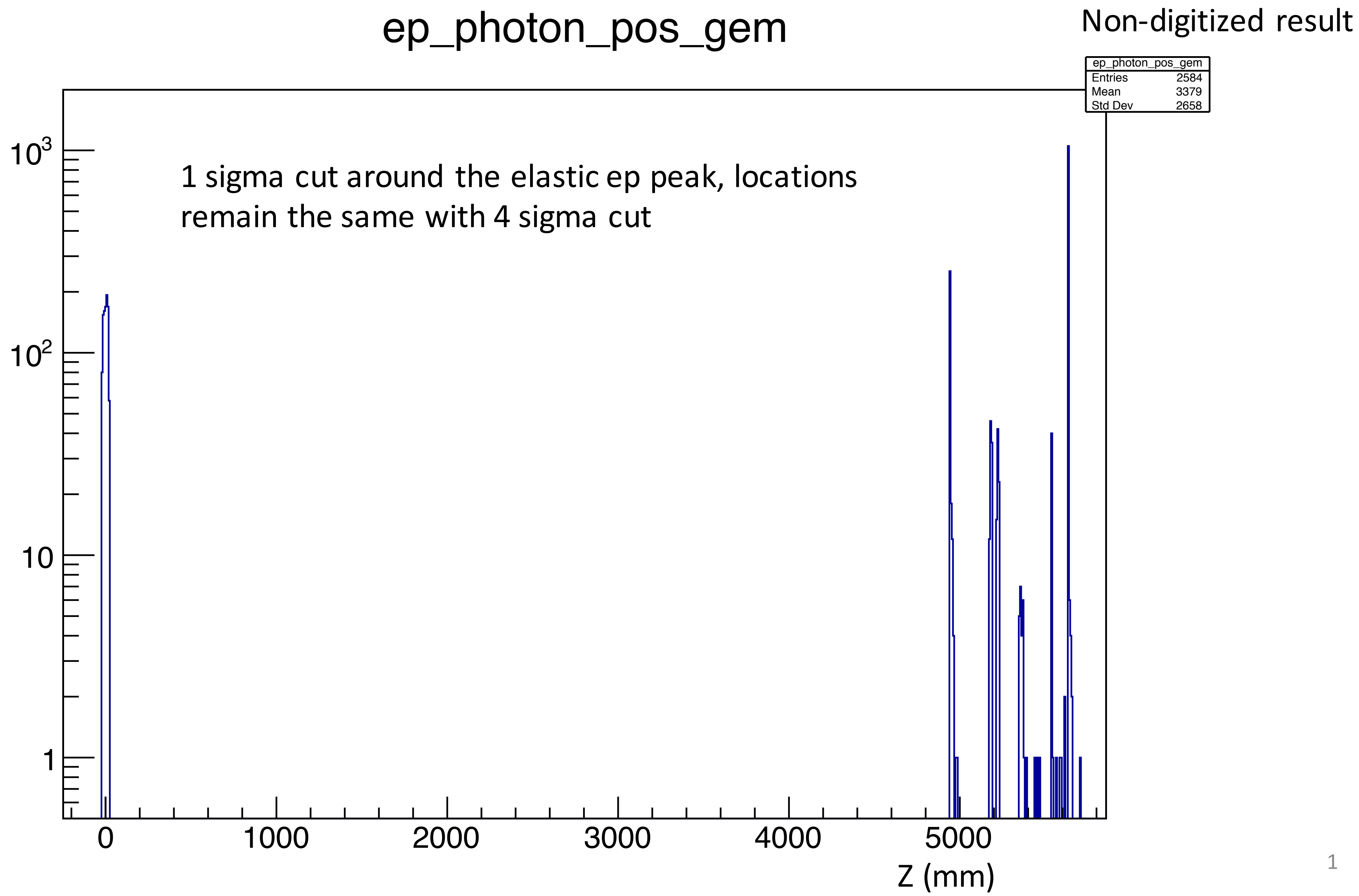
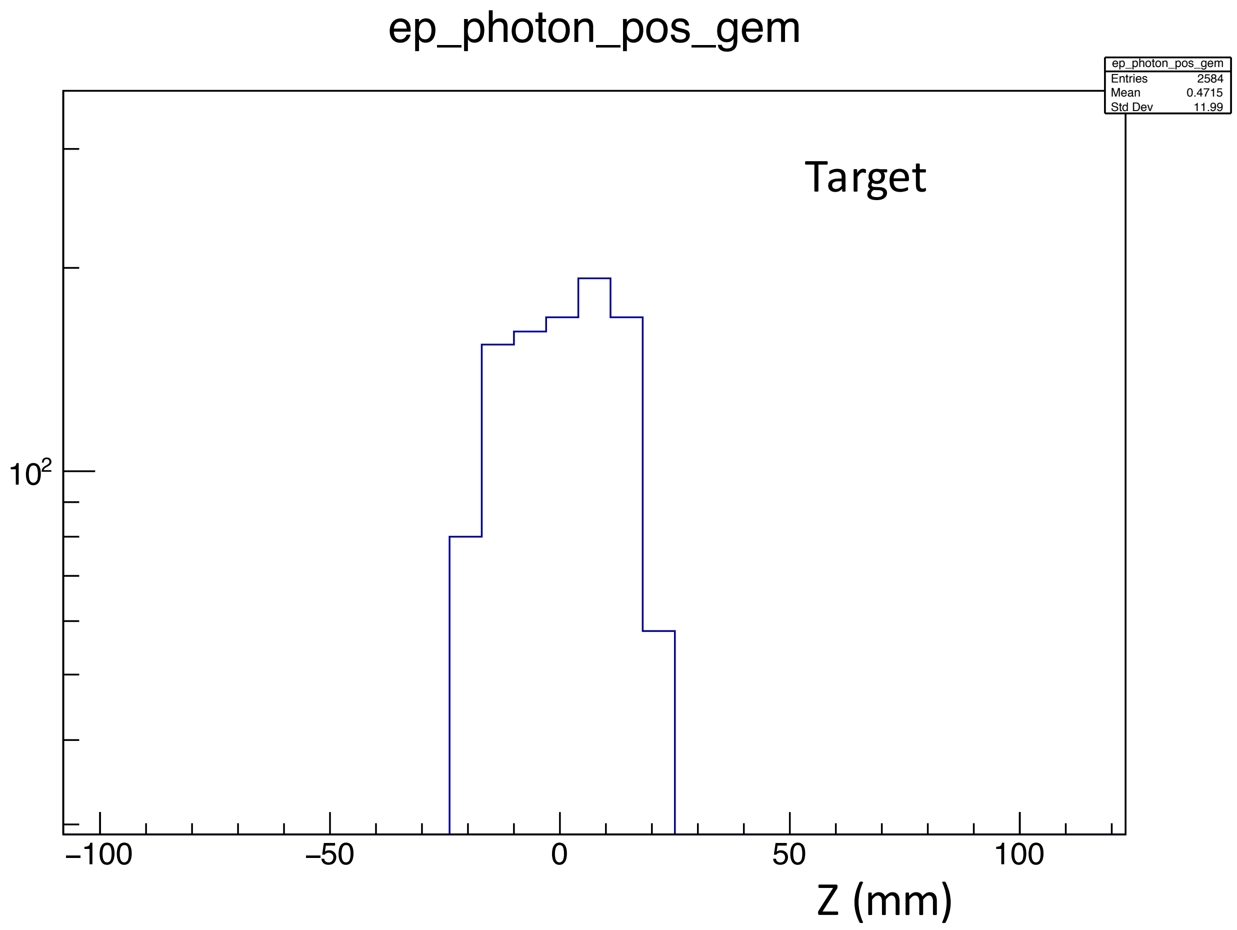
Location of high energy photon production

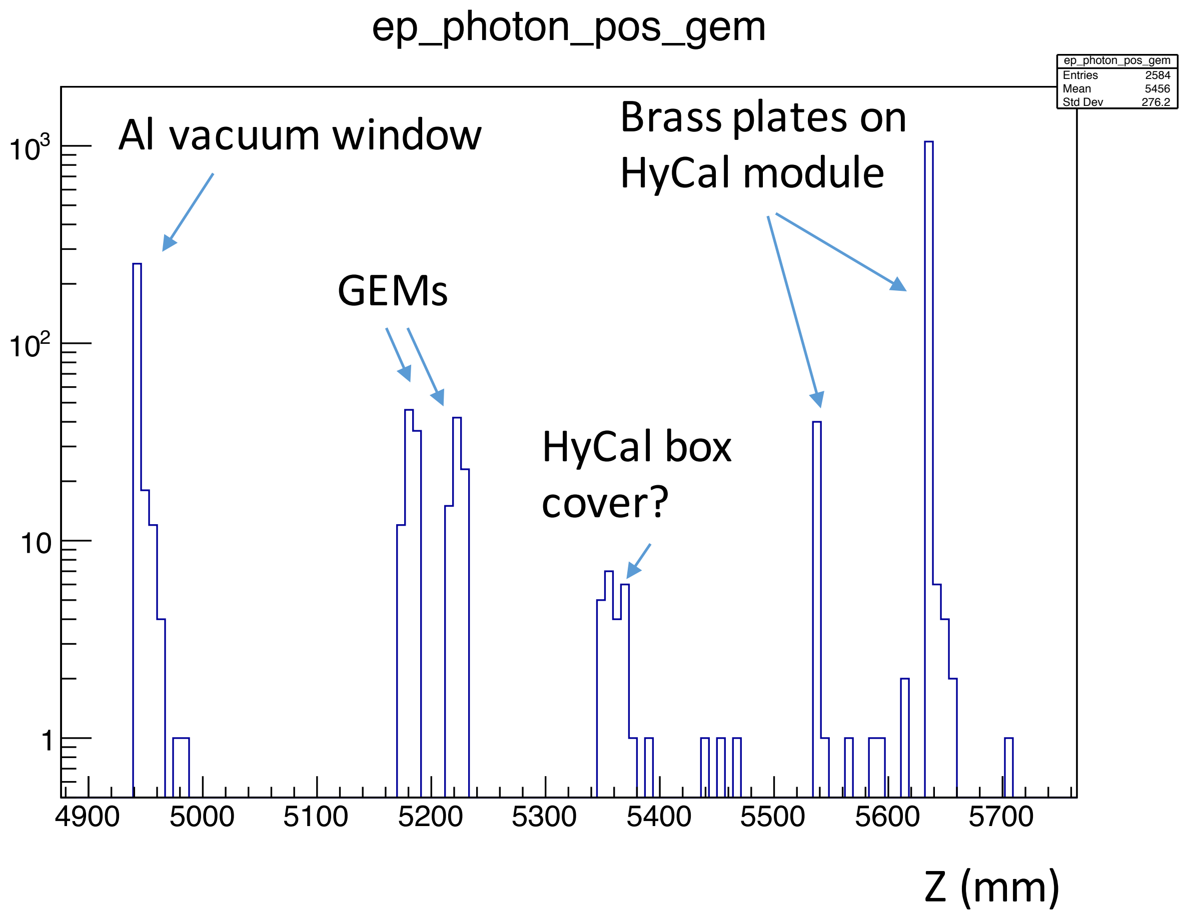


Location of high energy photon production

Zoom in plots for the previous plot

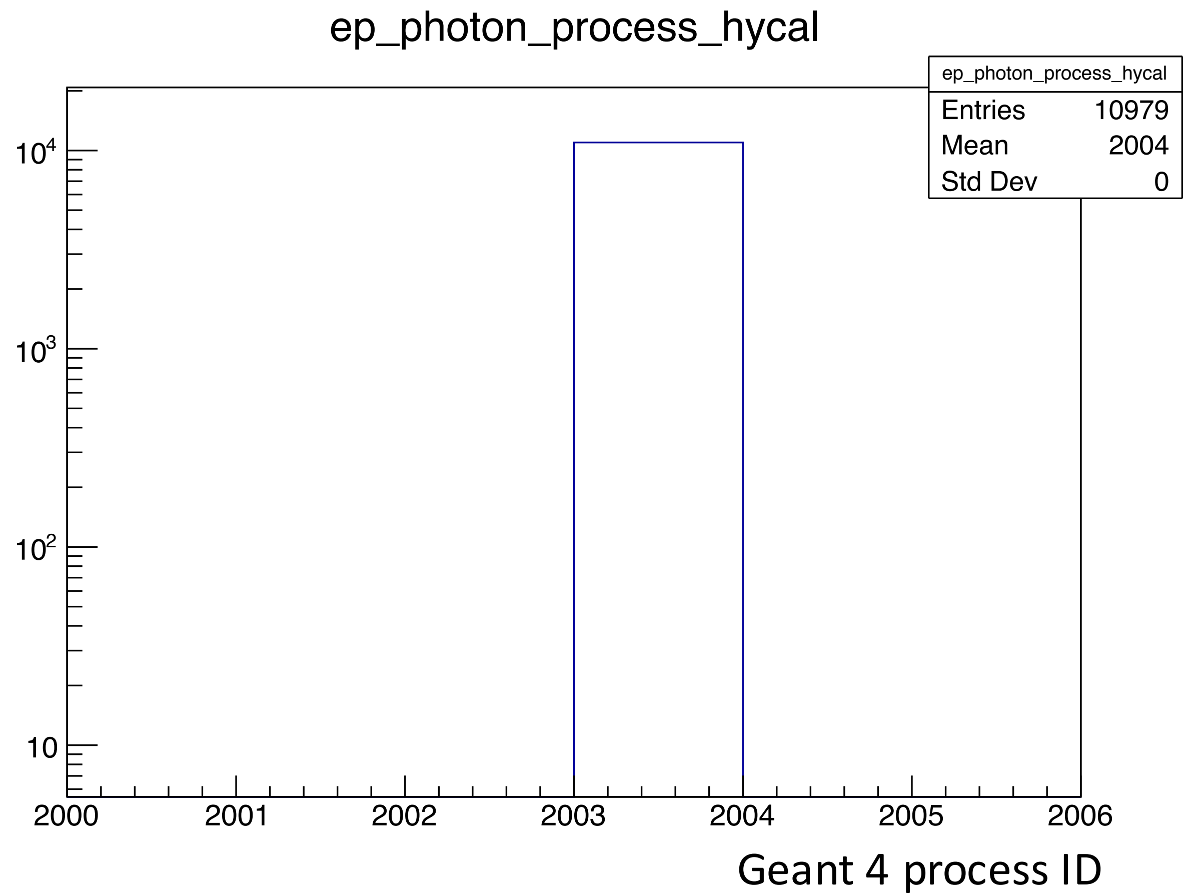
Non-digitized result

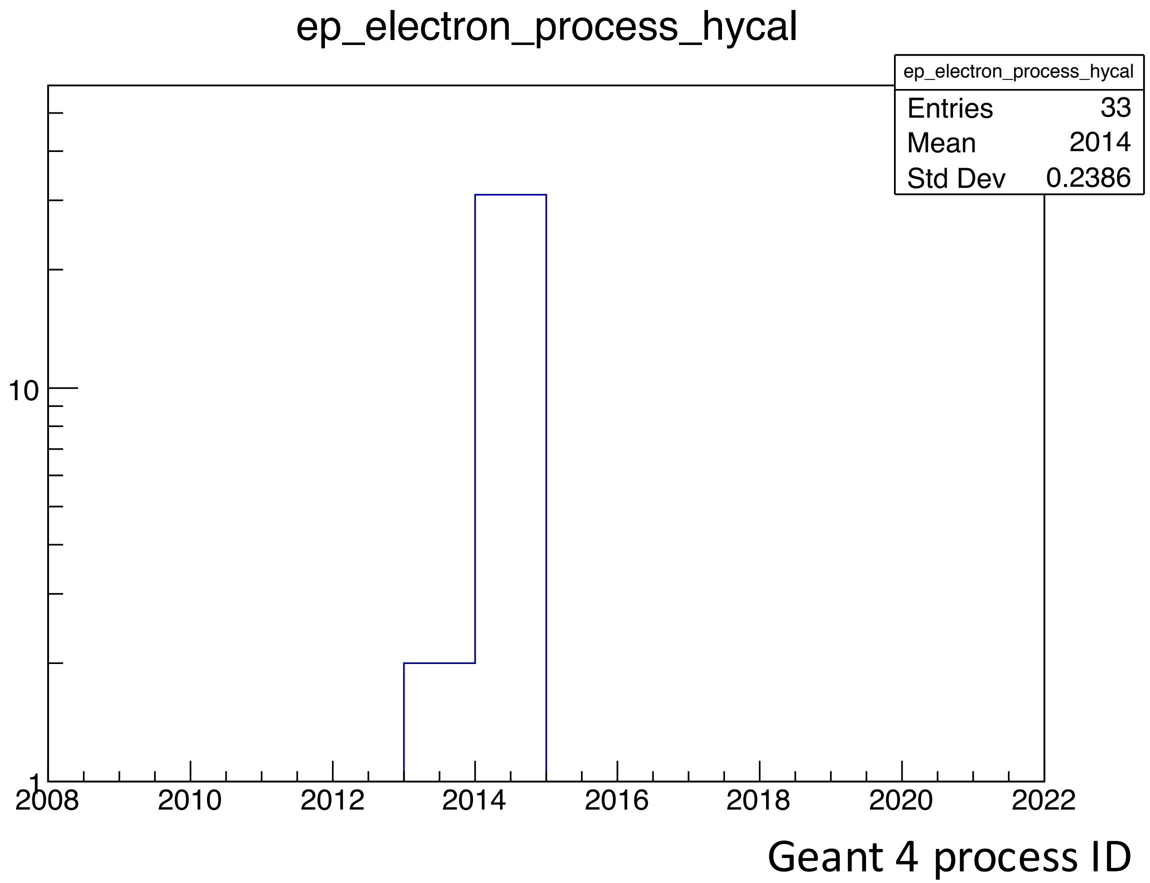




Process of high energy secondary particle

- When there is a high energy photon, it is certain that it goes through Bremsstrahlung radiation
- When there is a high energy electron (excluding elastic elections), it most likely come from pair production, also possible to come from Compton. The rate is negligible even compared to high energy photon rate





An adjustment to the study

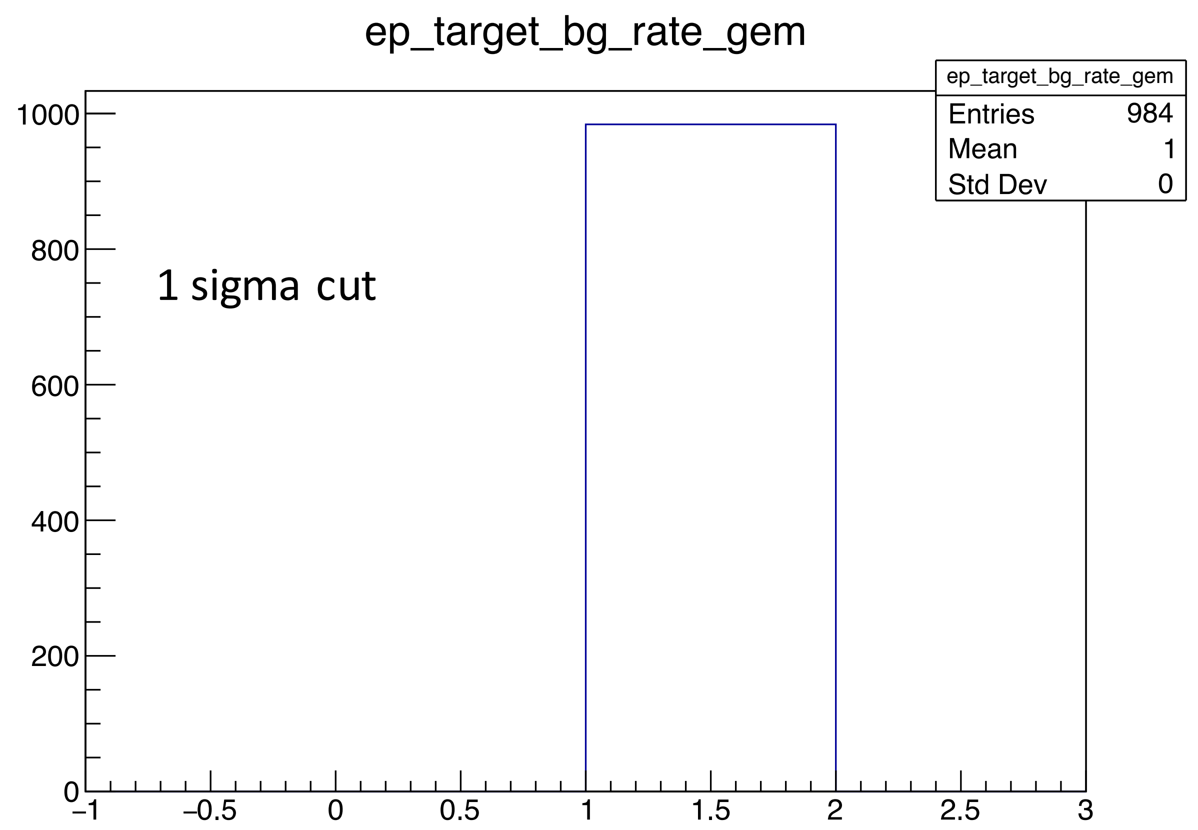
- Previously I have been looking at photon and charged particles hitting HyCal. This is not exactly the right thing to do because there are a lot of material between GEMs and HyCal.
  - For example a charged particle come be produced after GEM, and thus never hit the GEMs, but still seems like photon-electron pair when hitting HyCal

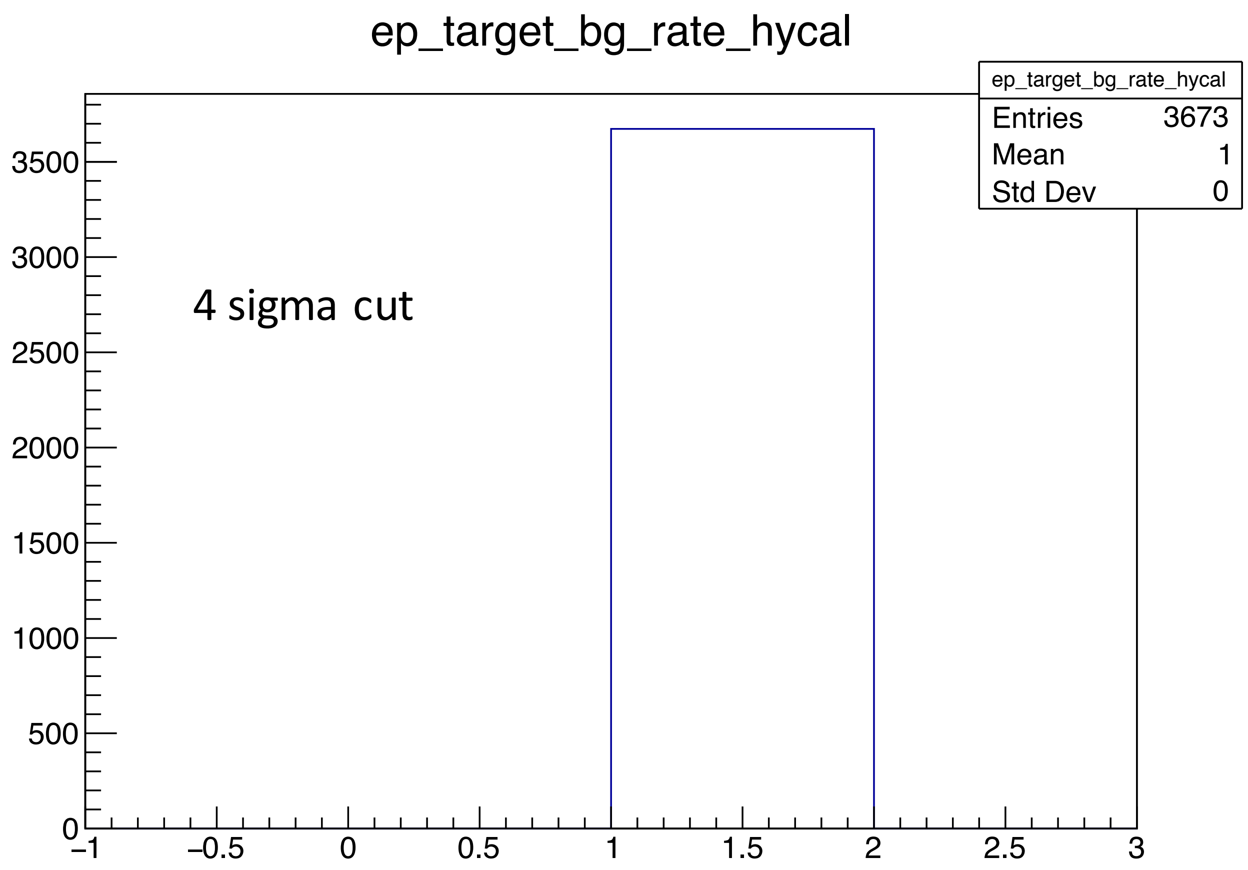
- Currently, for each high energy hit on HyCal, project all GEM hits on to HyCal and see if there is on fall inside the matching radius

Background rate due to target photon

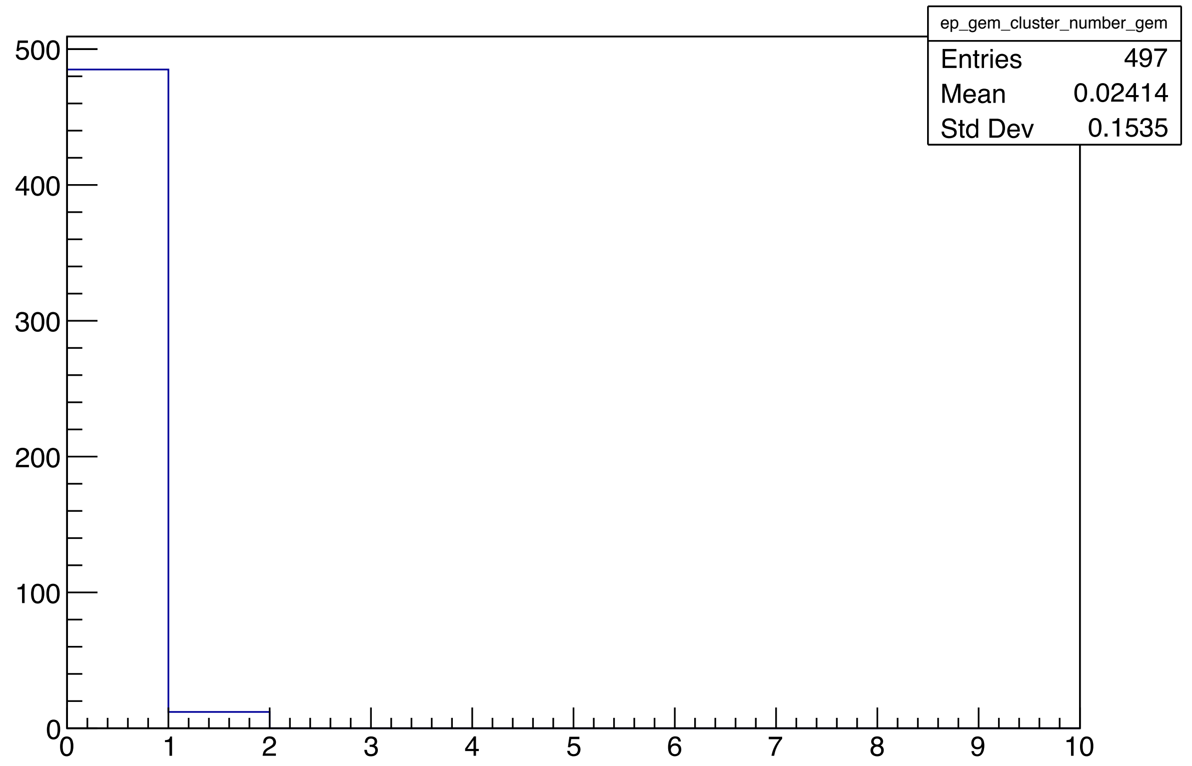
- Using cuts location of high energy photon production to select high energy photon from the target
- 0 means there is at least 1 GEM hit within matching radius around the high energy photon
- 1 means there is no GEM hit within matching radius around the high energy photon

Non-digitized result

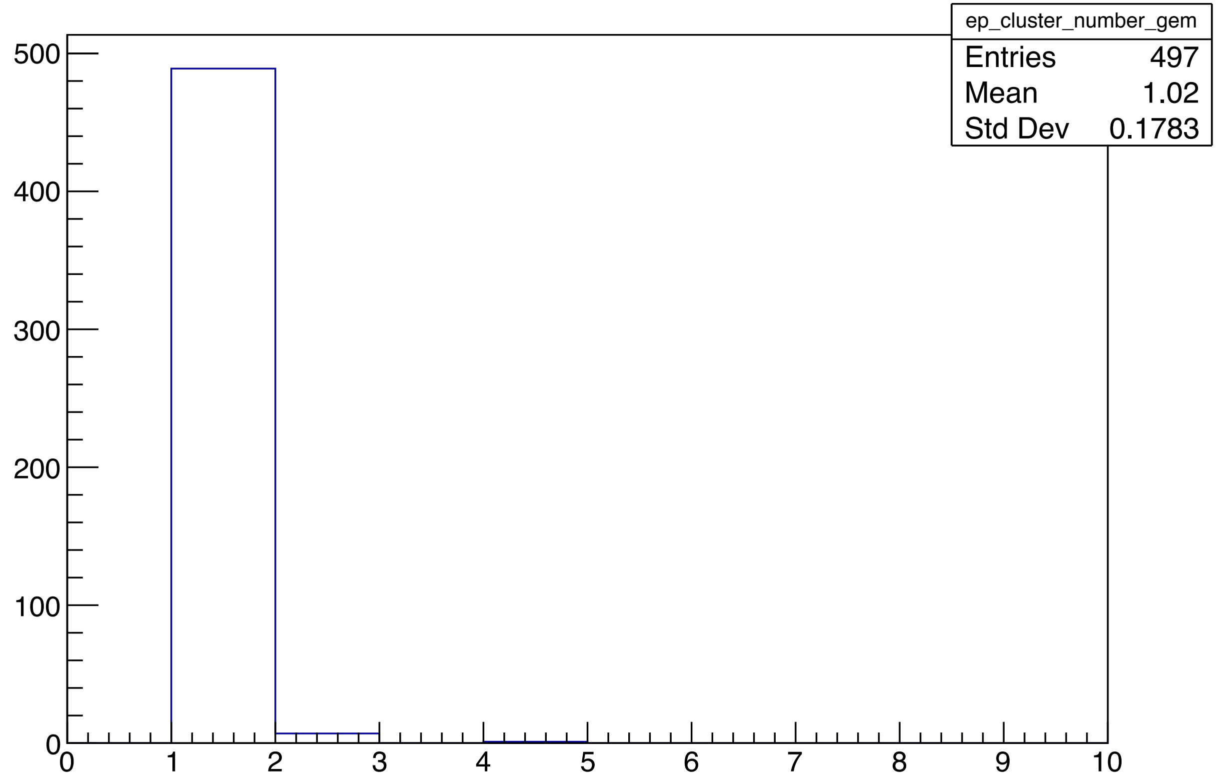




Number of hits on GEM for high energy photon from target



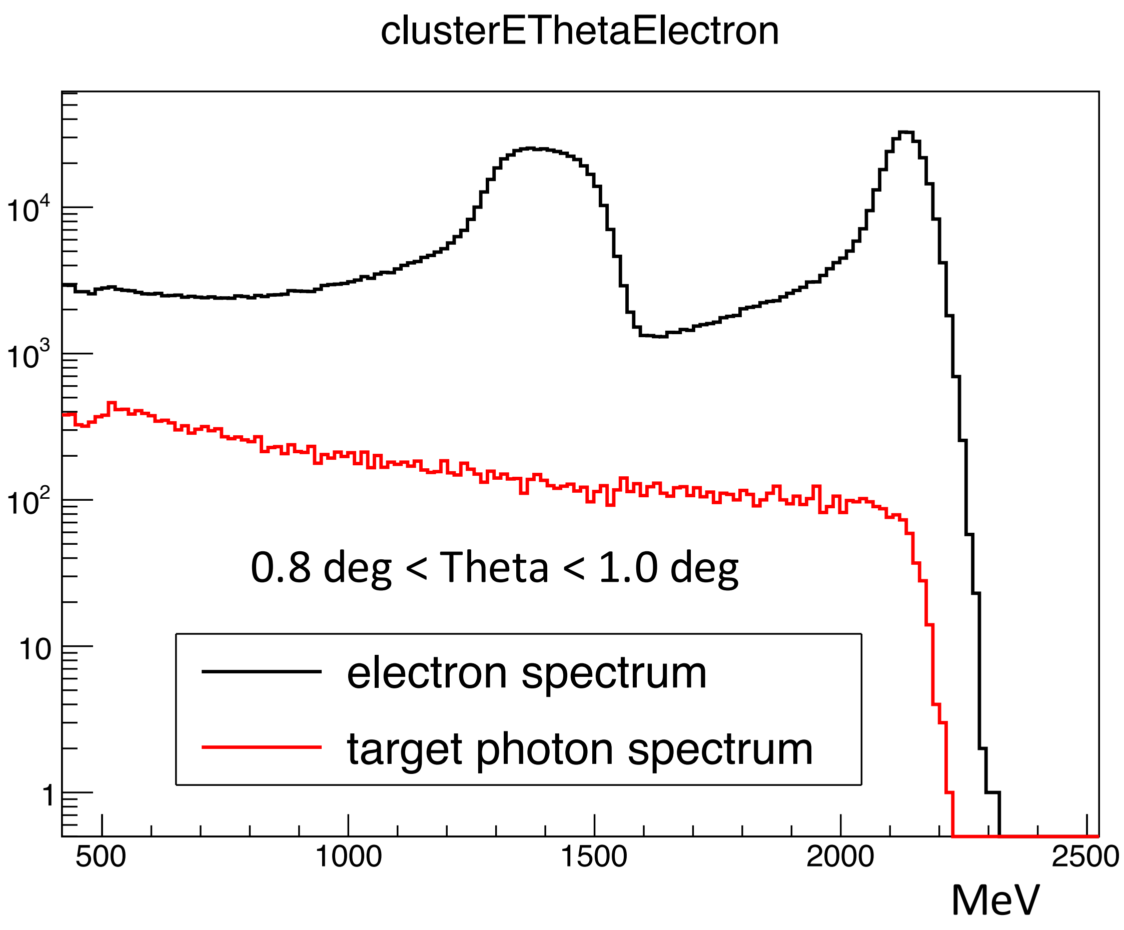
Number of reconstructed clusters on HyCal for high energy photon from target

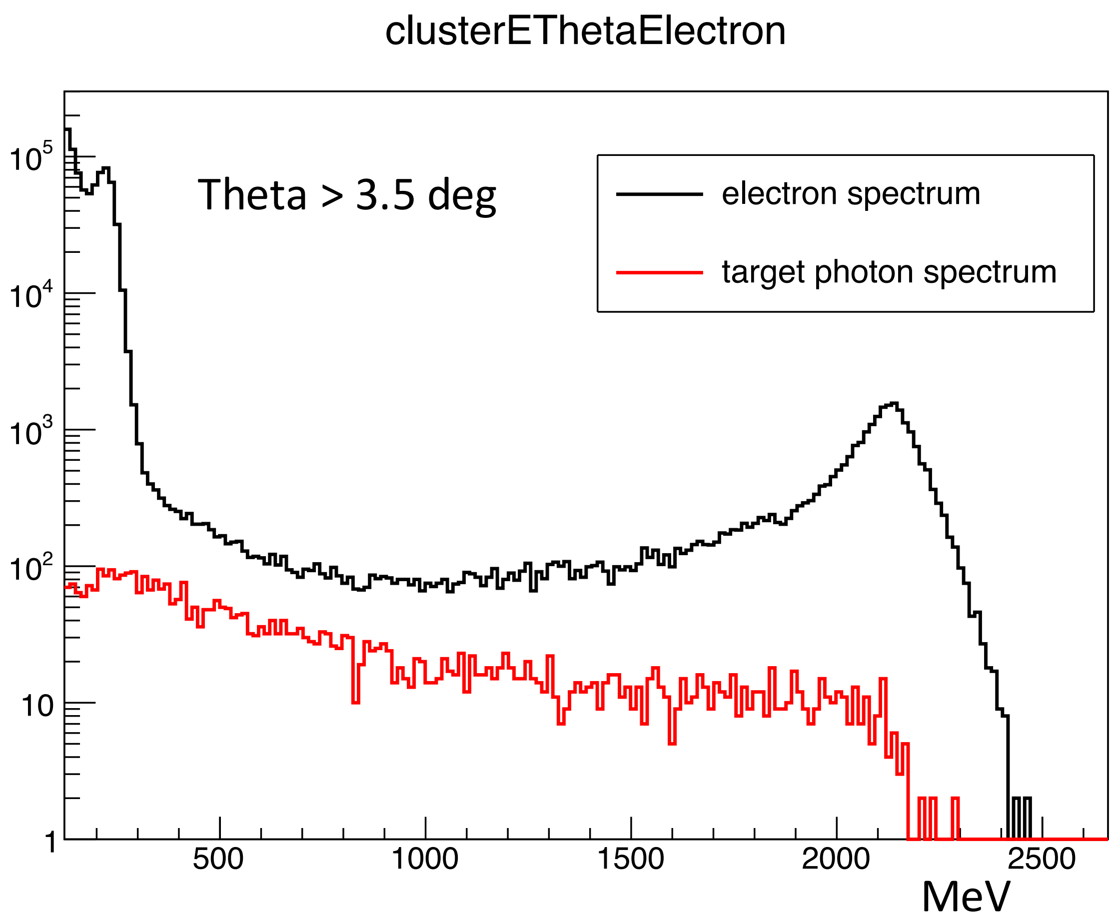


For the GEM efficiency, the single cluster cut will not be able to reject these photon as well

Energy spectrum comparison

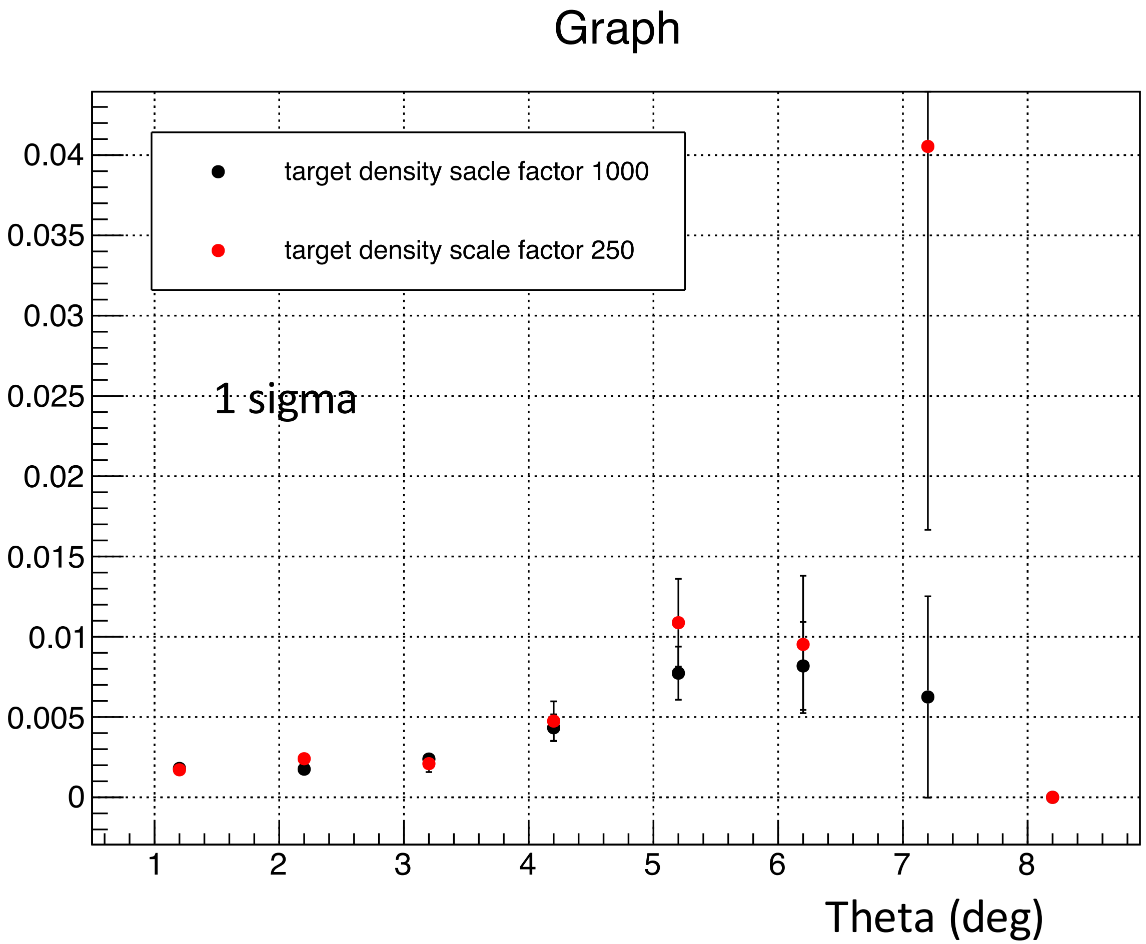
Non-digitized result

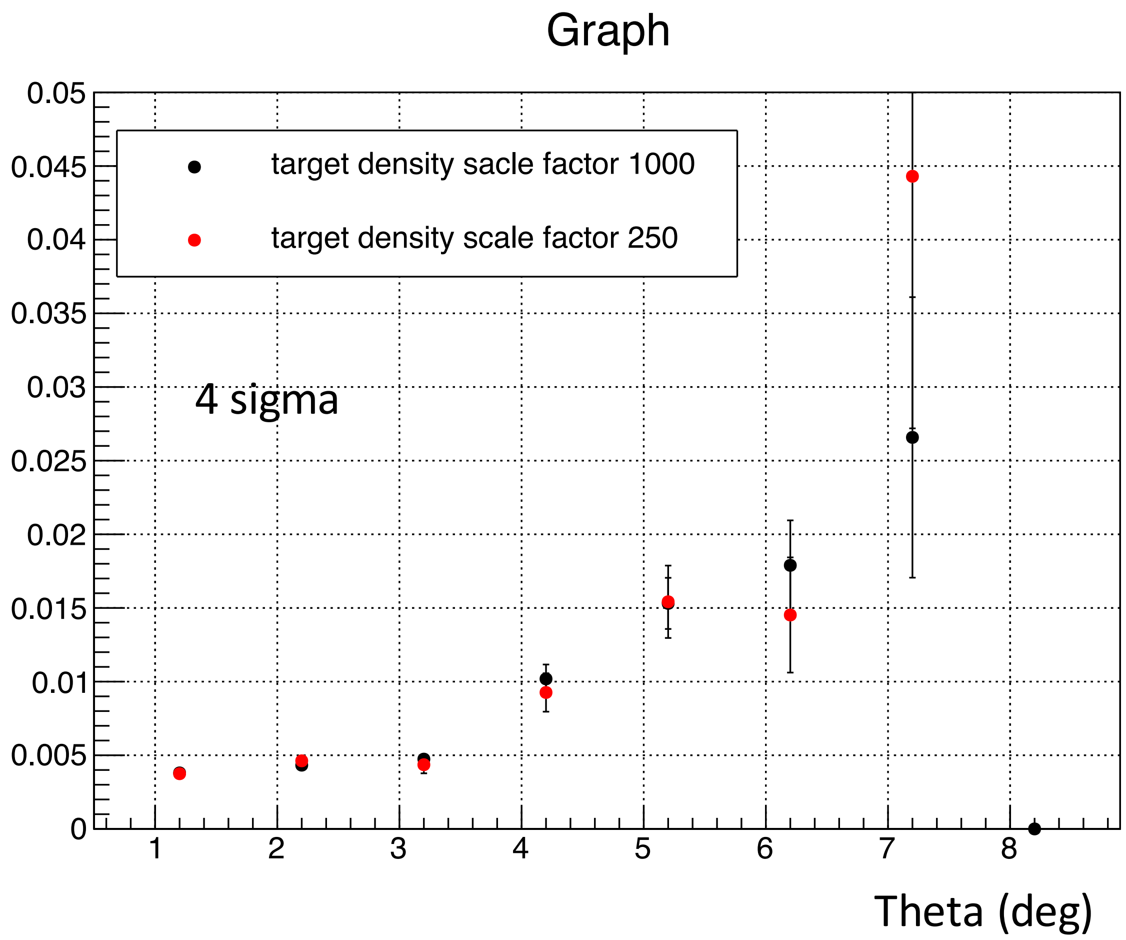




Target high energy photon rate

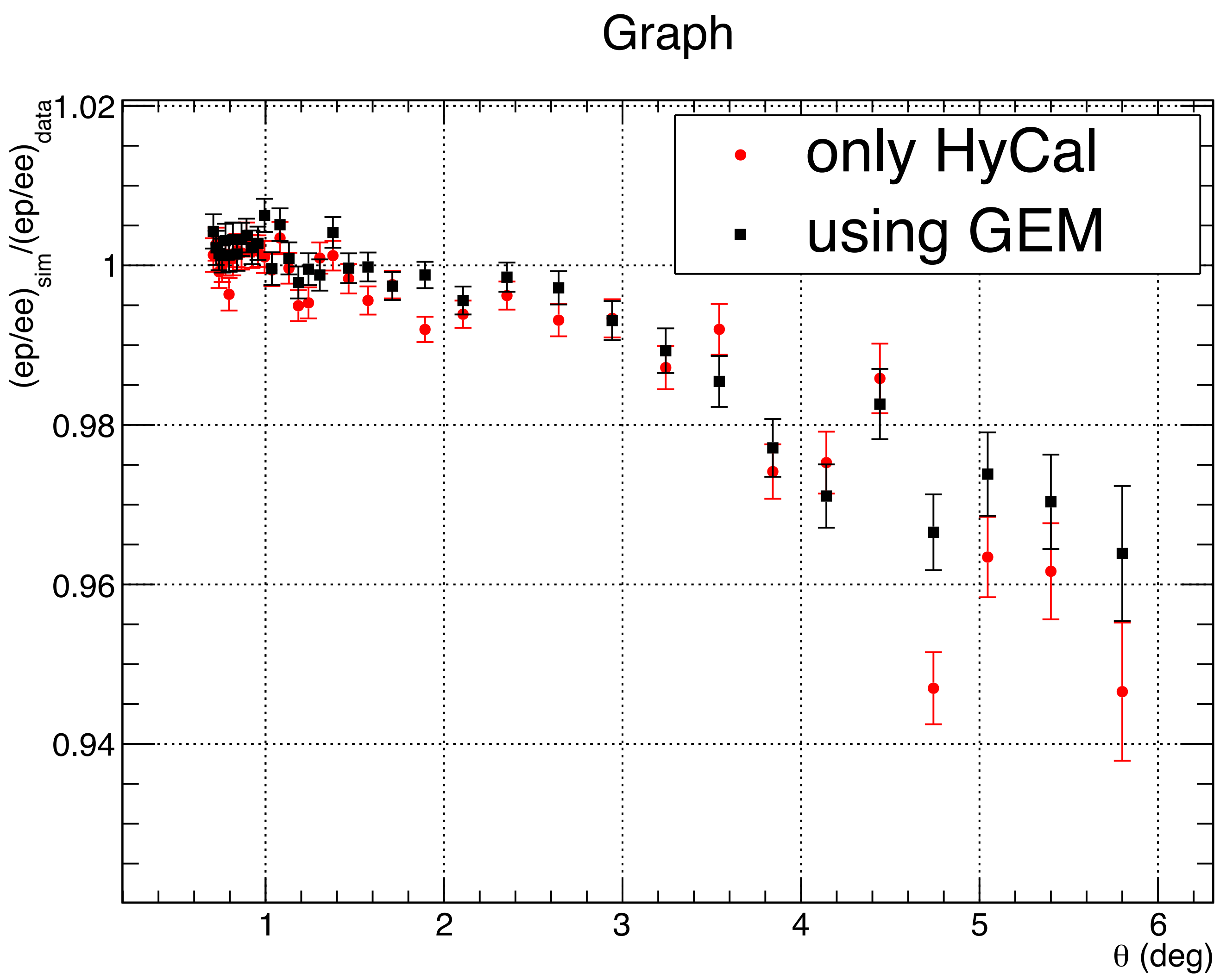
Non-digitized result





Super-ratio from 2GeV

- If without using GEM, the super ratio in LG region gets ~ 1 to 2 % lower, which mean more clusters are selected as ”ep”
- We have shown that the live time ratio is about the same as live charge ratio, so cosmic should be cleanly subtracted at first order
- This seems to suggest that there are some extra photons



Different effects on GEM efficiency

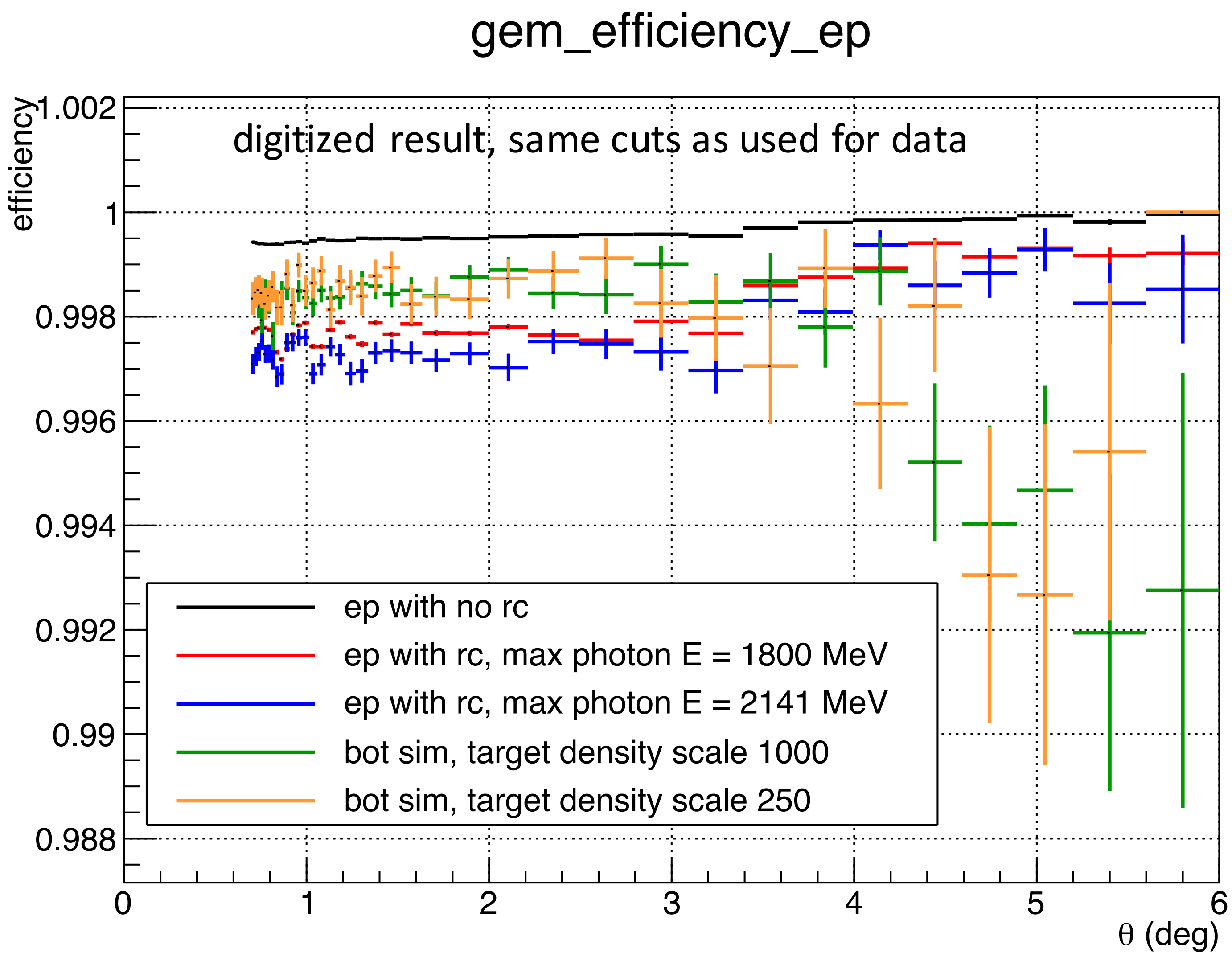
- Important things to note about GEM efficiency
  1. GEM has very low chance to detect photon, but HyCal see photon almost the same as electron
  2. GEM efficiency depends on the matching radius between GEM and HyCal. So even though there is a right hit on GEM, if it does not fall inside the matching radius, GEM is counted as inefficient.

- Possible source of high energy photon:
  1. Photon generated when scattered electron interact with materials (vacuum window, target cell window…)
  2. Photon generated from radiative effect of ep
  3. Photon generated by incident electron beam on target

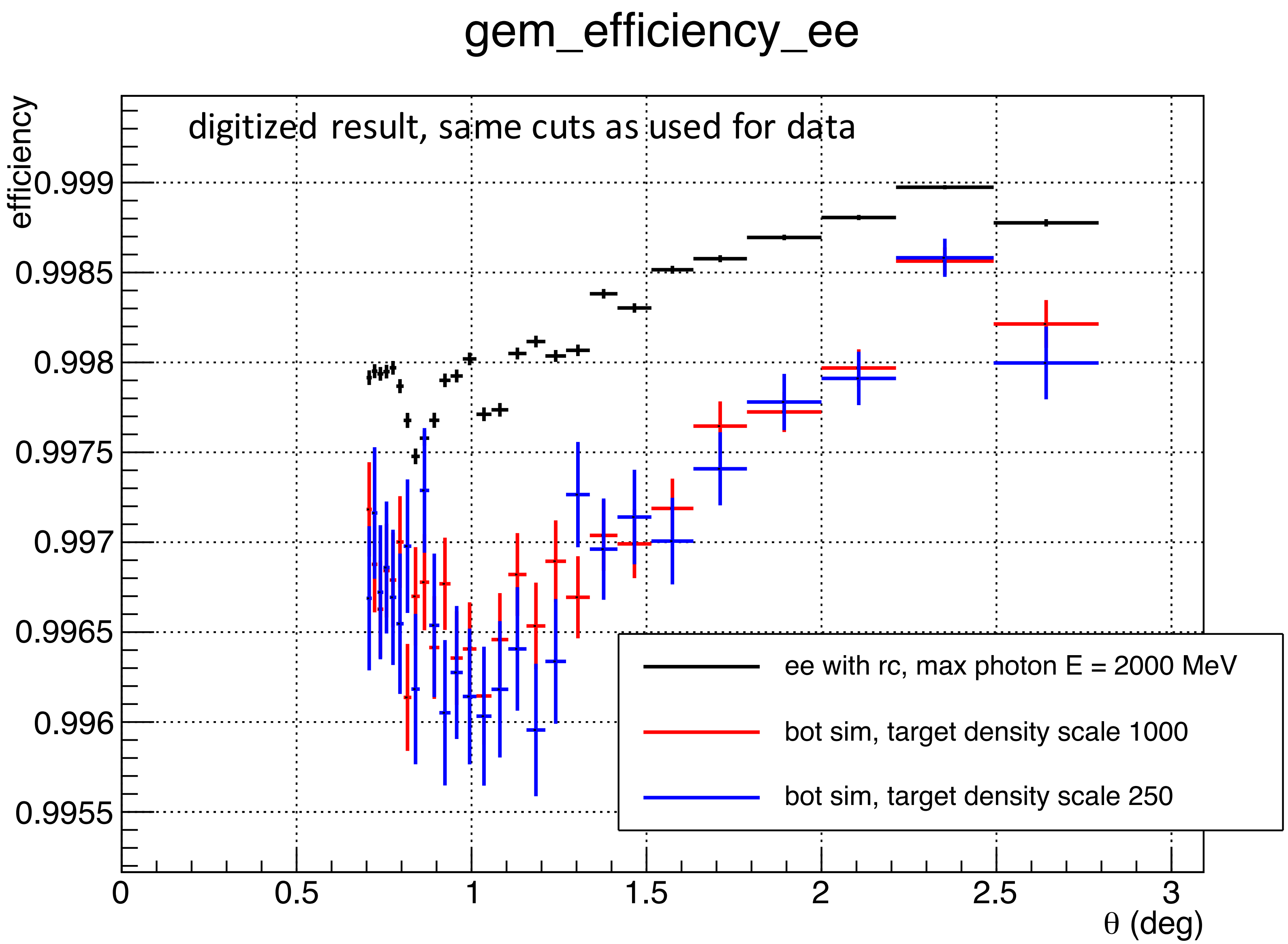
- To study these effect on the GEM efficiency, I have run simulation and digitization, and then calculate GEM efficiency based on:
  1. Simulation using ep generator with no radiative effect
  2. Simulation using ep generator with radiative effect
  3. Beam on target simulation

Different effects on GEM efficiency

- Black histogram tells the effect of external material on GEM efficiency
- Blue histogram tells the effect of external material + ep radiative effect on GEM efficiency
- Red histogram is similar to blue, but it doesn't have very high energy photon emitted. So the effect of ep radiative effect on GEM efficiency is more than simply just emitting high energy photons
- Green and orange histograms are fully digitized beam on target simulation. Contains all effect excluding ep radiative effect



Different effects on GEM efficiency



Conclusion

- High energy photon generated from target has a non-negligible rate compared to the ep elastic scattering
- They are mostly iso photons
    1. They will not affect the ep counts if we are requiring GEM-HyCal matching
    2. They will only affect the GEM efficiency
- Running beam on target simulation with scale factor = 1, will be able to compare the scaling behavior at very forward angle
- If it is confirmed that the high energy photon from target is an issue, it should be rather easy to correct
    - We will need a more accurate Bremsstrahlung generator
    - We can mix the Bremsstrahlung events with the ep and ee events in the simulation, go through full digitization, and then calculate GEM efficiencies using the simulation
    - We take the efficiencies, with and without target photon as correction to real efficiency