WIMP search at the mono photon channel at 500 GeV ILC +Update

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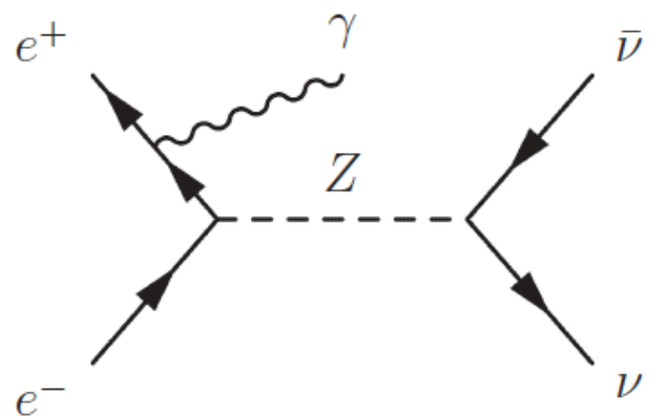
Samples



- Events used: $e^+e^- \to \nu\bar{\nu}\gamma$ (nung) including beam backgrounds. Besides, $e^+e^- \to \nu\bar{\nu}\gamma\gamma$ and $e^+e^- \to \nu\bar{\nu}\gamma\gamma\gamma$ are also included.

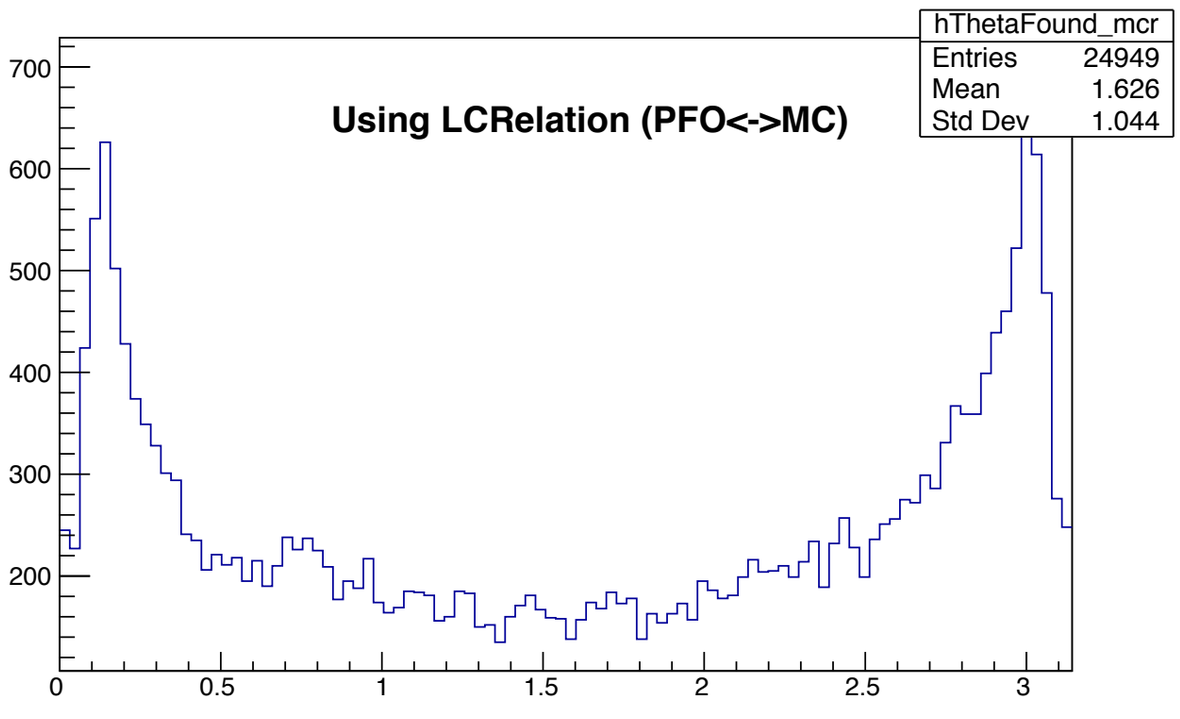
- The current analysis aims at determining the efficiency of detecting the events containing only single photon i.e. only the photon corresponding to $e^+e^- \to \nu\bar{\nu}\gamma$

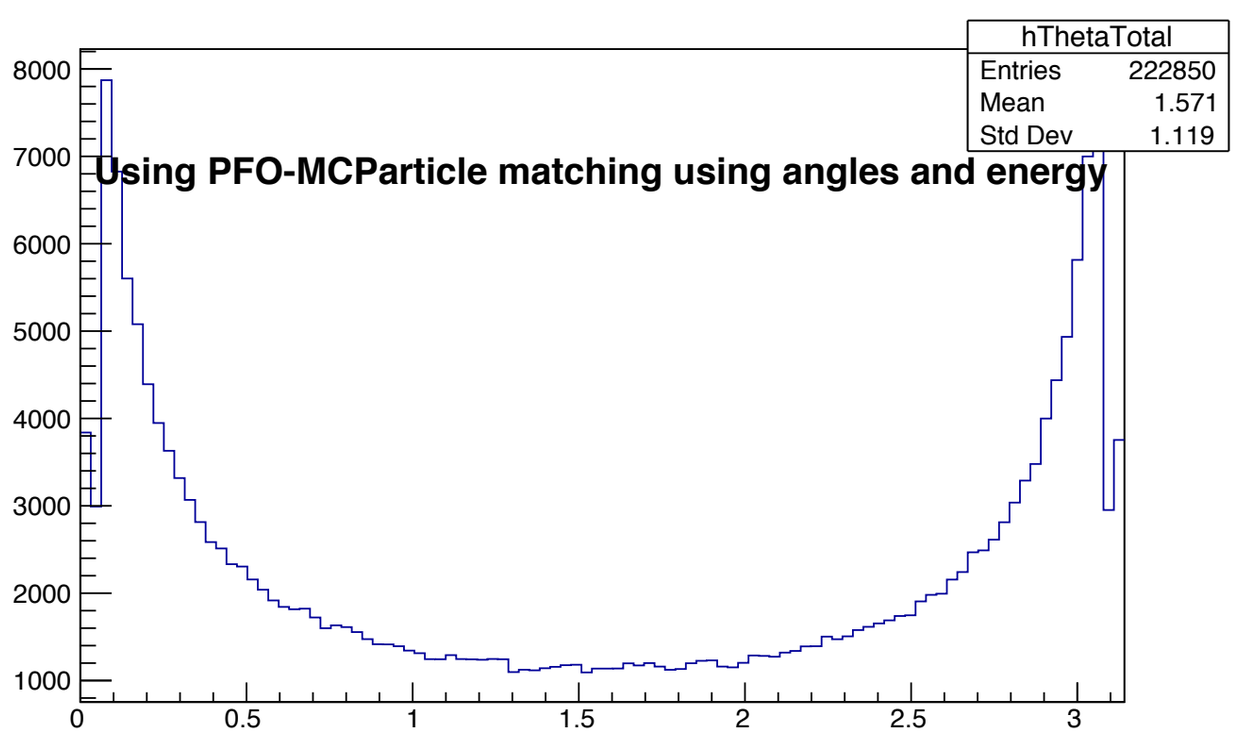
Efficiency

- Efficiency = $\frac{Number\ of\ reconstructed\ particles}{Number\ of\ simulated\ particles}$
- Information of reconstructed particles are contained in PFOs
- Information of simulated particles are contained in MCs (MCPs/MCRs)
- Comparison between PFOs and MCRs/MCPs is necessary

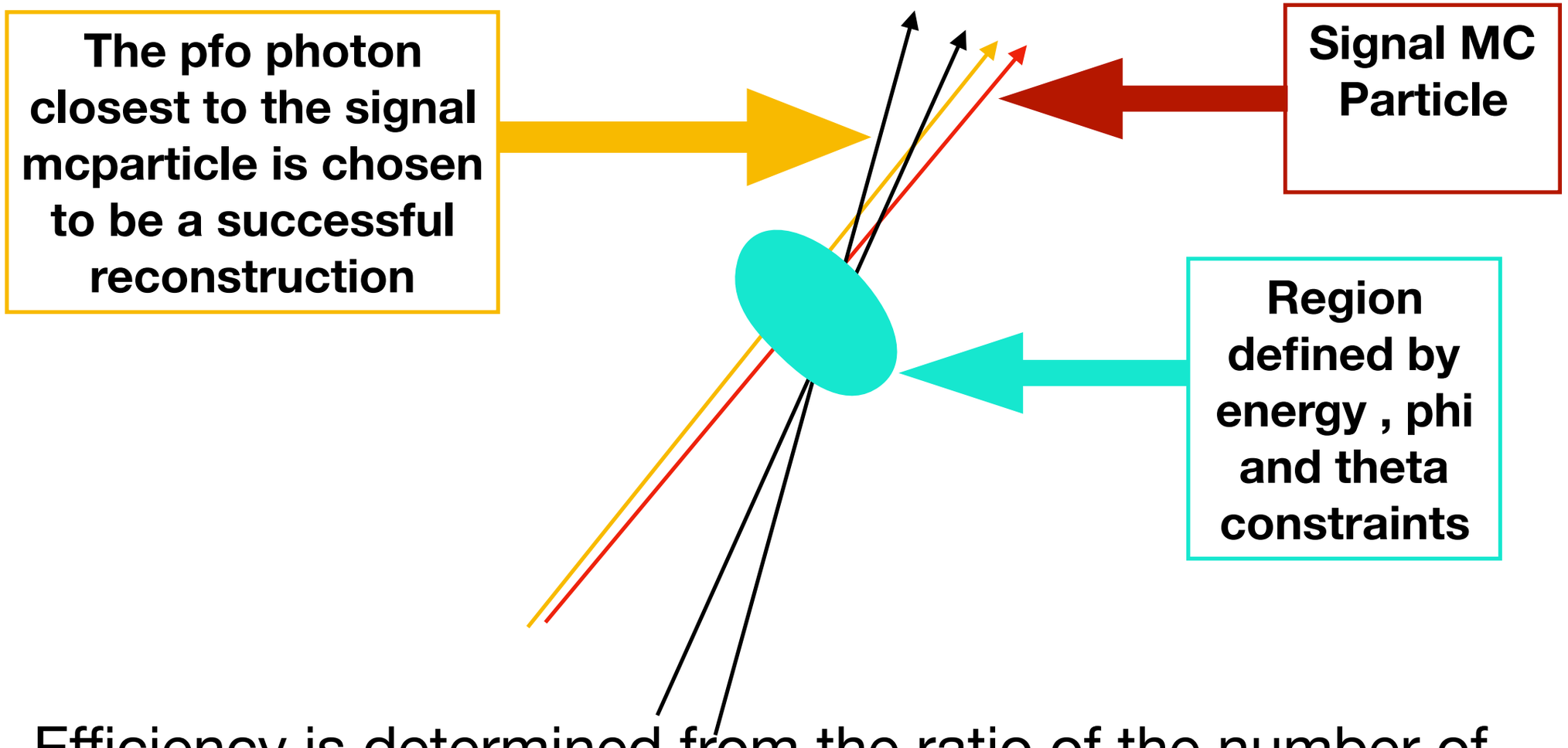
Two methods to link PFO and MC Particles

- Distribution with MC Relations has low statistics=>





Successful reconstruction



- Efficiency is determined from the ratio of the number of successful reconstruction and the number of signal MC Particles

Method of selecting the signal photons

- Obtaining the energy, theta and phi constraints described in the previous slide =>Comparing MC relations and PFO particles

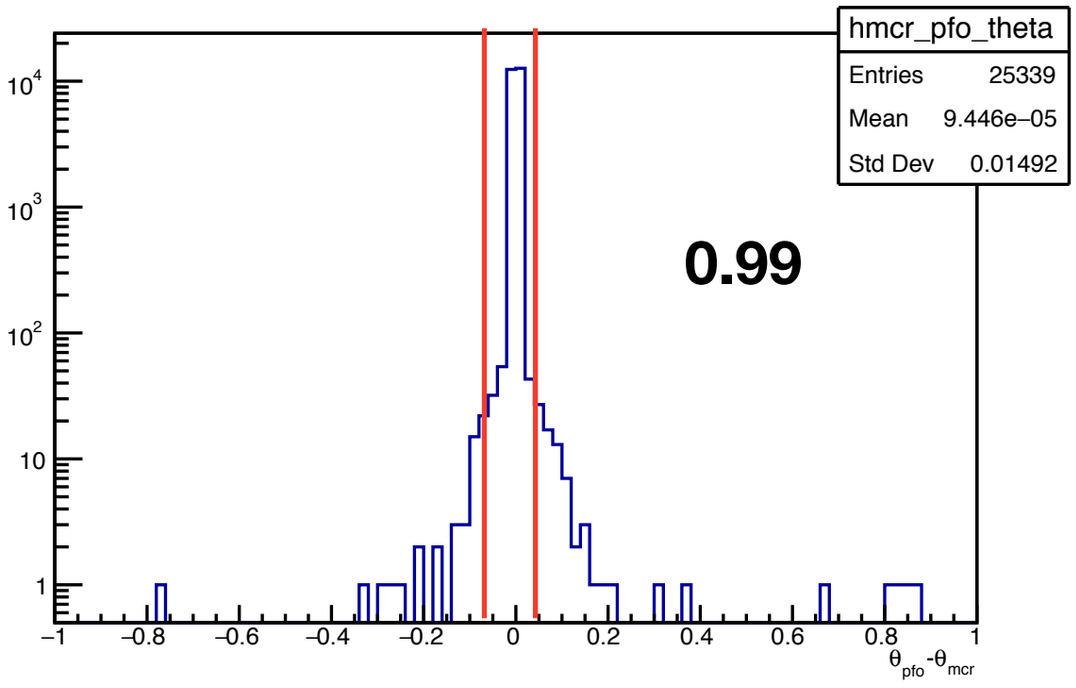
- Determine the signal by observing the particle IDs and number of parent and daughter particles

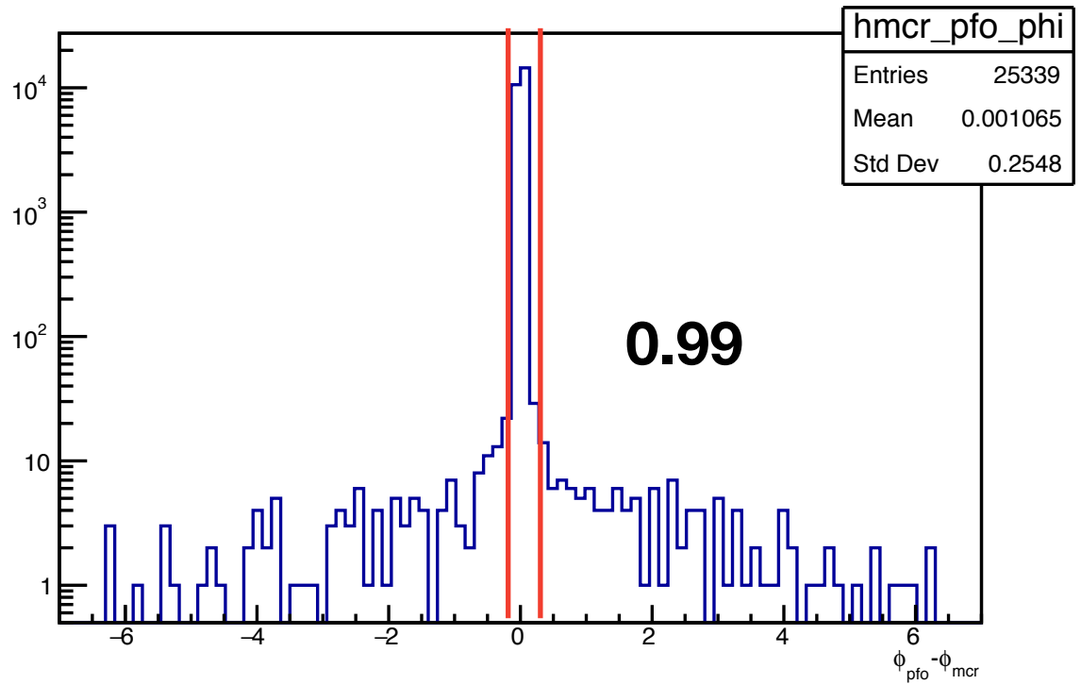
- Plotting the theta distribution of the MC particles and PFO particles that fall within the energy, theta and phi constraints

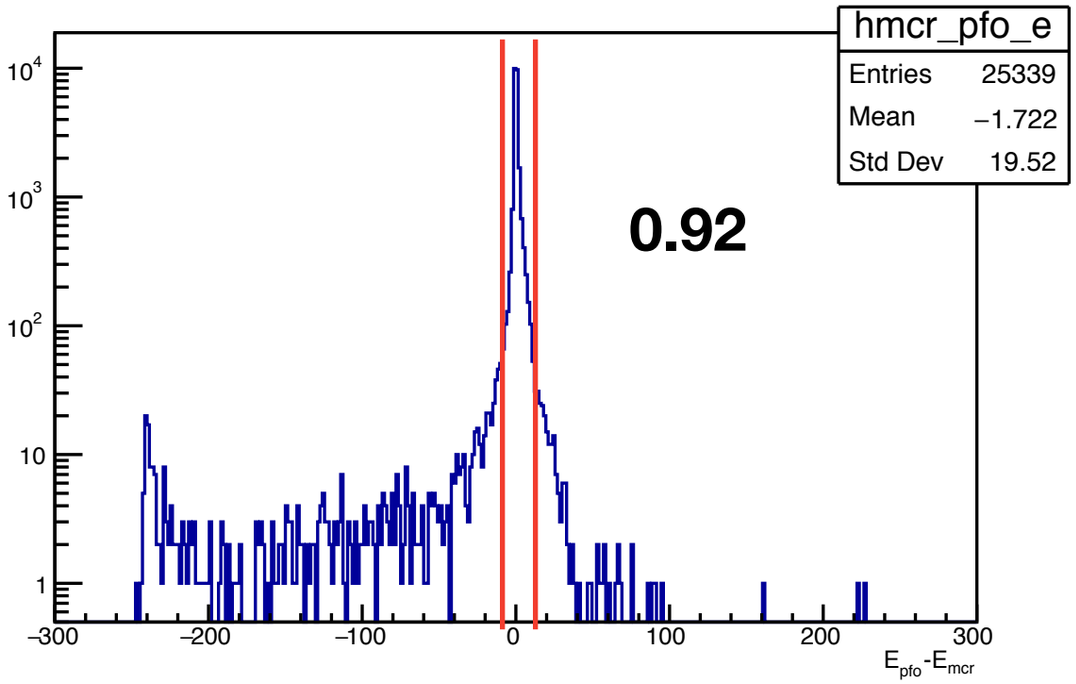
- Determine the distribution of the PFOs closest to the MC particle in case of the presence of more than one PFOs within the constraint

- Obtain the efficiency from the ratio of the above two plots

Residual (PFO- MC)







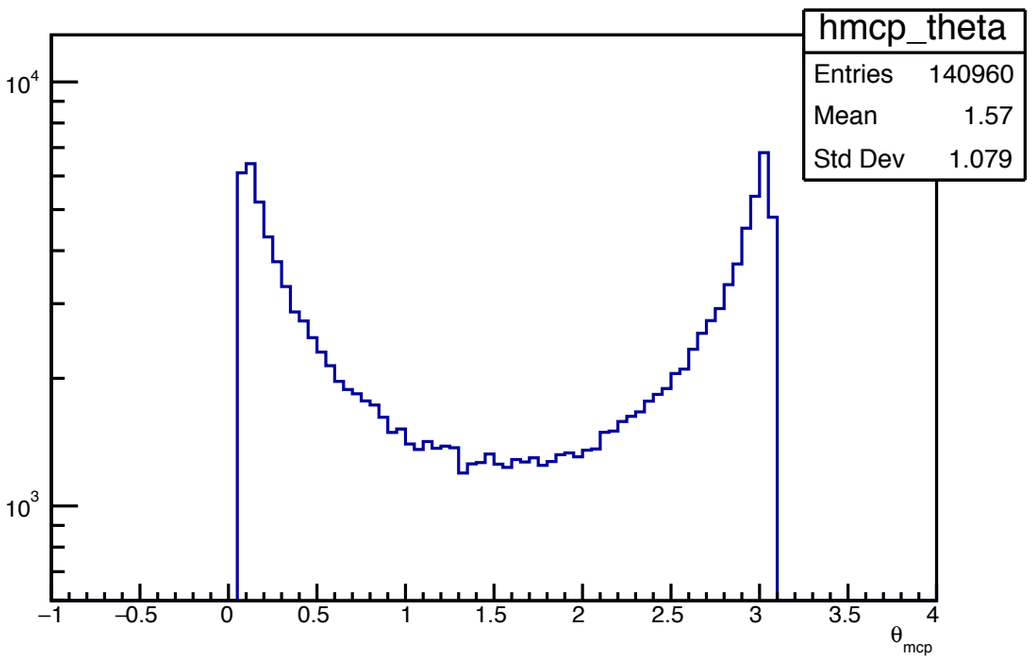
bPassed = ((mcr_pdg[ip]==22) && (mcr_parentIndex[ip][0]==2 && mcr_parentIndex[ip][1]==3))

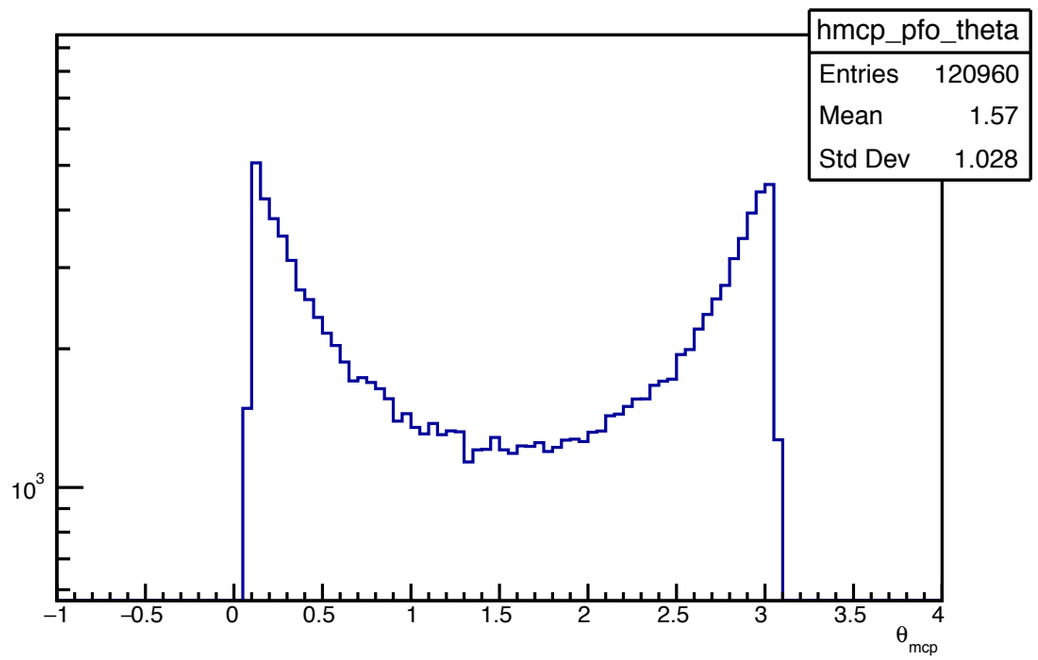
$$\frac{\text{Entries } -0.01 \le \theta \le 0.01}{\text{Entries when bPassed==1}} = 0.987016$$

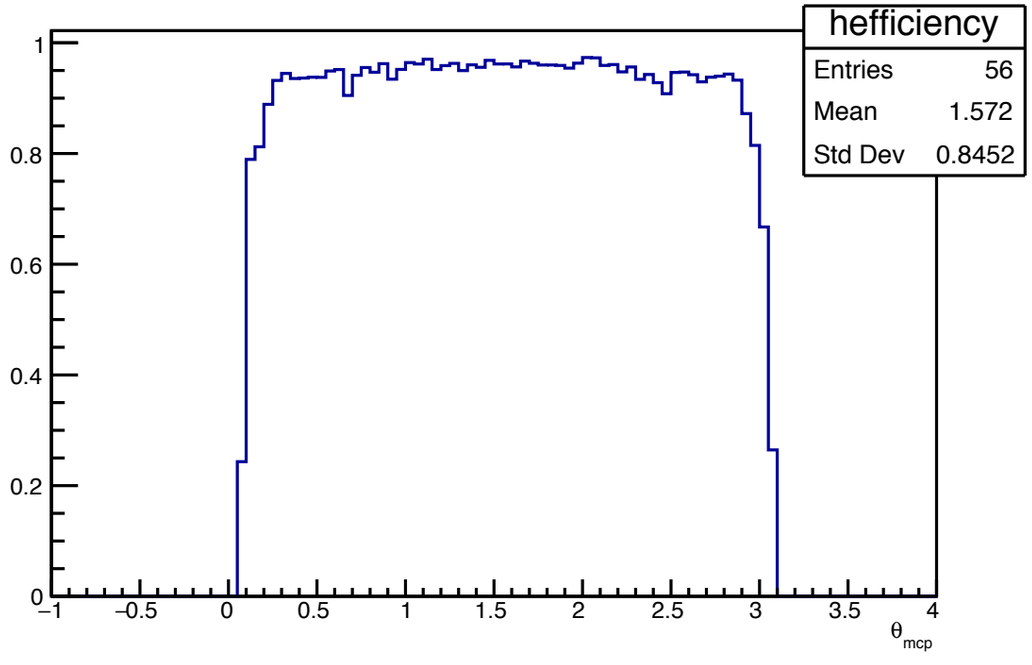
$$\frac{\text{Entries } -0.1 \le \phi \le 0.1}{\text{Entries when bPassed==1}} = 0.987884$$

$$\frac{\text{Entries } -5 \le \text{Energy} \le 5}{\text{Entries when bPassed==1}} = 0.920912$$

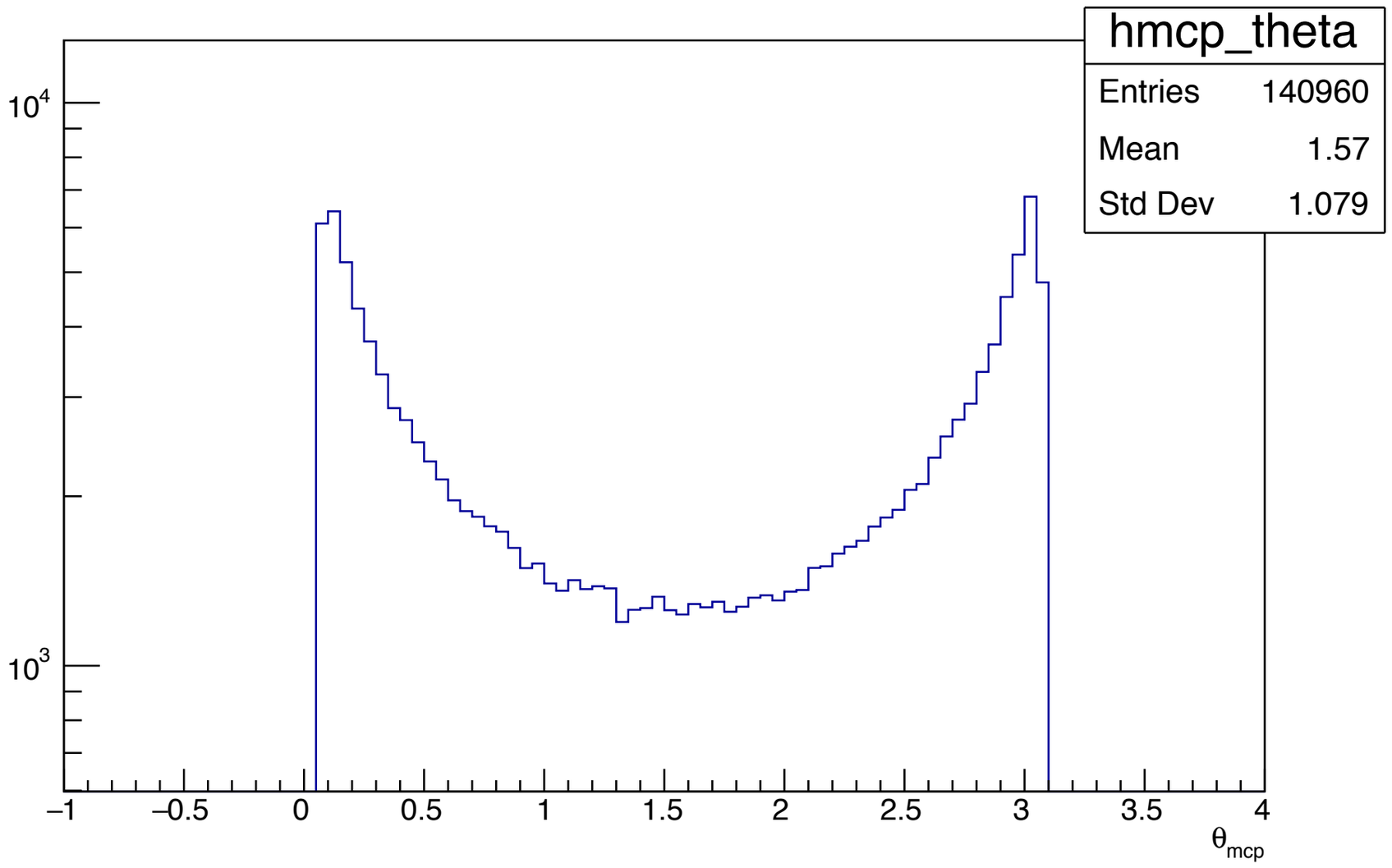
Distributions of MC Particles and PFOs within constraints



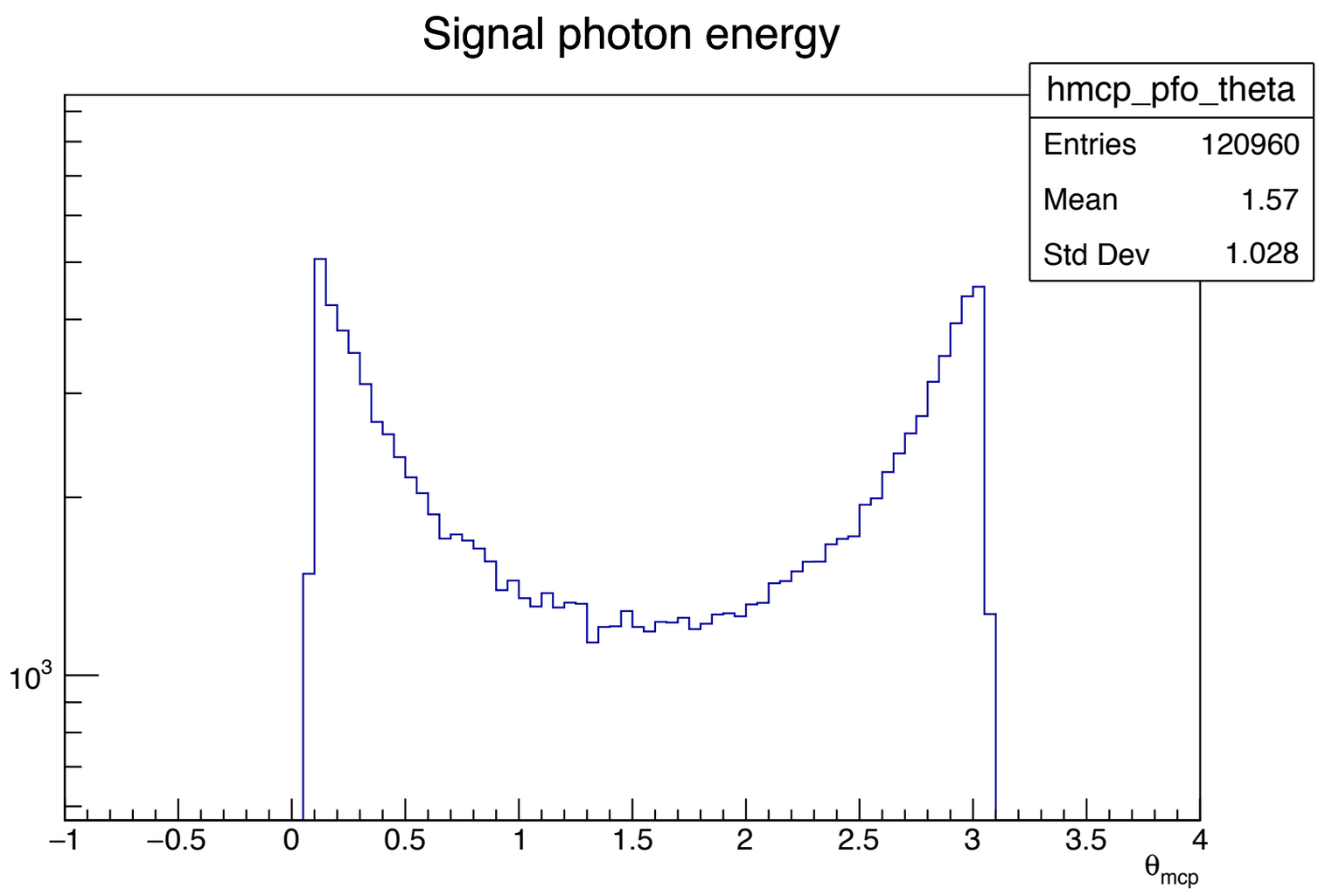




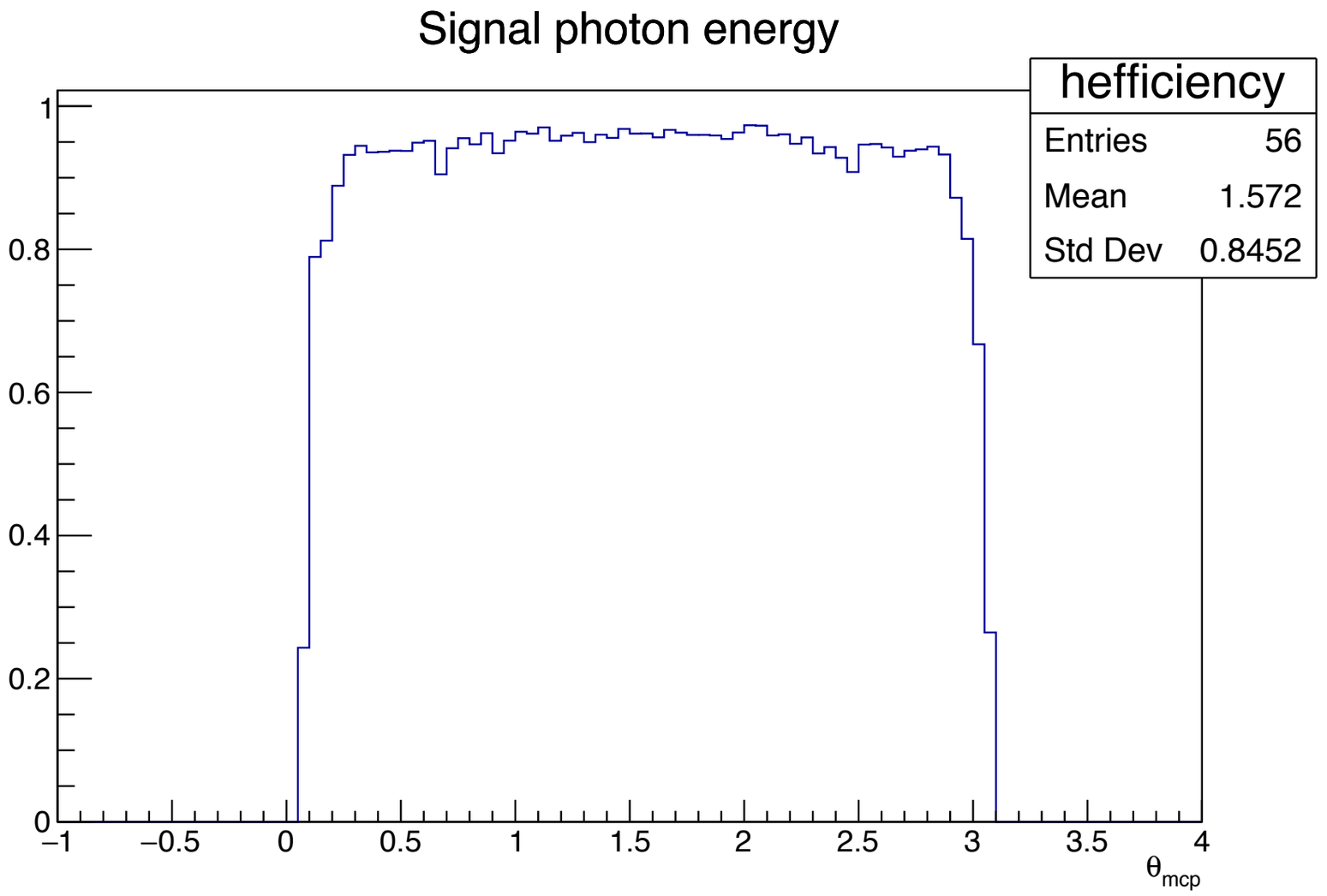
MC Particle Theta Plot



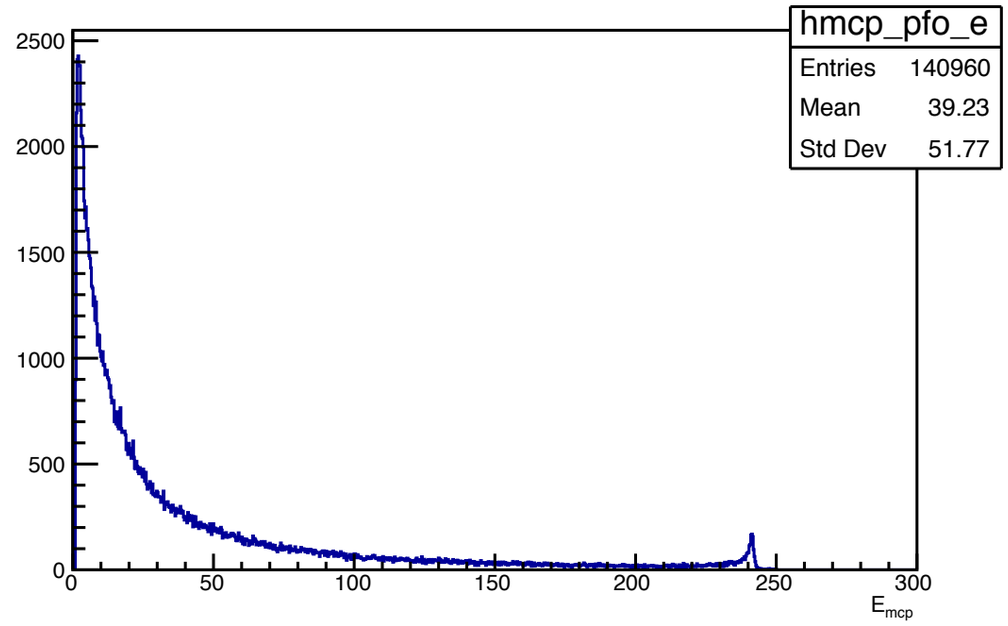
PFO signal plot

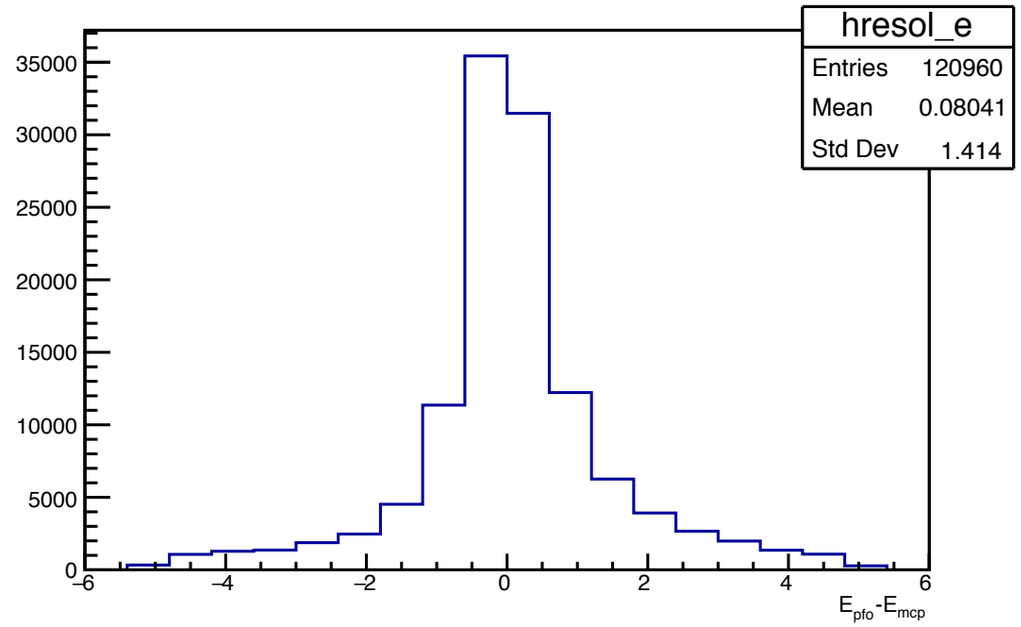


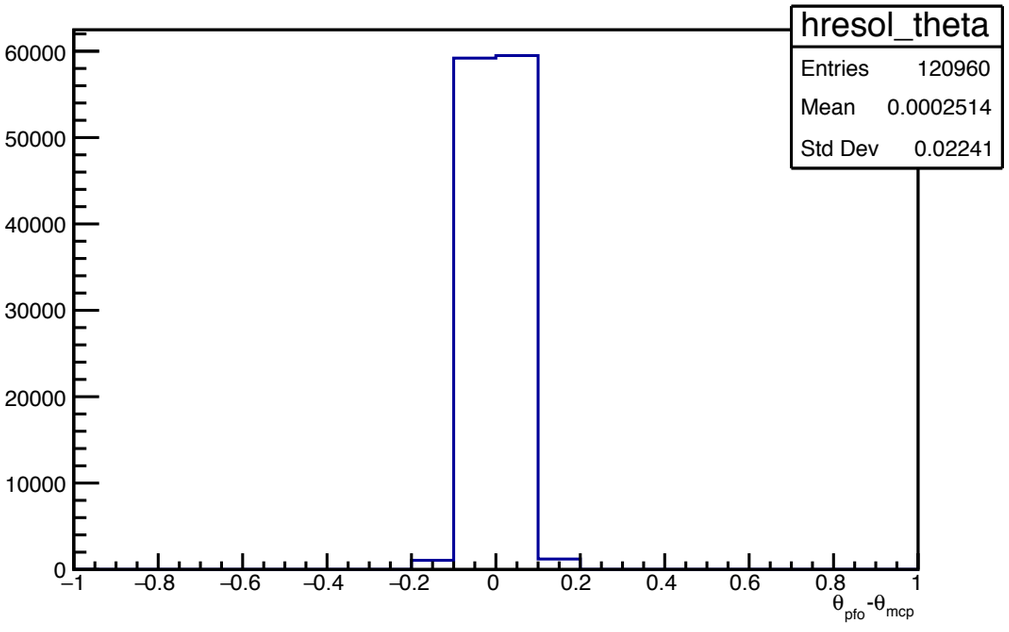
Efficiency Plot

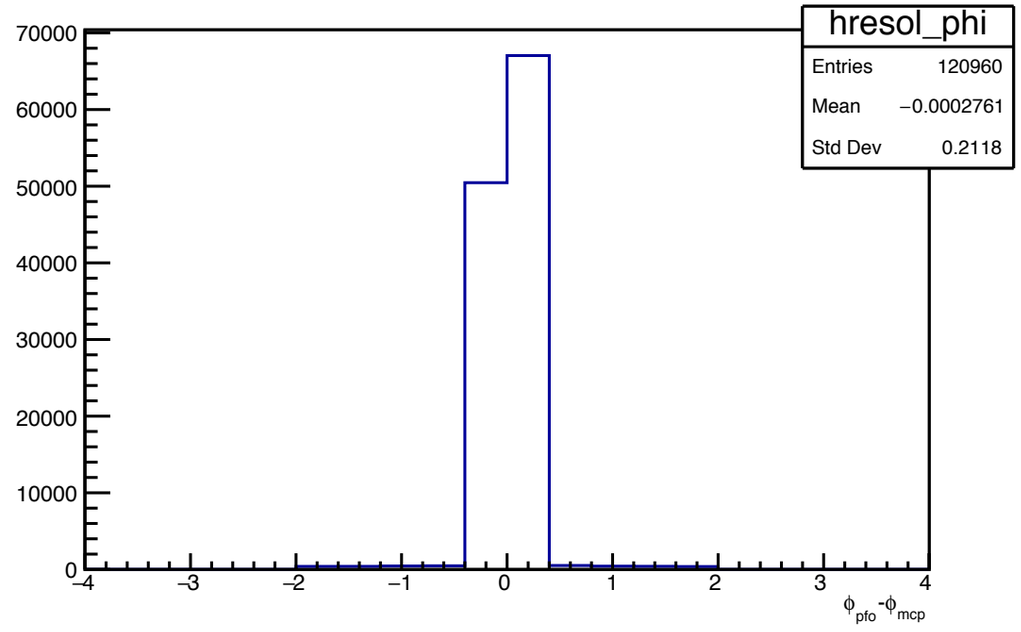


Energy of MC and MC-PFO plot for energy, theta, phi









Works to be done

- Include photon energy cuts, costheta cut etc. ●
- Only one file now=>Future incresase statistics ▲
- Use Bhabha samples ▲
- Use RecoFile to obtain BeamCal info=> Currently using DST file X
- Signal photon selection without MC information ▲
- Determine Purity
- Reweigh nung process to emulate signals ●
- Calculation of mass limits; Use beam Polarization(now mixed. will separate later)

Calculation of Weights

- Instead of producing WIMP directly, weights are applied to the number of nung samples.

- $w_{sig} = \sigma(\chi\chi\gamma)/\sigma(\nu\bar{\nu}\gamma)$

Calculation of Weights

- Differential CS(cross-section) of WIMP is calculated from the following formula

- Annihilation fraction $\kappa_e = 0.6$, Annihilation cs $\sigma_{an} = 7\ pb$

- WIMP mass, $m_\chi = 120\ GeV$, $J_0 = 0$ (s-wave), spin $S_\chi = 0$

$$\frac{d\sigma}{dxdcos\theta}(e^+e- \to 2\chi + \gamma) \approx \frac{\alpha\kappa_e\sigma_{an}}{16\pi}\frac{1+(1-x)^2}{x}\frac{1}{sin^2\theta}2^{2J_0}(2S_\chi+1)^2\left(1-\frac{4M\chi^2}{(1-x)s}\right)^{1/2+J_0}$$

Calculation of Weights

- Differential CS of nung is calculated from the E vs cos(theta) plot

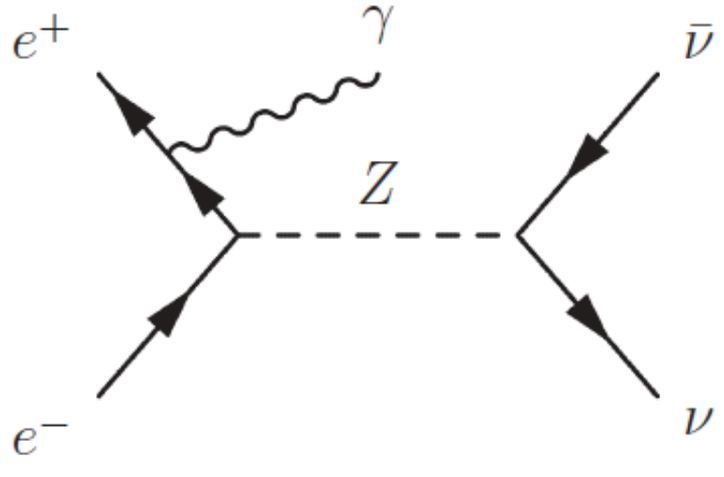
- Tolerance on E and cos(theta), a specified range in the 2D plot where CS from theory (shown in the last slide) does not vary, is evaluated

$$weight = \frac{\Delta\sigma_{theory}}{N_{\nu\nu\gamma\ in\ tol}\ \sigma_{total}/N_{total}} \qquad \Delta\sigma_{theory} = \frac{\Delta^2\sigma_{theory}}{\Delta E\ \Delta cos\theta}\ \Delta E\ \Delta cos\theta$$

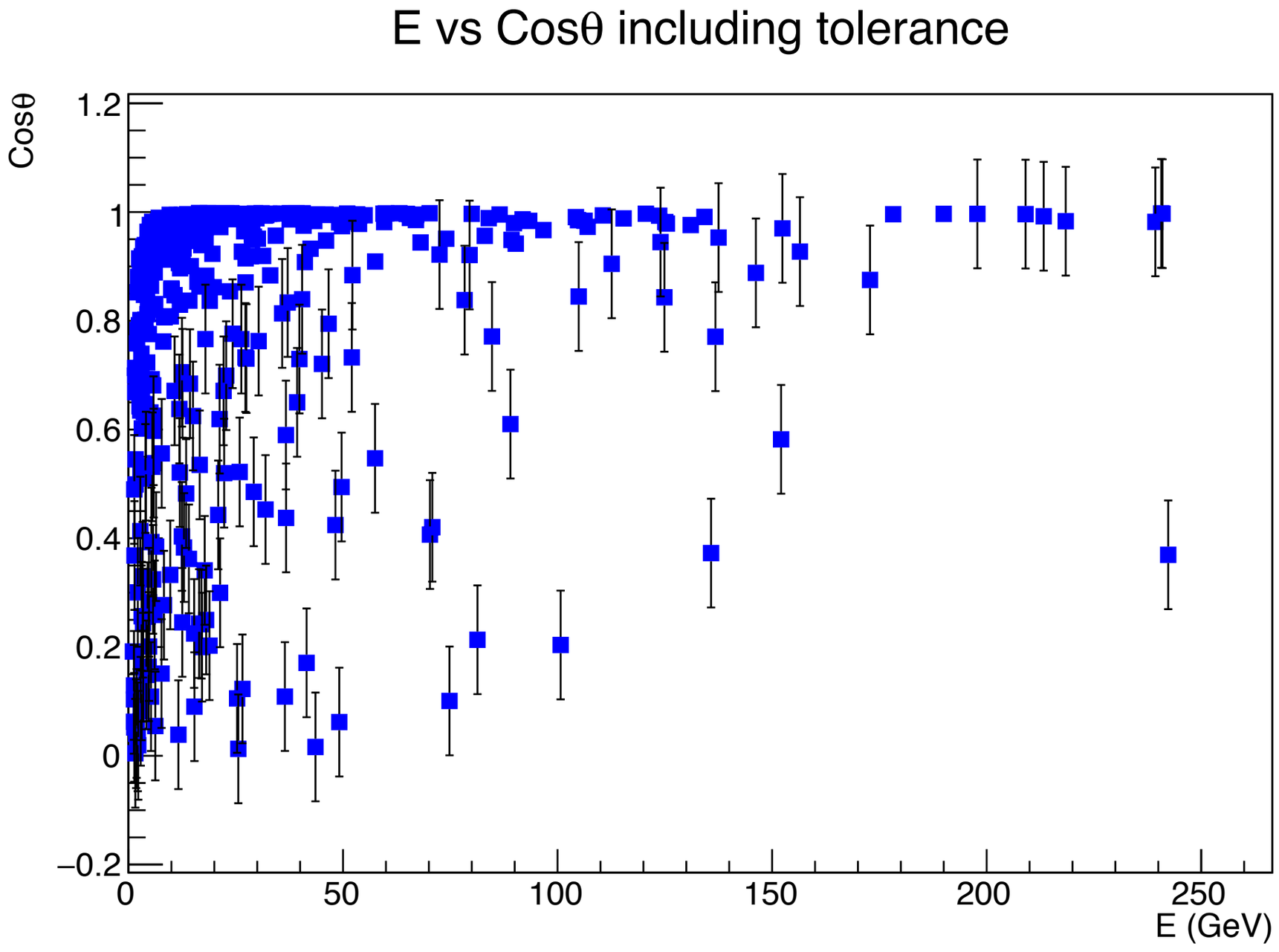
- Eventually the formula for weight is, The E vs cos(theta) plot has been provided with a color weight of differential CS (in the next page)

Calculation of Weights

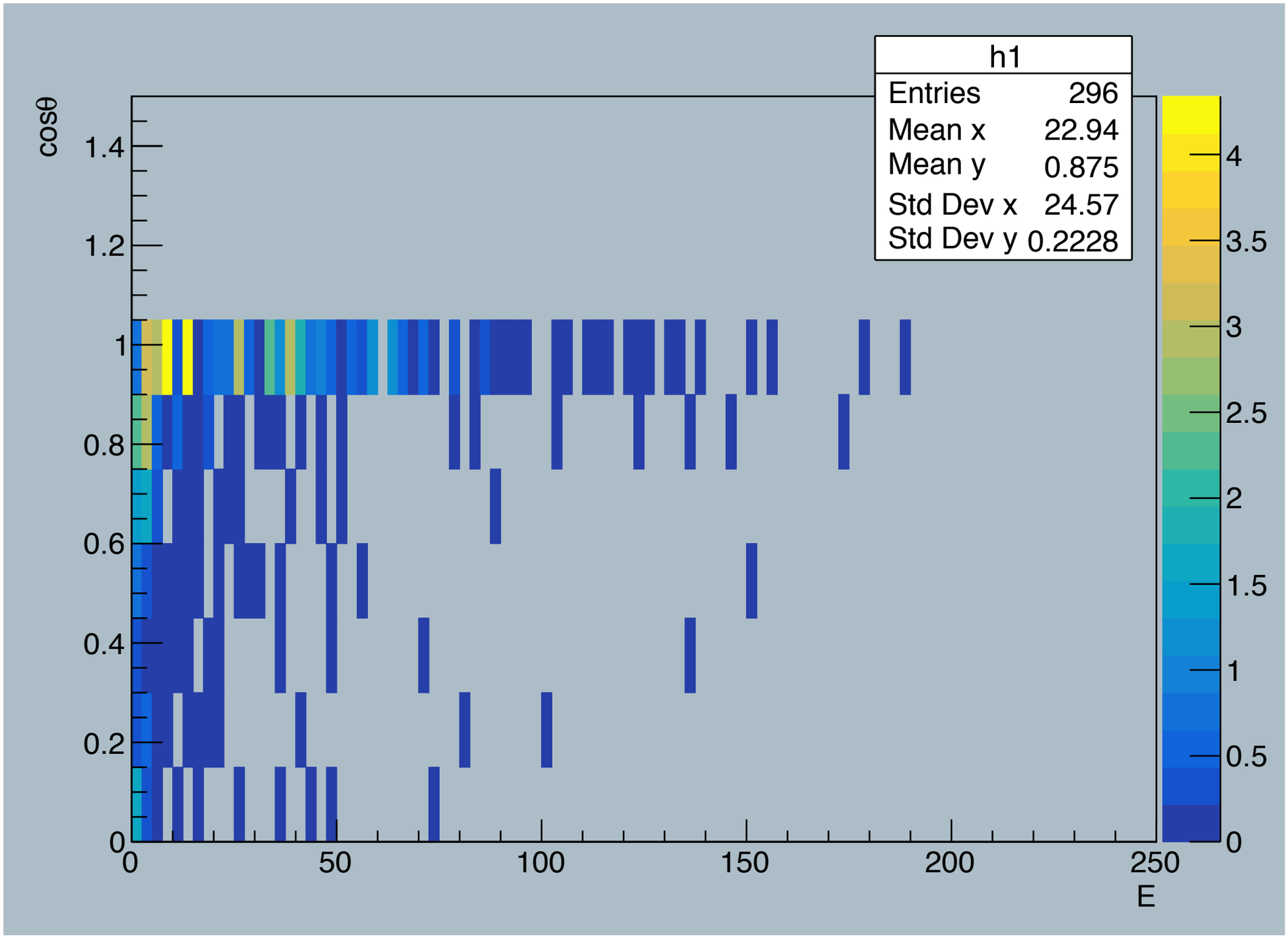
- The sample has been produced from a mixture of right and left handed electrons and positrons
- S-Channel Z (spin=1) causes CS_LL and CS_RR to vanish.
- $\sigma_{total} = 1/4\ \sigma_{LR} + 1/4\ \sigma_{RL}$



Plot of E vs cos(theta)

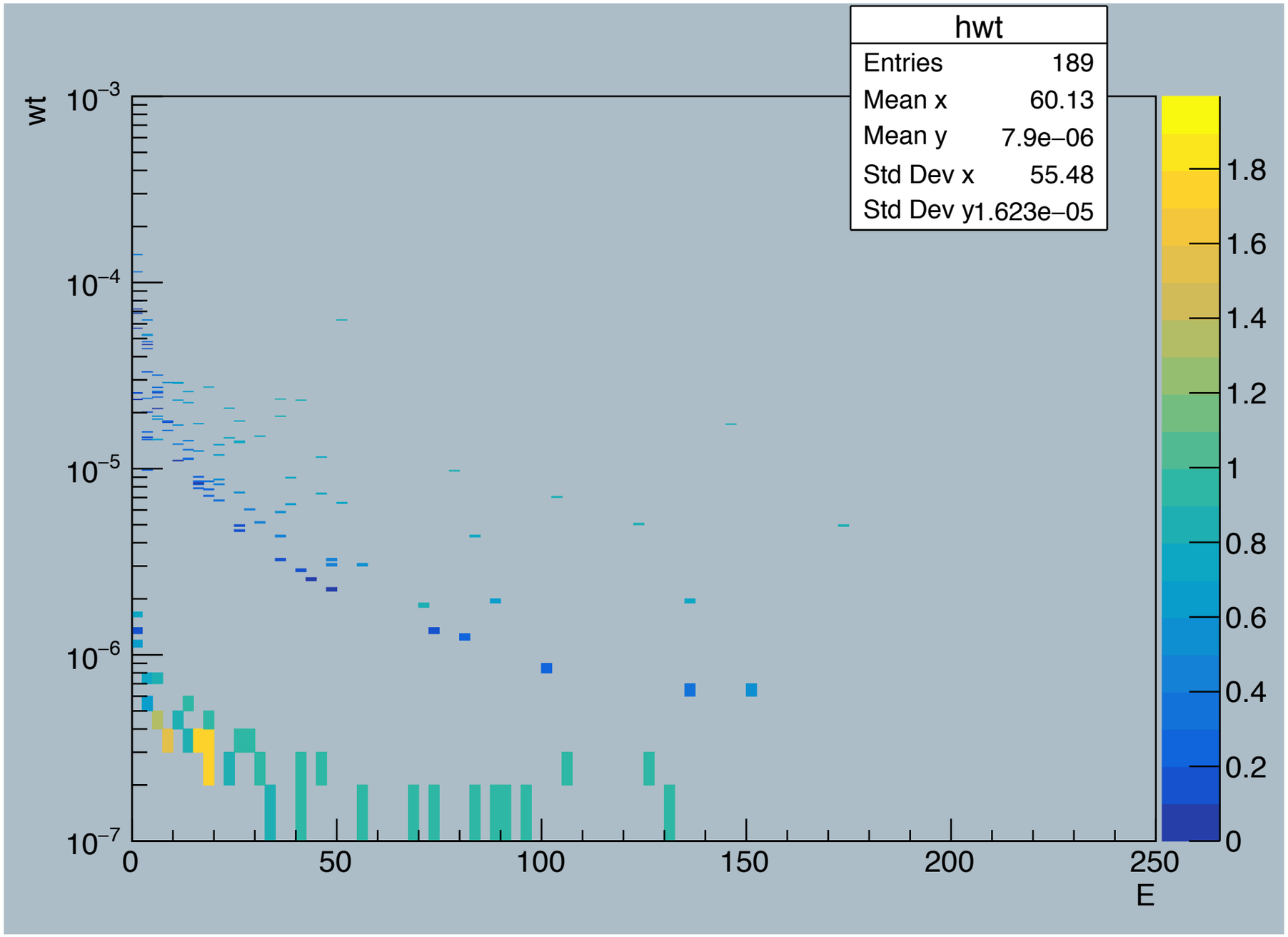


Plot of E vs cos(theta)



Plot of E vs weight (wt)

- Cos(theta) as color bar



To Do in the coming days

- Superimpose weighted nung and sample nung and compare the energy
- Plot each of the above plots by taking polarisation into account
- Include Bhabha events
- Apply cuts without using MC information
- Determine purity
- <= Can be completed in the next few days