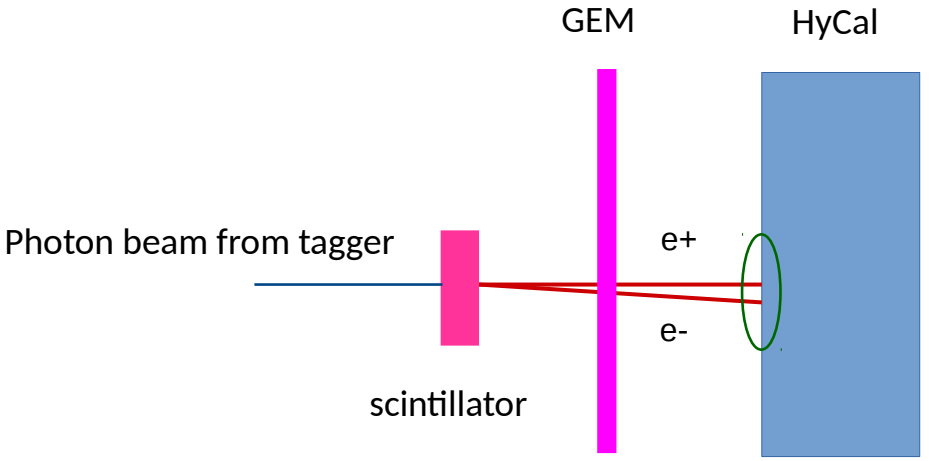
a brief geant4 simulation for pair/Compton event ratio of photon beam on Scintillator

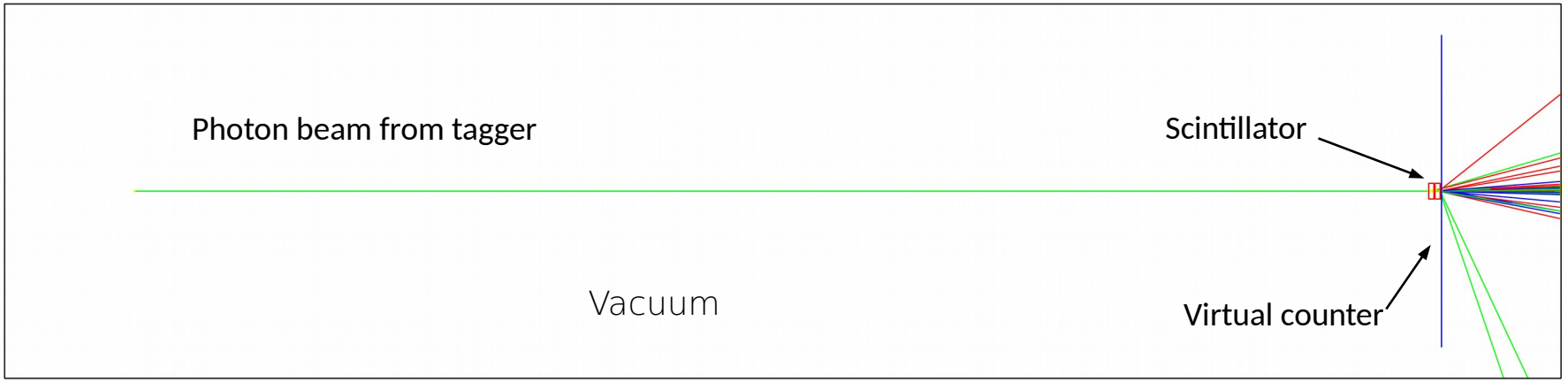
GEM efficiency correction for calibration data

- < 1 GeV photon beam
- Major process: pair production, Compton Scattering
- Forward Compton electrons, and electron positron pairs
- Correct the effect when GEM detects two charged particles (e+, e- pair) and HyCal sees one shower



Schematic for how pair production event affect GEM detection efficiency

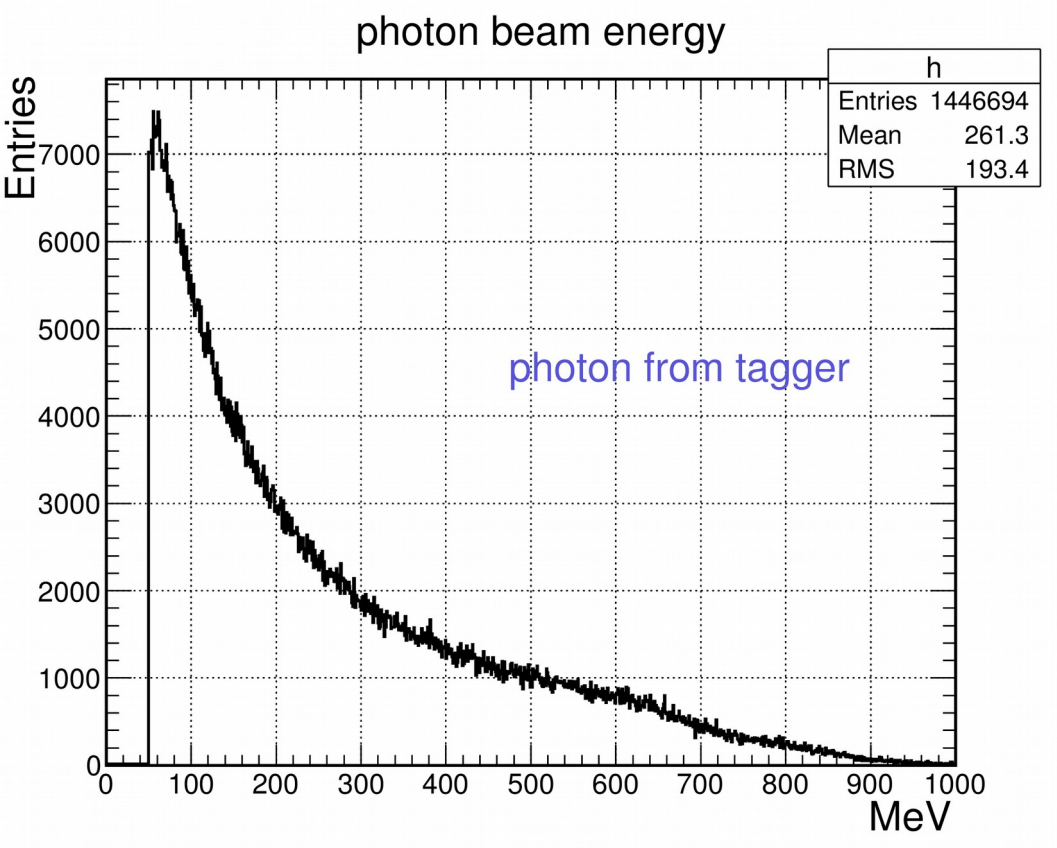
Geant4 setup and process



- Beam positioned 5 meter upstream of scintillator
- Two scintillators closely neighboring each other
- A virtual counter placed right after scintillators to detect positron and electron flux in each event
- Standard Geant4 EM Physics List
- Current (modification) for each event: pair event = <positron flux>, Compton event = <electron flux> - <positron flux>
- Get pair / Compton ratio for each run.

Photon Beam

- Incident photon follow the distribution from real experiment.
- Tagger
- Generate random photons from this histogram.

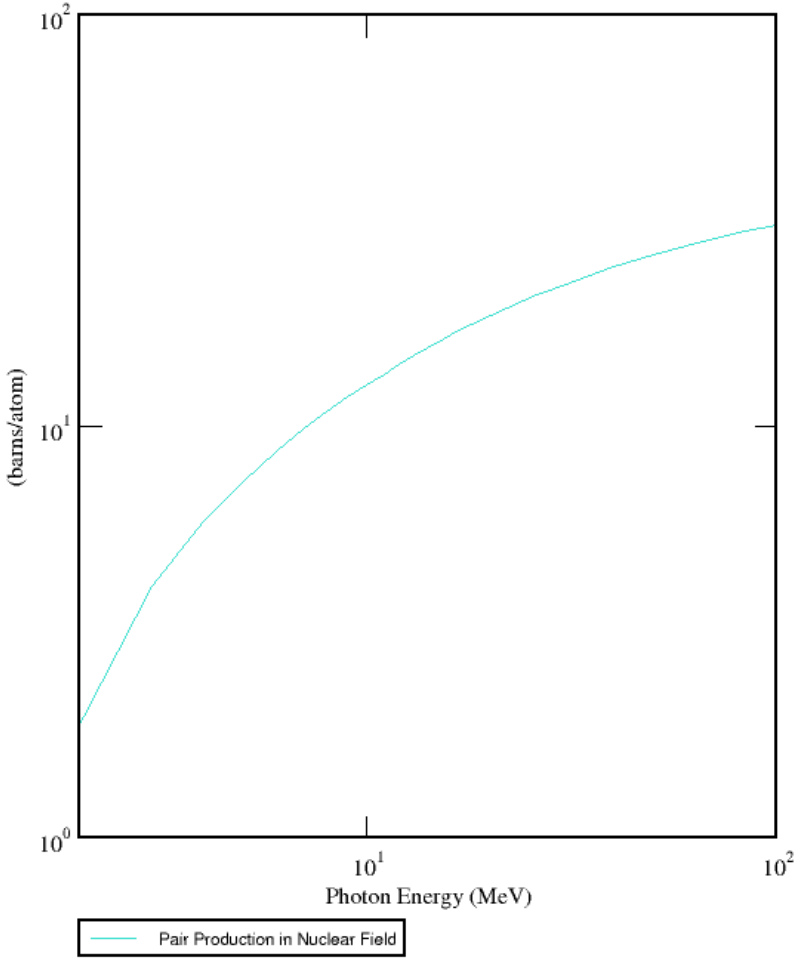


Photon energy from HyCal

Setup Check

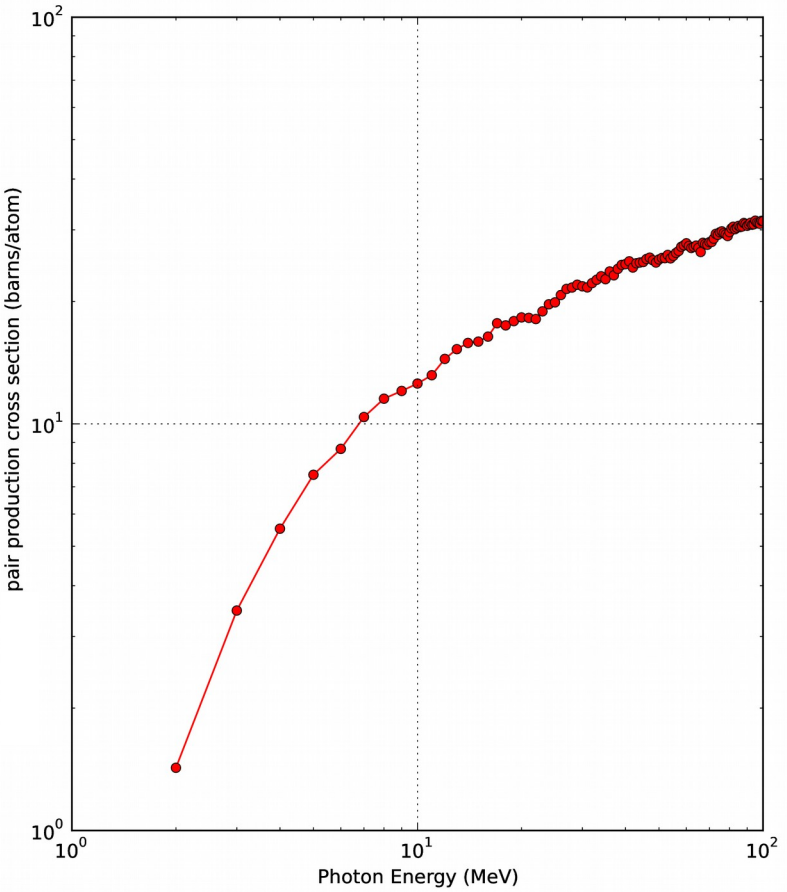
Pair production cross section of lead from this simulation setup

Lead



<ref: physics.nist.gov>

Thin layer lead target

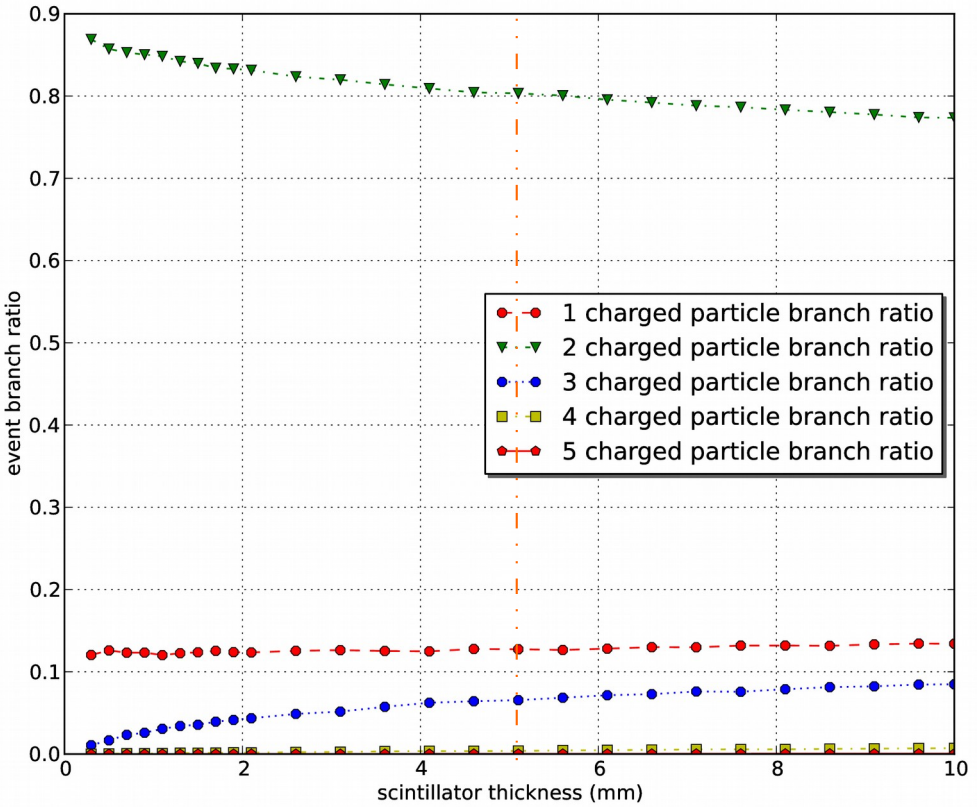


Simulated cross section on a thin layer of lead target

Scintillator thickness scan

Event branch ratio with different scintillator thickness.

- GEMs do not distinguish electron and positron, so count charged particles, ignore particle type.
- Event ratio vs scintillator thickness.



Event Ratio:

$$R_i = \frac{N_i}{\sum_i N_i}$$

N_i: count of triggered events with i charged particles

Summary

- Incident photon energy > 50MeV and < 1GeV
- Photoelectric effect, Rayleigh scattering, etc, are negligible, it is safe to ignore
- Mostly pair production and Compton effect
- Shower effect is not negligible, needs to consider shower effect

Next:

- Confirm simulation results with experimental data.