# comptonRad generator results

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# Simulation setup

https://arxiv.org/pdf/hep-ph/9711447.pdf

https://gitlab.com/eic/mceg/comptonRad

- To understand the generator (and cross check with others) I look at the output fron it directly and will apply increasingly more corrections
  - Version control available in the EIC MCEG rep
- The generator gives out the 4-momentum for both the photon and electron together with 4 weight factors: unpolarized and polarized tree level cross sections (eq 26,27 of paper) and the order alpha corrections (not used for the following analysis)
  - Not yet passed through magnetic fields or G4 geometry (magnet apertures) – although most of the photons pass significantly below the 9 cm radius of the last Quad
- To obtain the average analyzing power for a particular configuration (or average over any number of bins) we need to weight by cross section
- Most plots in this presentation are for 18GeV electron and 532nm laser

$$W_1 = \frac{1}{2\rho^{(n)}(x)}\left[\frac{d^n\sigma^{(0)}}{dx^n}(s,-) + \frac{d^n\sigma^{(0)}}{dx^n}(s,+)\right] \quad (26)$$

**unpolarized xsection**

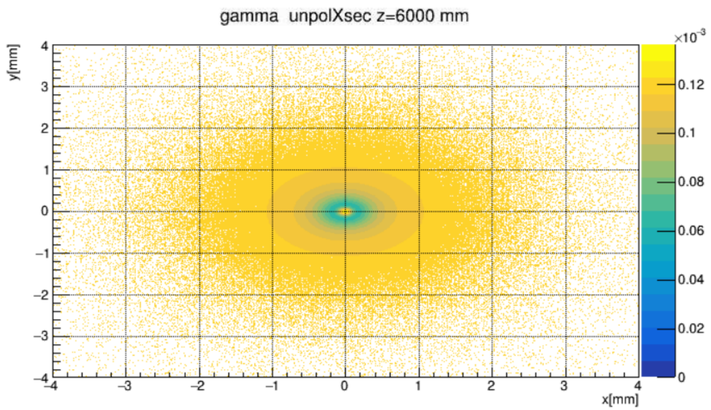
$$W_2 = \frac{1}{2\rho^{(n)}(x)}\left[\frac{d^n\sigma^{(0)}}{dx^n}(s,-) - \frac{d^n\sigma^{(0)}}{dx^n}(s,+)\right] \quad (27)$$

**polarized xsection**

$$A_N = \frac{\sigma^- - \sigma^+}{\sigma^- + \sigma^+} = \frac{\sigma^p}{\sigma^u} \equiv \frac{W_1}{W_2}$$

$$\langle A_N \rangle = \frac{\sum_i A_{N,i}\cdot\sigma_i^u}{\sum_i \sigma_i^u} = \frac{\sum_i \sigma_i^p}{\sum_i \sigma_i^u}$$

$$\langle E\cdot A_N \rangle = \frac{\sum_i E_i\cdot\sigma_i^p}{\sum_i E_i\cdot\sigma_i^u}$$



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# Simulation setup

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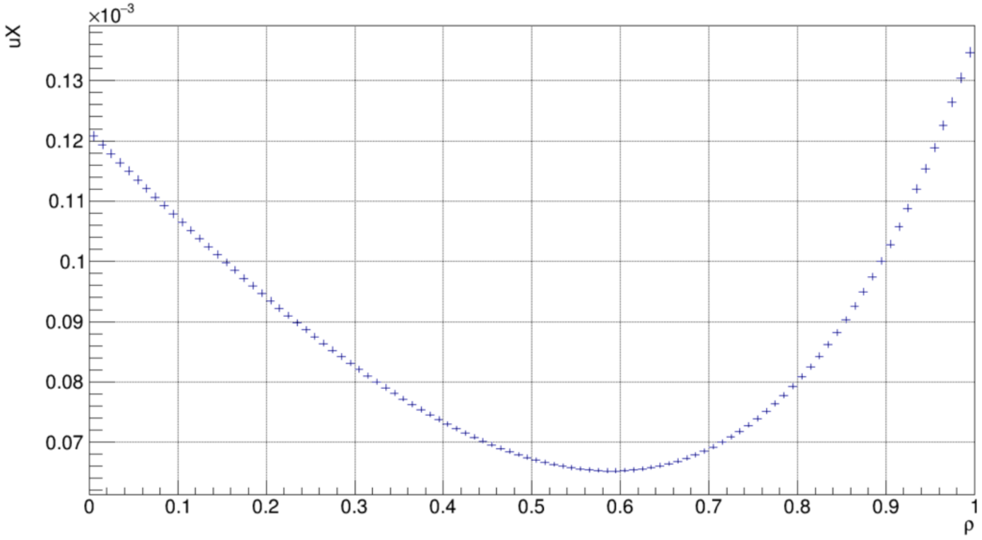
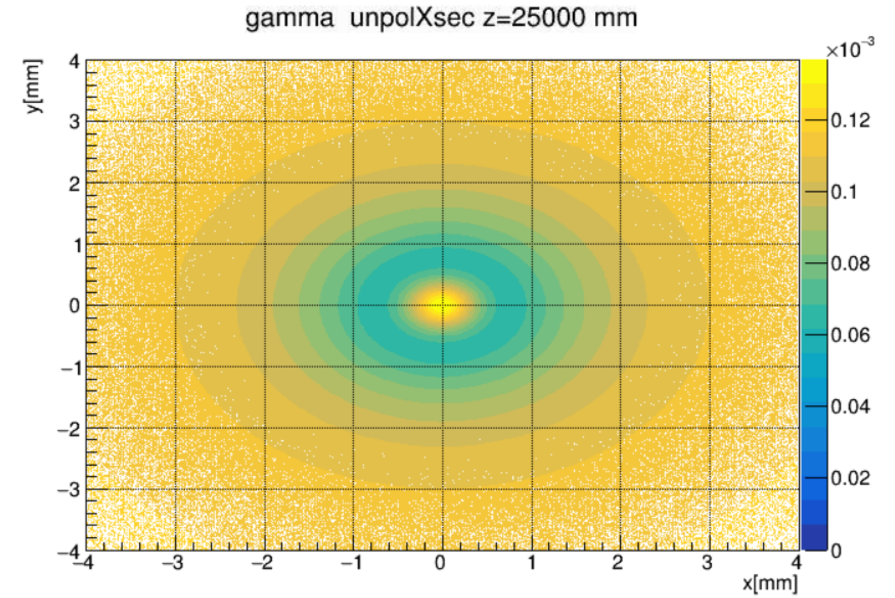
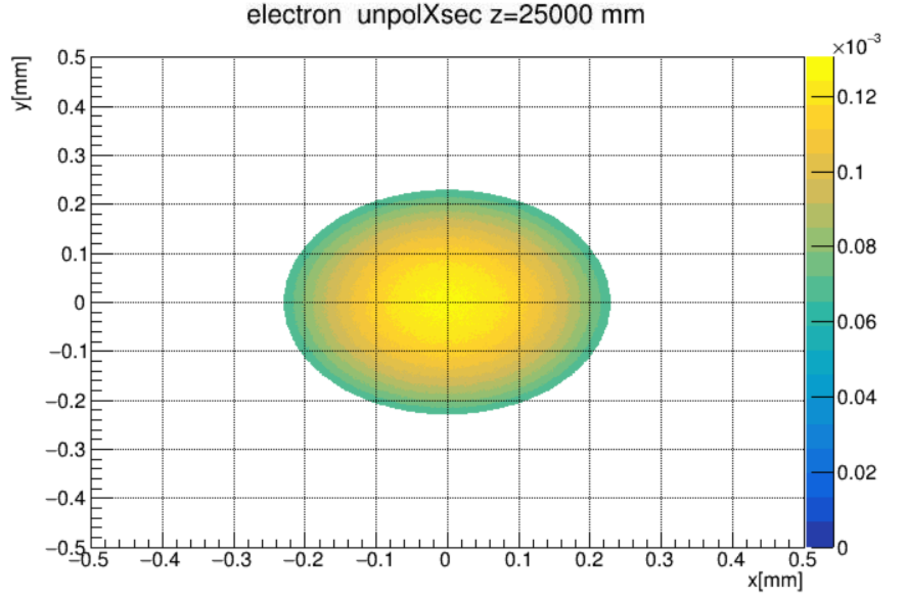
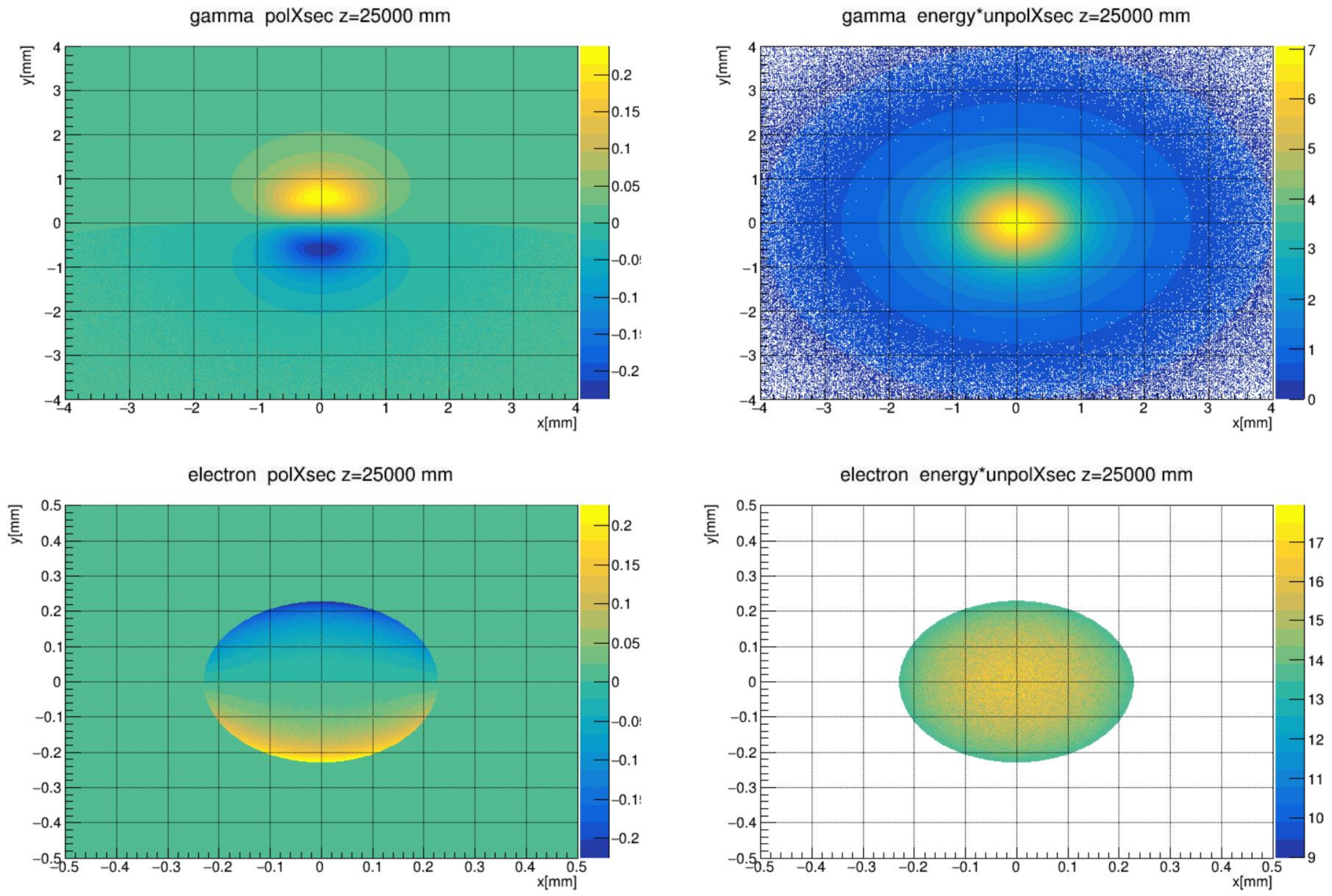


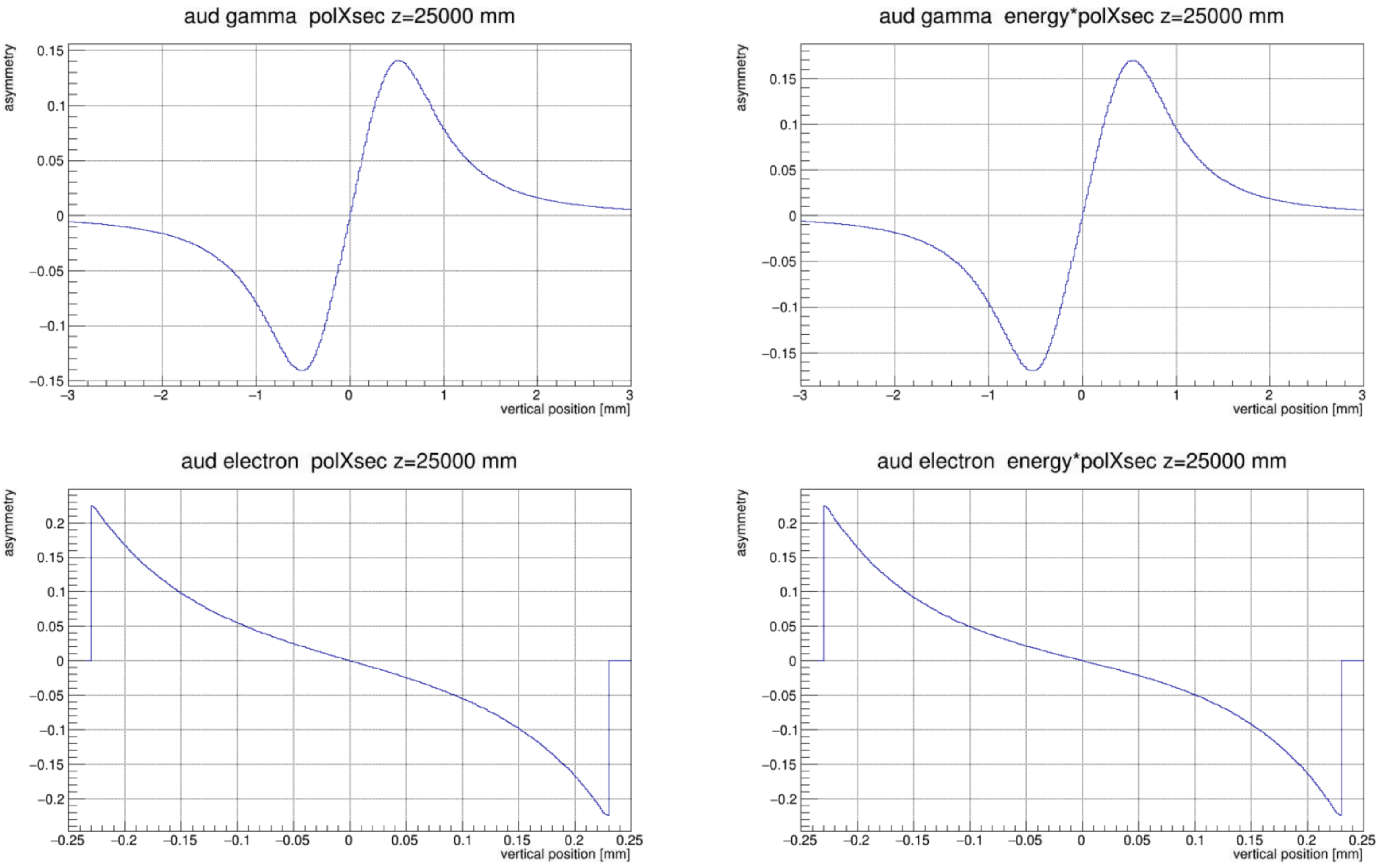

- The electron and photon were projected 25m downstream to look at the distributions on the face of the detector
  - From here we can calculated the analyzing powers
- The average unpolarized cross section (per bin) on the right show that the photons are (mostly) contained in a 4x4mm2 detector while the electrons sit (totally?!) withing 0.23x0.23 mm2

# Average energy/asymmetry




- The average energy distribution is up to 7.04 GeV for the photon and almost 18 GeV for the electron
- The average asymmetries (in each bin) show a significantly different distributions for the electrons from the photons
  - The maximized asymmetry at the edges of the Compton edge for the electrons could offer some leverage to increase our sensitivity

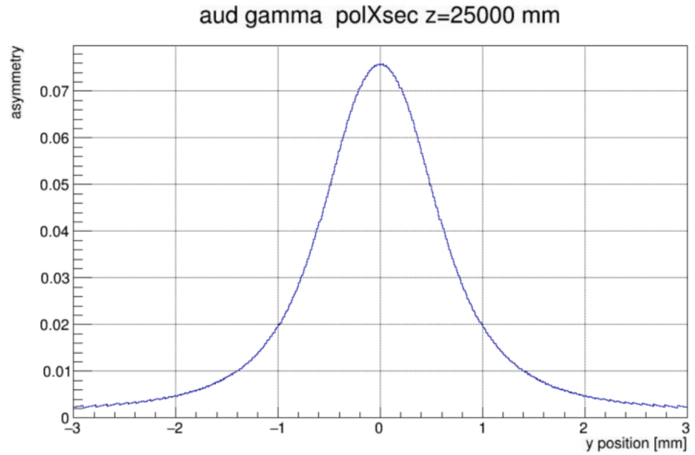
# Vertical asymmetry

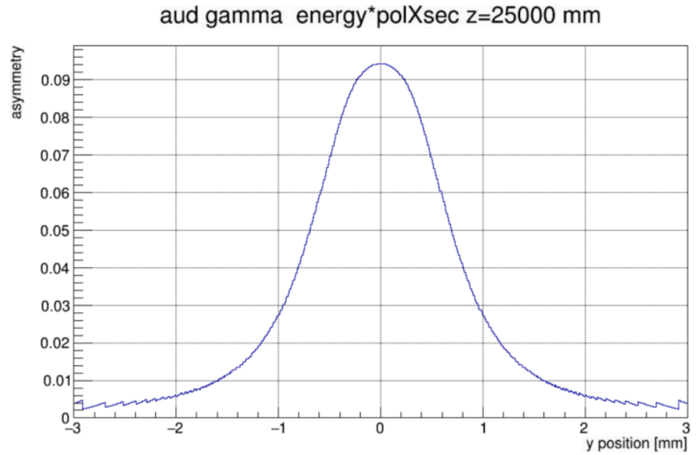


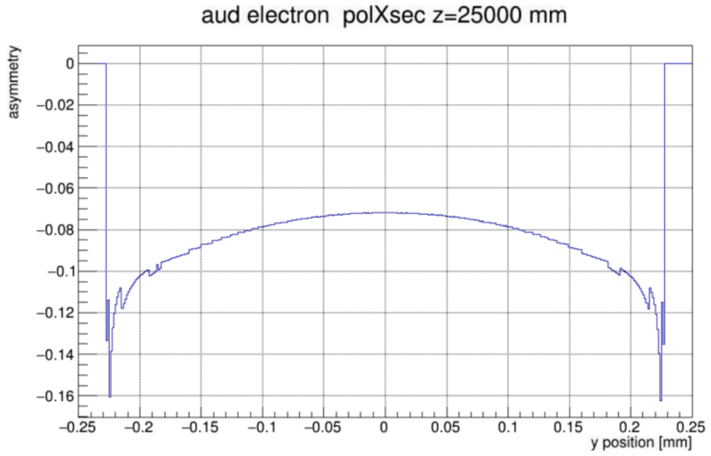

- We can observe the same behaviour if we look at the asymmetry as a function of the vertical position on the detector (i.e. the photon AN sits on a very steep slope at the center while the electron maximizes at the edges)
  - This means that the photon detector will be much more sensitive to the positioning (or beam instabilities)
- Doing energy weighting gains us a little bit in terms of AN for the photons

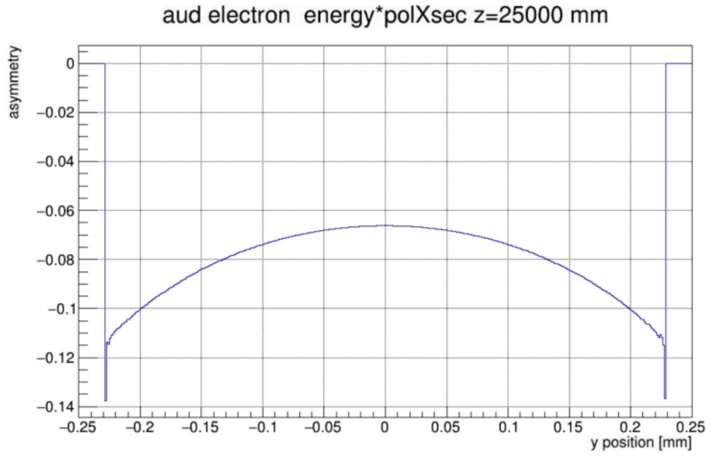
# AUD and position offsets

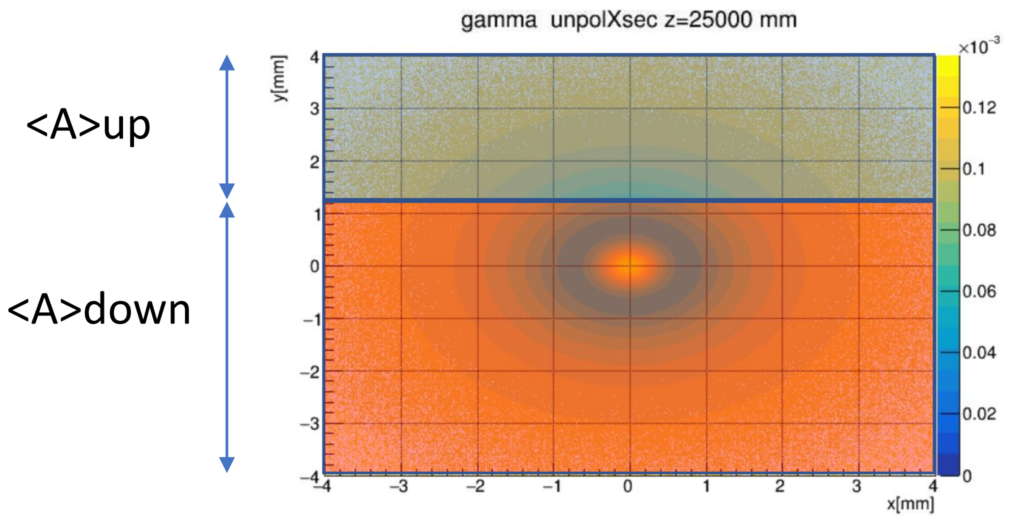
**Vertical axis: (<A>up - <A>down )/2**



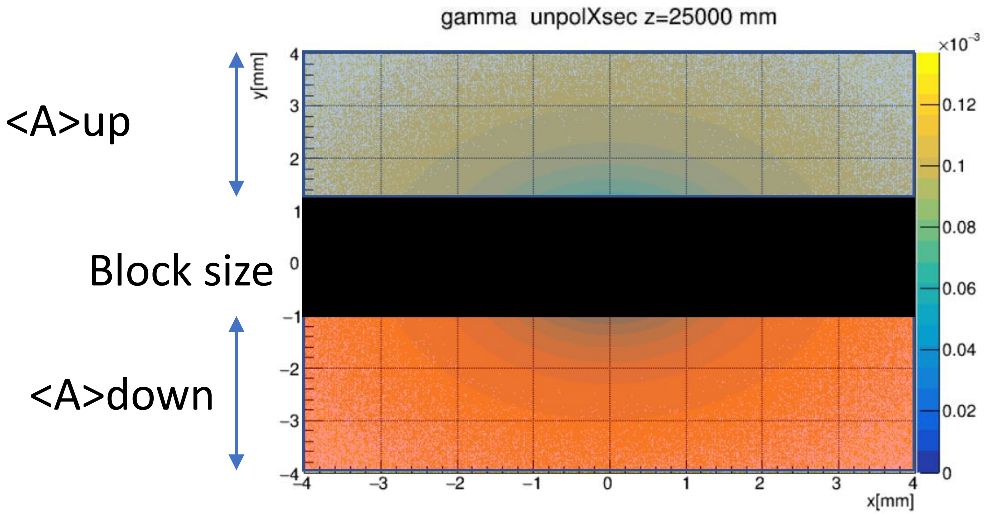



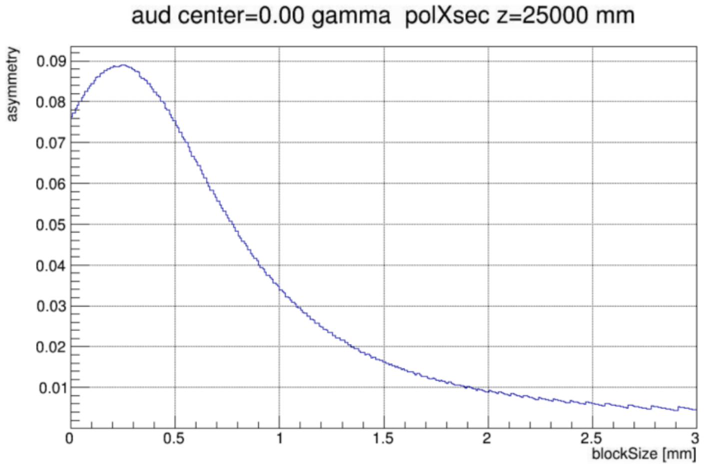



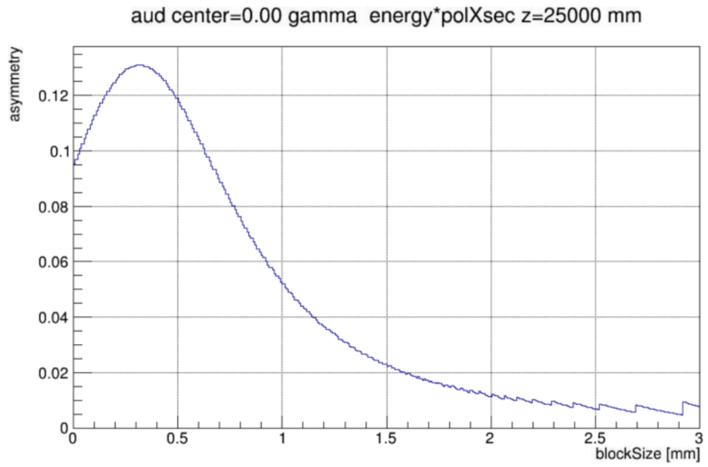

- If we look at the sign corrected average asymmetry for the upper and lower part of the detector plane it can give us the effective analyzing power
- If we move where were do the integration it can tell us about position sensitivities for the photon detector
    - Photon: <A> drops by ~1% at about 70um and <EA> drops by ~1% at 110um
- For the electron moving off center will add more “non-sensitive” events to one side and increase the <A> for the other

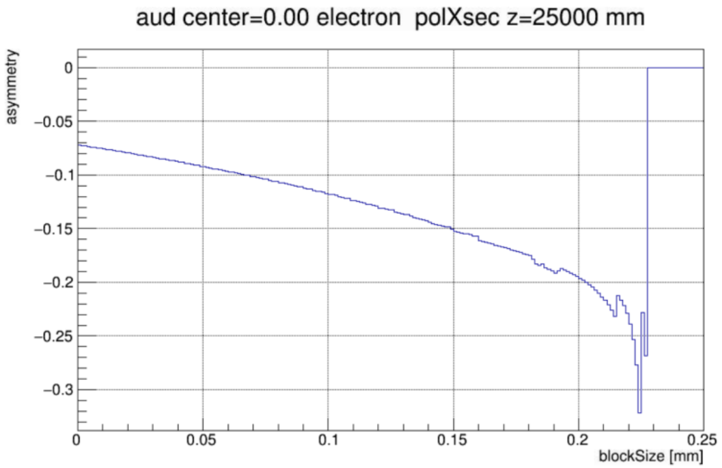
# AUD and partial measurements

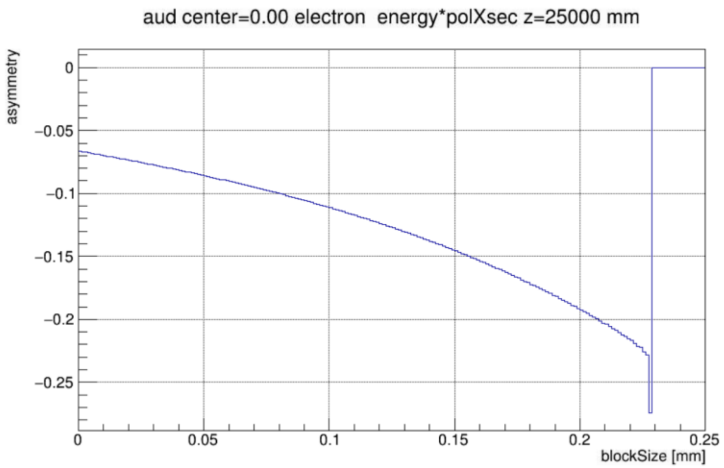



**Vertical axis: (<A>up - <A>down )/2**



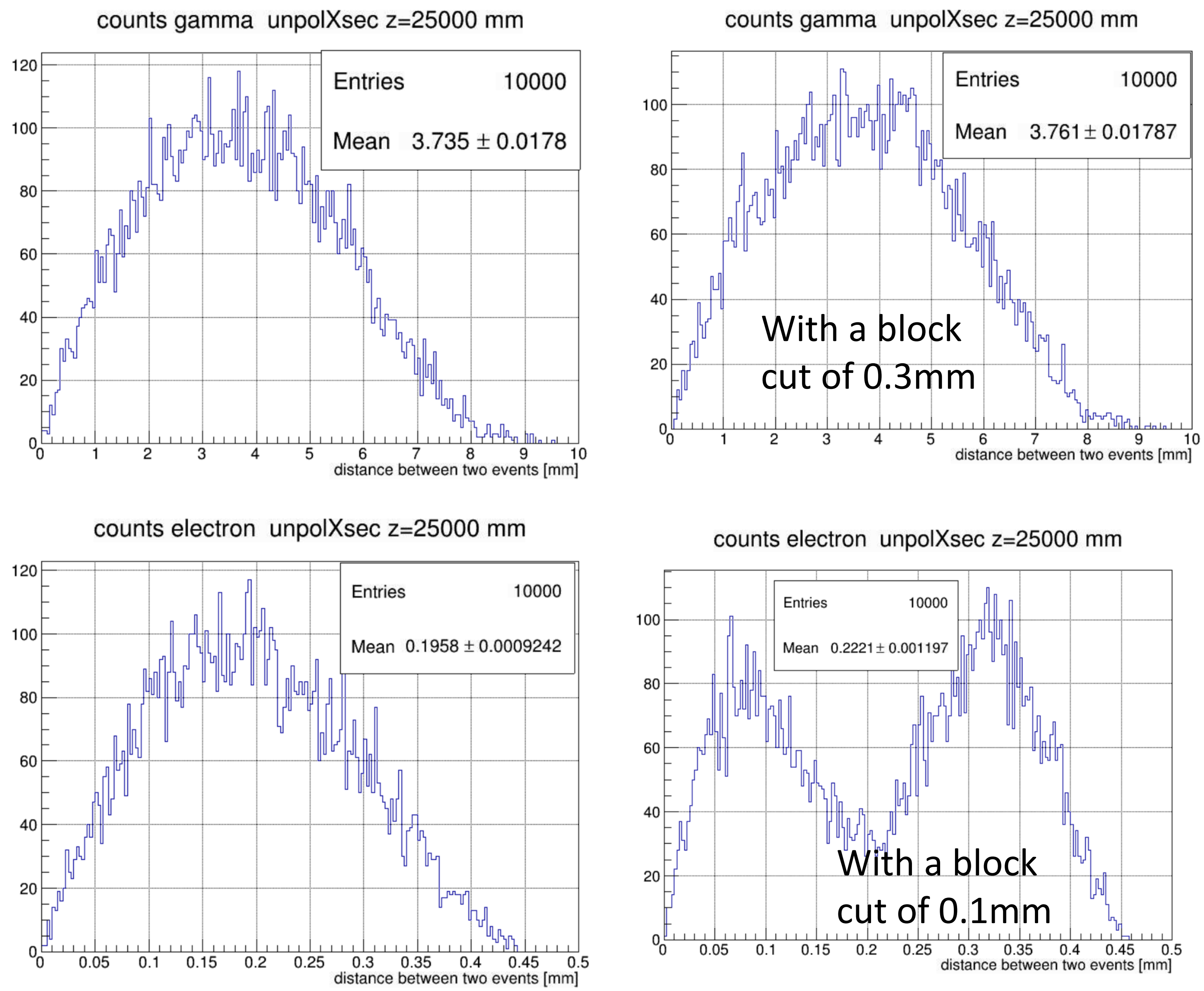



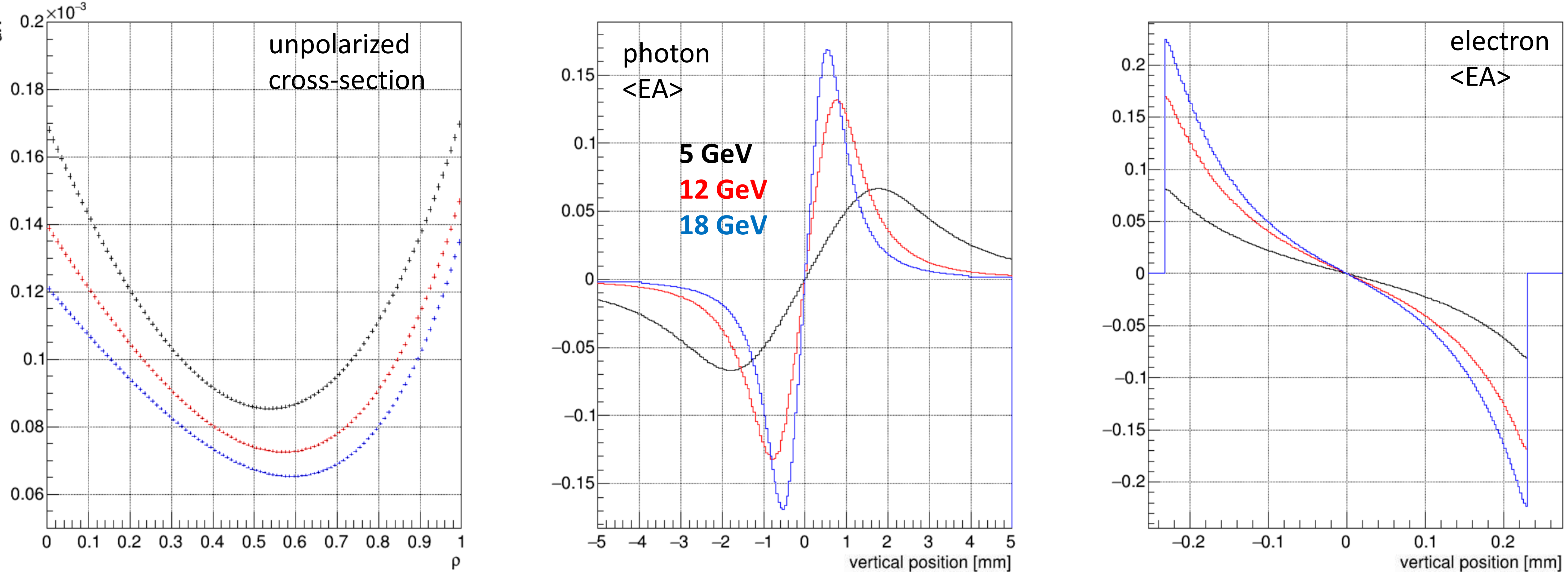

- If we sit in the center but average only partially (or equivalently block out some of the acceptance) we can see if we can get an effective analyzing power that is larger
- For both the electron and photon we can make some gains
- The photon AN raises until we start eating into the region that has the highest vertical AN (note that for the <EA> the peak is at about 300um while for <A> it sits at 250um)
  - If we take a cut of 0.3mm for the photon detector we lose about 10% of the statistics
- The electron seems a steady increase up to the Compton edge (of course we lose more and more events)
  - If we take a cut of 0.1mm for the electron we lose about 60% of the statistics

# AUD and multiple particle msmt



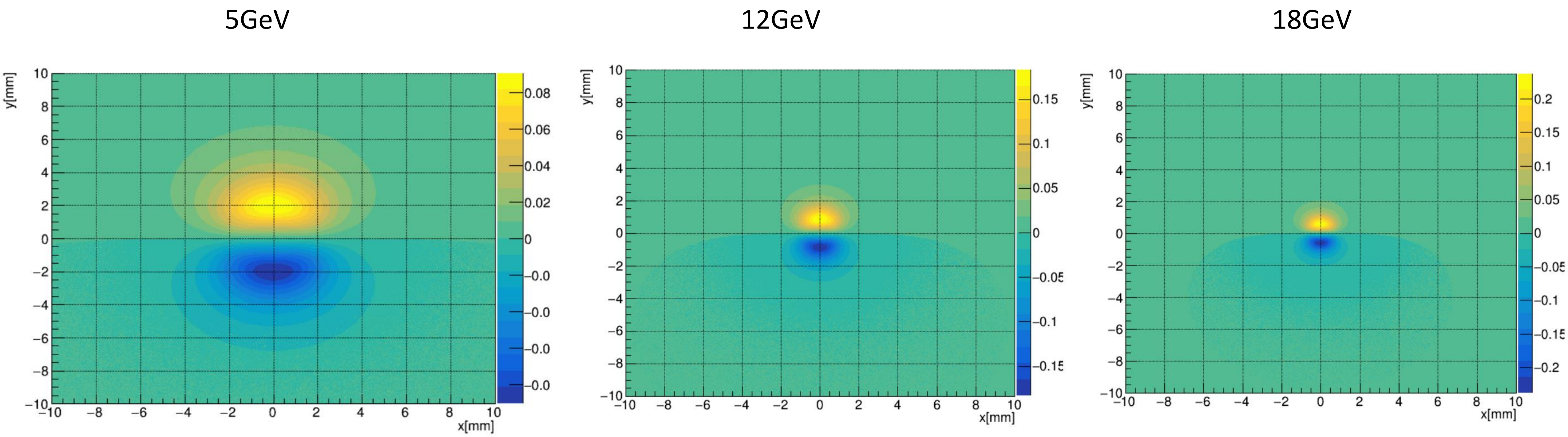

- Sampling randomly from the unpolarized distributions we can get a sense of the distance between two events and answer the question if these particles could be measured at the same time
- The distance between the particles would not allow for separation using only calorimetry (lead tungstate has a Mollier radius of 2.2cm)
- The segmentation for the electron detector is going to be much more stringent

# Scan over energies




- I took a look at the other two energies and qualitatively things are similar to what we discussed already besides the asymmetries and cross sections

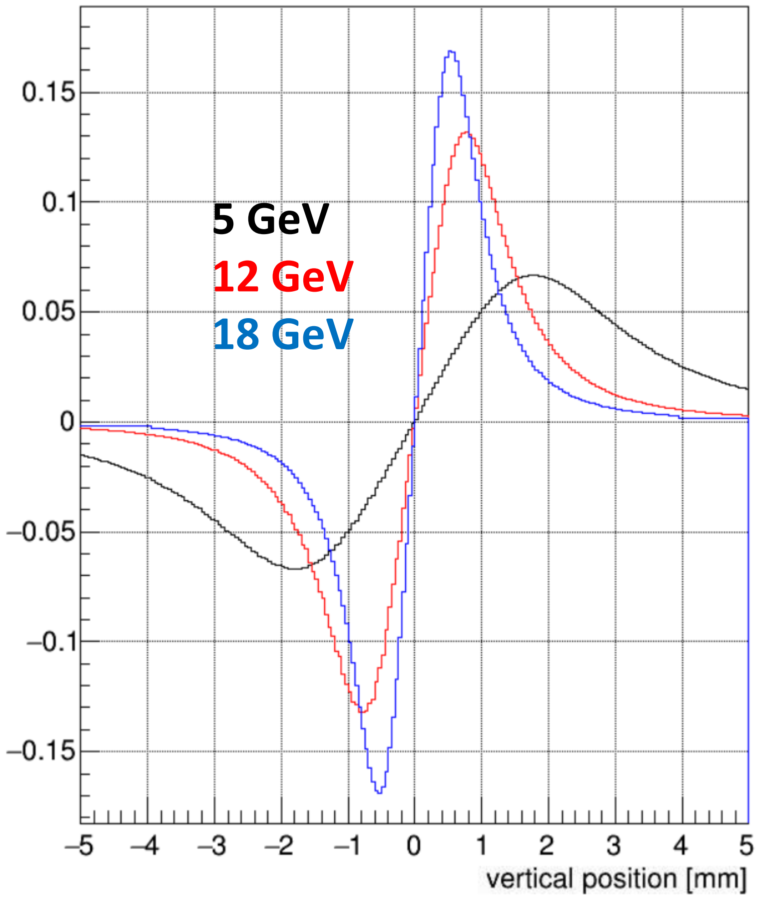
# Scan over energies




- While this was probably obvious it bears repeating that the center of the detector will be more important with a higher density of particles at higher and higher energies

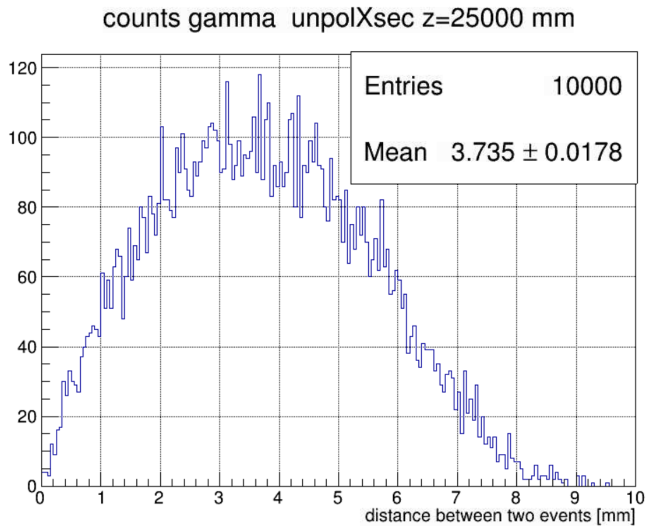
# To do

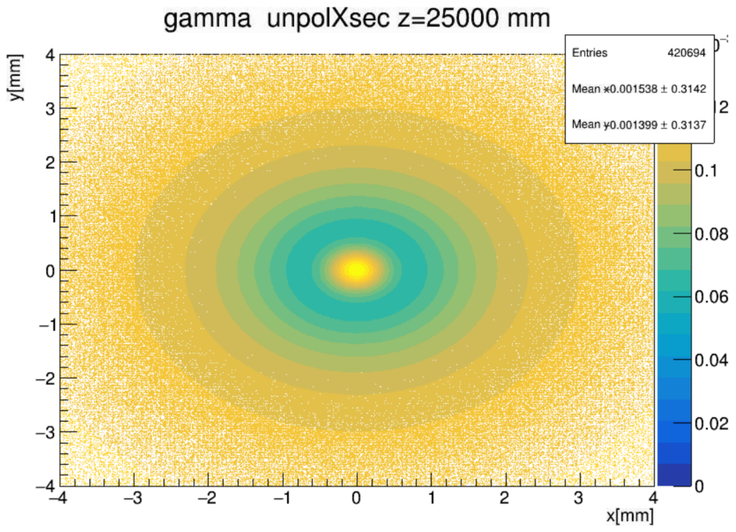
- Investigate the beam envelope effects (electron beam width and divergence)
- Add these to a G4 setup with a beampipe, magnet apertures (probably not that important) and air
- Repeat analysis for IP6

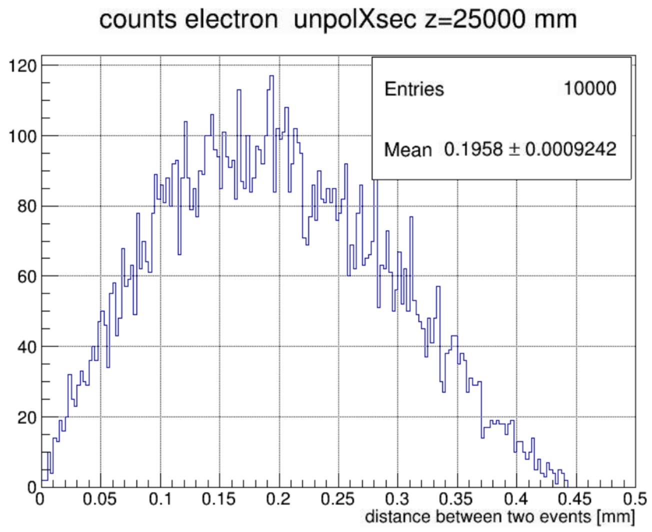


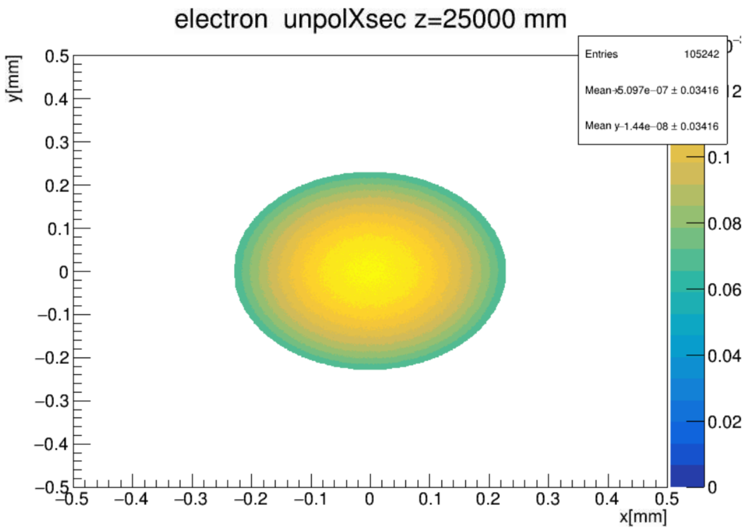
# backup

# AUD and multiple particle msmt



# AUD and multiple particle msmt