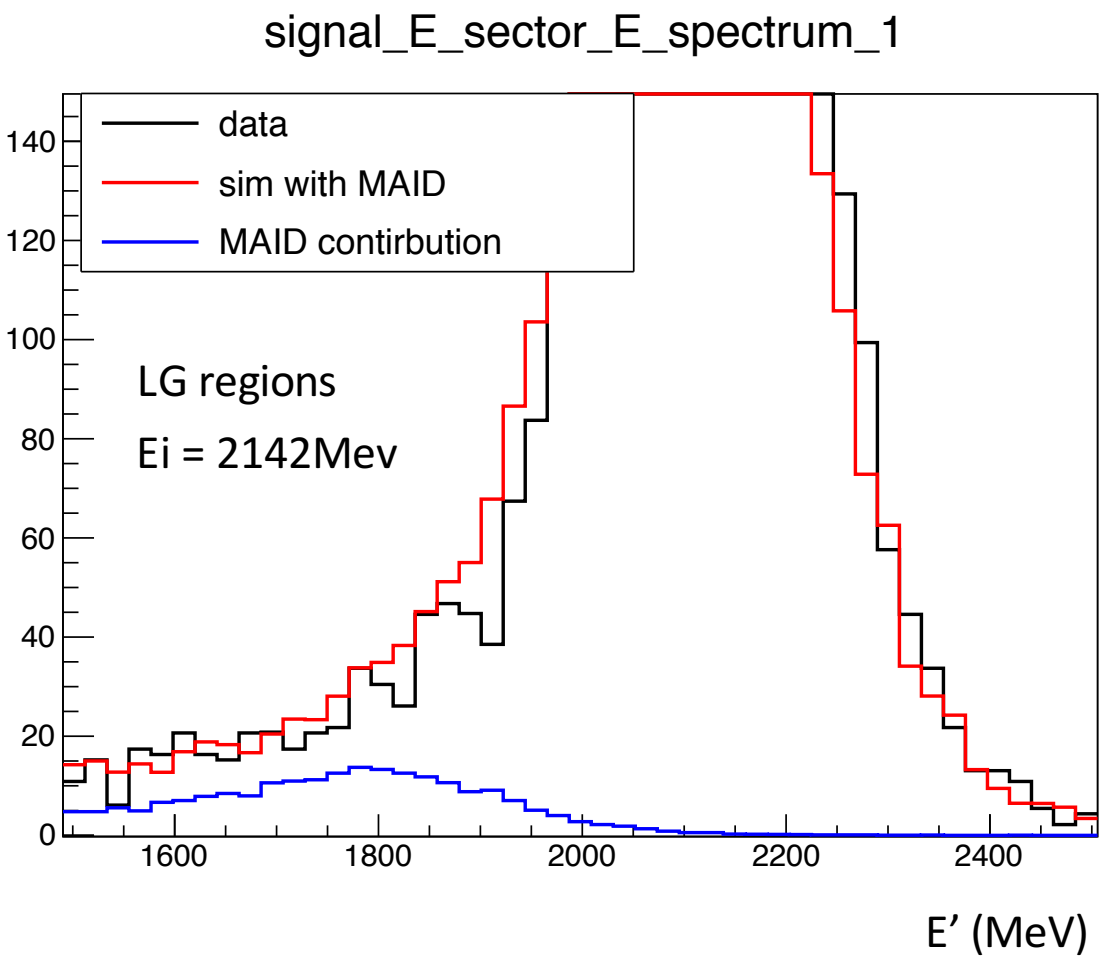




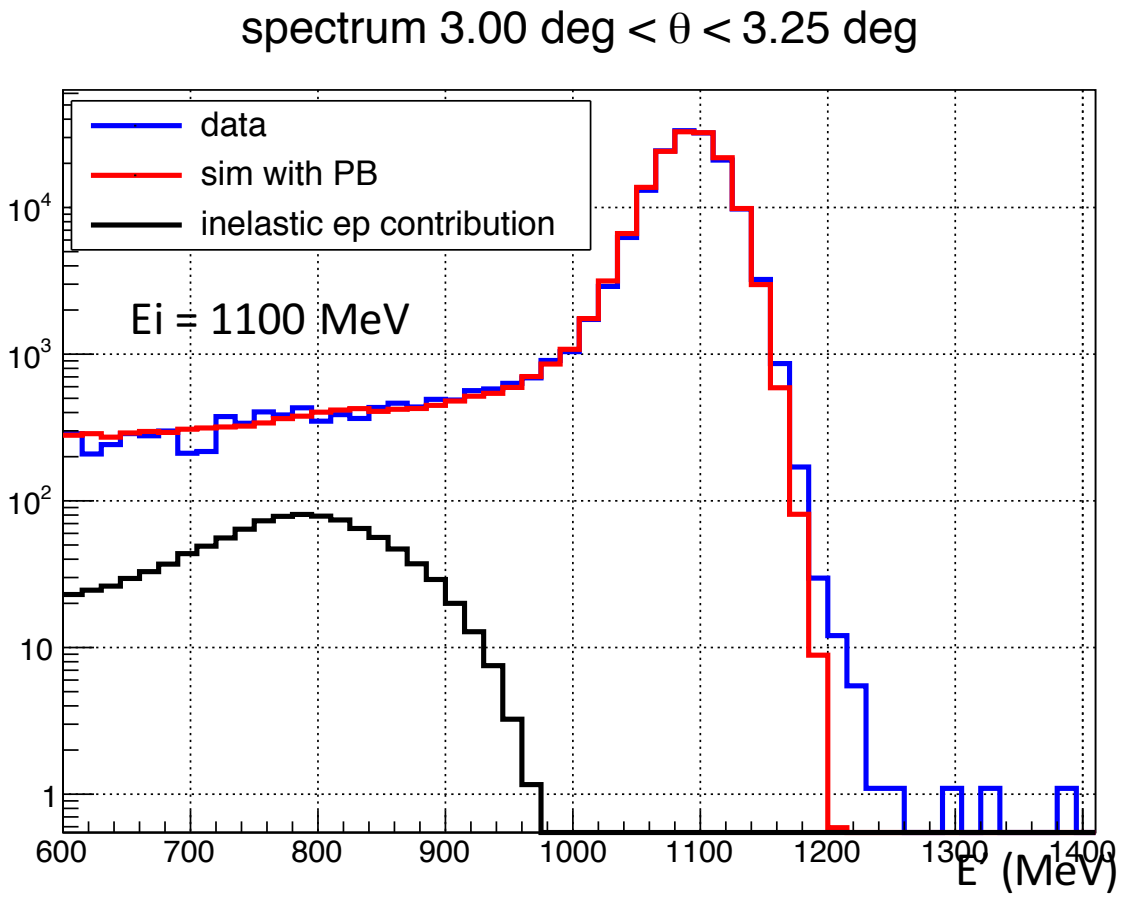
Inelastic ep cross section comparison

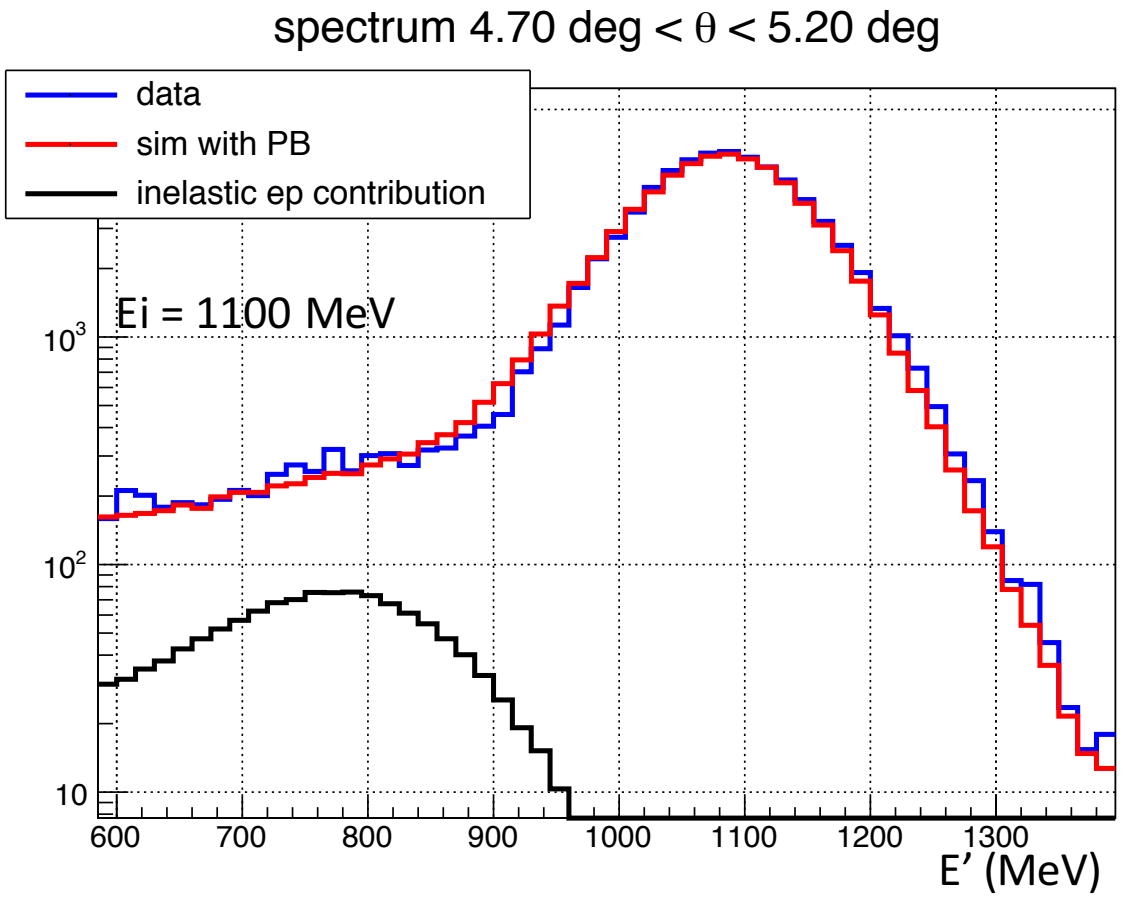
Same theta angle 4.2 ~ 4.3 deg



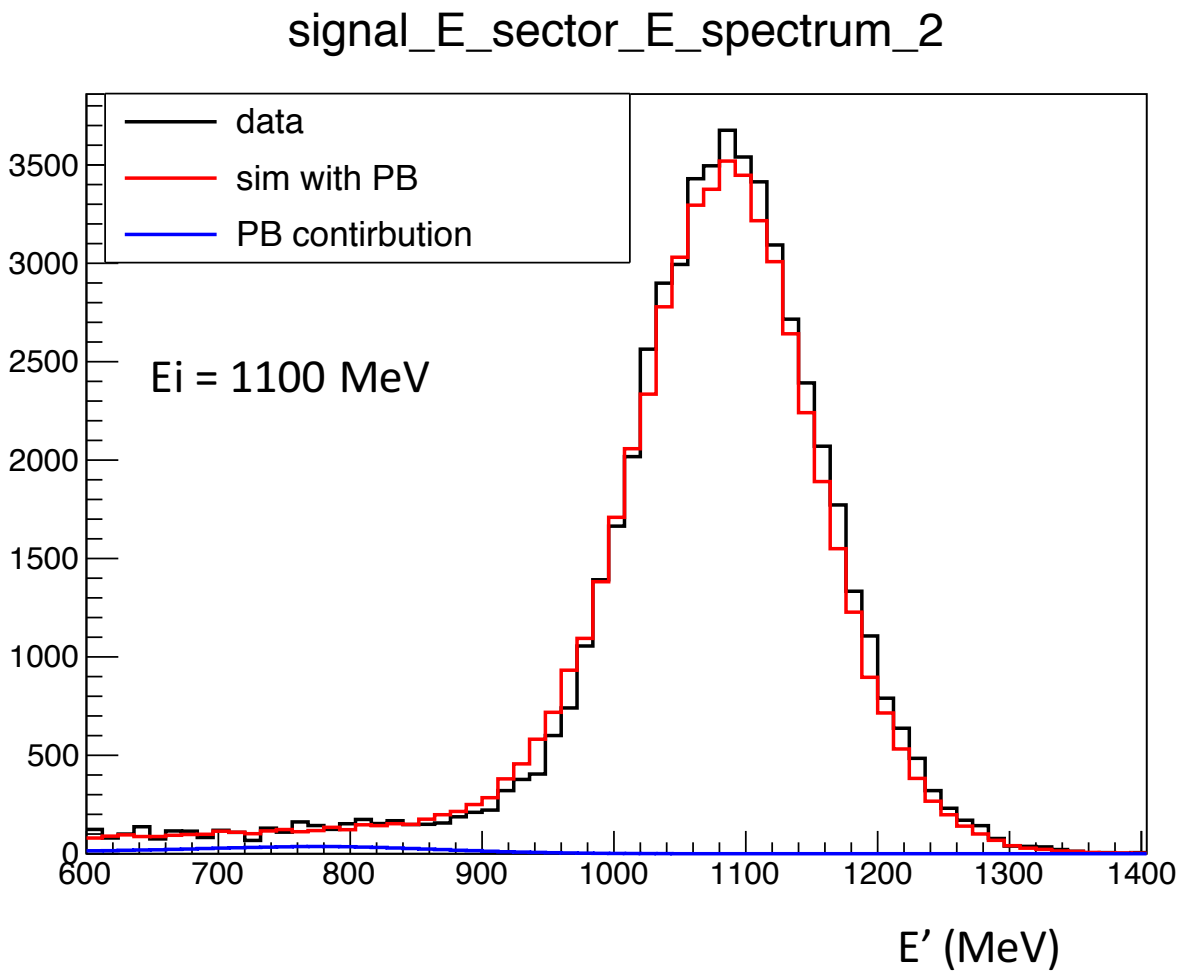


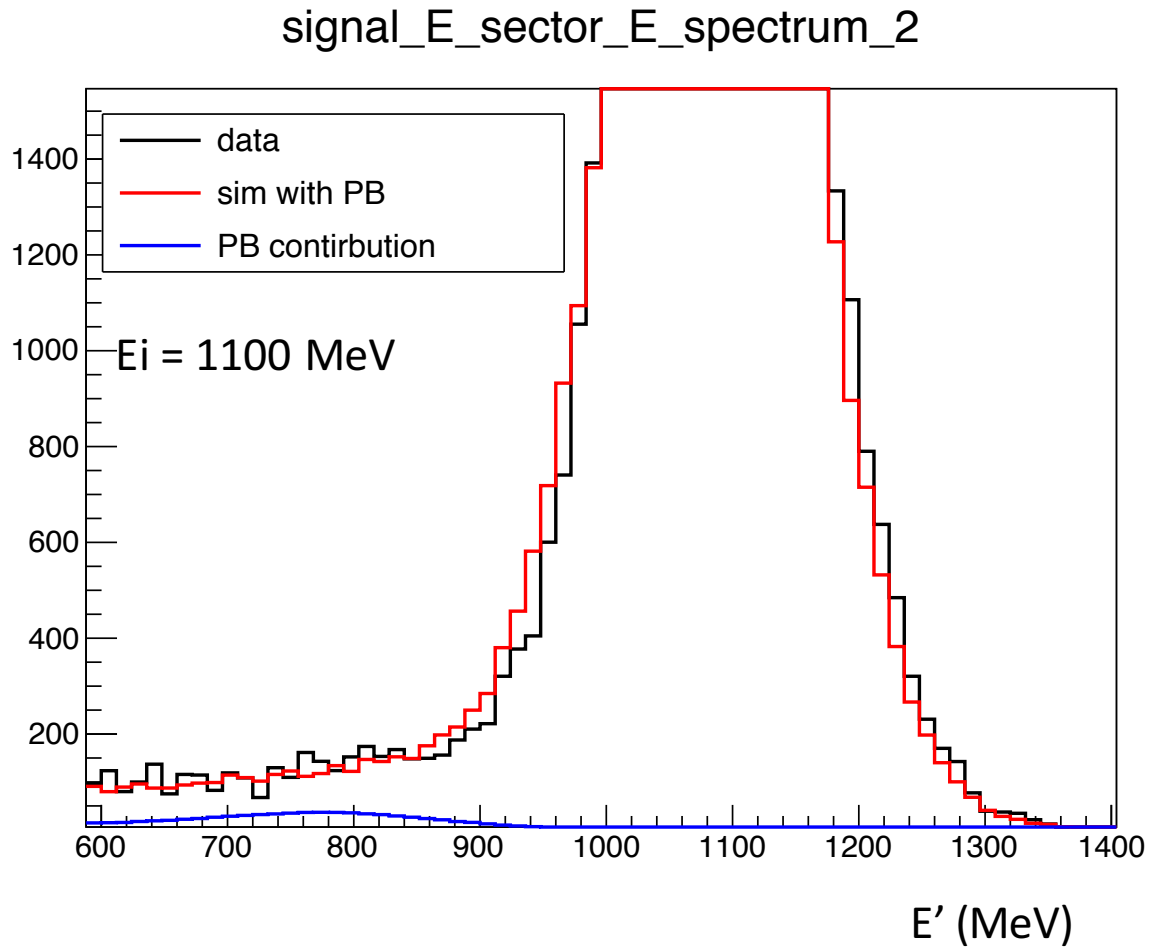
Inelastic ep cross section comparison

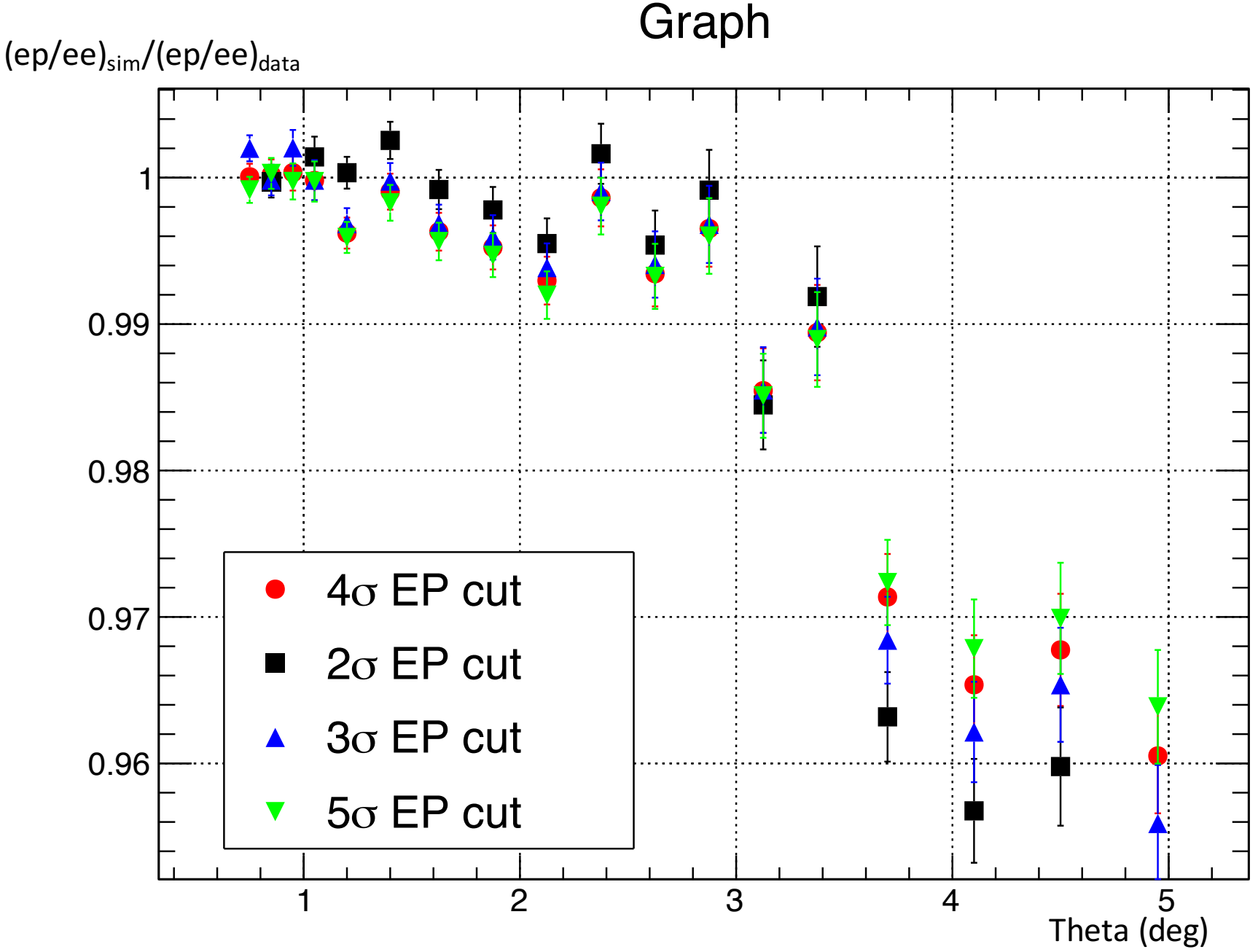




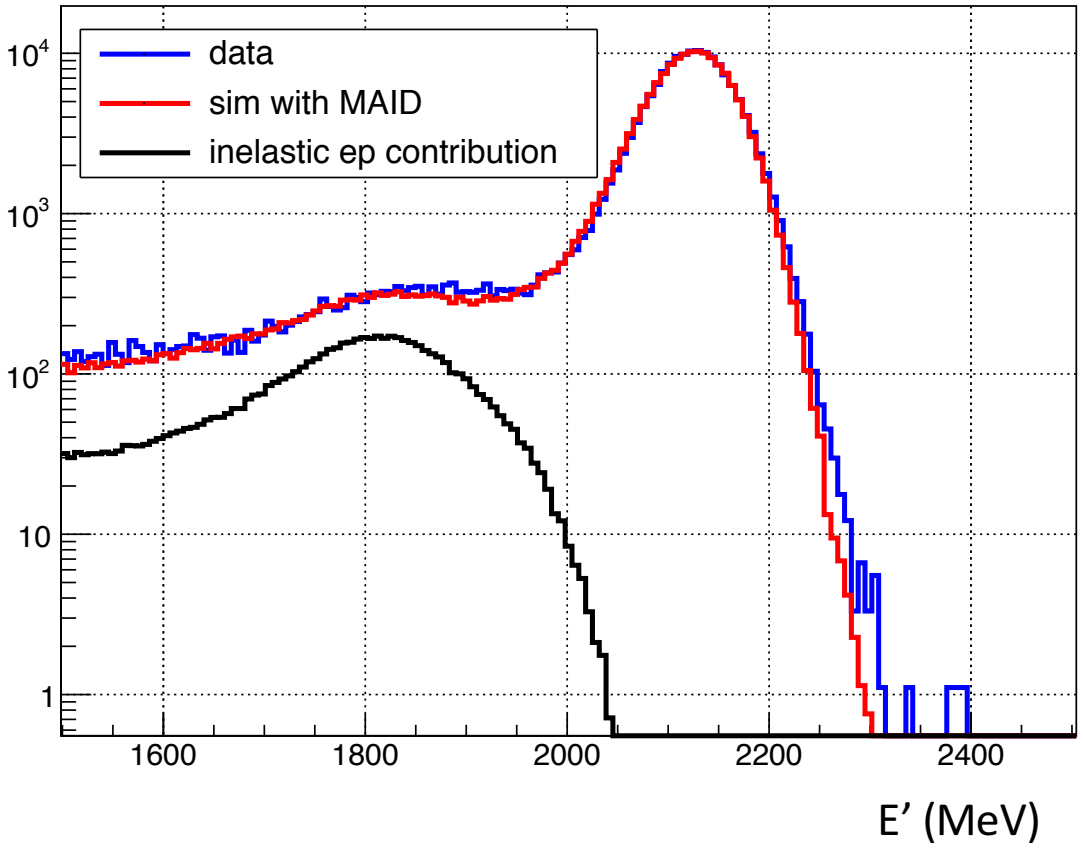
Inelastic ep cross section comparison



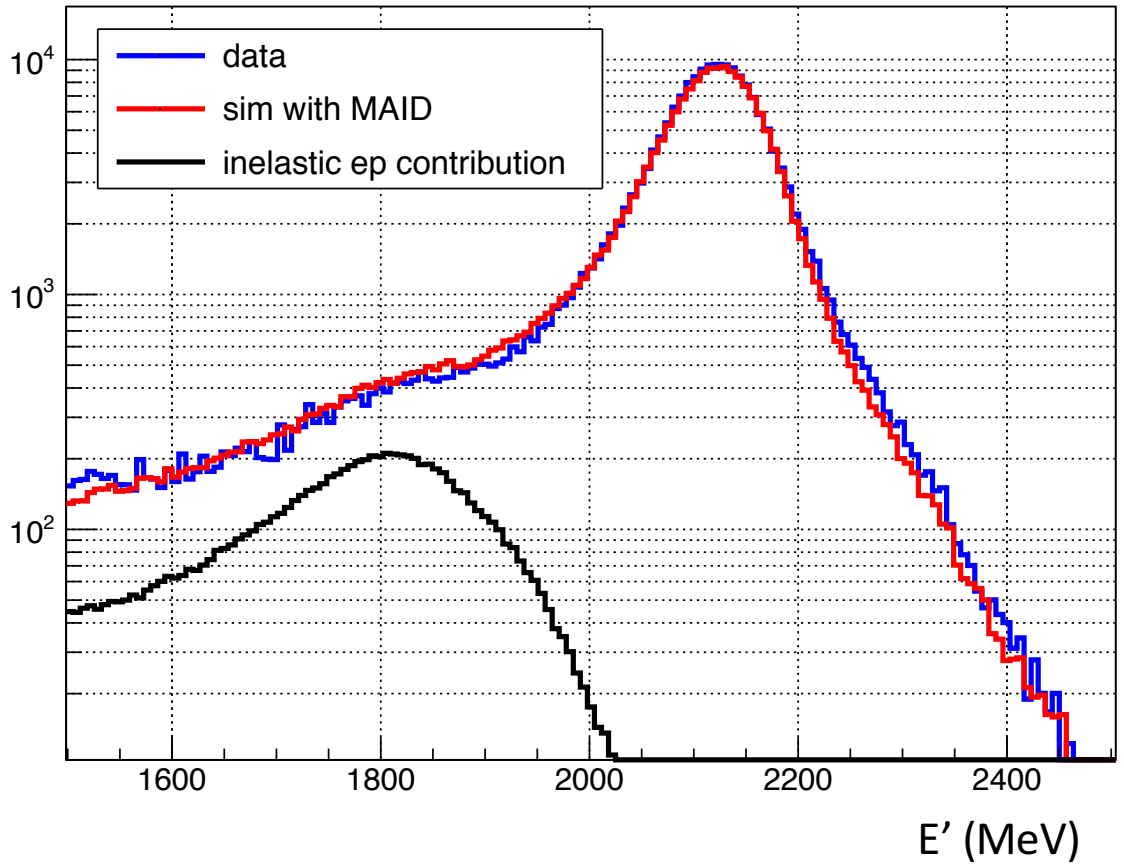



Graph
(ep/ee)sim/(ep/ee)data
1
0.99
0.98
0.97
0.96
1
2
3
4
5
Theta (deg)
4σ EP cut
2σ EP cut
3σ EP cut
5σ EP cut

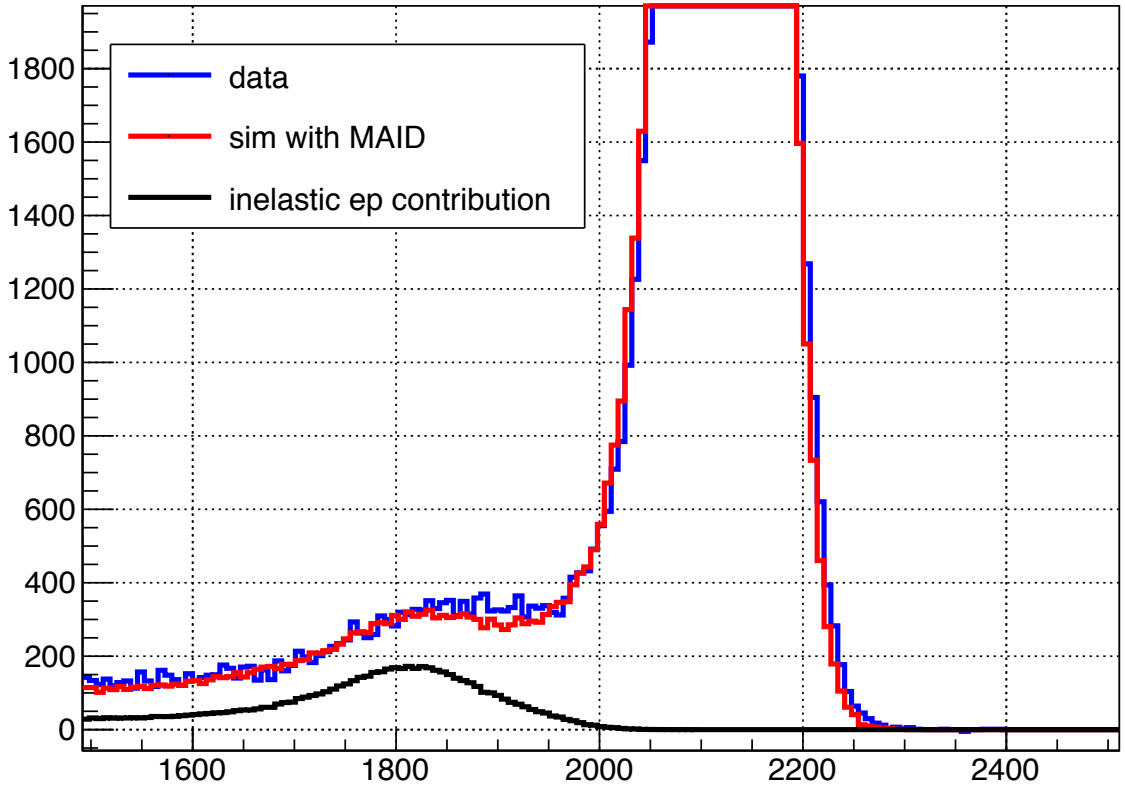
spectrum 3.25 deg < θ < 3.50 deg



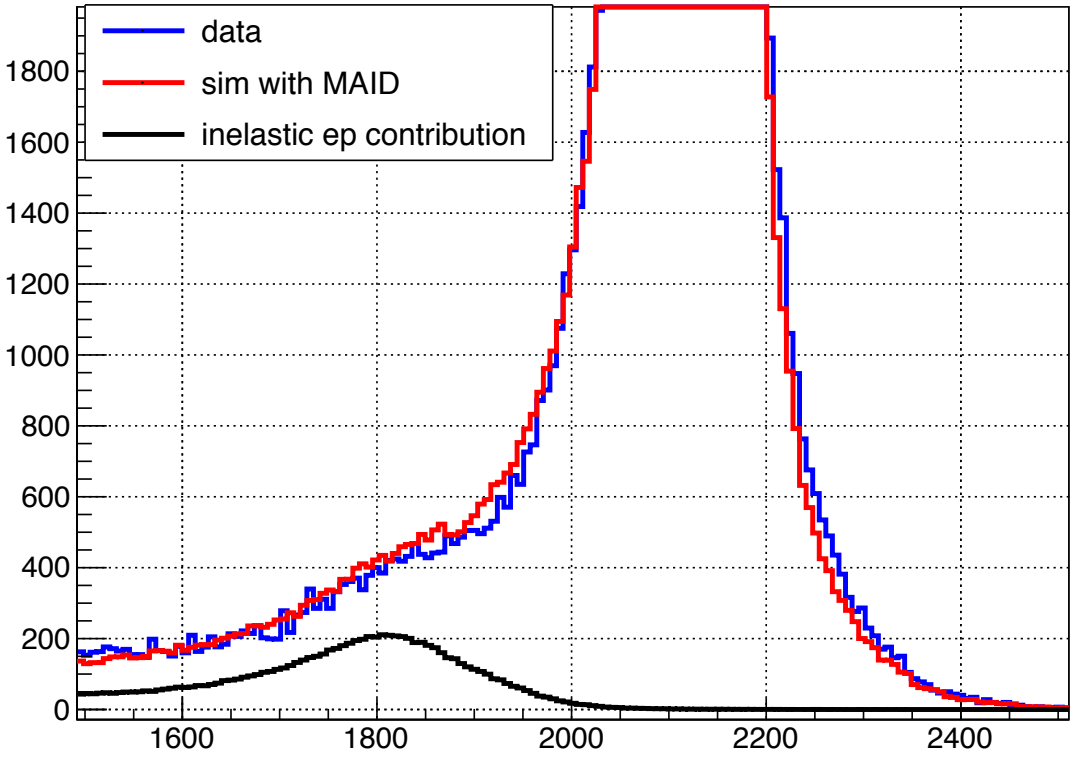
spectrum 3.50 deg < θ < 3.90 deg



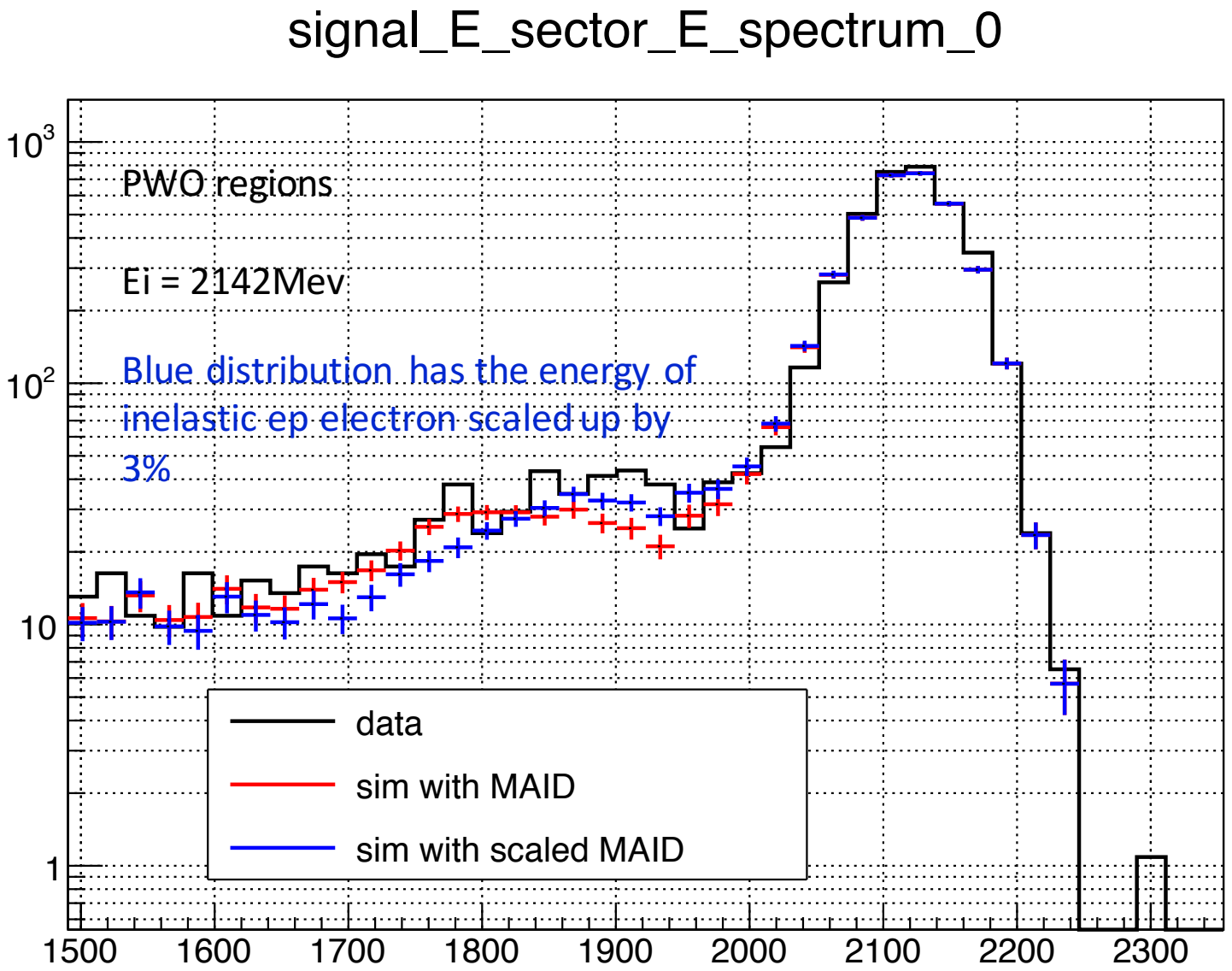
spectrum 3.25 deg < θ < 3.50 deg



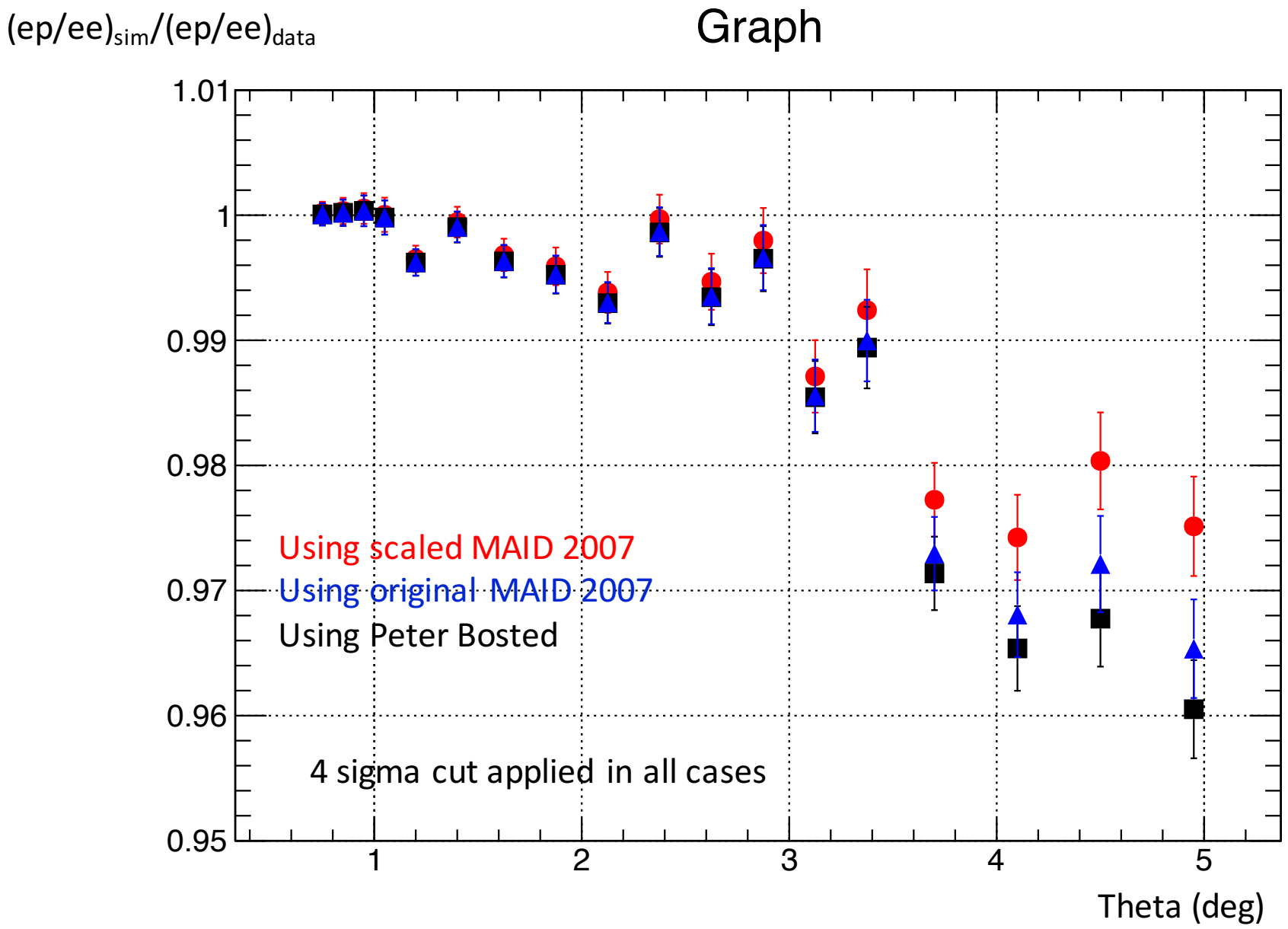
spectrum 3.50 deg < θ < 3.90 deg



Inelastic ep cross section comparison



Inelastic ep cross section comparison



Summary and to-do

- For 2GeV PWO, simulation in the delta-resonance peak region is smaller than the data
  - Inelastic ep is underestimated
  - Inelastic ep peak is probably shifted, check non-linearity in data and simulation
  - Effect of produced pions from inelastic ep, check Nick's generator
  - Data has additional leakage

- For 2GeV LG part, simulation is larger than the data
  - Unlikely due to inelastic ep alone
  - Some additional leakage for the LG in the simulation, try different material for the modules and different reconstruction algorithm

Non-linearity in data and simulation

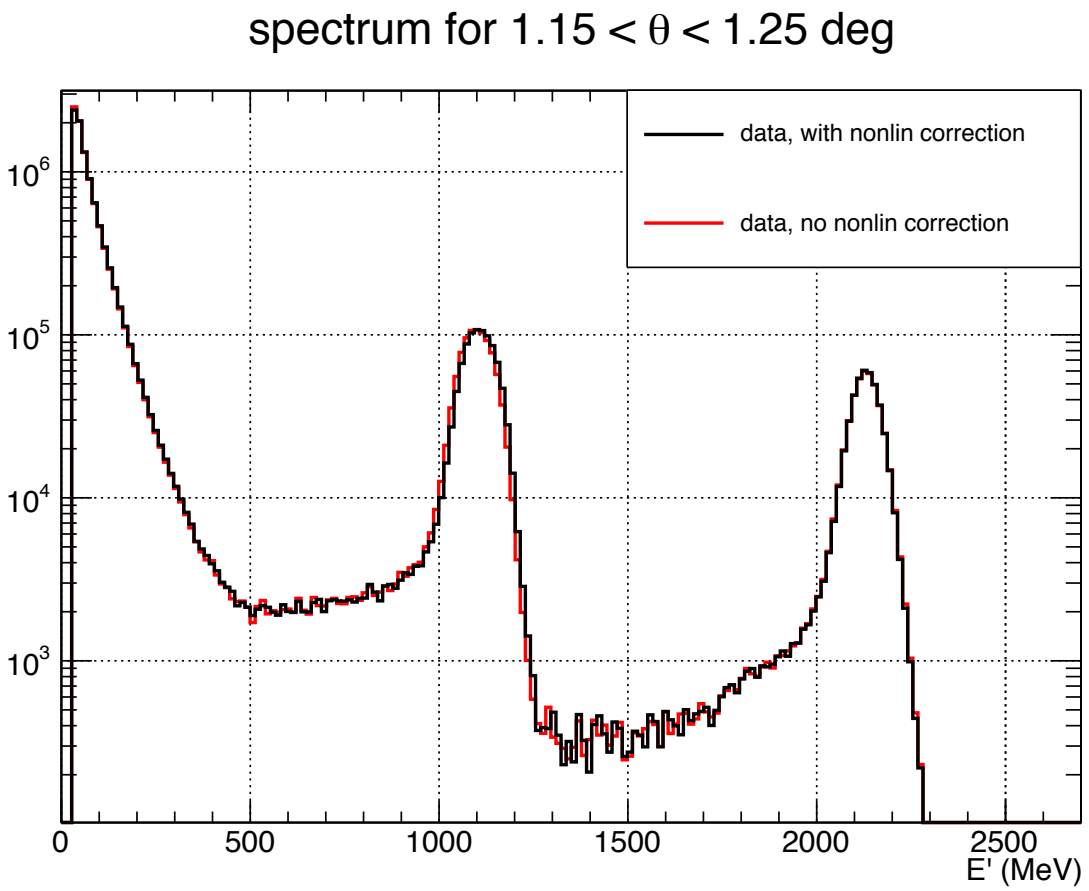
- Formula we use for the non-linearity correction:

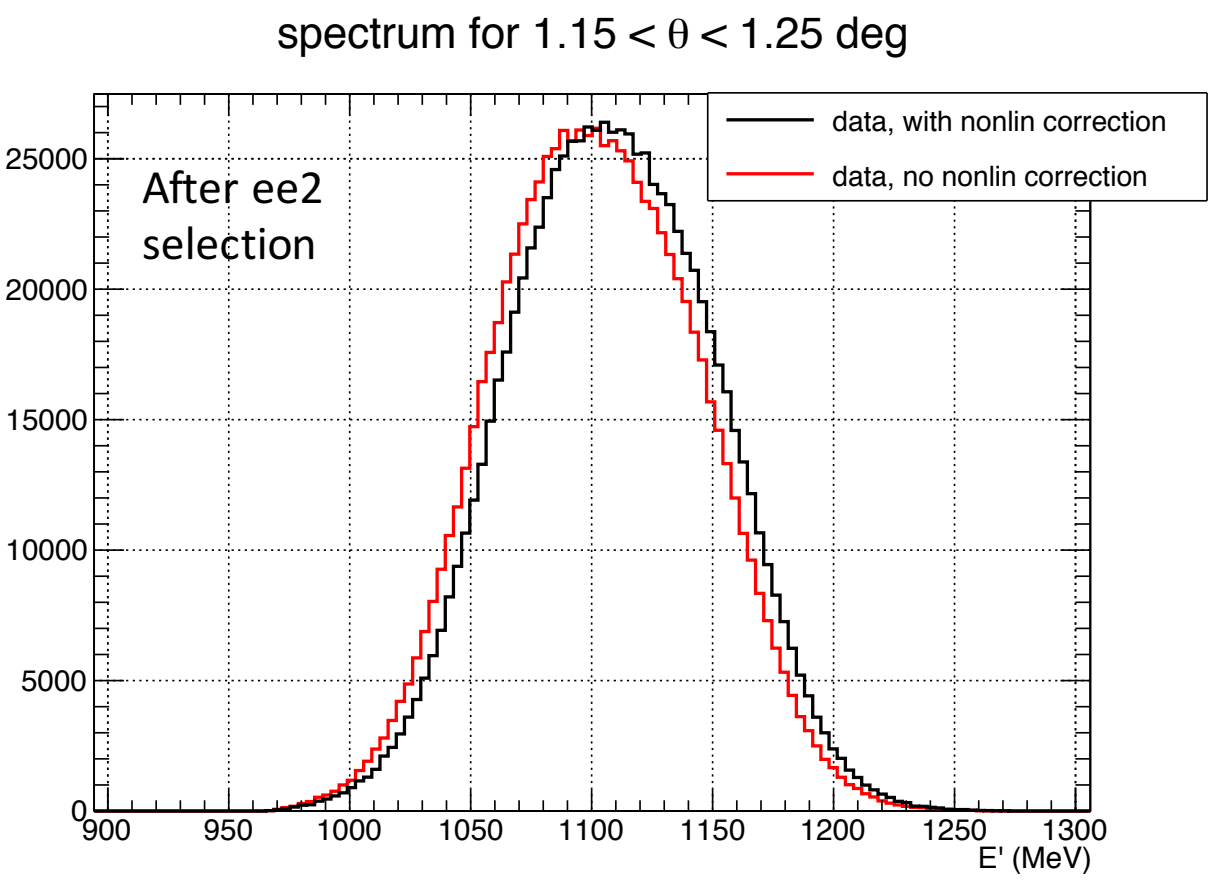
$$E_{corr} = \frac{E_m}{1 + \alpha(E_m - E_{cali})}$$

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

Non-linearity in data

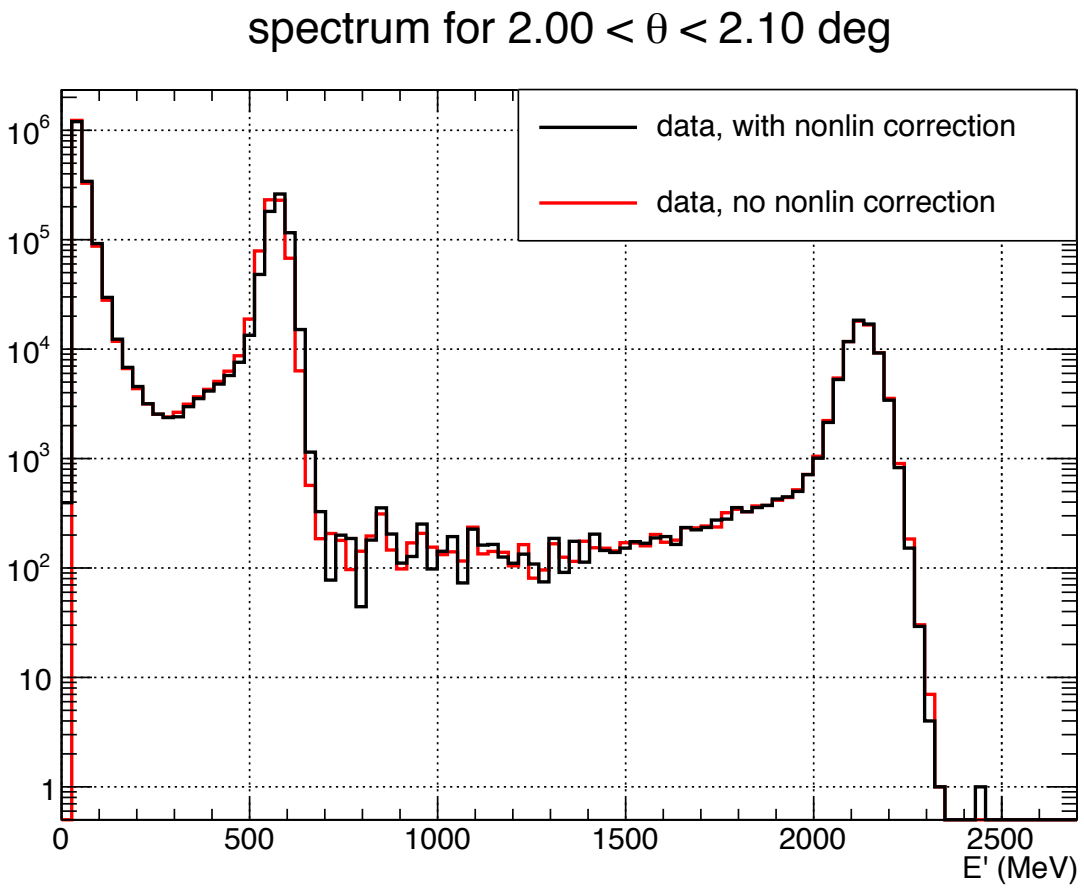
- The non-linearity behavior is actually quite small in the data
- 7 MeV (~0.65%) difference with and without non-linearity correction for the ee peaks

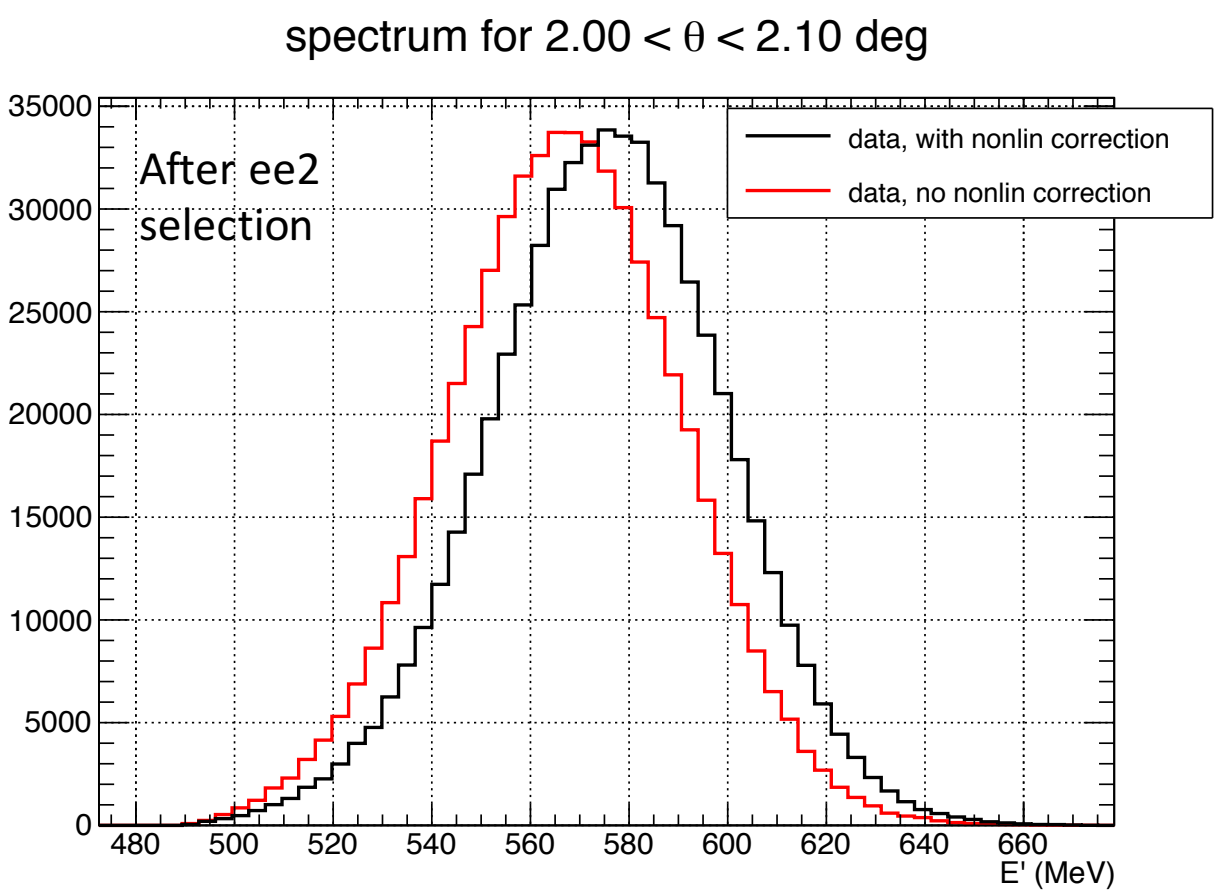




Non-linearity in data

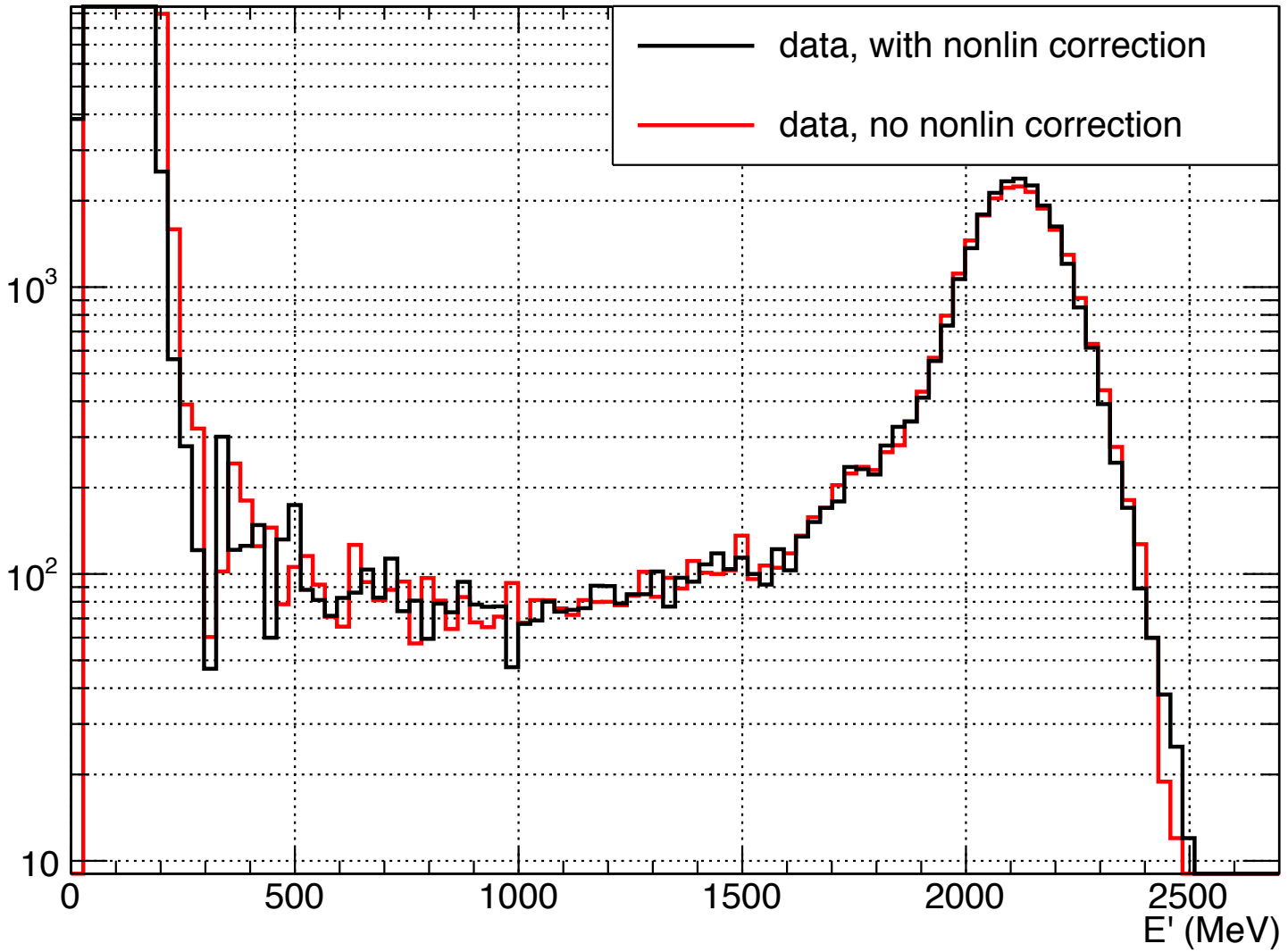
- The non-linearity behavior is actually quite small in the data
- 8.8 MeV (~1.5%) difference with and without non-linearity correction for the ee peaks





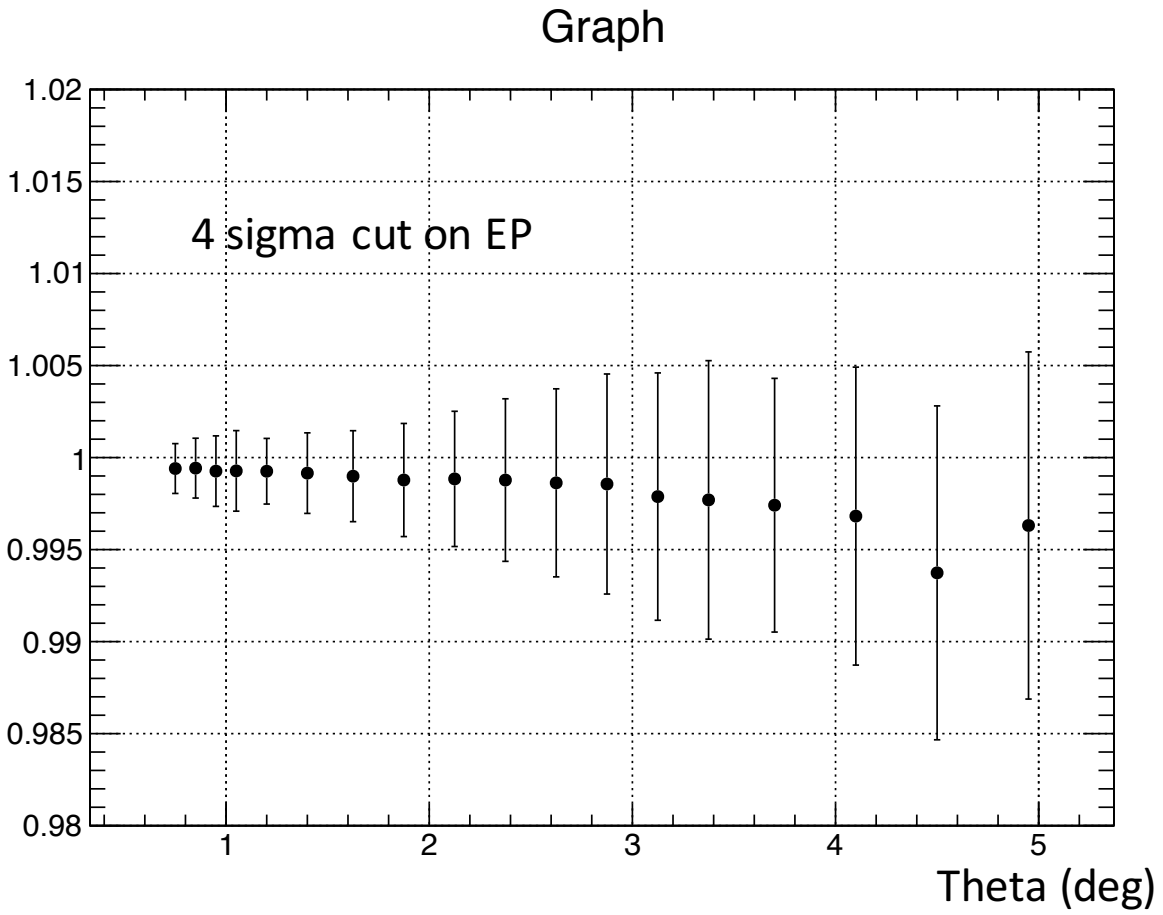
Non-linearity in data

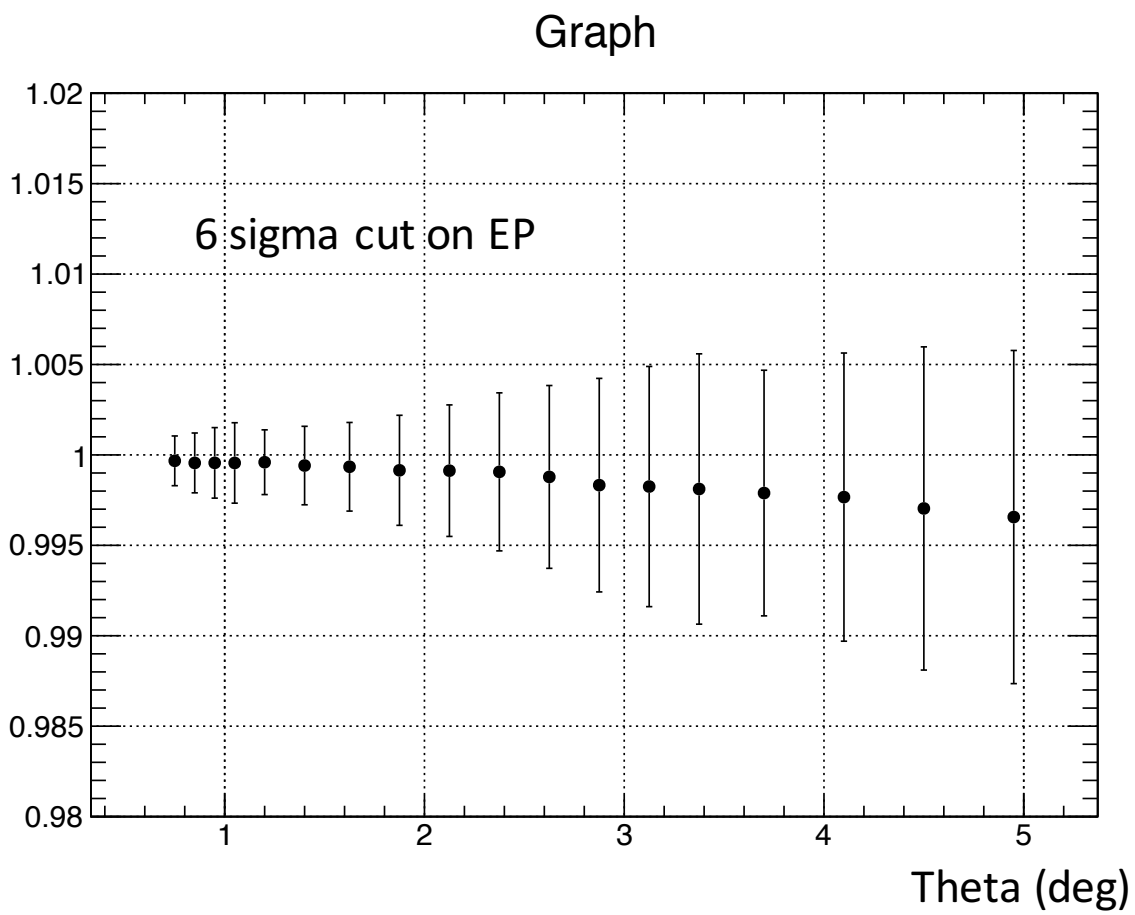
spectrum for $4.70 < \theta < 5.20$ deg



Non-linearity in data

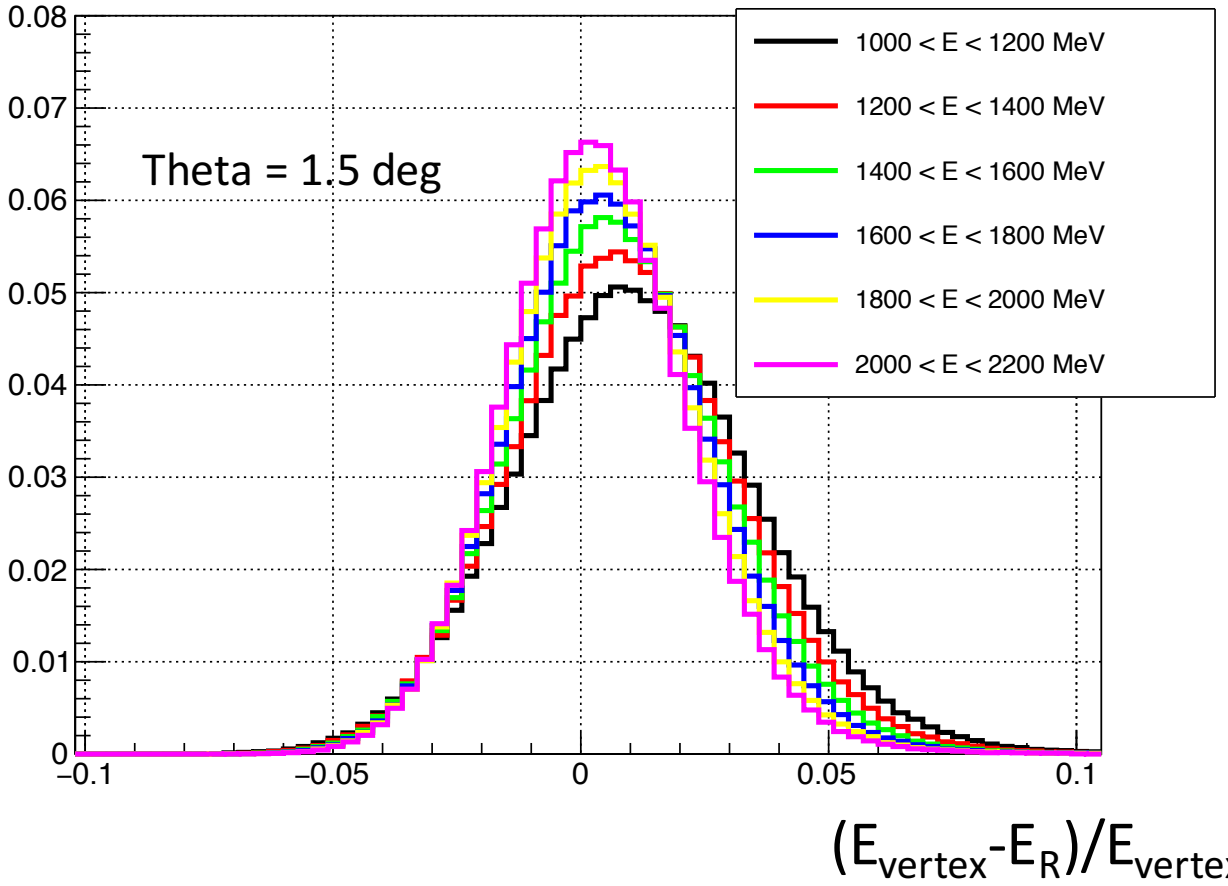
(ep yield without nonlin)/(ep yield with nonlin)

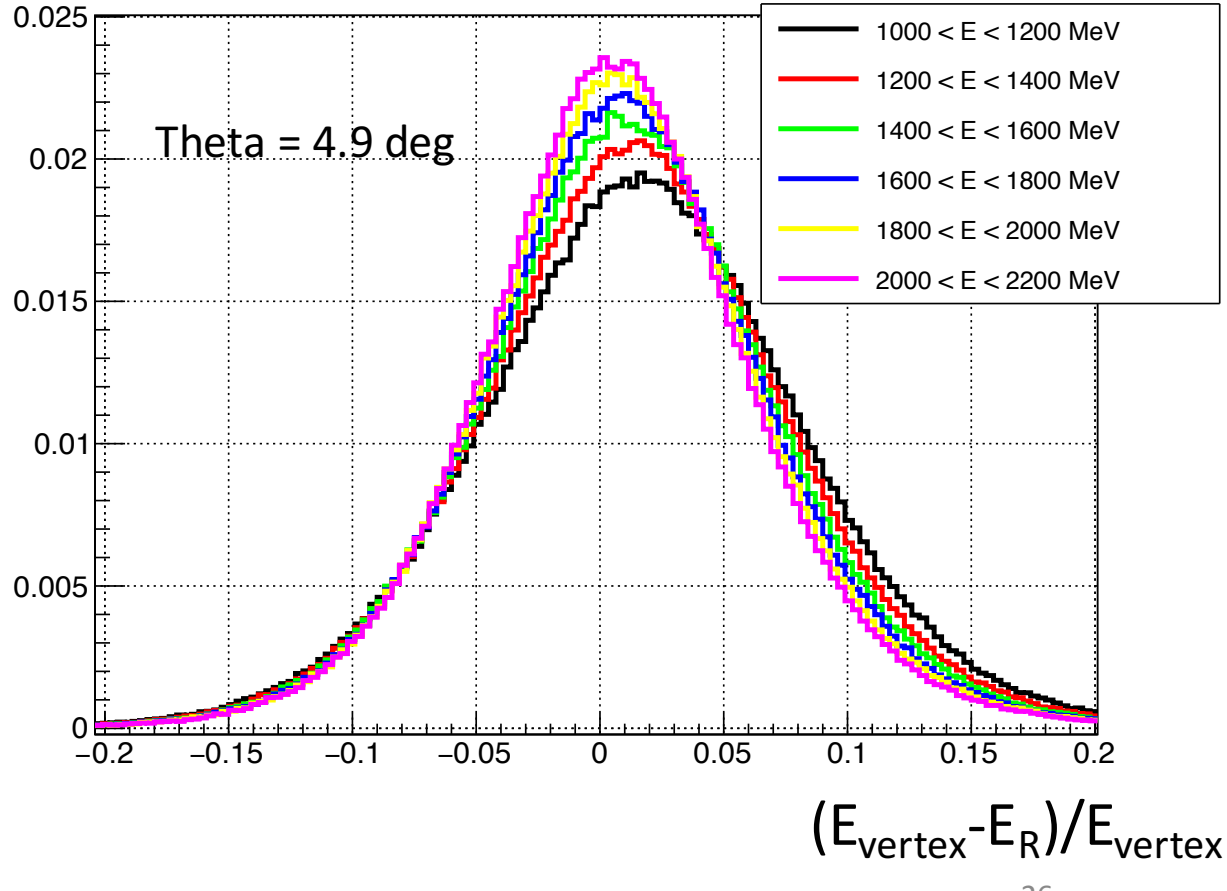




Non-linearity in simulation

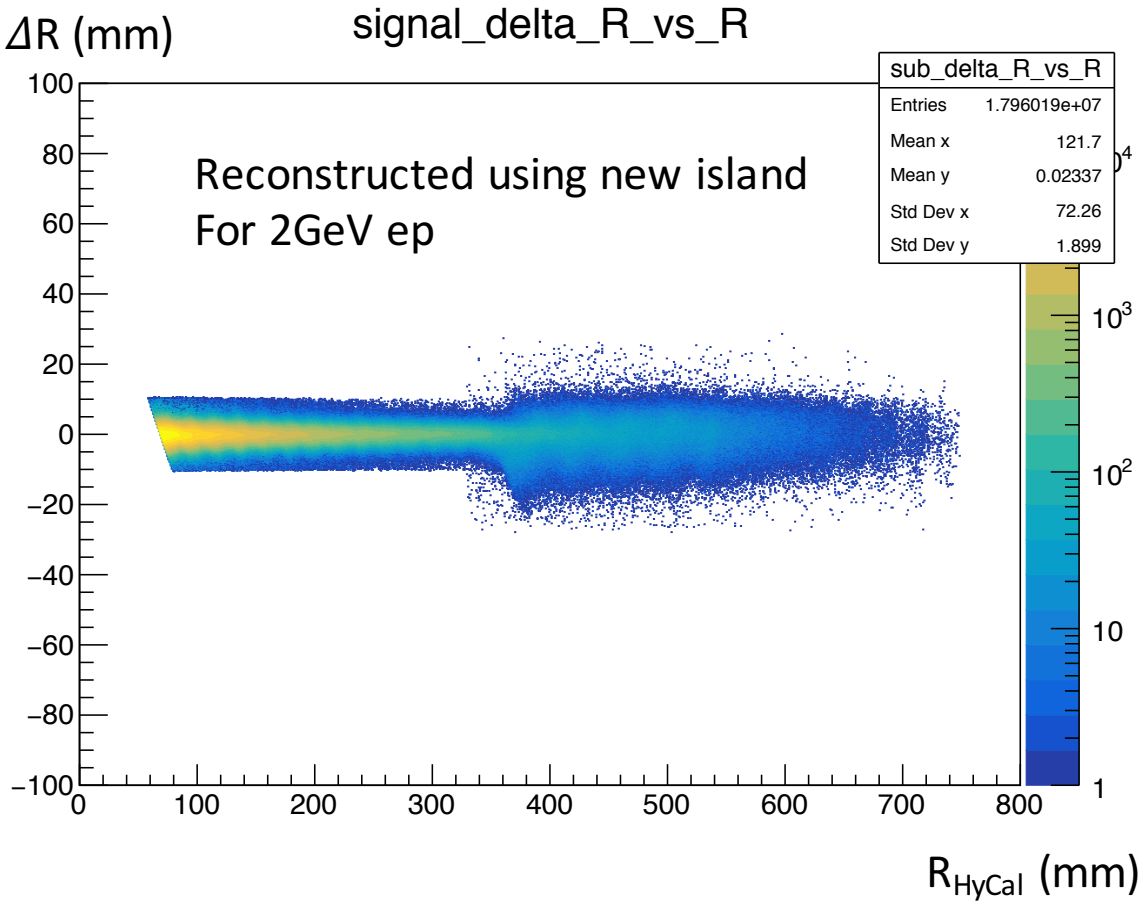
- Similar non-linearity behavior also exists in the simulation, but it is not fully corrected

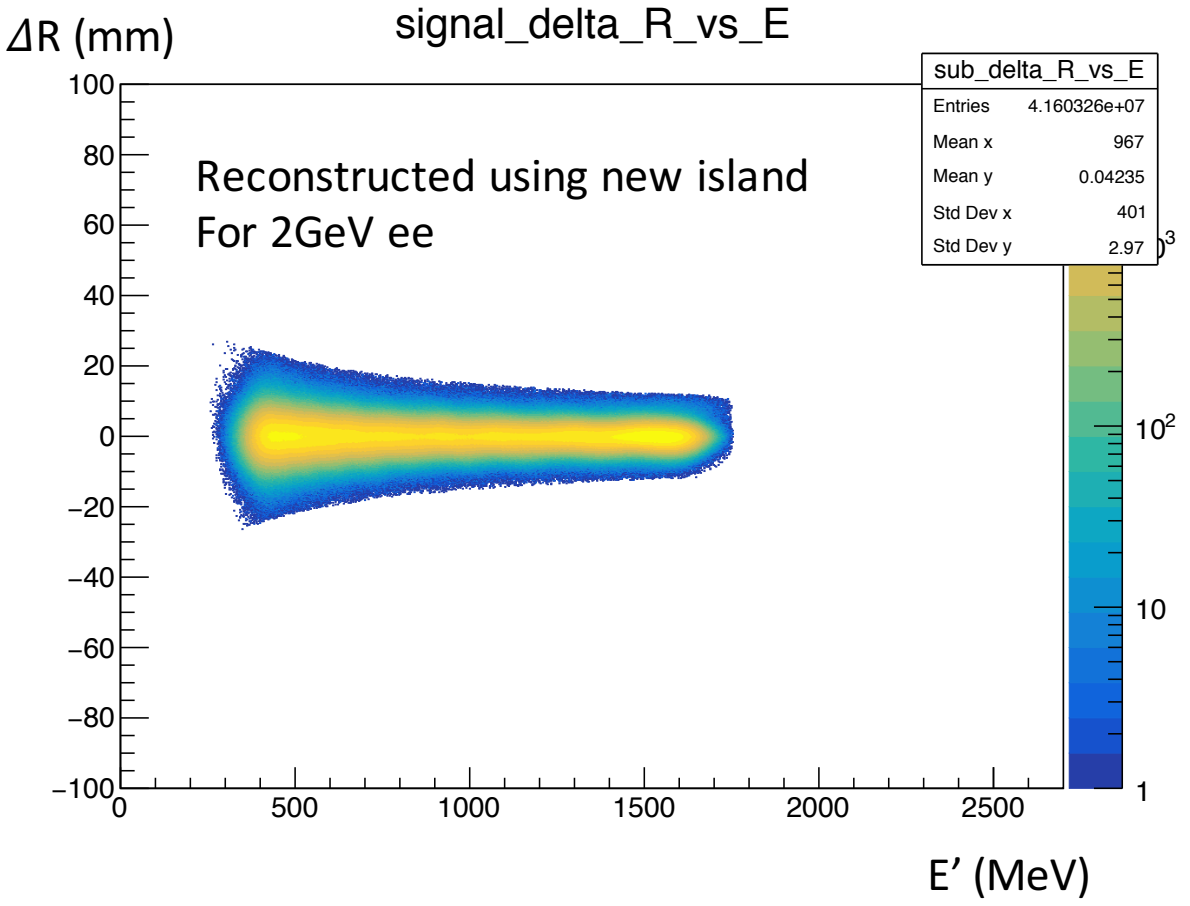




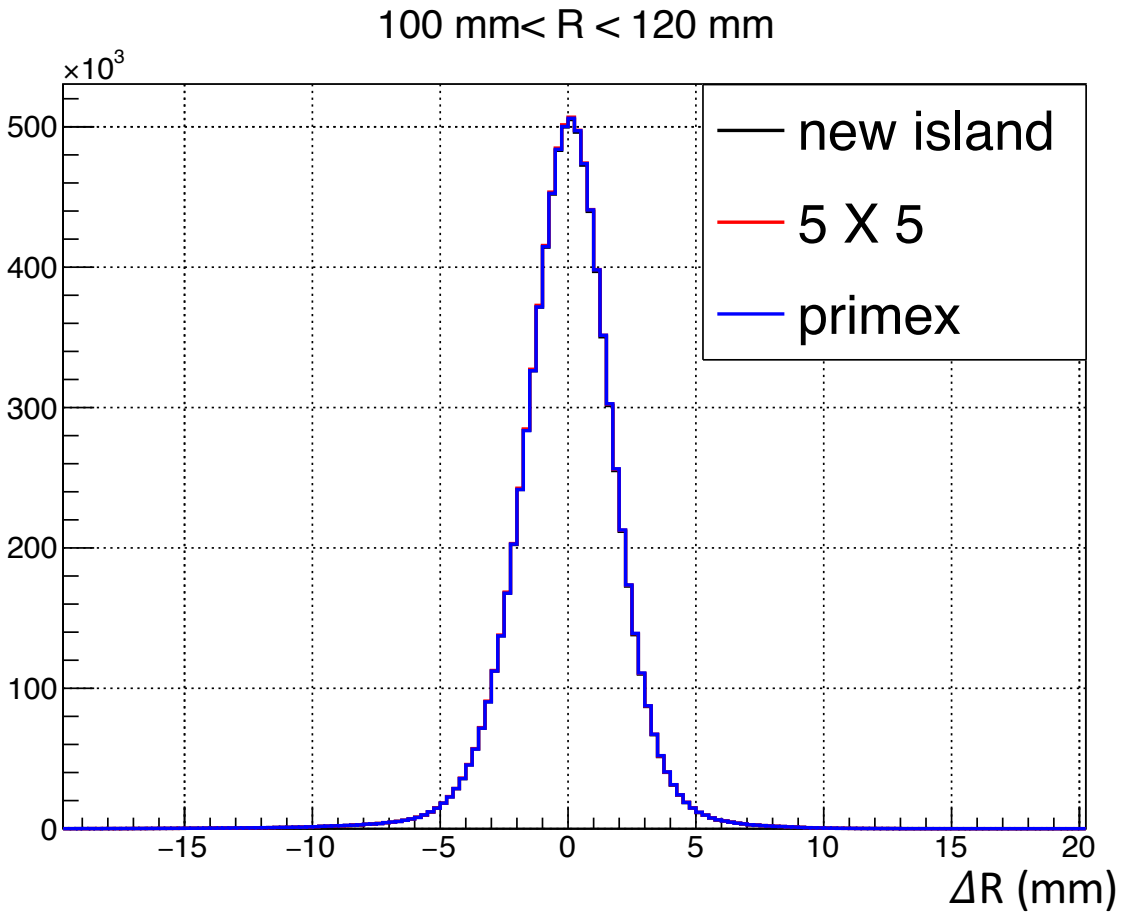
Algorithm comparison - Position

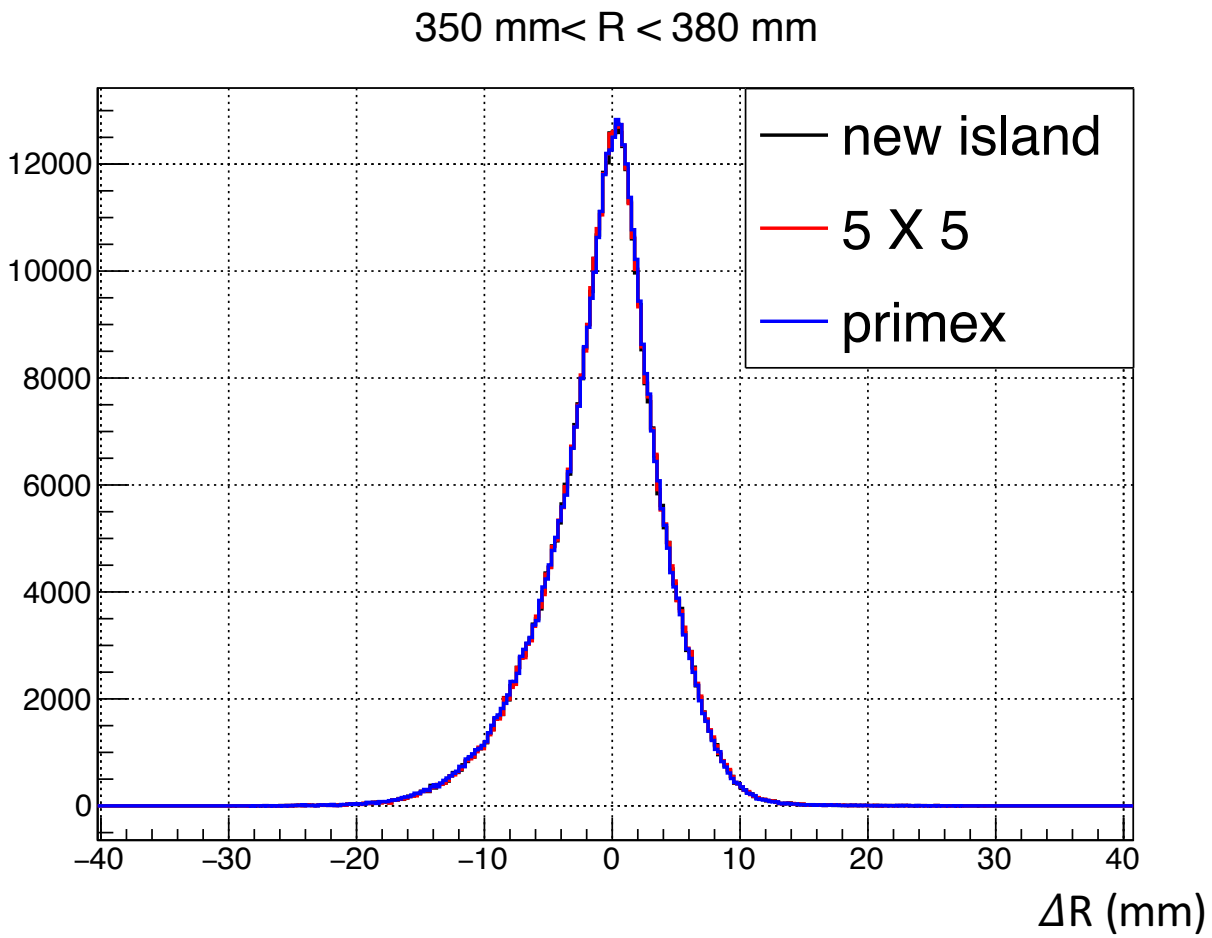
- To compare the position reconstruction of an algorithm, we can compare the HyCal reconstructed coordinates with GEM projected coordinate
- $\Delta R = R_{GEM} - R_{HyCal}$



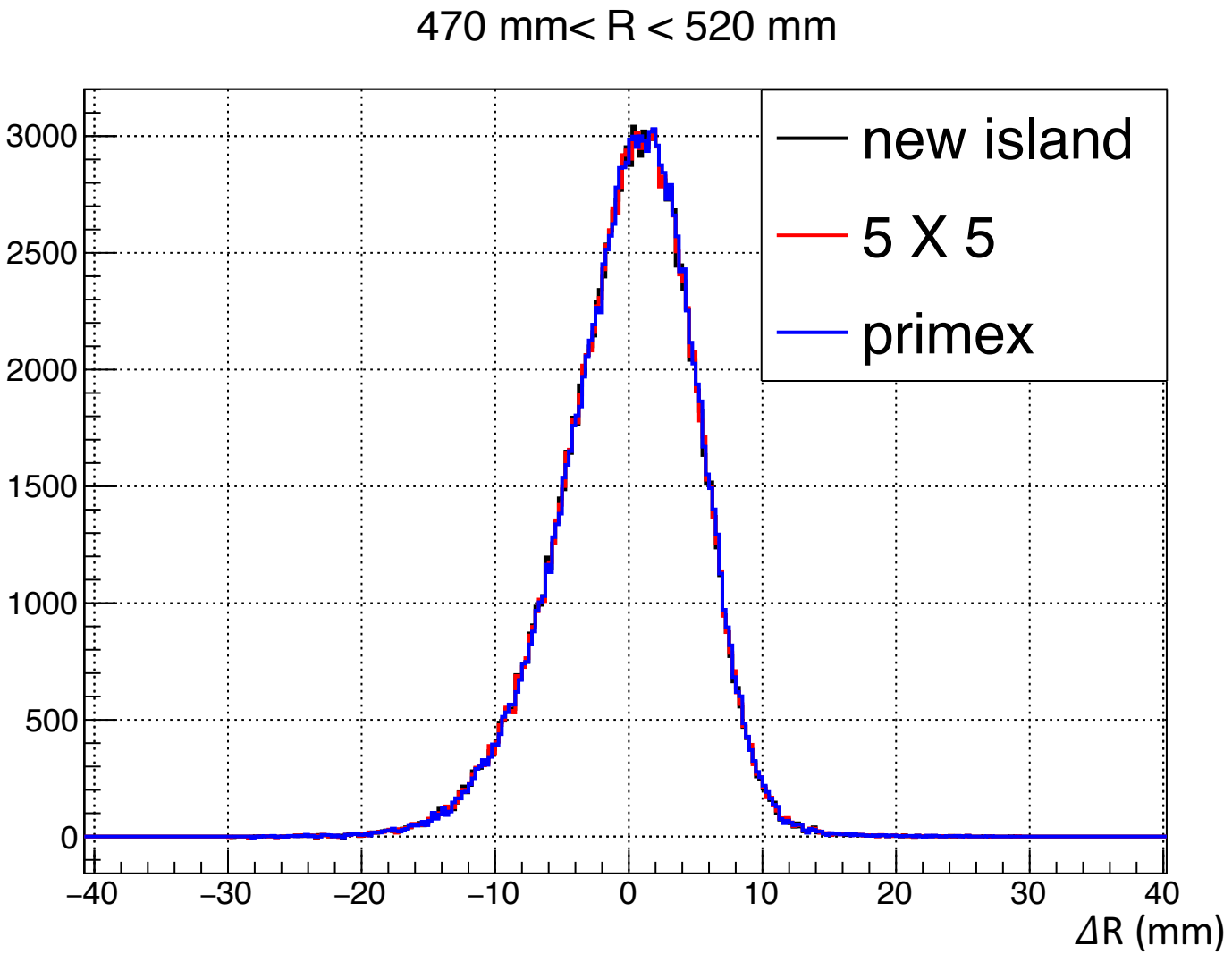


Algorithm comparison - Position

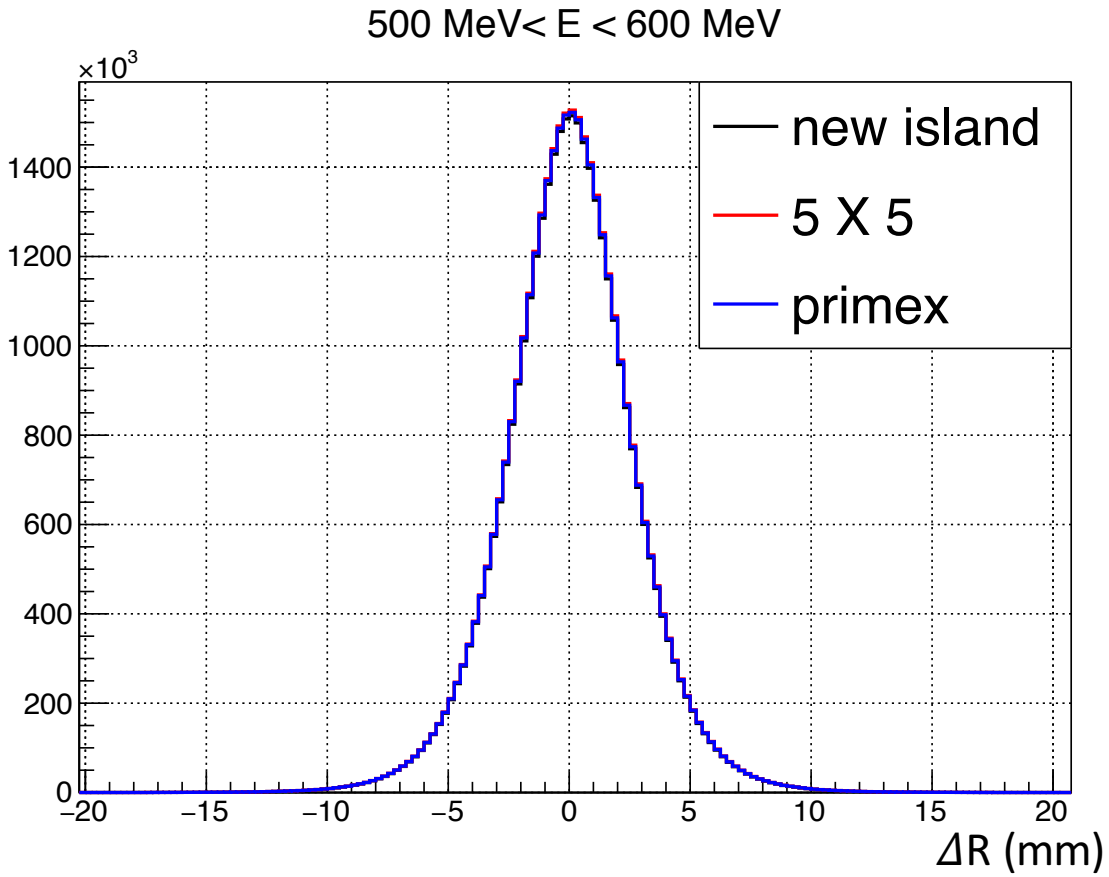


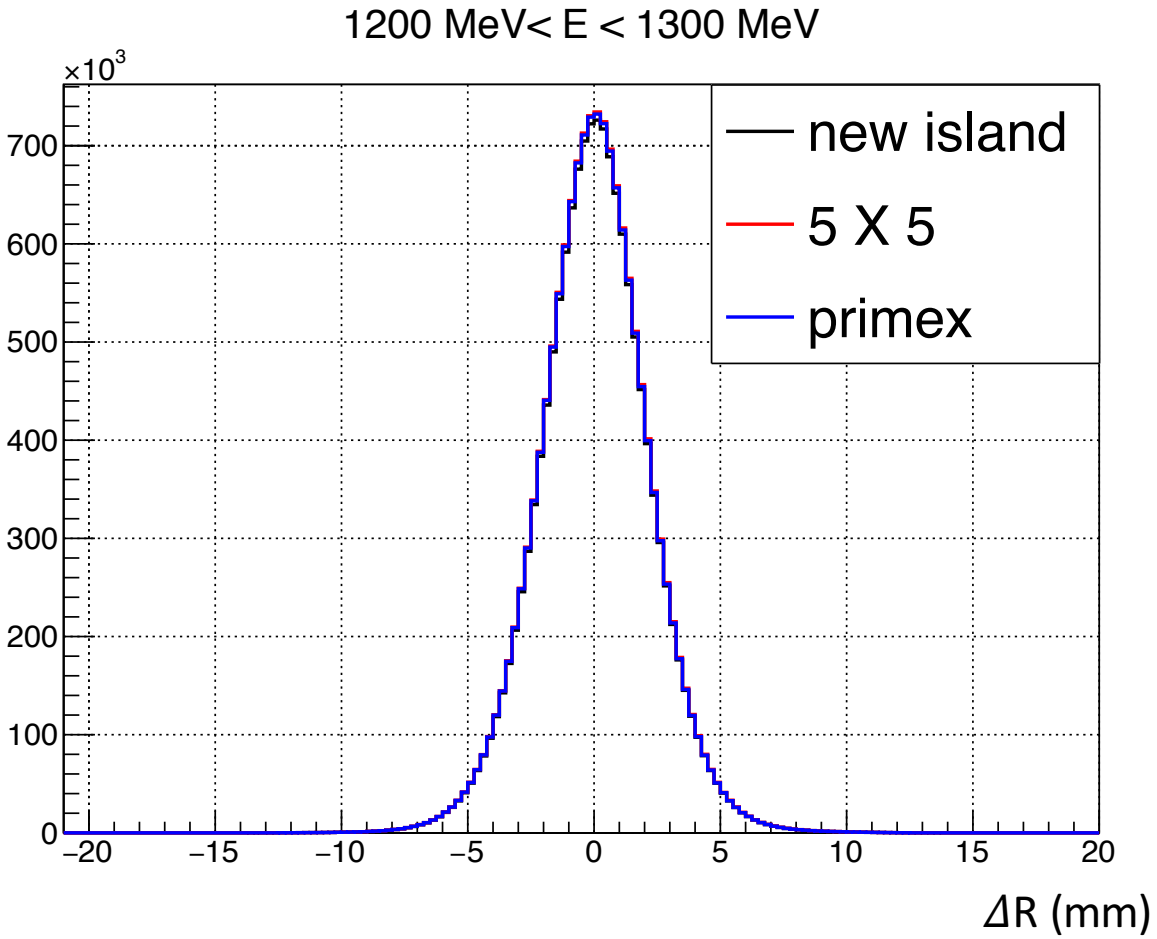


Algorithm comparison - Position



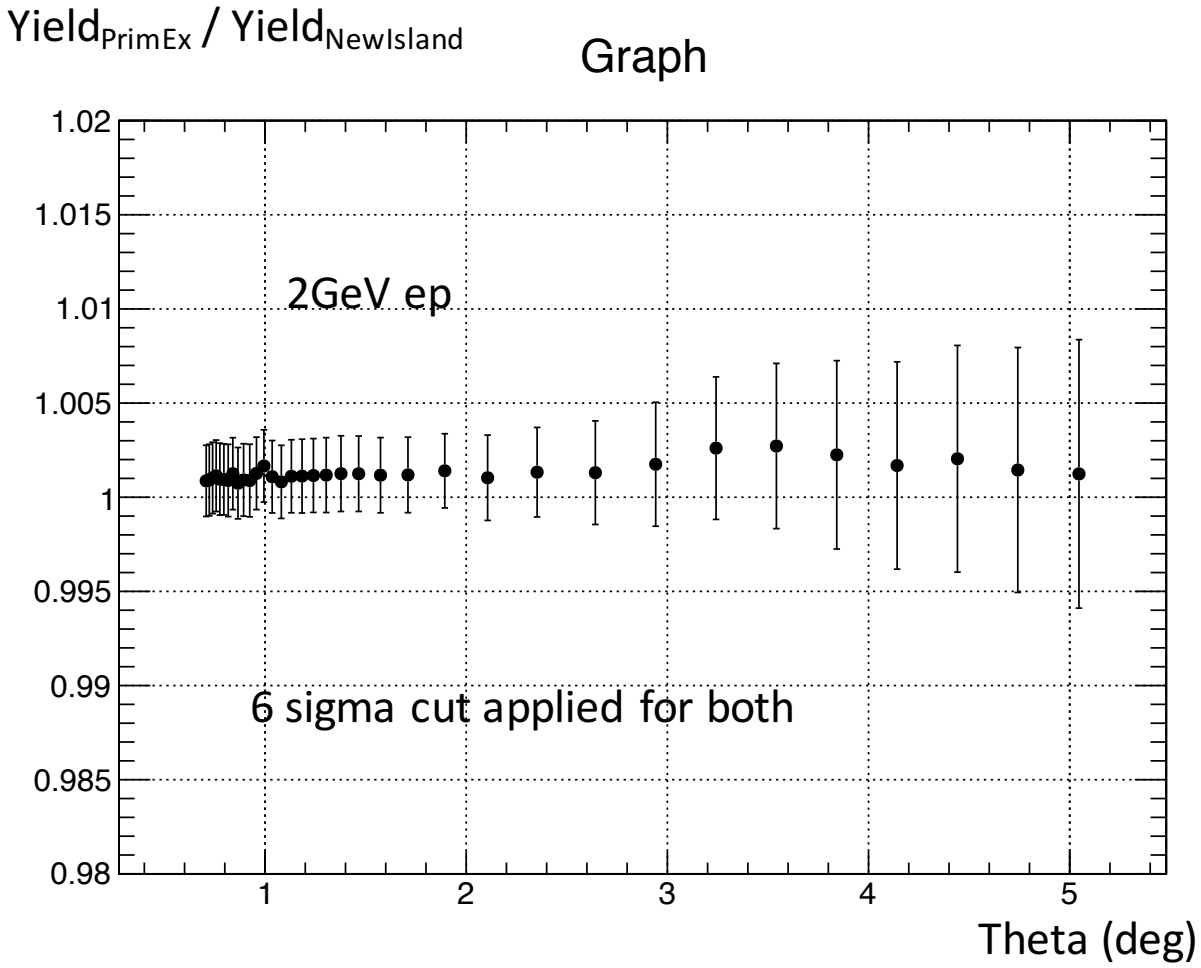
Algorithm comparison - Position

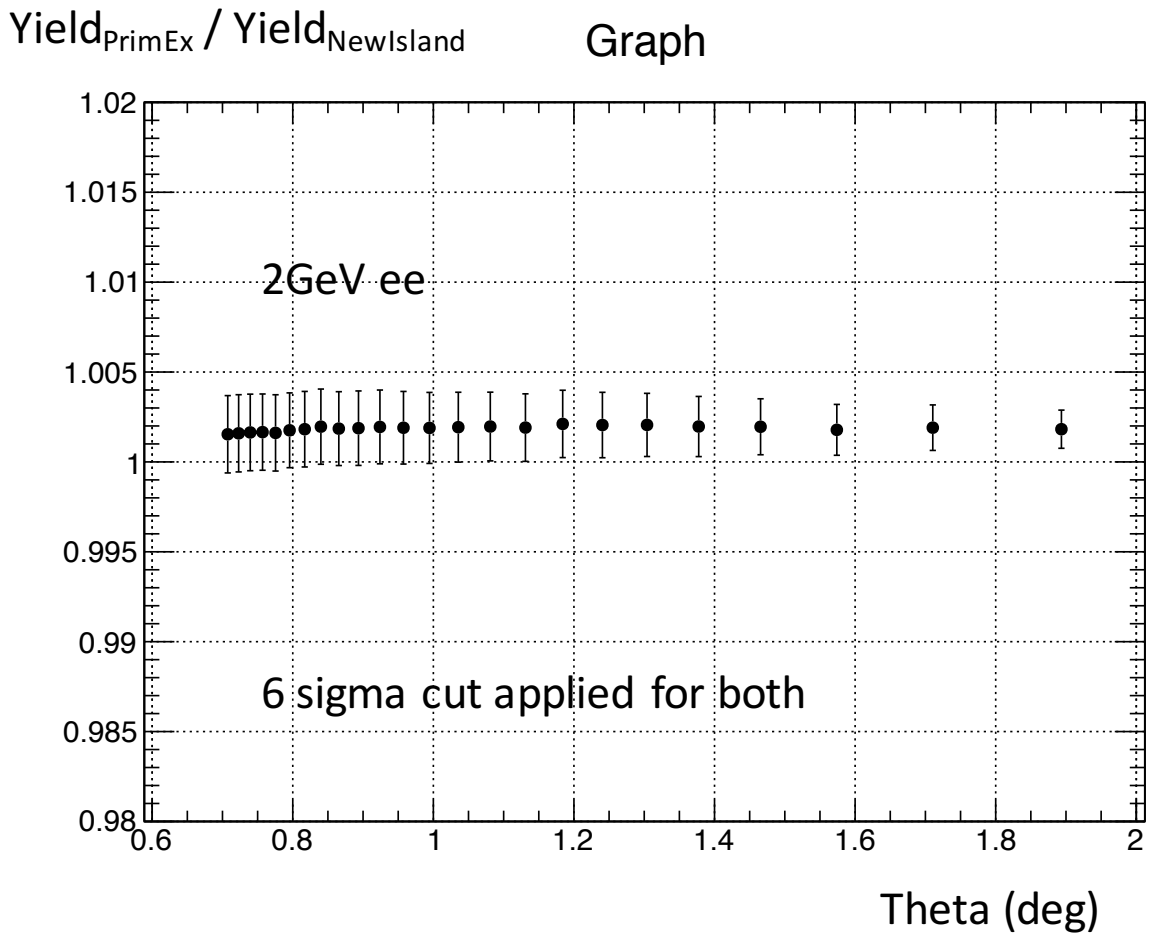




Algorithm comparison - Yield

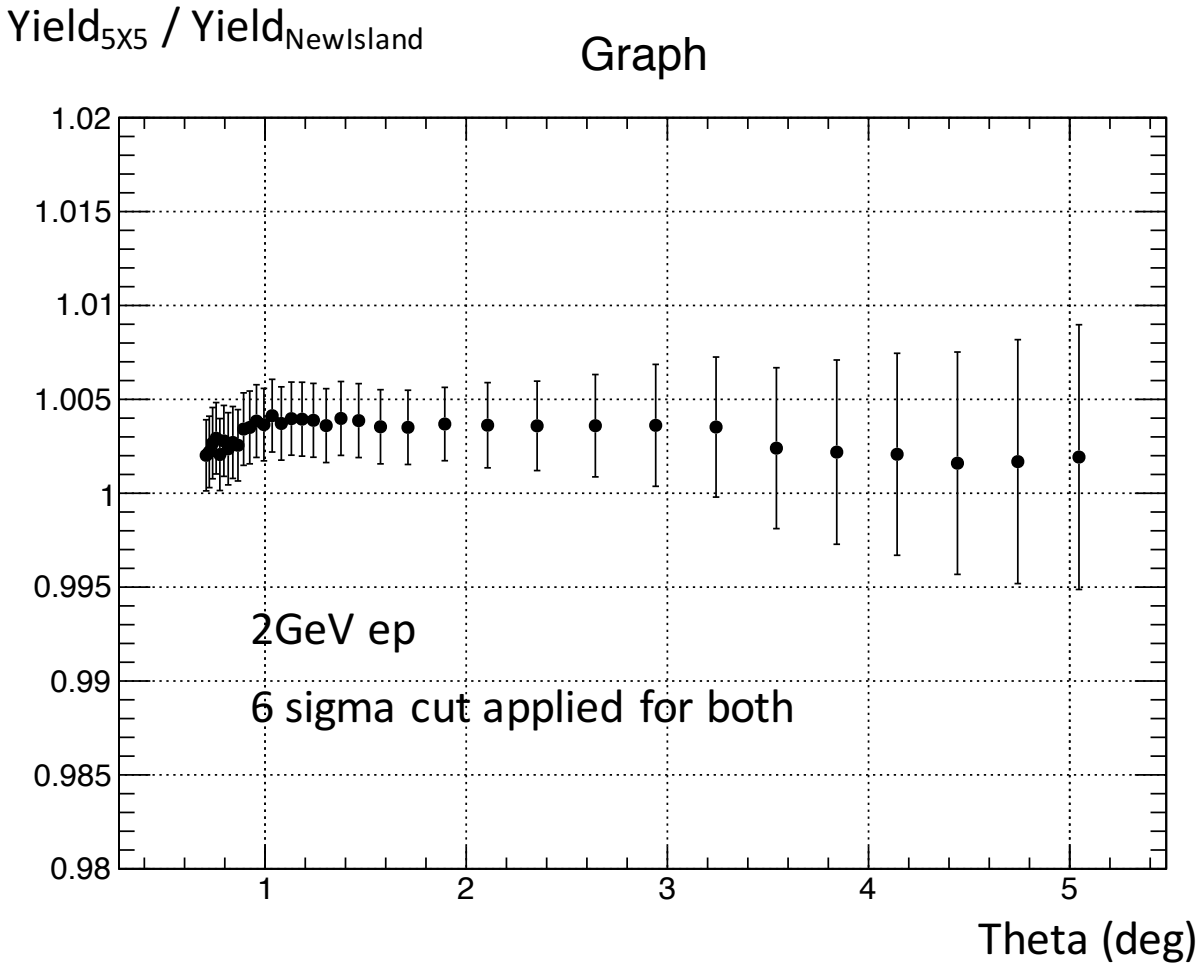
New island vs PrimEx island

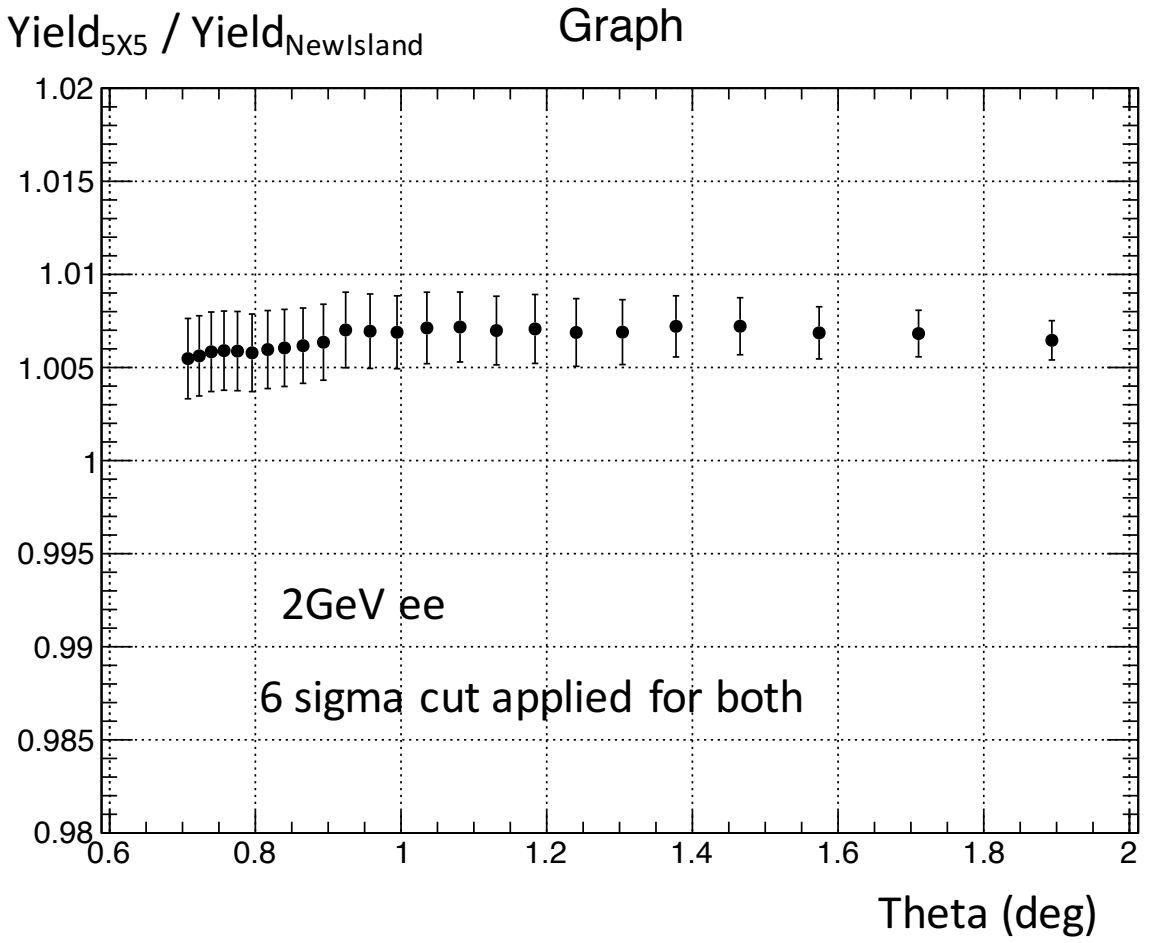




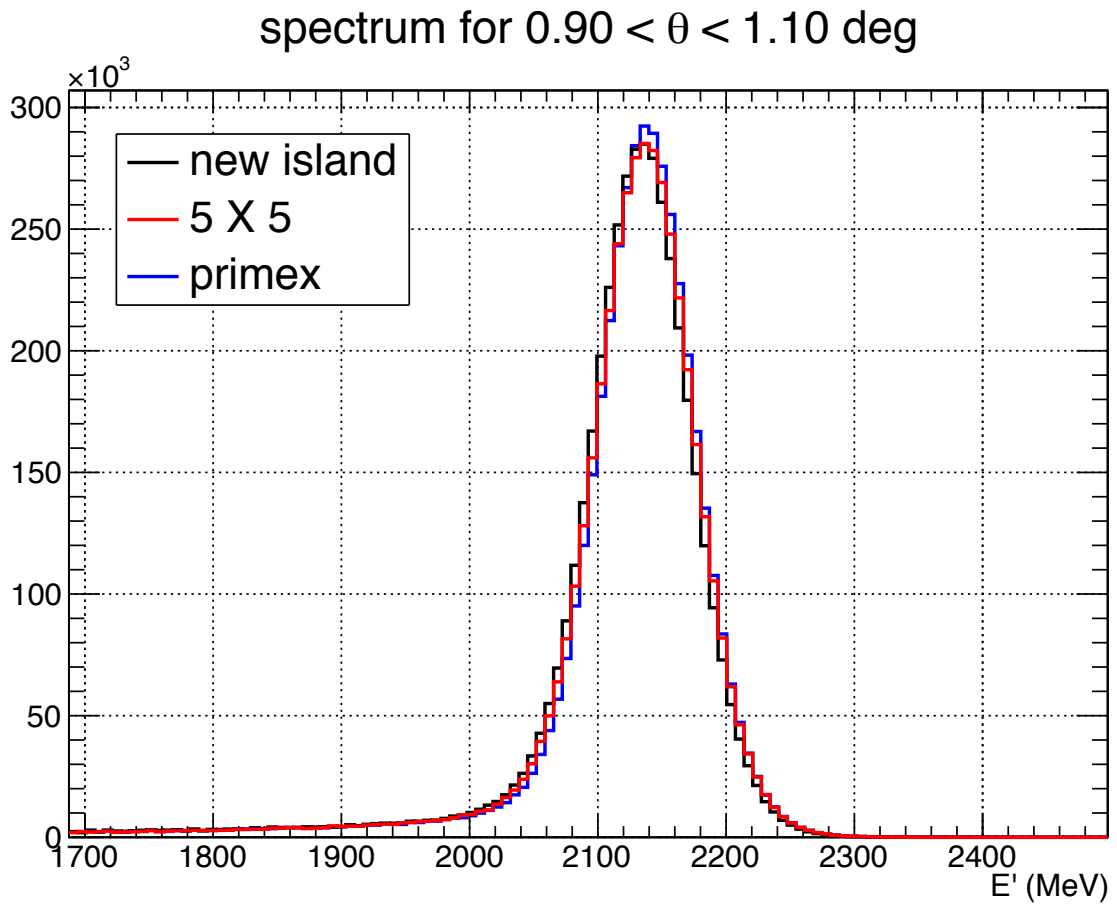
Algorithm comparison - Yield

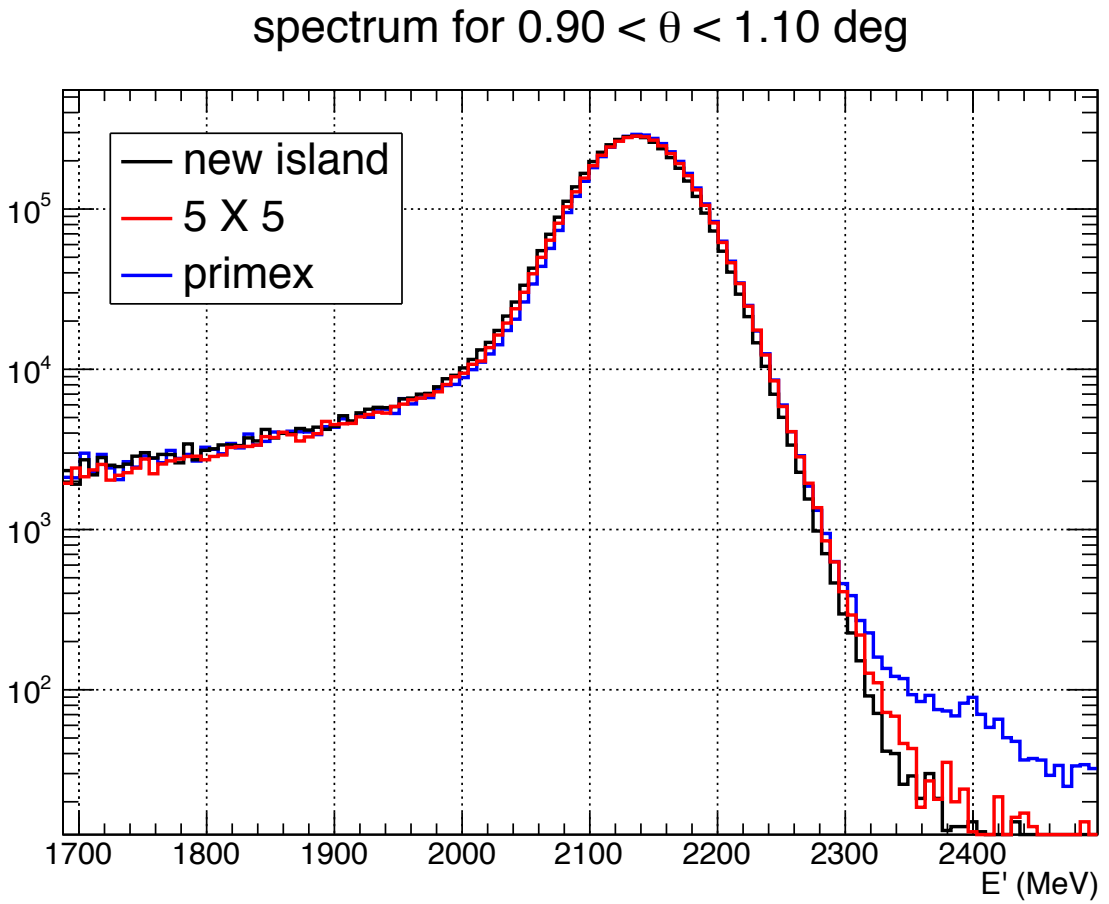
New island vs 5 X 5





Algorithm comparison – Energy Spectrum





Algorithm comparison – Energy Spectrum