Outline

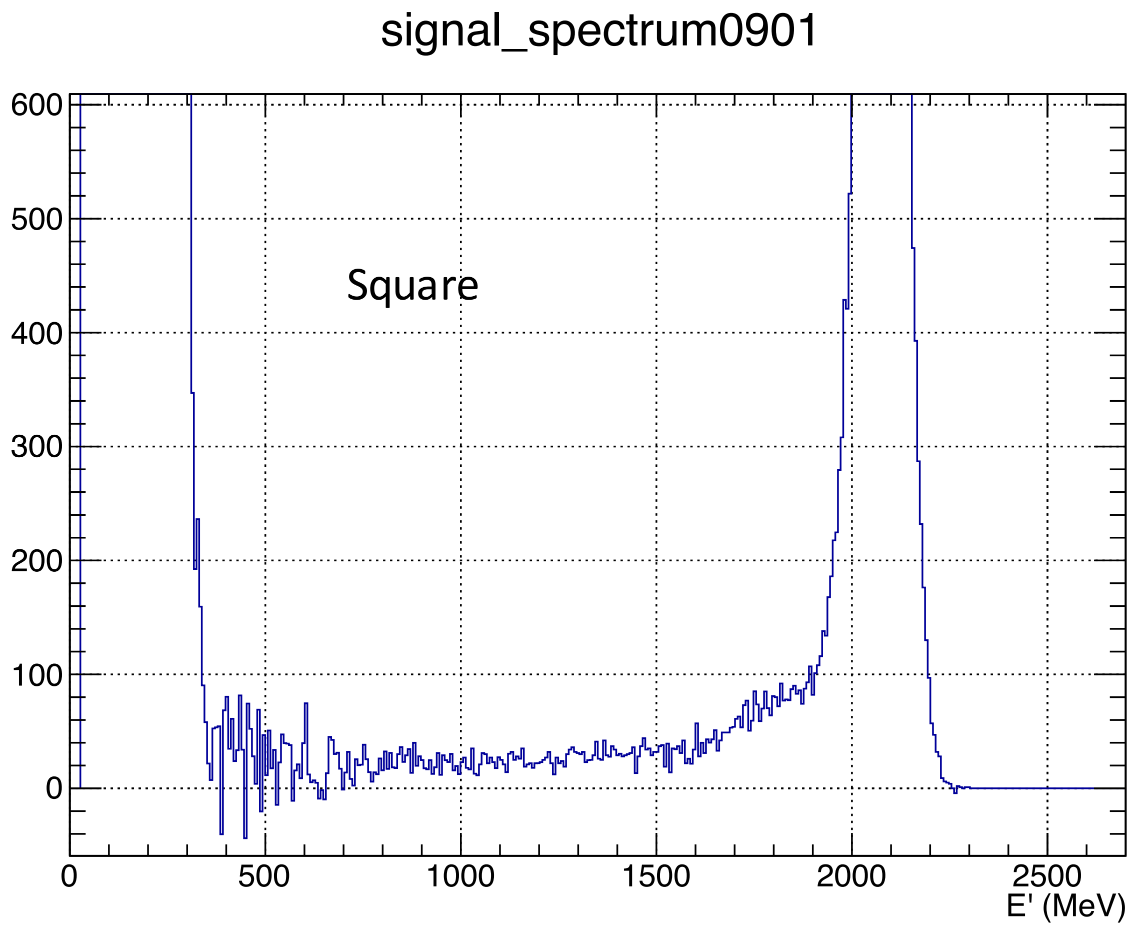
- Energy spectrum obtained with different reconstruction methods
- Effect of the HyCal module wrapper on the energy spectrum
- Inelastic ep contribution to the energy spectrum

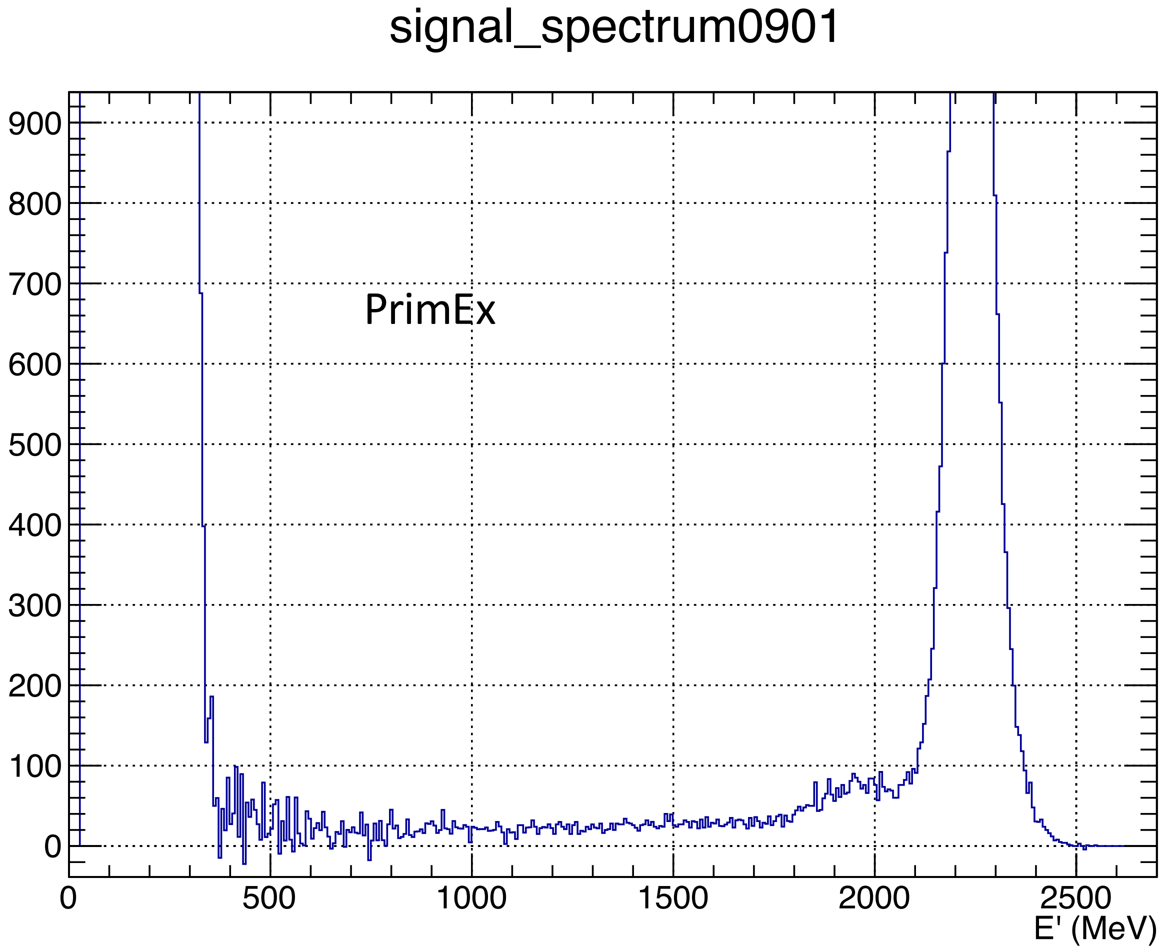
- Effect of the offset shift for the ep/ee ratio

- Problem with simulation in the transition and LG region

Square (5 x 5) and PrimEx reconstruction methods

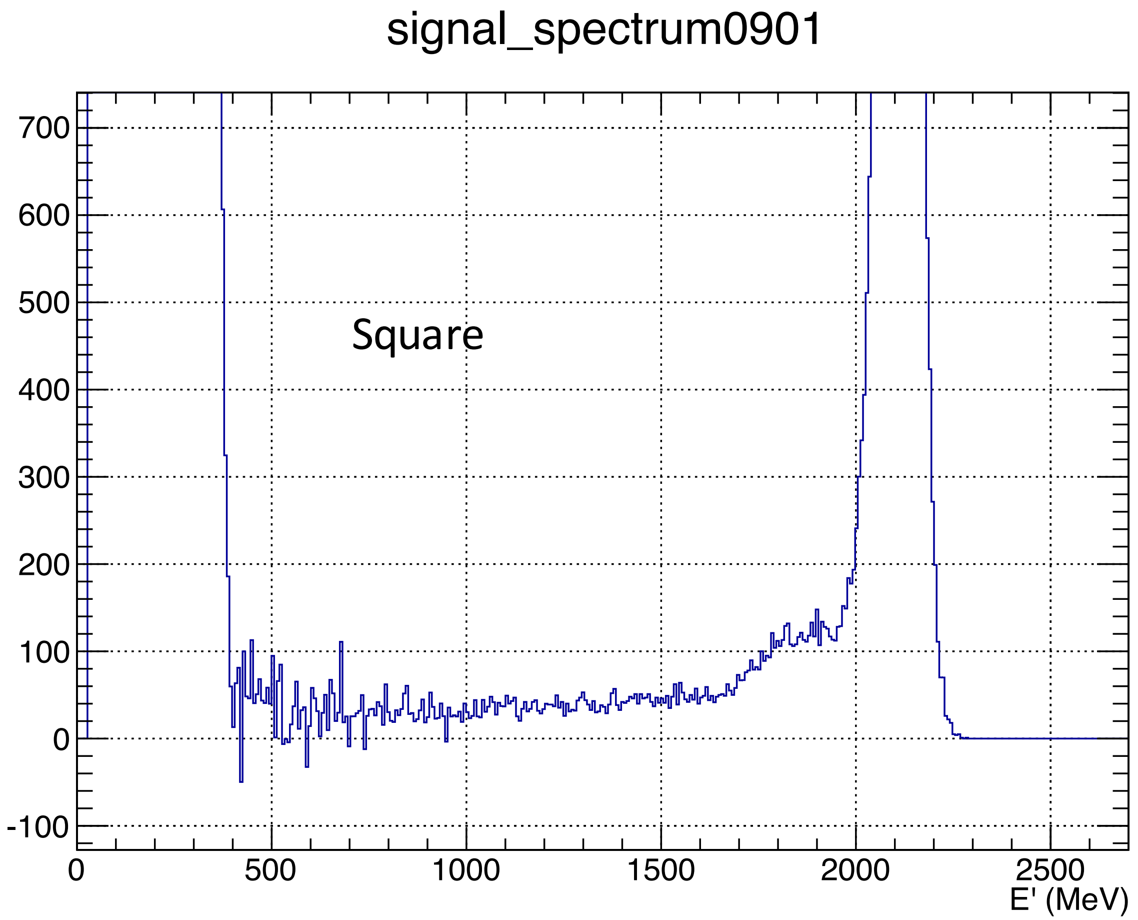
Outermost PWO layer

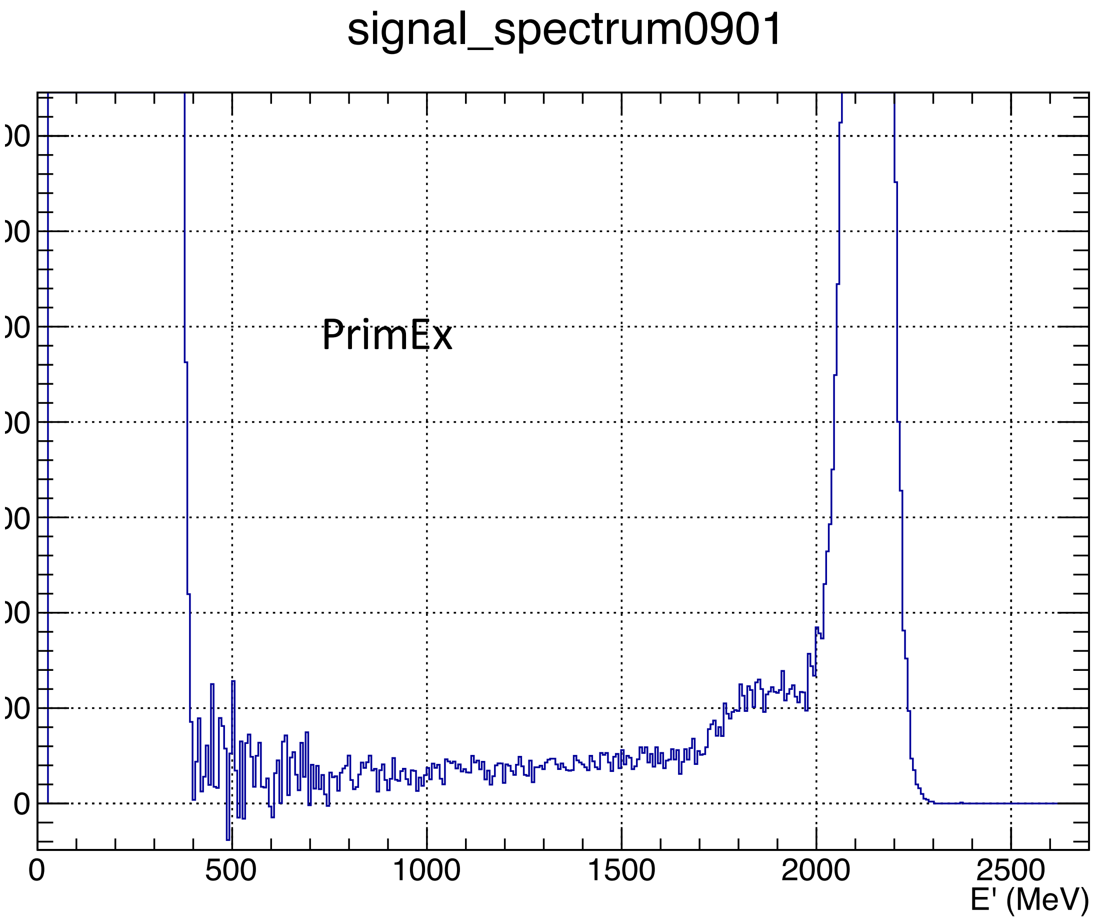




Square (5 x 5) and PrimEx reconstruction methods

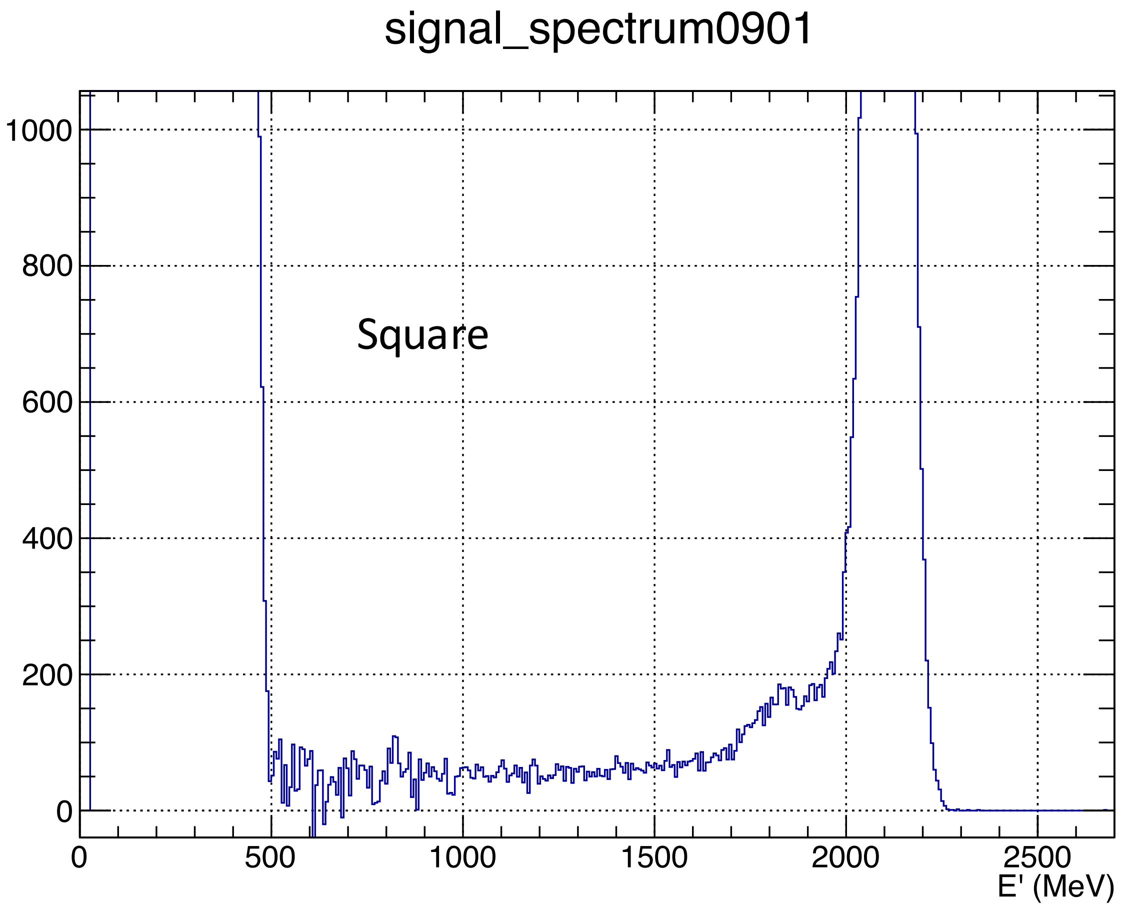
3rd Outermost PWO layer

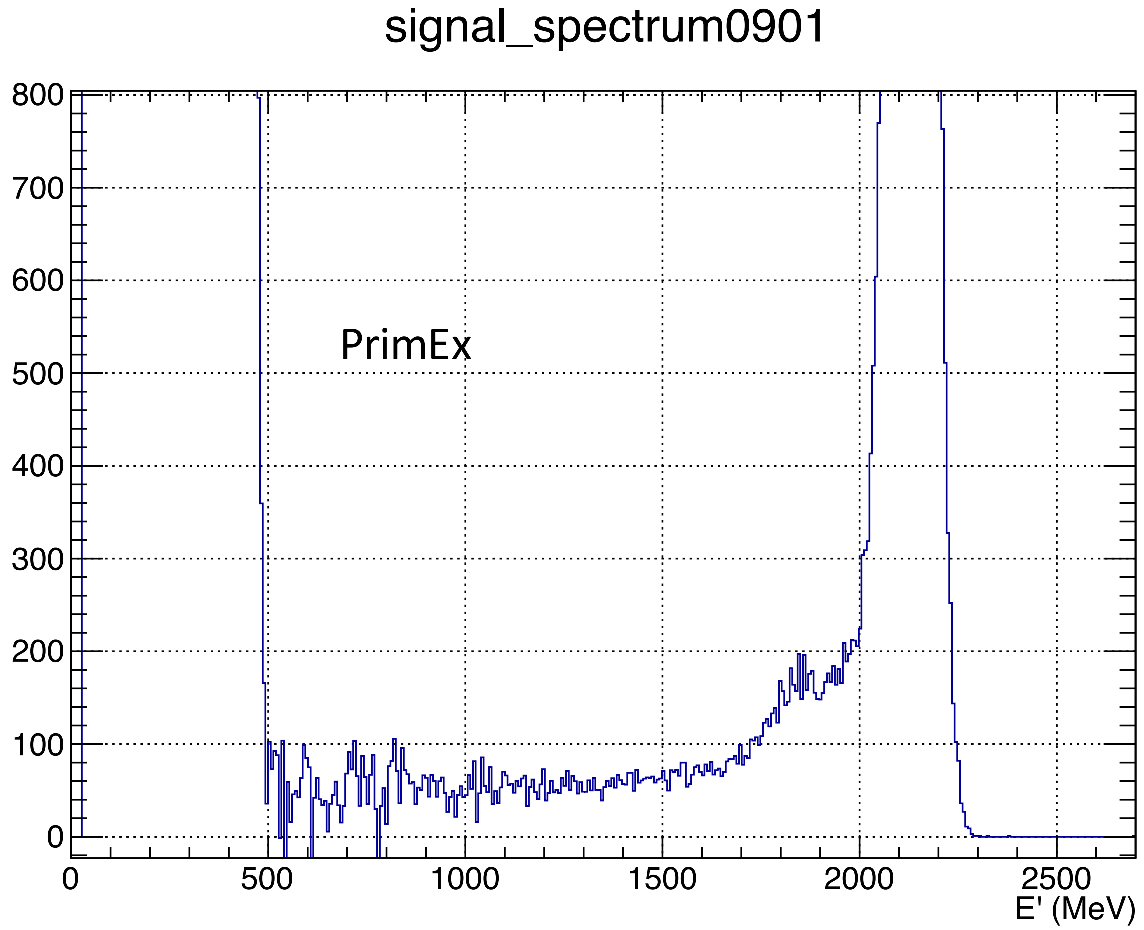




Square (5 x 5) and PrimEx reconstruction methods

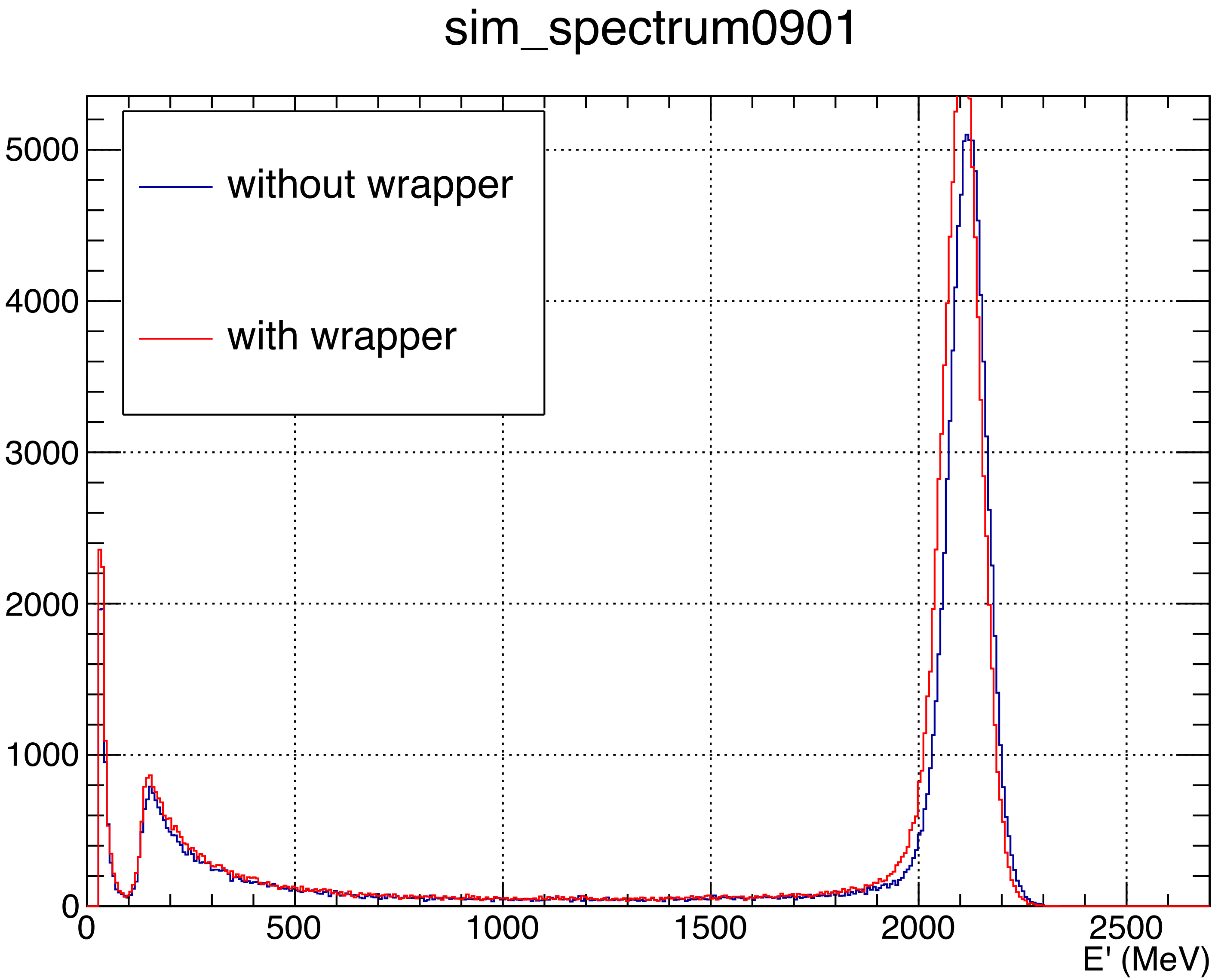
5th Outermost PWO layer





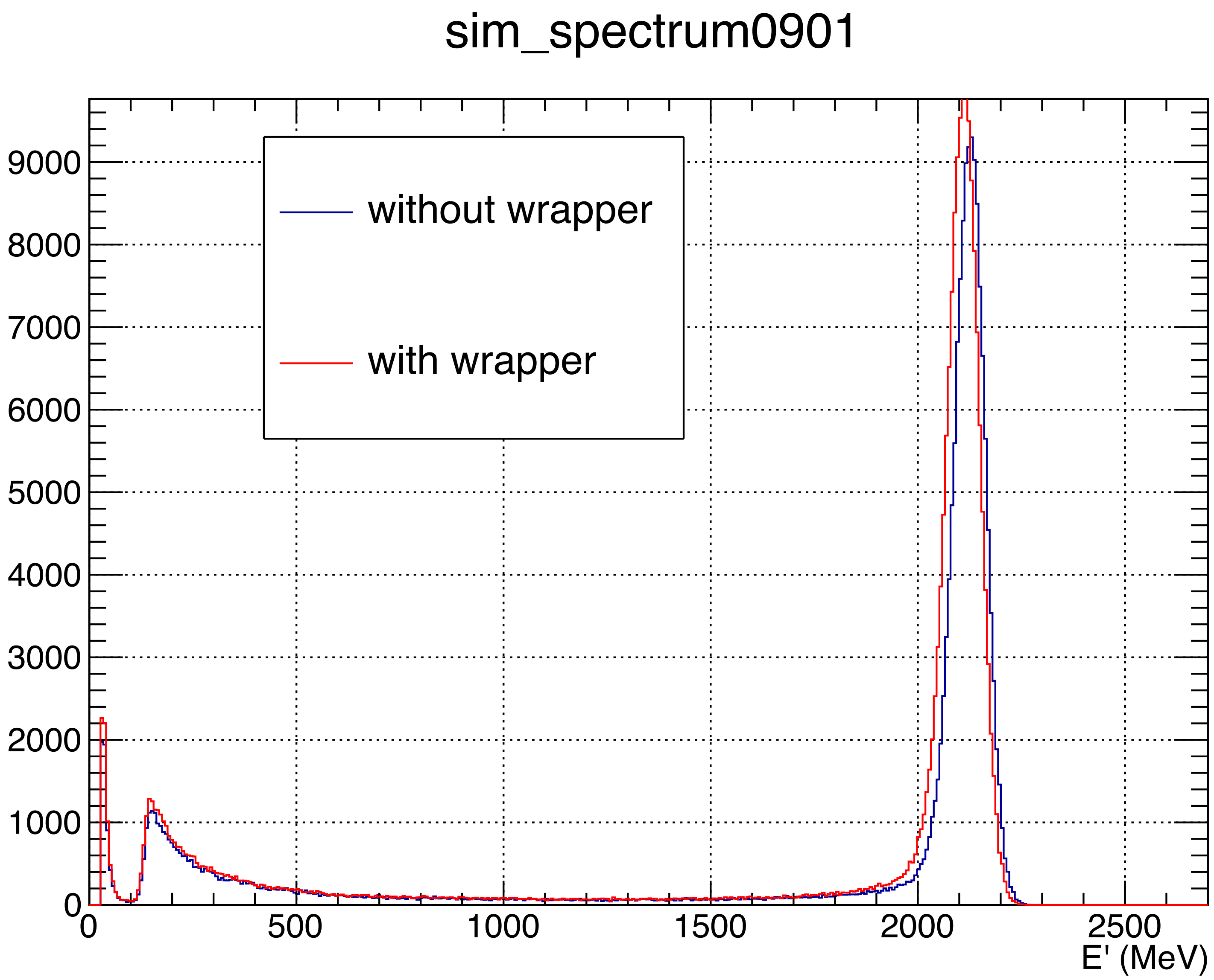
Effect of module wrapper in simulation

Outermost PWO layer



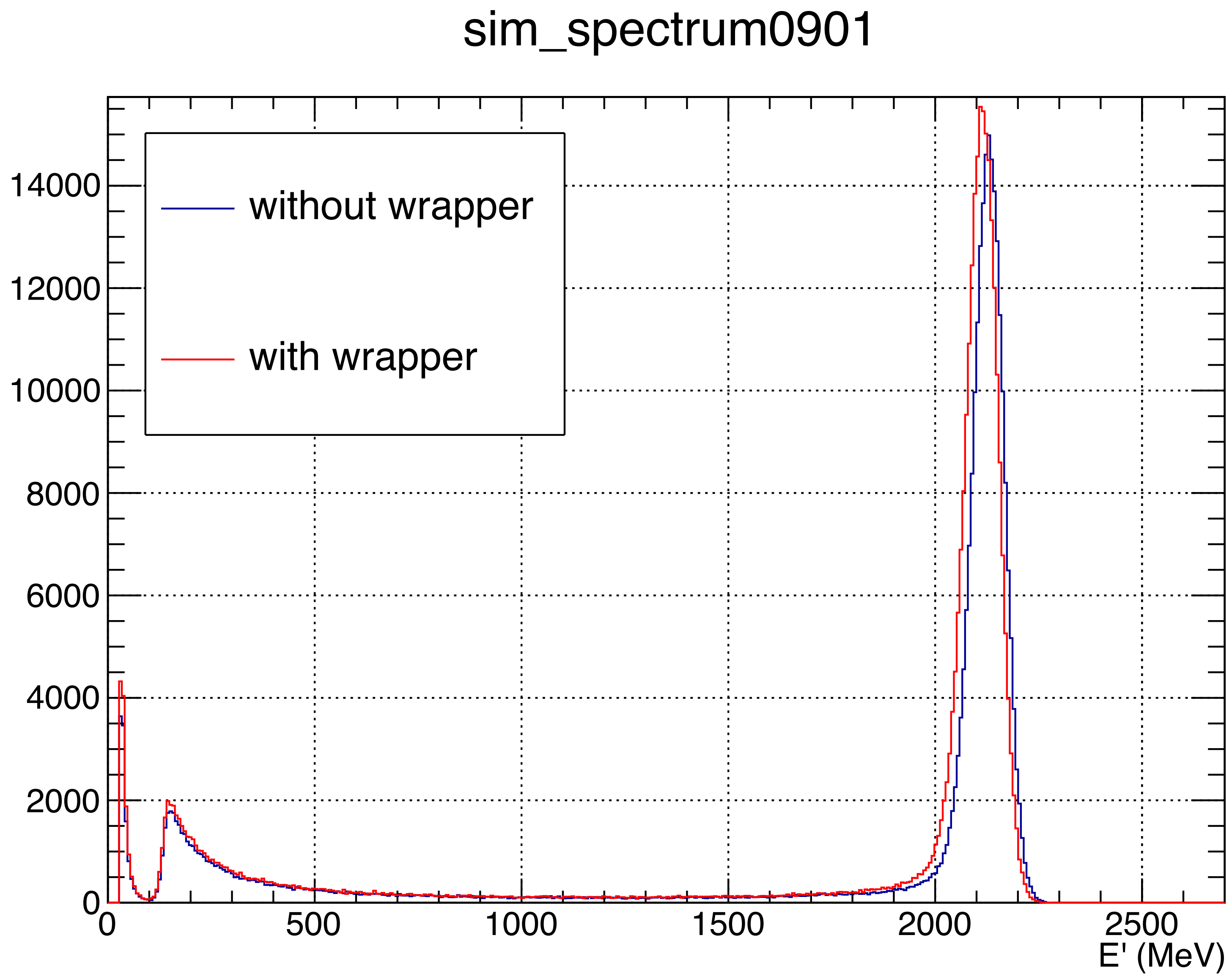
Effect of module wrapper in simulation

3rd Outermost PWO layer



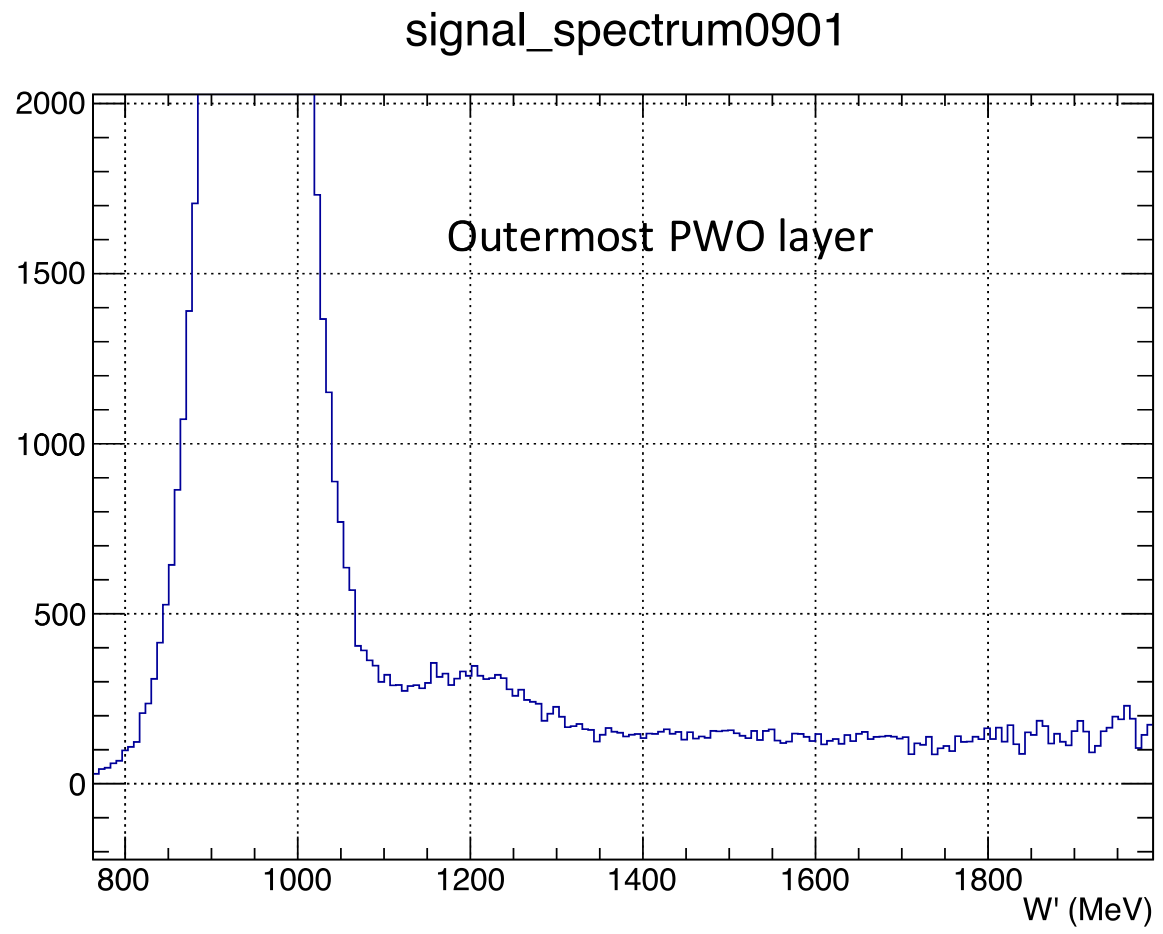
Effect of module wrapper in simulation

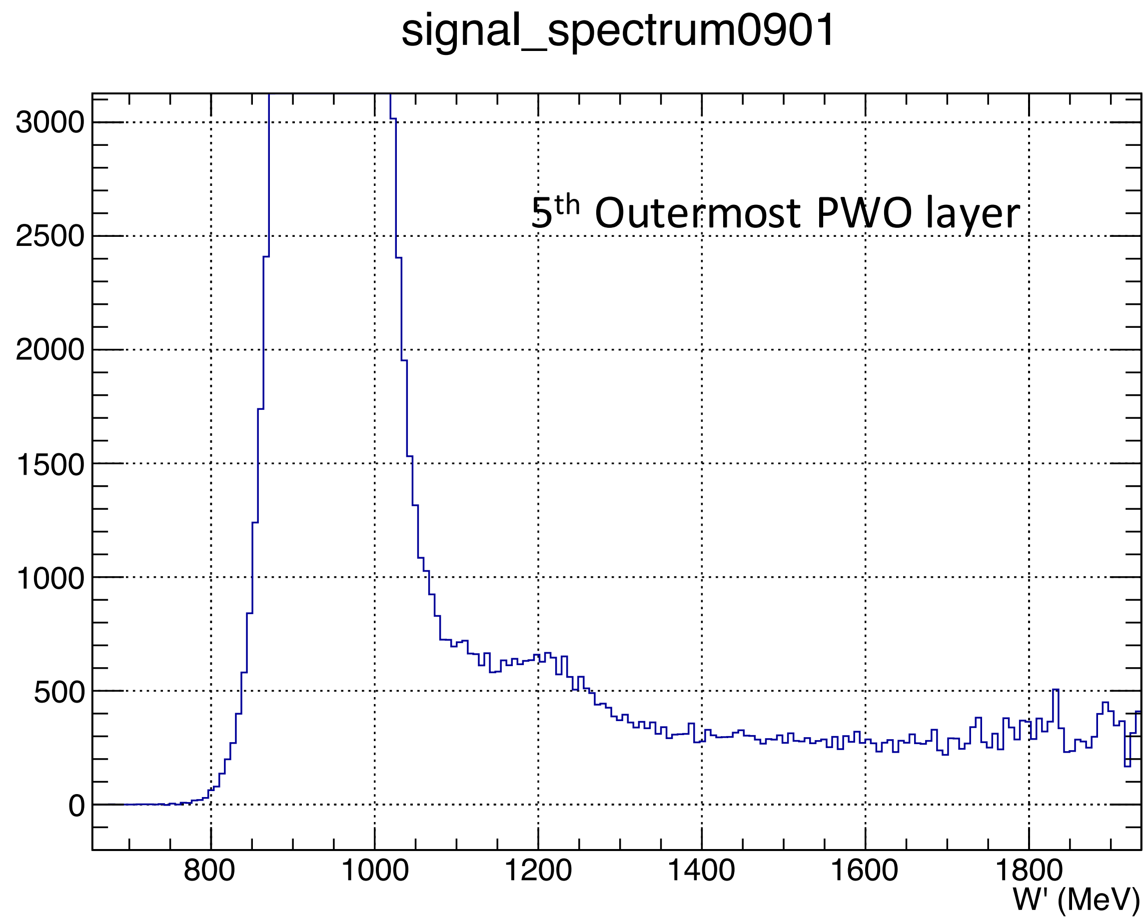
5th Outermost PWO layer



W spectrum of X

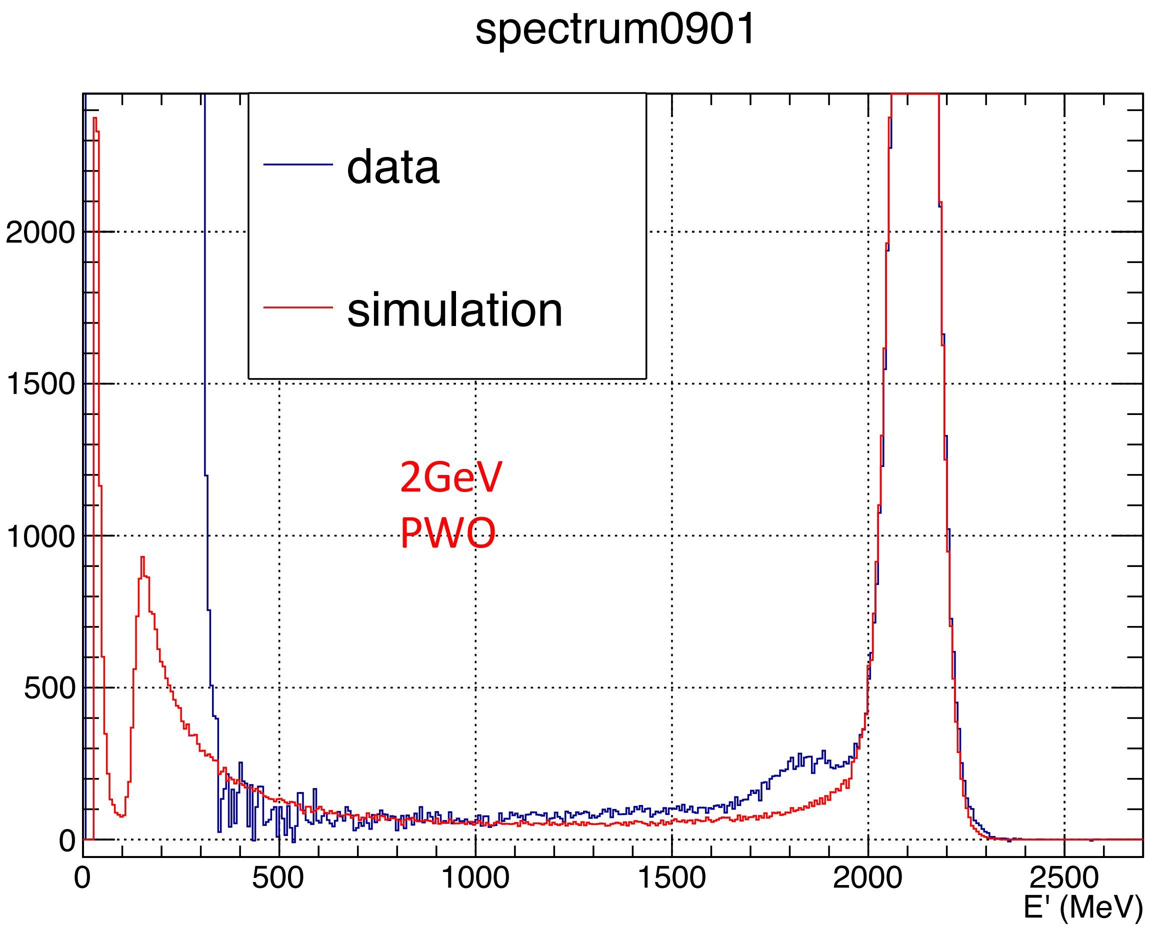
$$W = \sqrt{M_P^2 + 2M_P(E - E') - Q^2}$$

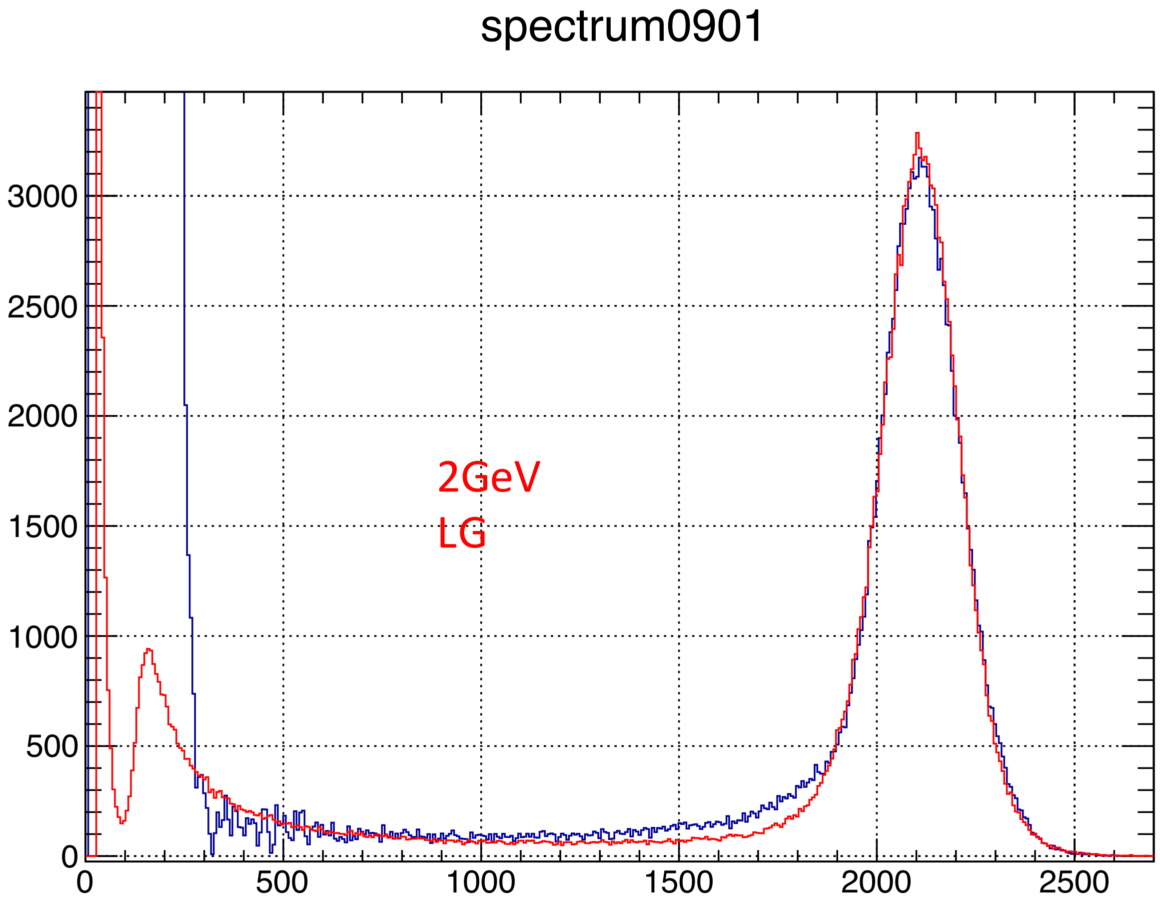




MC vs data near transition region

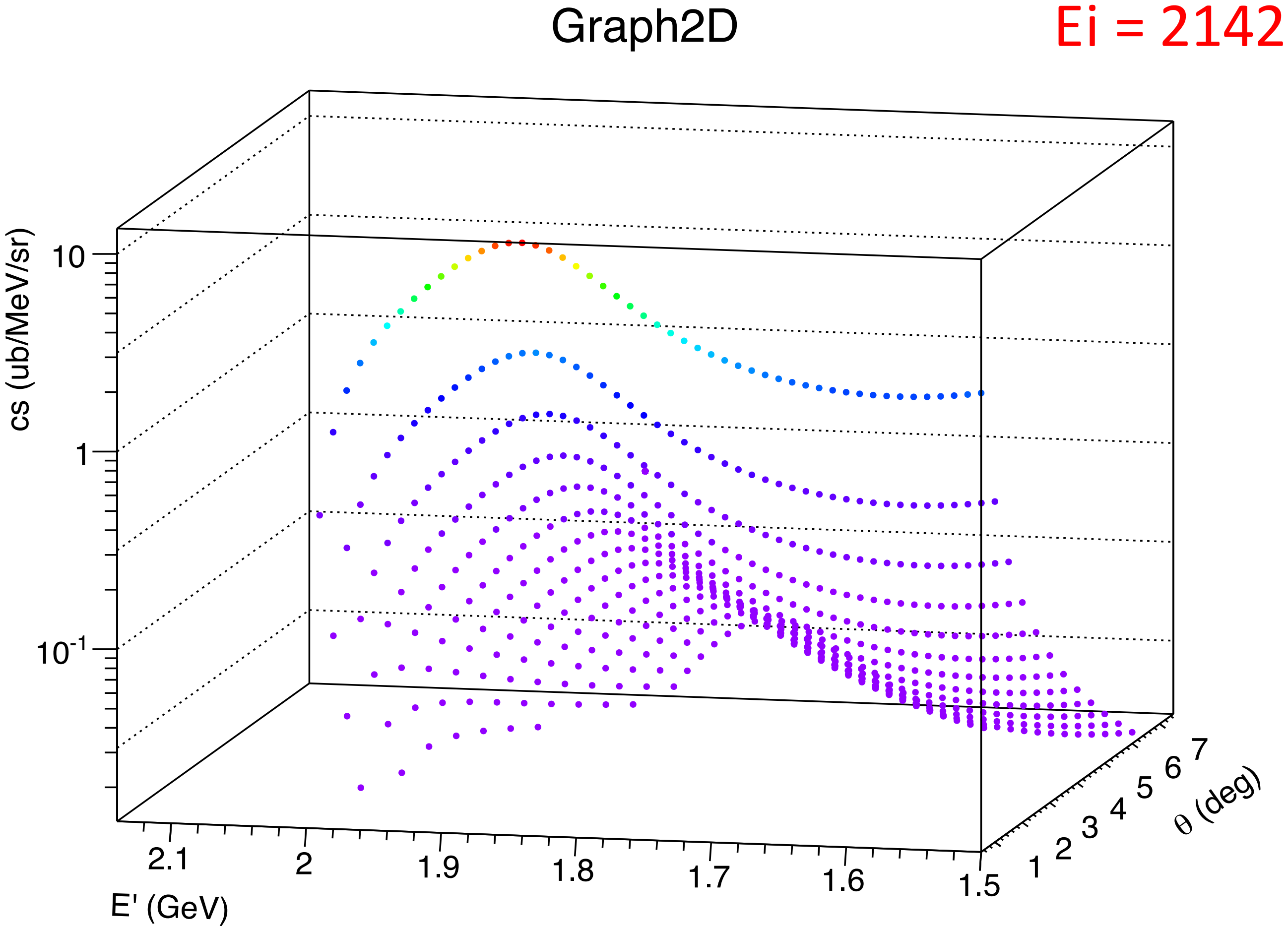
Outermost PWO layer

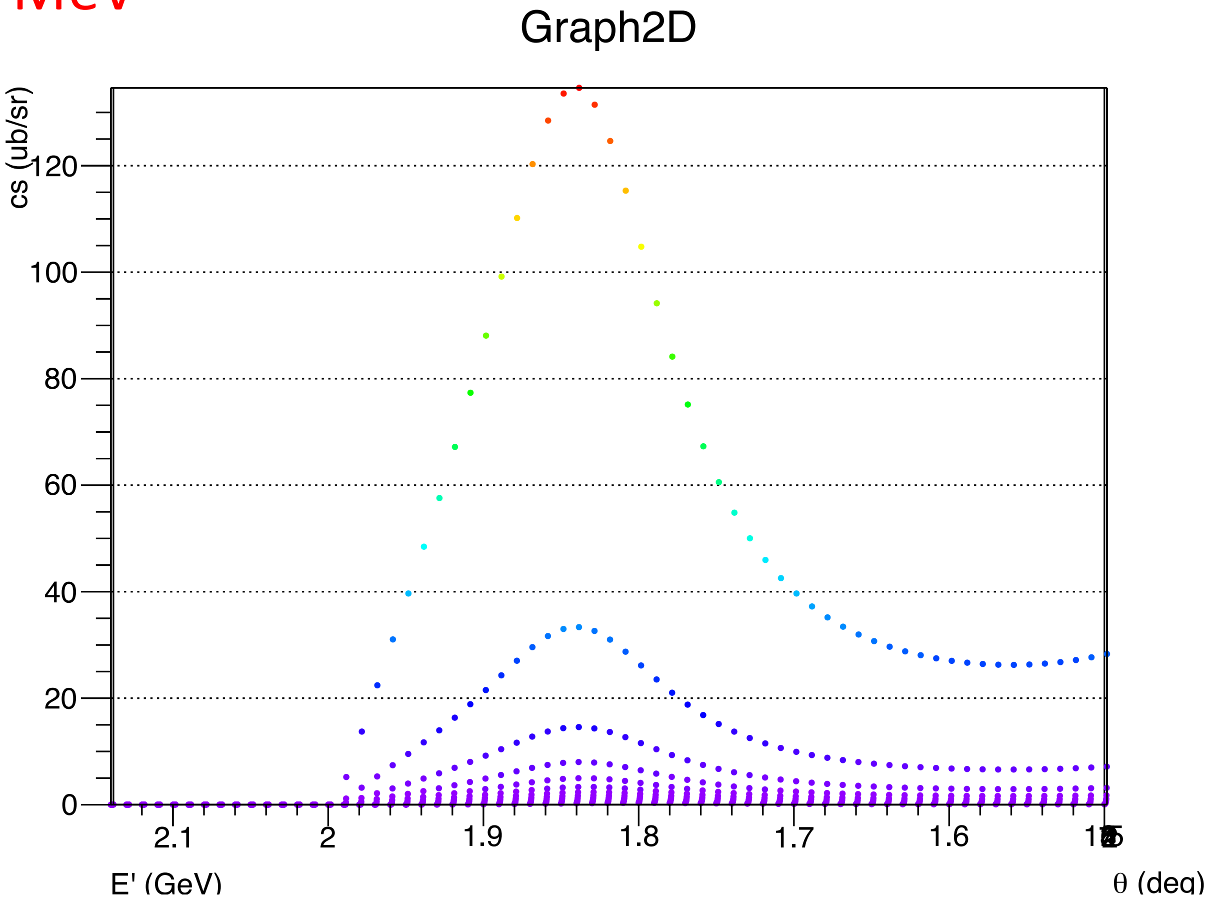




Peter Bosted empirical fit for the inelastic ep cs

Ei = 2142 MeV





In PWO region, our ep cut starts at 2000MeV (4sigma), very close to the spot where the inelastic cs drops to 0.

Inelastic event will only leak into the elastic cut through detector resolution

In LG region, ep cut starts at 1780 MeV, which has included the inelastic peak.

Some info about Peter Bosted inelastic ep fit

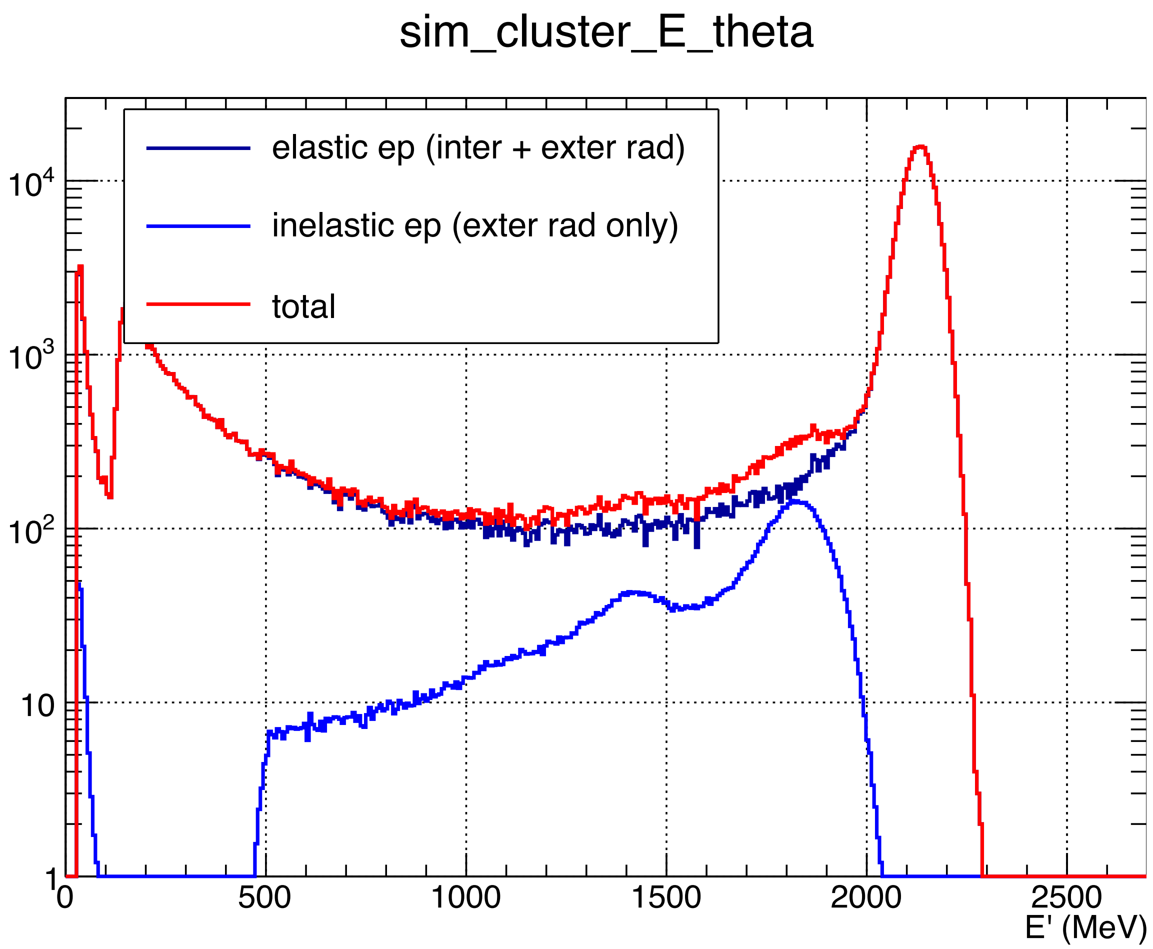
An empirical fit is described to measurements of inclusive inelastic electron-proton cross sections in the kinematic range of four-momentum transfer $0 \leq Q^2 < 8$ GeV^2 and final state invariant mass $1.1 < W < 3.1$ GeV. The fit is constrained by the recent high precision longitudinal and transverse (L/T) separated cross section measurements from Jefferson Lab Hall C, un-separated Hall C measurements up to $Q^2 \approx 7.5$ GeV^2, and photoproduction data at $Q^2 = 0$. Compared to previous fits, the present fit covers a wider kinematic range, fits both transverse and longitudinal cross sections, and features smooth transitions to the photoproduction data at $Q^2 = 0$ and DIS data at high Q^2 and W.

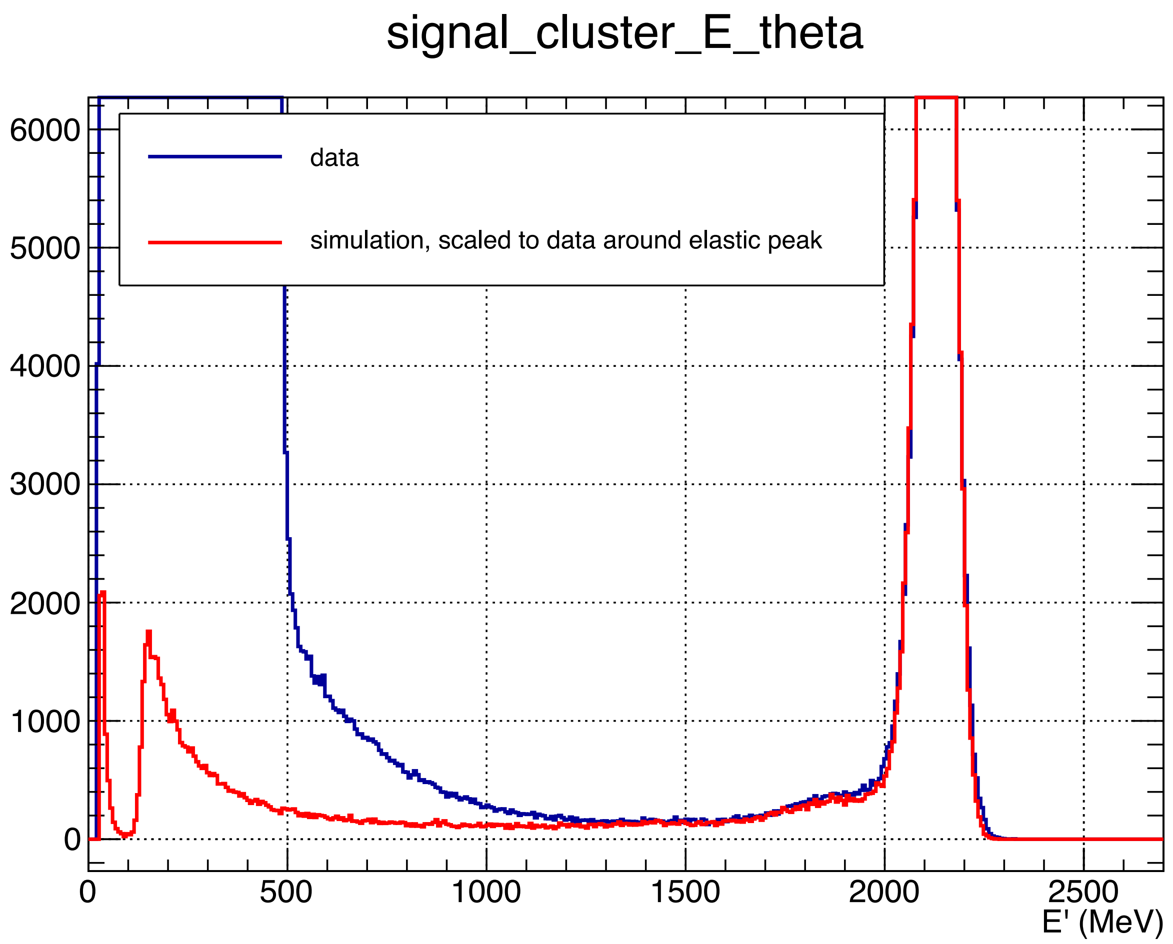
I	State	$\beta_{1\pi}$	$\beta_{2\pi}$	β_{η}
1	$P_{33}(1232)$	1.0	0.0	0.0
2	$S_{11}(1535)$	0.45	0.10	0.45
3	$D_{13}(1520)$	0.65	0.35	0.0
4	$F_{15}(1680)$	0.65	0.35	0.0
5	$S_{15}(1650)$	0.4	0.5	0.1
6	$P_{11}(1440)$	0.65	0.35	0.0
7	($l = 3$ assumed)	0.5	0.5	0.0

TABLE I: Resonance number I, name (and quantum numbers), and branching fractions for the resonant states included in the fit.

Simulation and data comparison including inelastic ep events

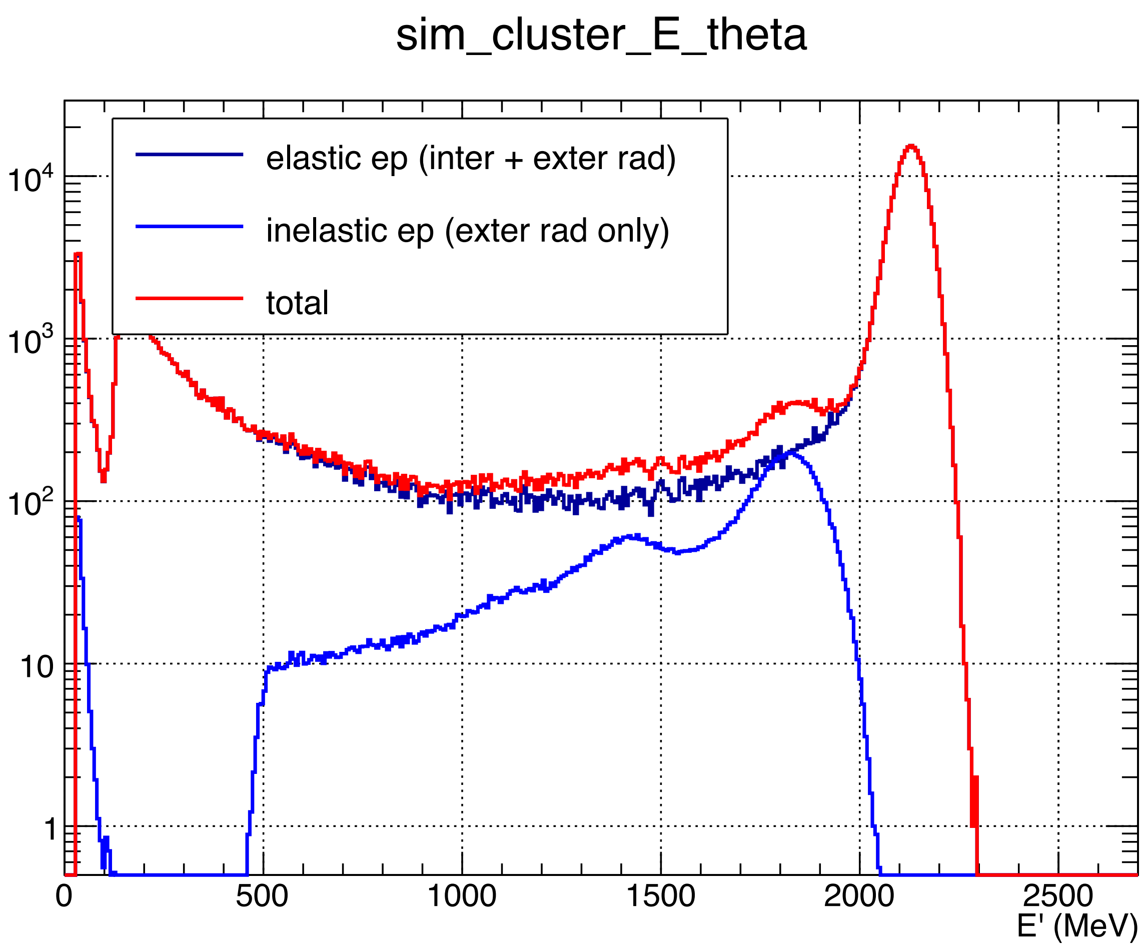
Theta = 2.5 deg

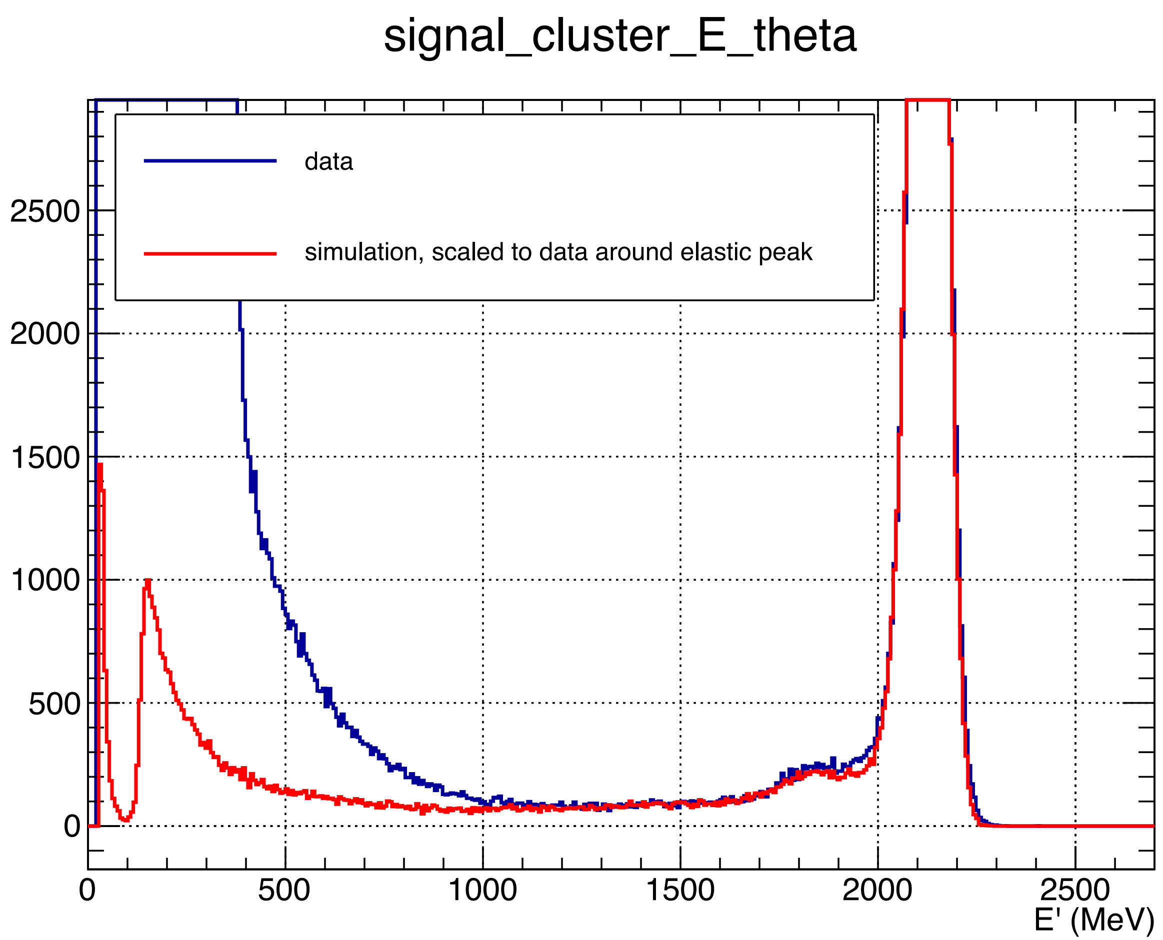




Simulation and data comparison including inelastic ep events

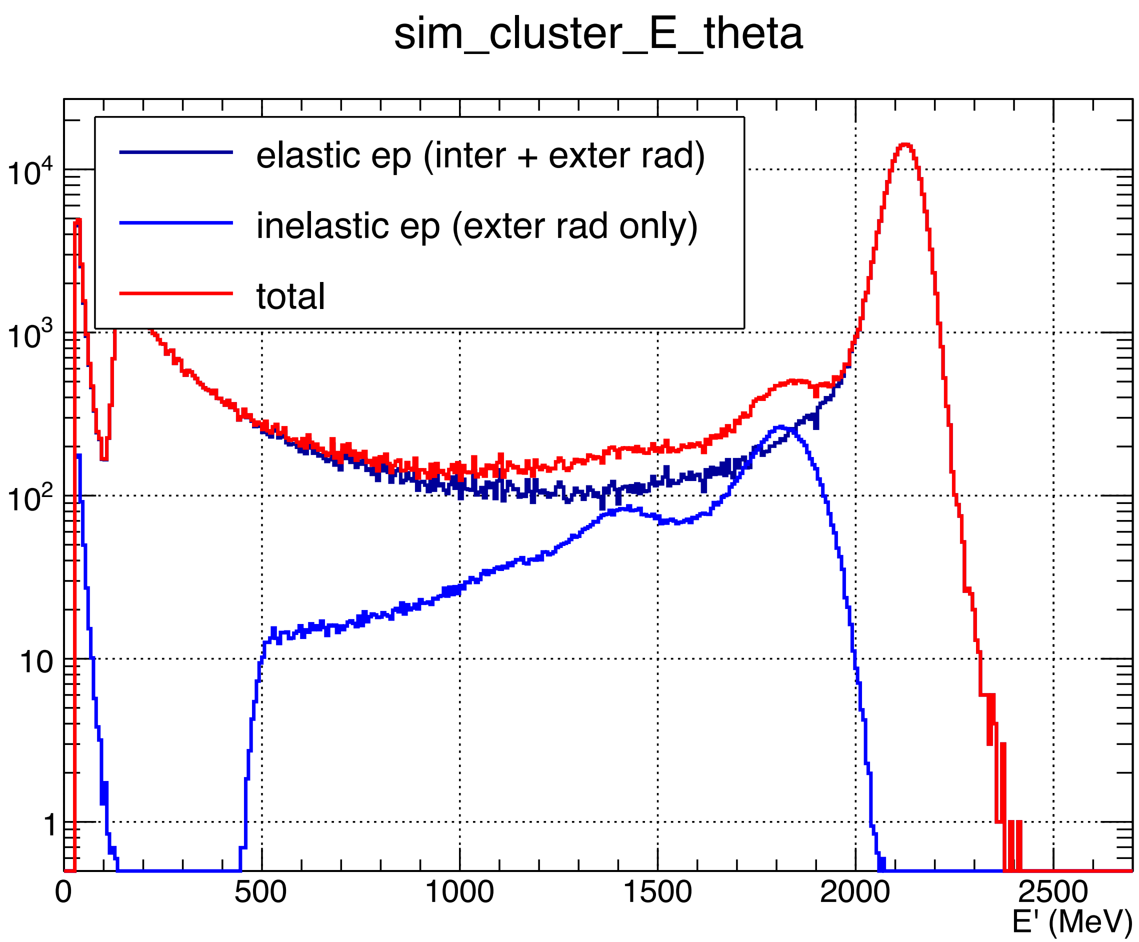
Theta = 3.0 deg

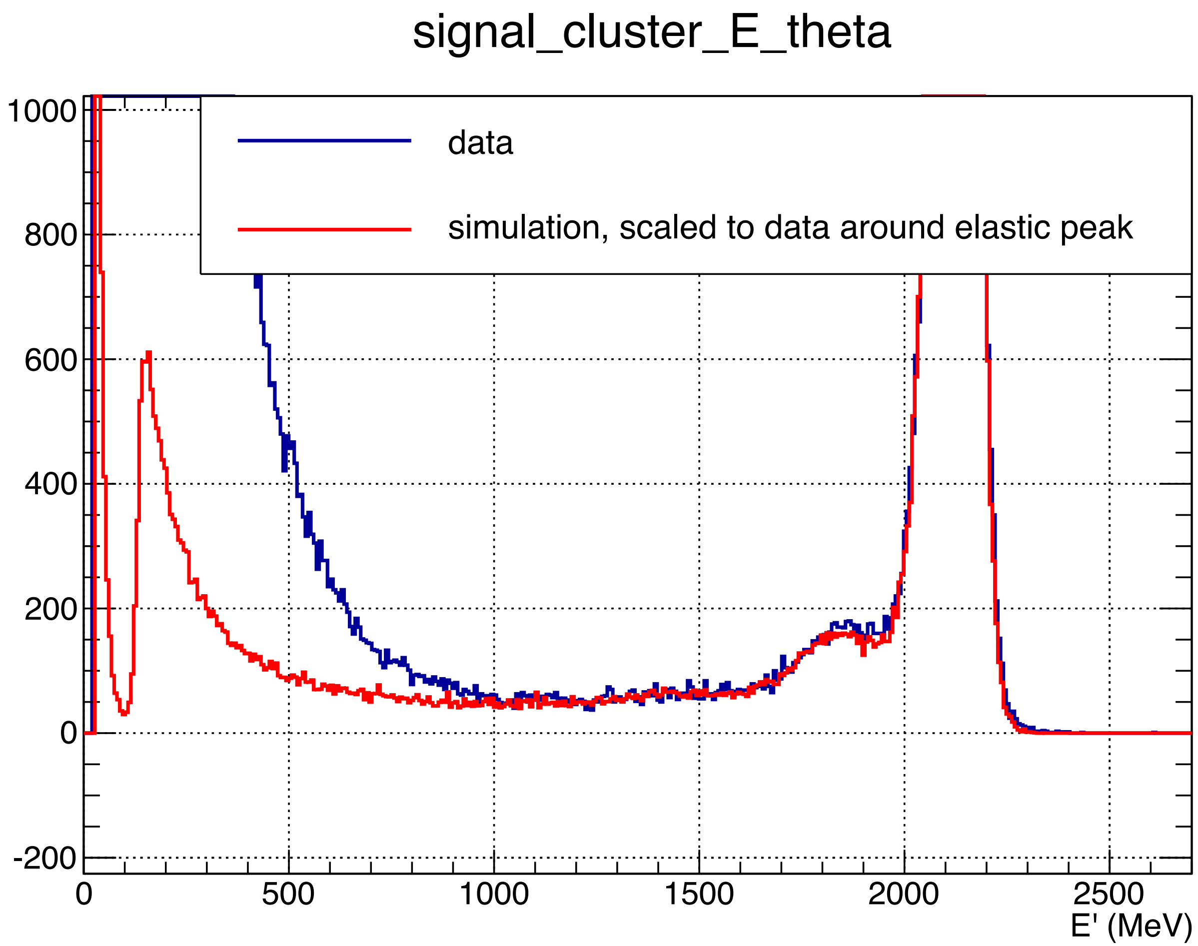




Simulation and data comparison including inelastic ep events

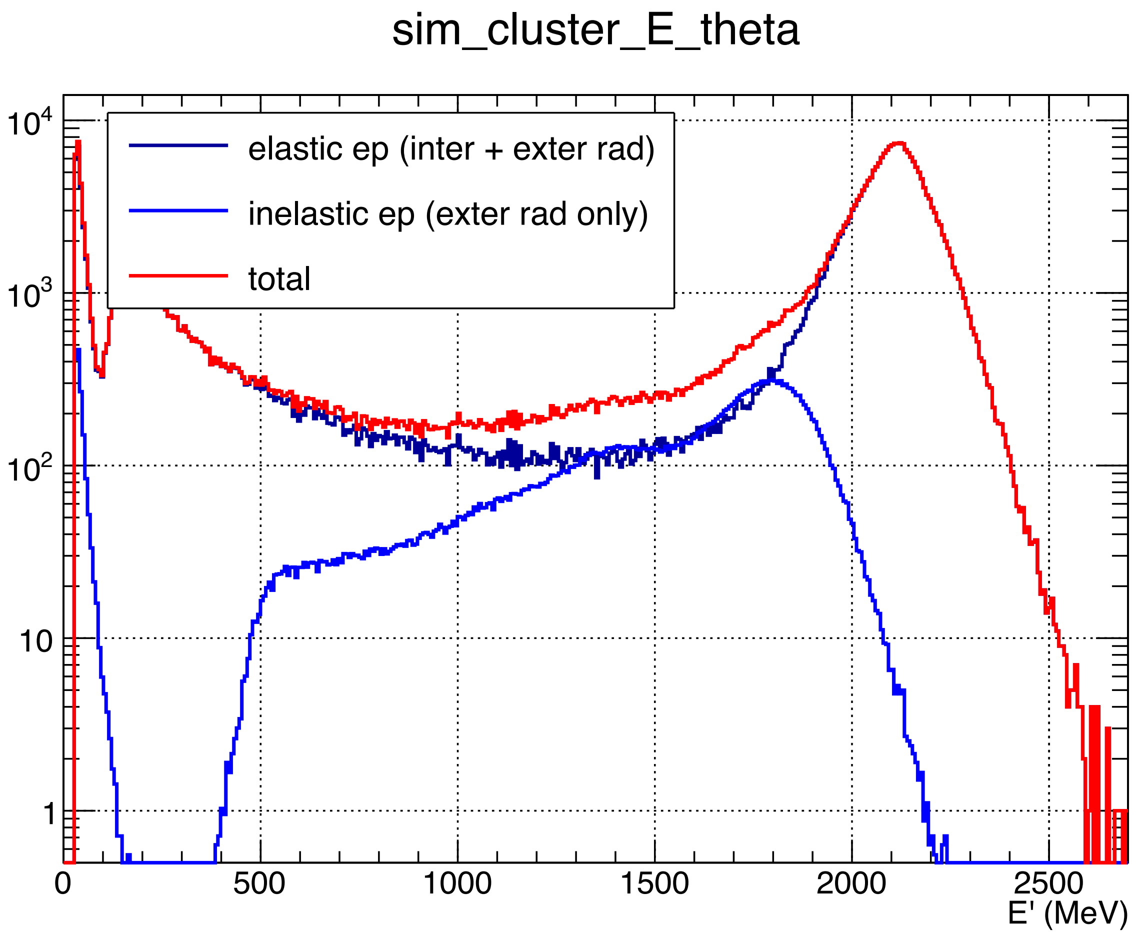
Theta = 3.5 deg

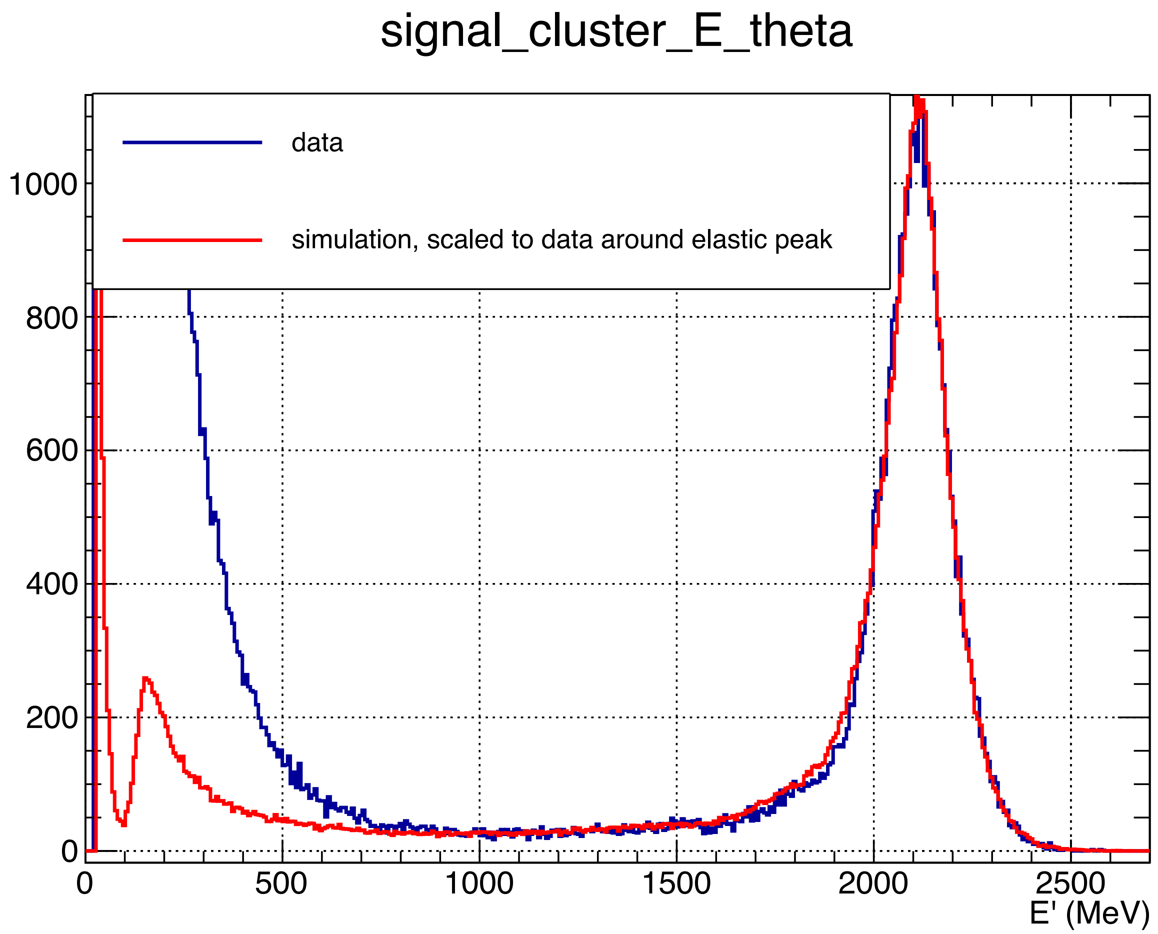




Simulation and data comparison including inelastic ep events

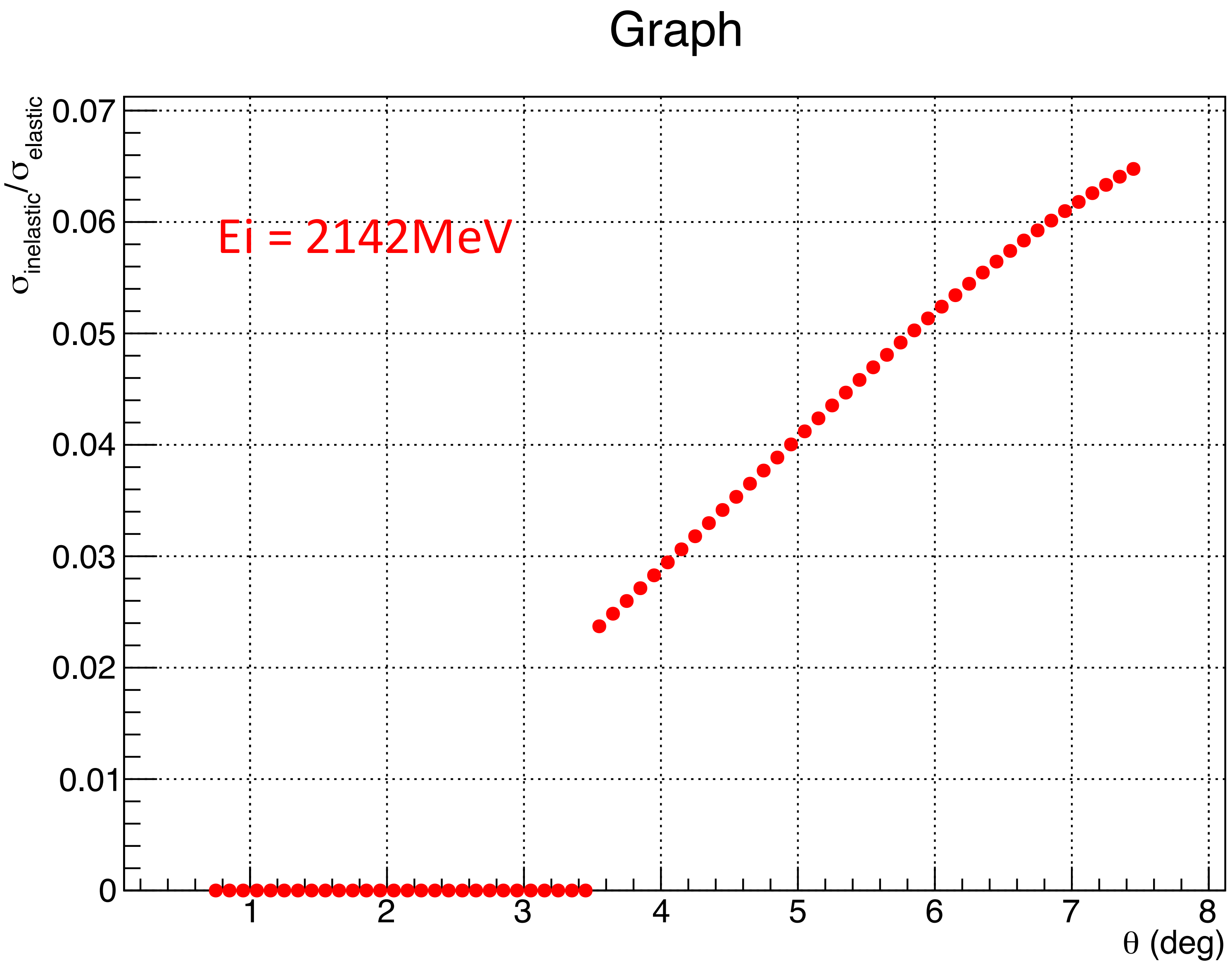
Theta = 4.5 deg





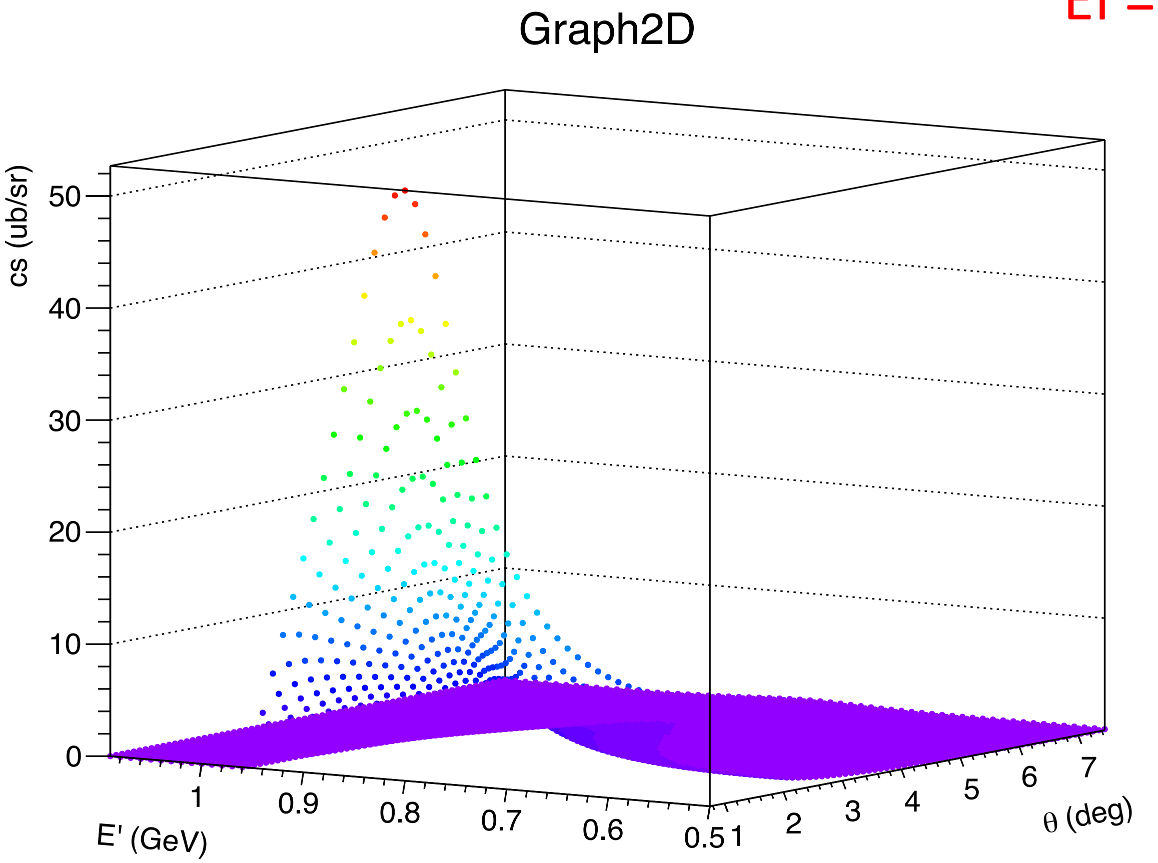
Rough estimation for the inelastic contamination

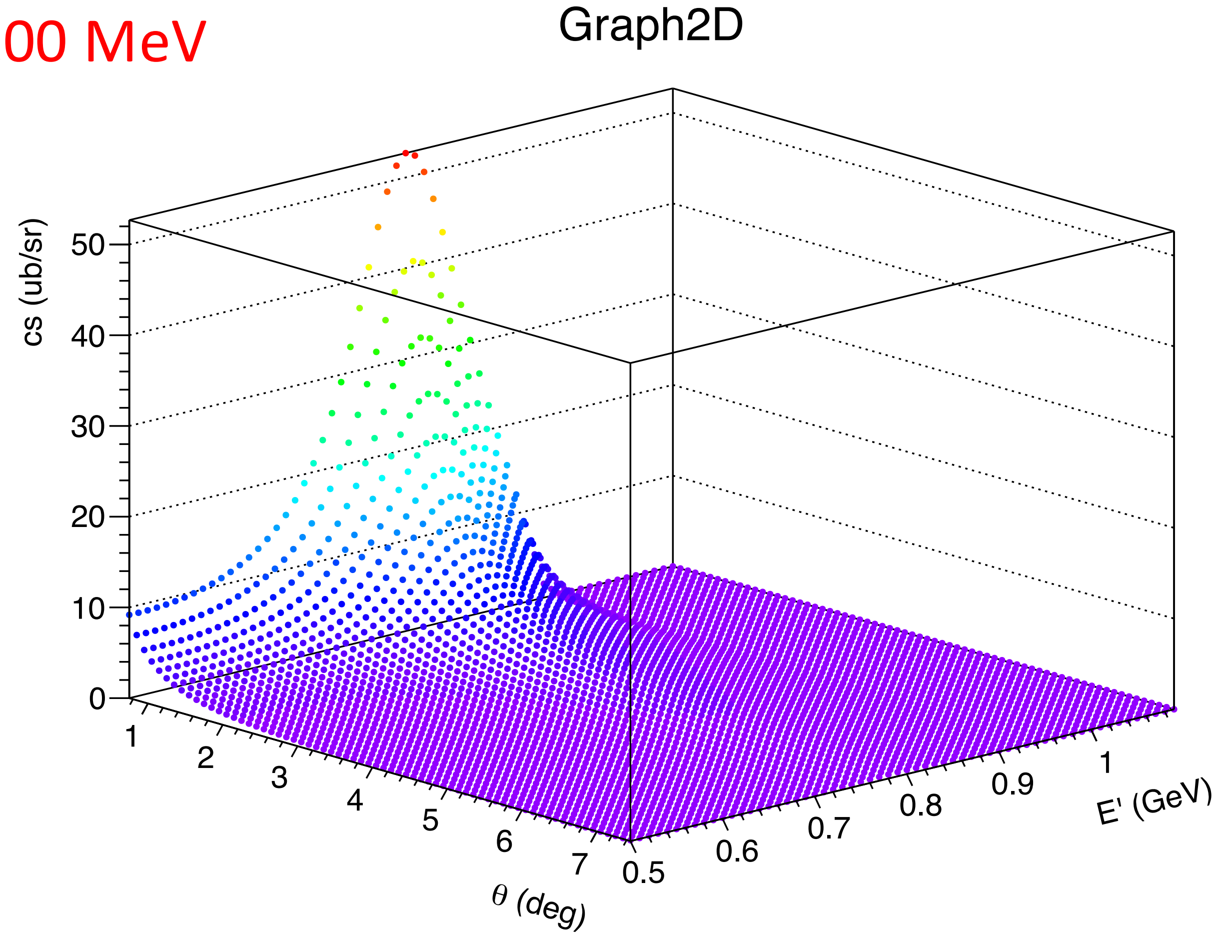
- For theta < 3.5 deg, assume using the PWO cut
- For theta > 3.5, assume using the LG cut
- Elastic cross section based on Zhan's FF
- Inelastic cross section based on the Peter Bosted model for proton
- The inelastic cross section is integrated for the range of the energy cut



Peter Bosted empirical fit for the inelastic ep cs

Ei = 1100 MeV



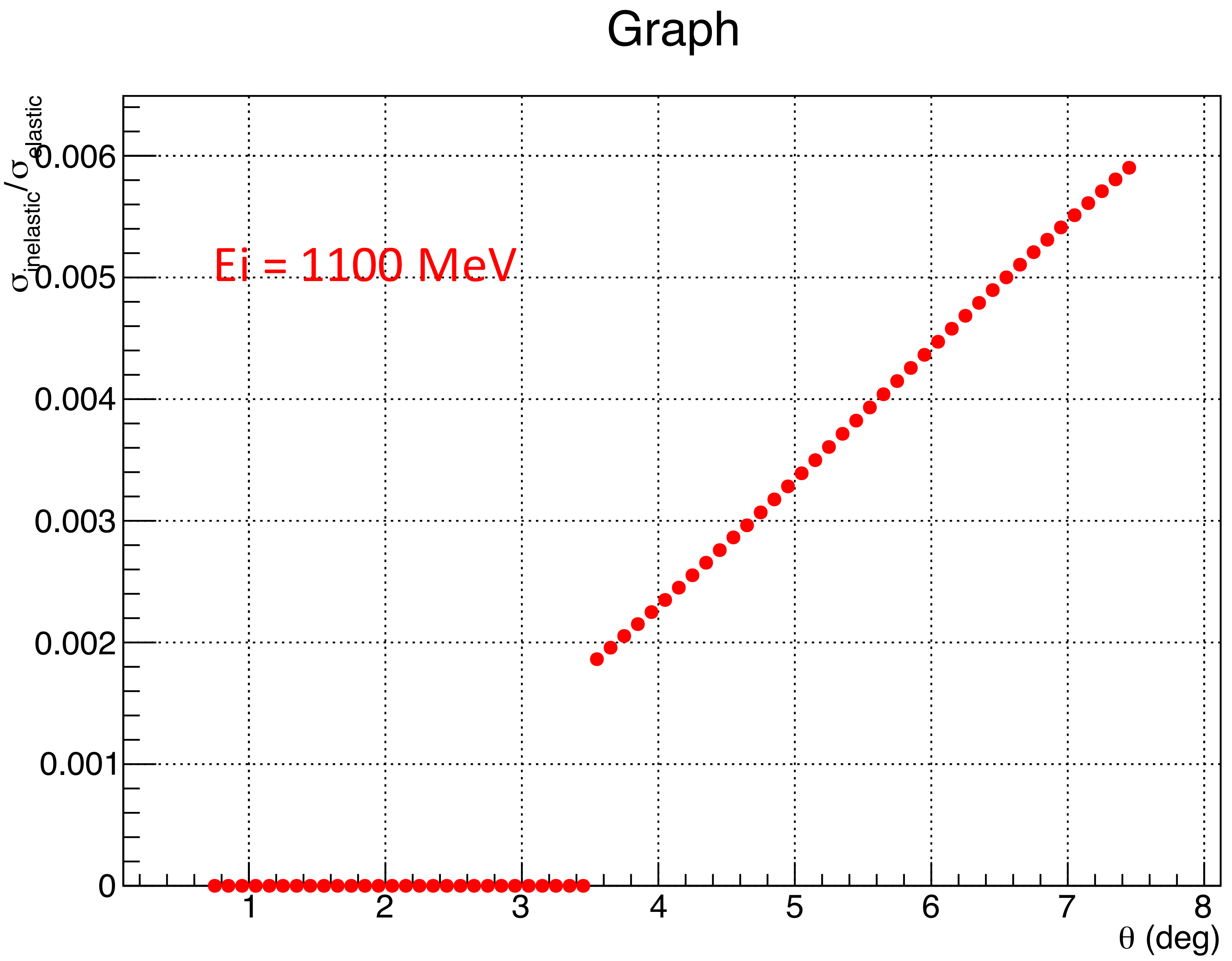


In PWO region, our ep cut starts at 1000MeV (4sigma), at least 50 MeV higher than the spot where inelastic cs drops to 0. Should be safe even for resolution effect

In LG region, ep cut starts at 840 MeV, slightly higher than the inelastic peak (~800 MeV)

Rough estimation for the inelastic contamination

- For theta < 3.5 deg, assume using the PWO cut
- For theta > 3.5, assume using the LG cut
- Elastic cross section based on Zhan's FF
- Inelastic cross section based on the Peter Bosted model for proton
- The inelastic cross section is integrated for the range of the energy cut



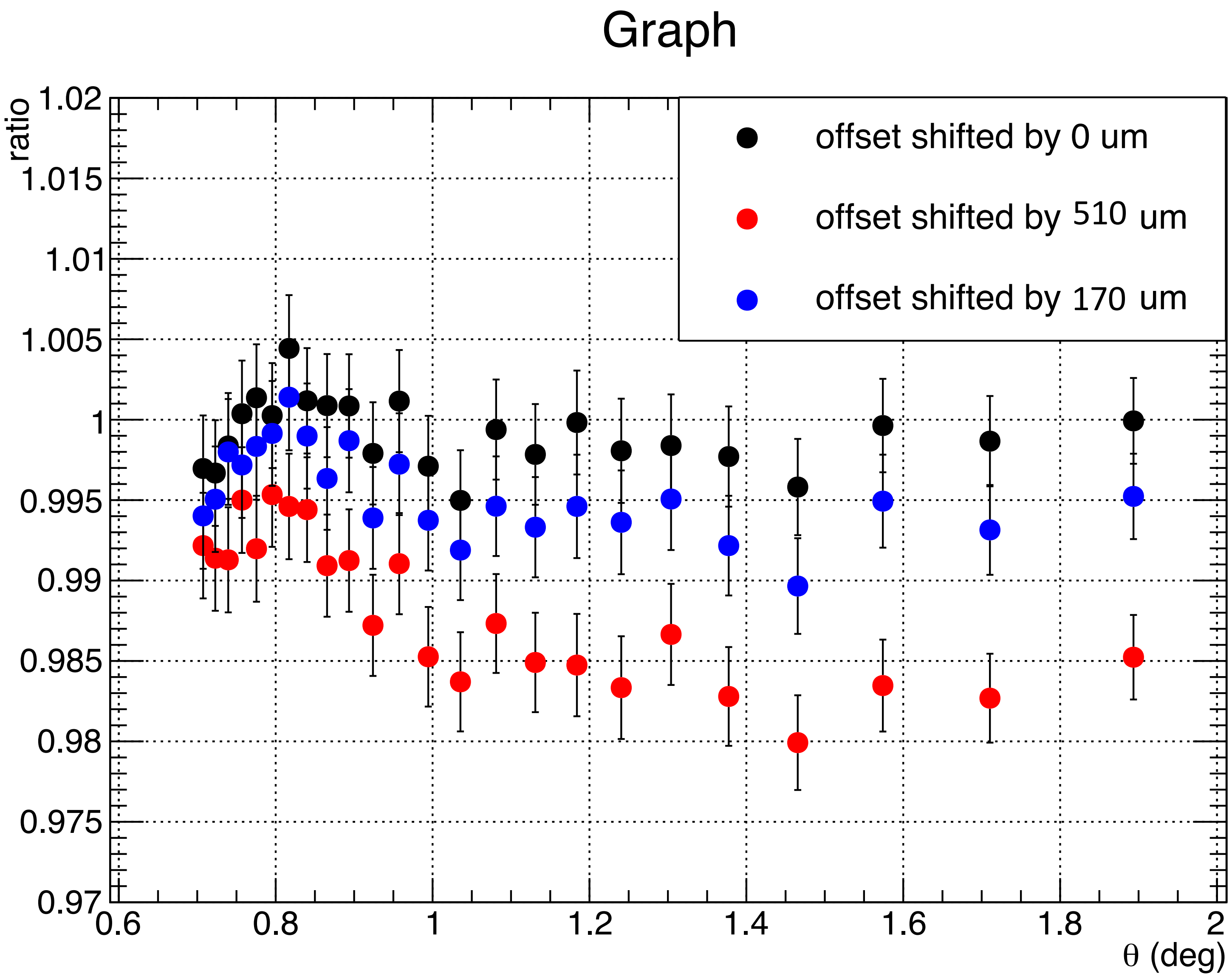
Summary for inelastic ep part

- This study rules out the possibility that the bump near ep elastic peak is due to reconstruction algorithm or missing wrapper in the simulation
- The bump agree reasonably well with the Peter Bosted inelastic ep model, both in peak location and amplitude, which suggests that this bump is indeed come from inelastic ep
- Inelastic ep contamination is expected to be very small 2GeV PWO region and entire 1GeV.
- ~4-5% contamination is expected in the 2GeV LG region

- We need a detailed inelastic ep generator including internal radiative effect
- The precision of the generator is better be less or around 10% in order to keep the uncertainty of this correction below 0.5%

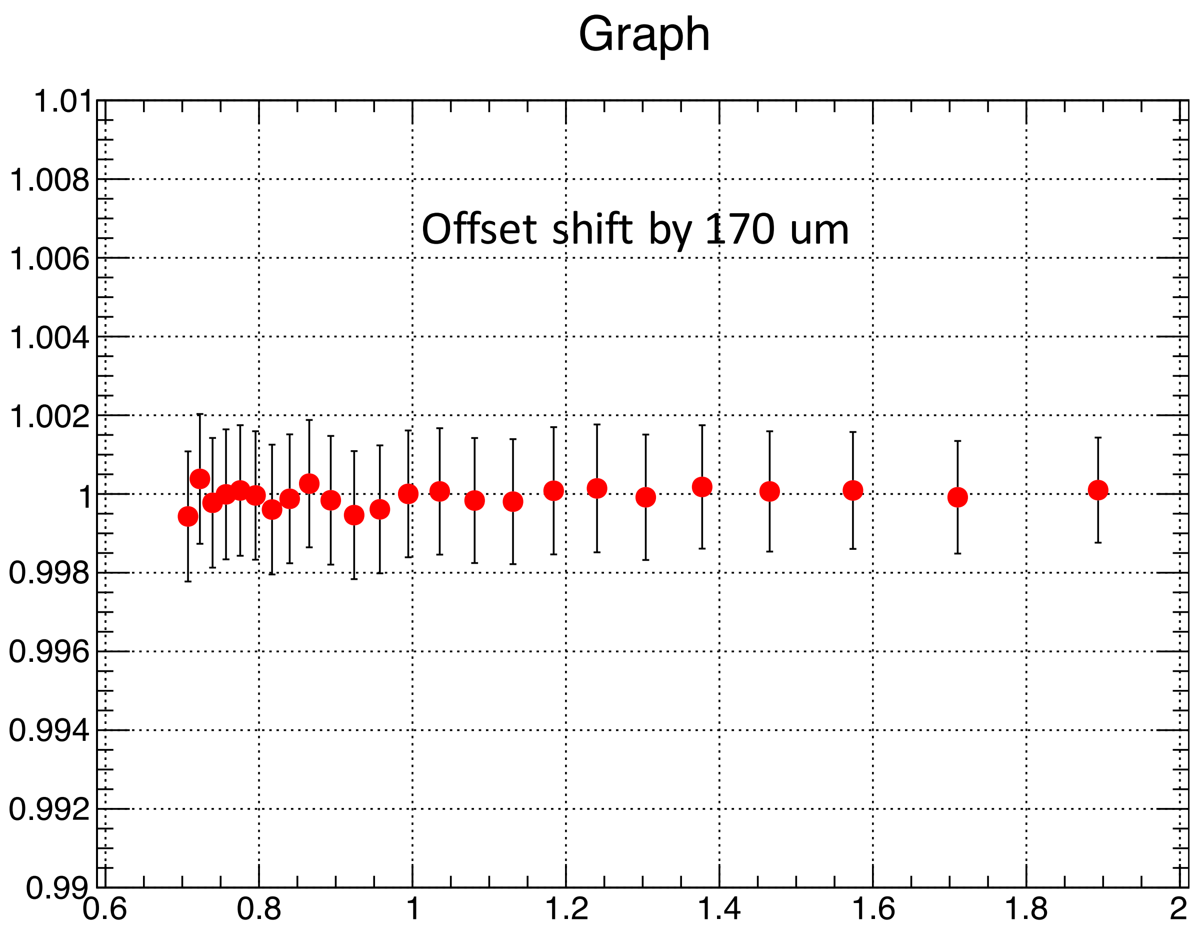
Effect of offset shift to ep/ee ratio in different quadrant

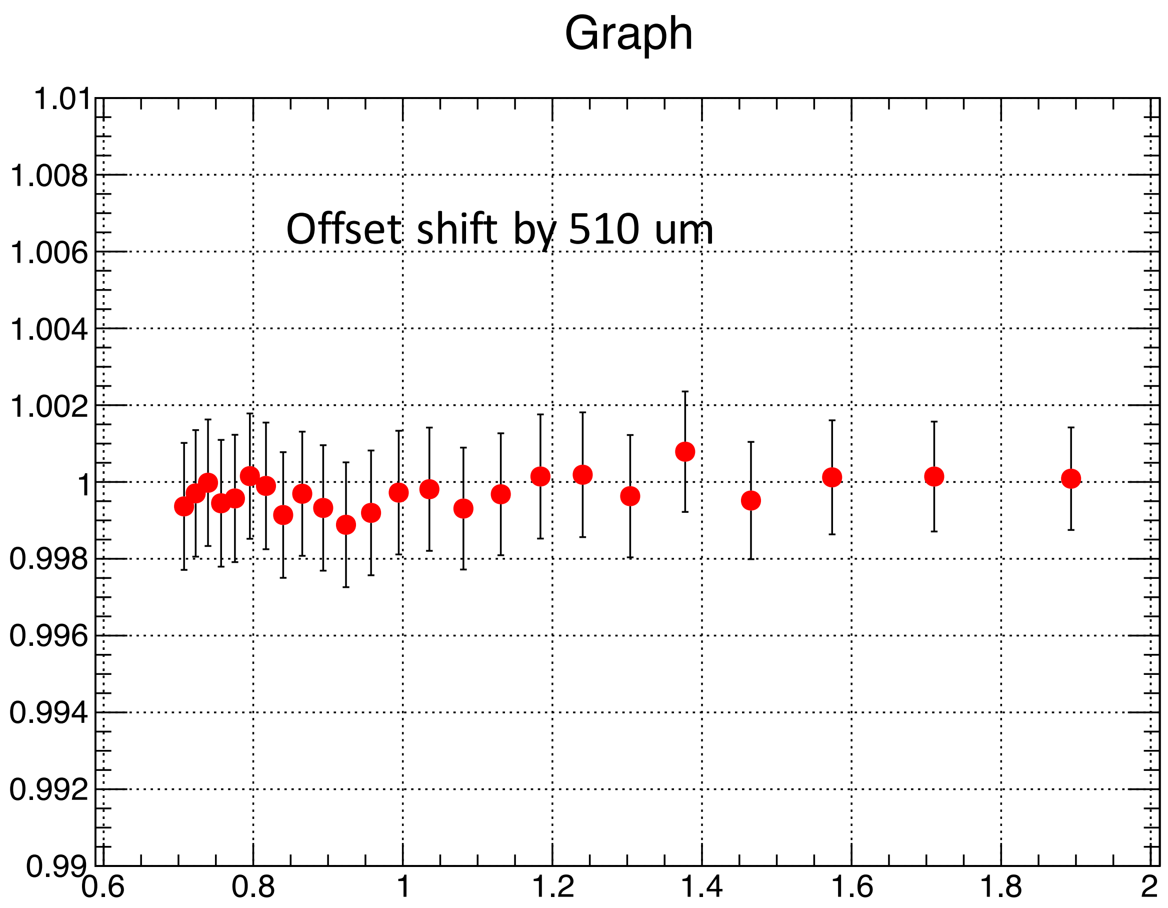
- According to the old offset table, beam spot is at (-0.89712, -1.45704) in the HyCal frame
- In the simulation, we set the beam spot at this position
- In the analysis, we assume the offset is something different from the input value to get the effect of wrong offset
- For the study, the assumed offset position is shifting along the line between beam spot and hycal center



Effect of offset shift to ep/ee ratio

If we use the full azimuthal angle, due to some averaging effect, the ratio is not very sensitive to the offset shift

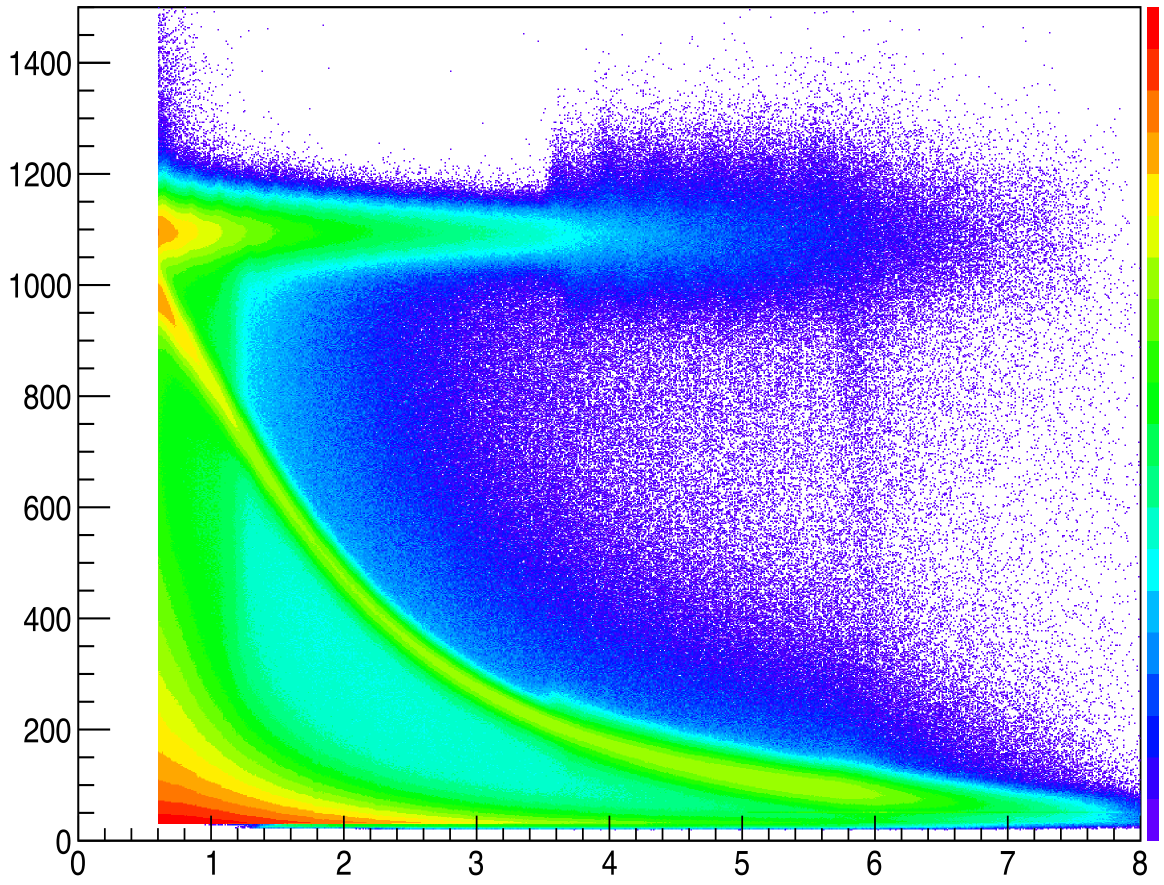




Problem in simulation near transition region

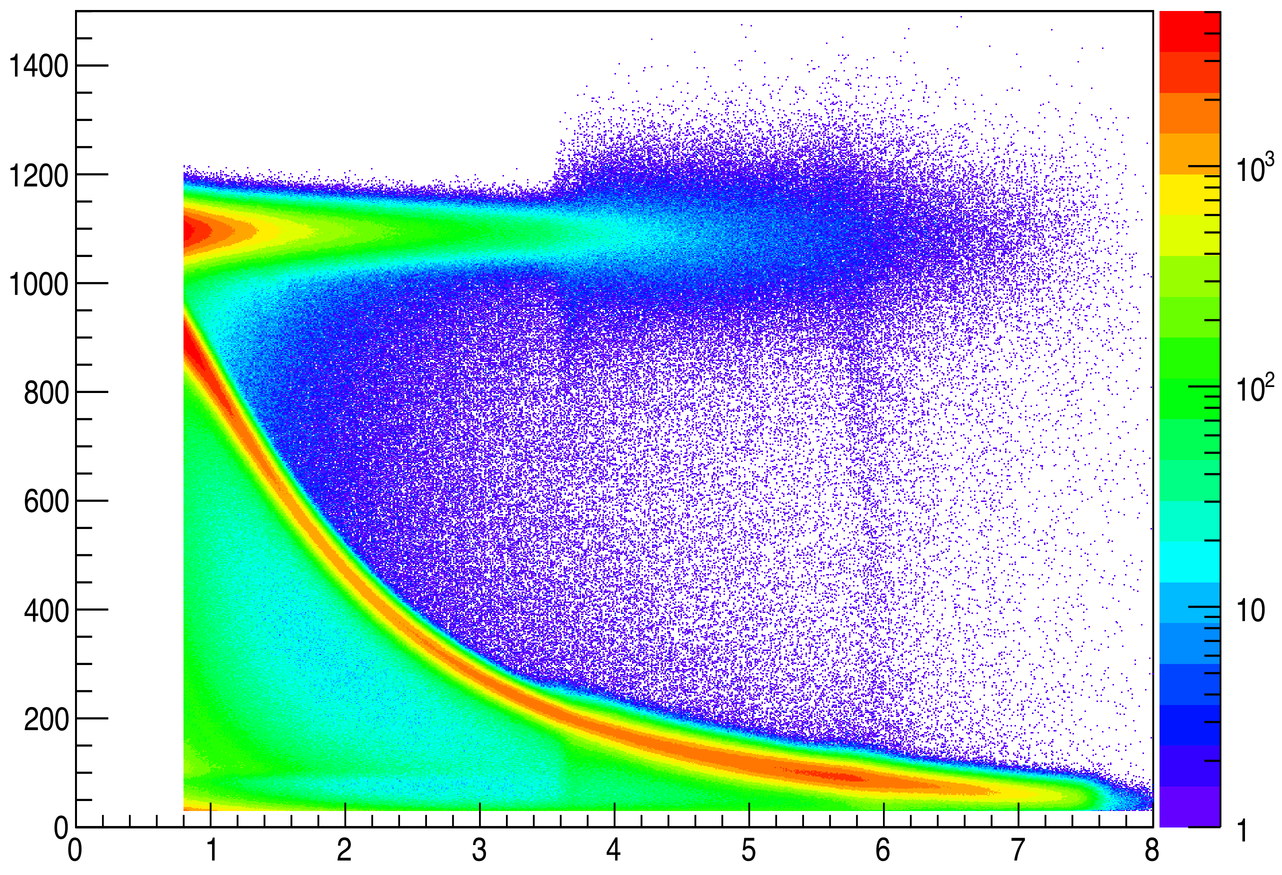
1 GeV data

signal_cluster_E_theta



1 GeV simulation

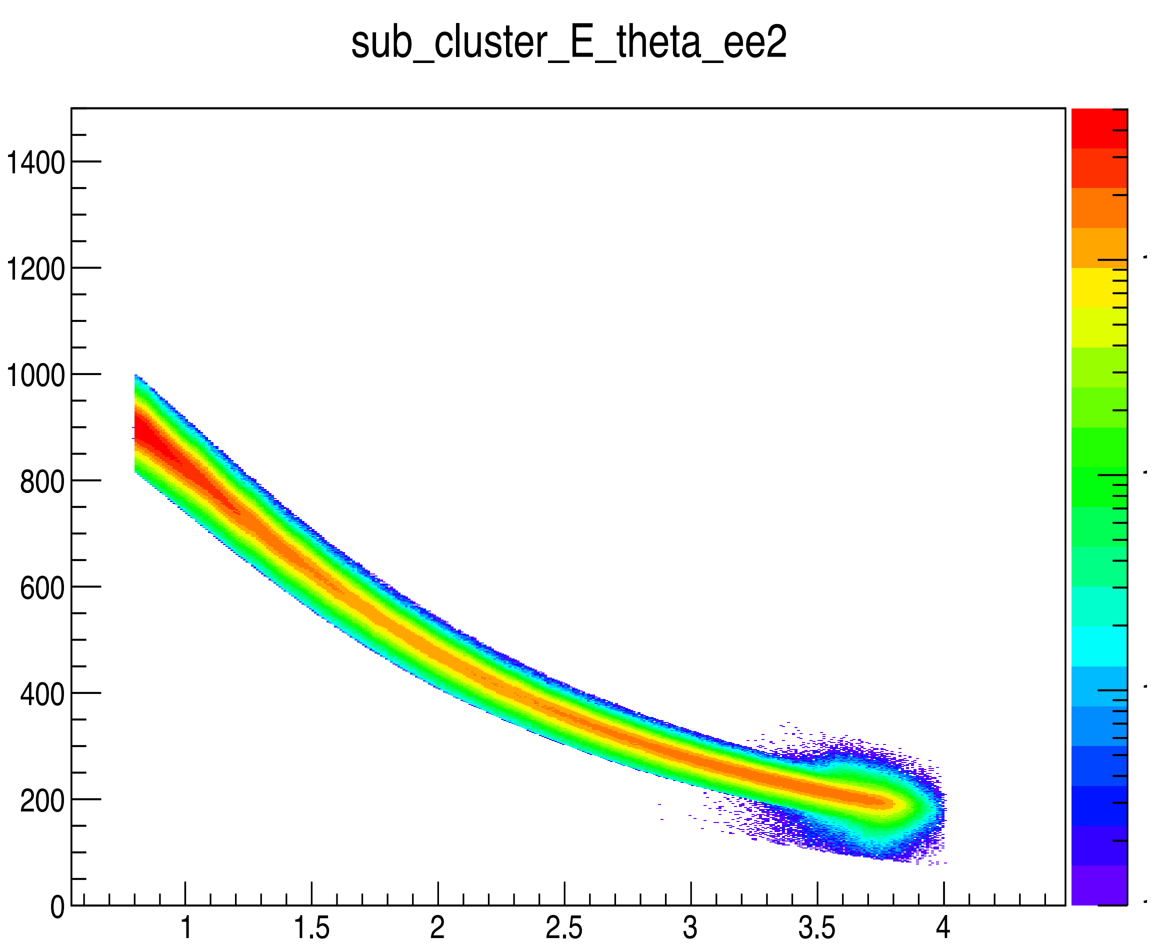
sim_cluster_E_theta



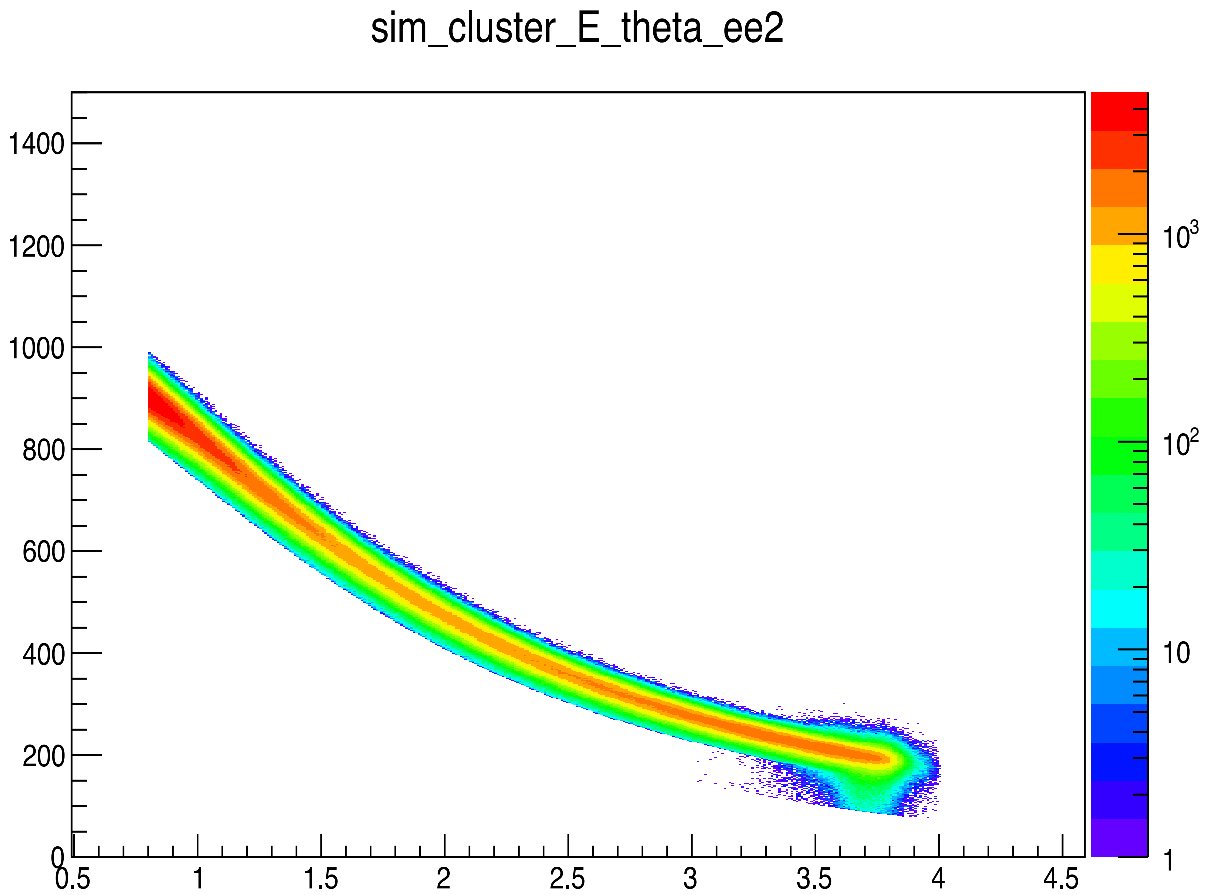
Problem in simulation near transition region

1 GeV Moller cluster E vs theta distributions, obtained after all double arm Moller selection cuts

1 GeV data

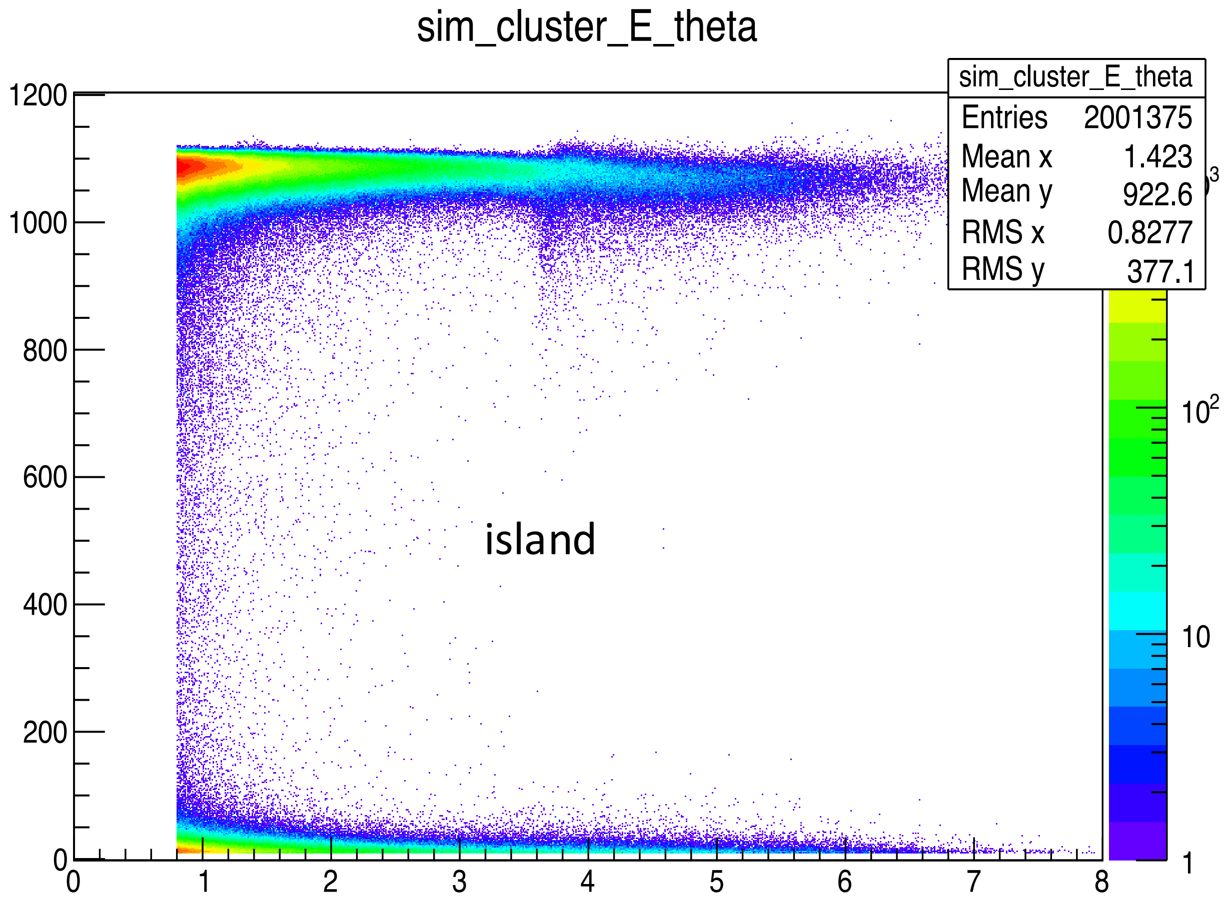


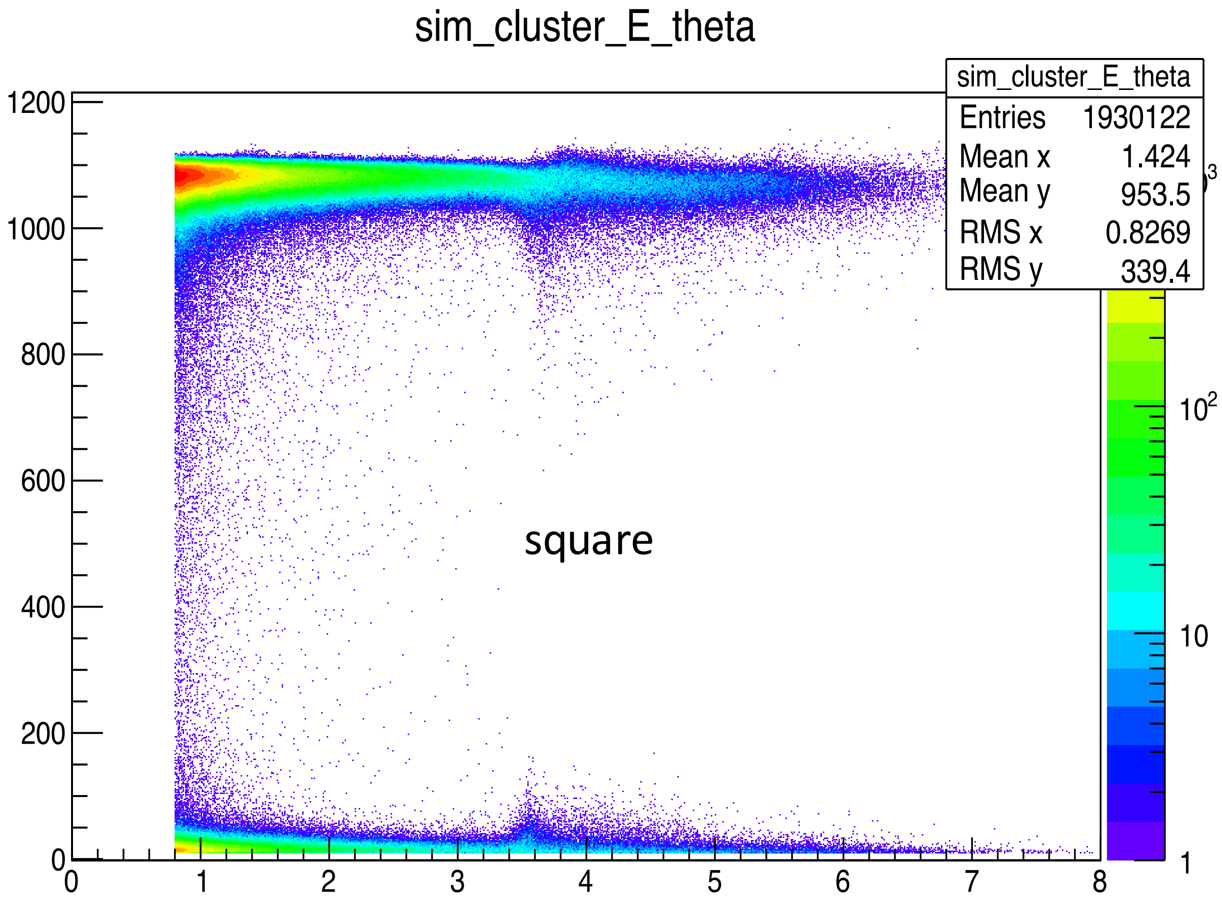
1 GeV simulation



Problem in simulation near transition region

Using non-radiative event generator and turn off HyCal resolution smearing





Problem in simulation near transition region

Using non-radiative event generator and turn off HyCal resolution smearing