TB2020 Bremsstrahlung Study

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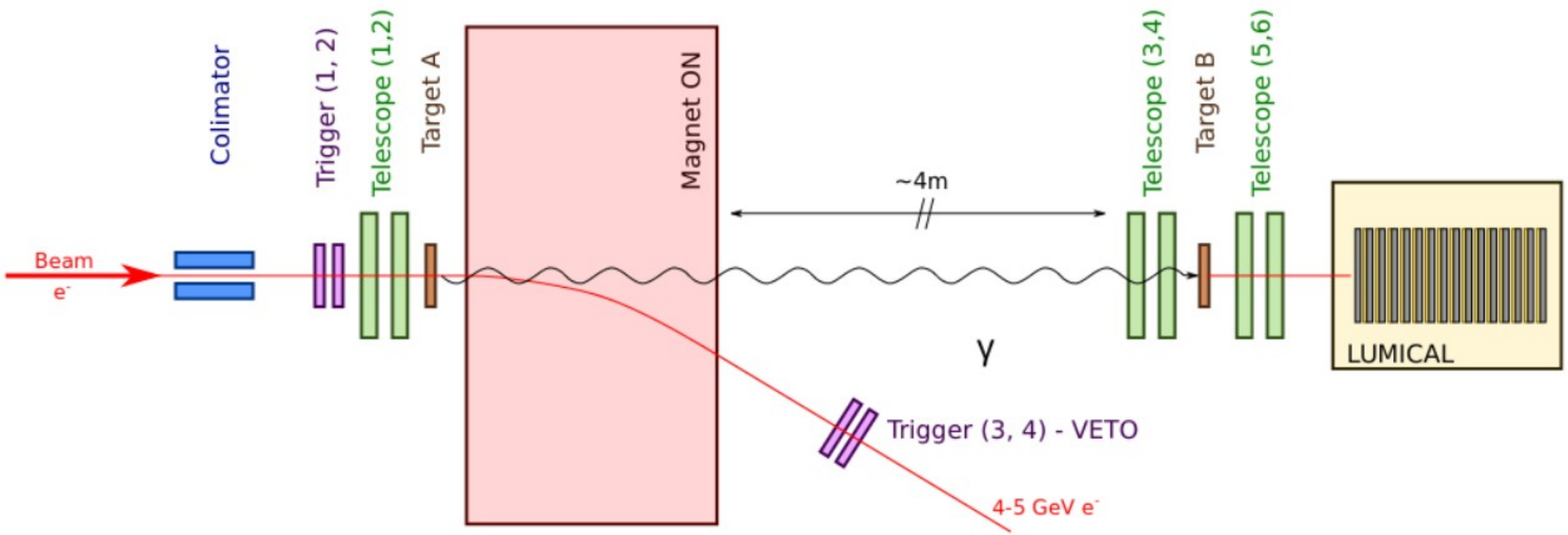
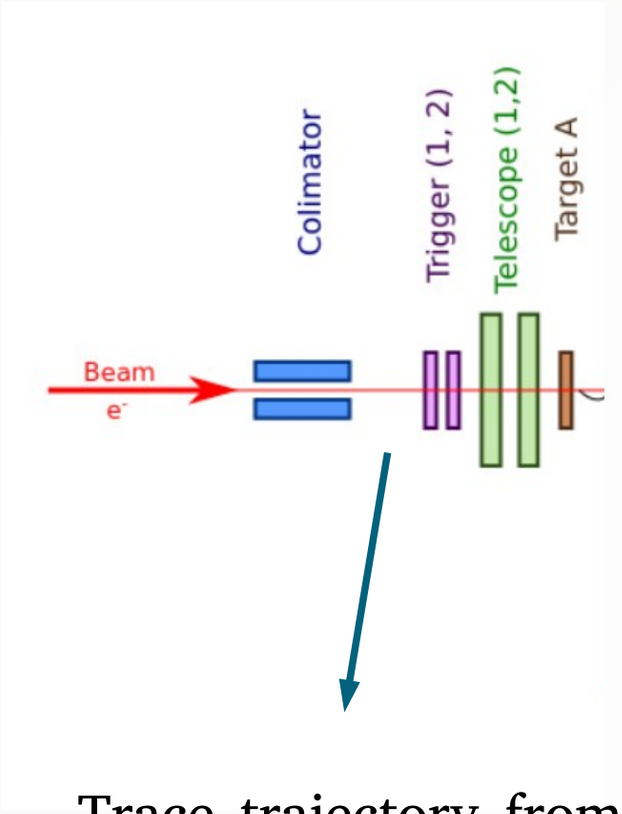
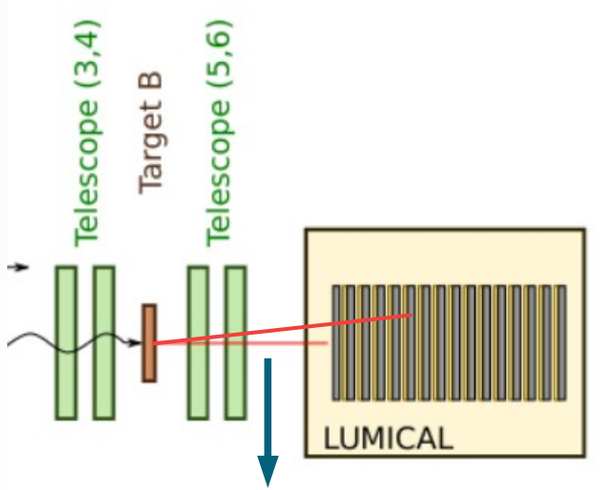
TB2020 Alpide Telescope Alignment



Idea is to use 2020 desy testbeam data to reconstruct the dispersion of bremsstrahlung photons, in particular the polar angle of the brem emission.



Trace trajectory from hitpoints in planes 1,2 to reconstruct incidence of target 1

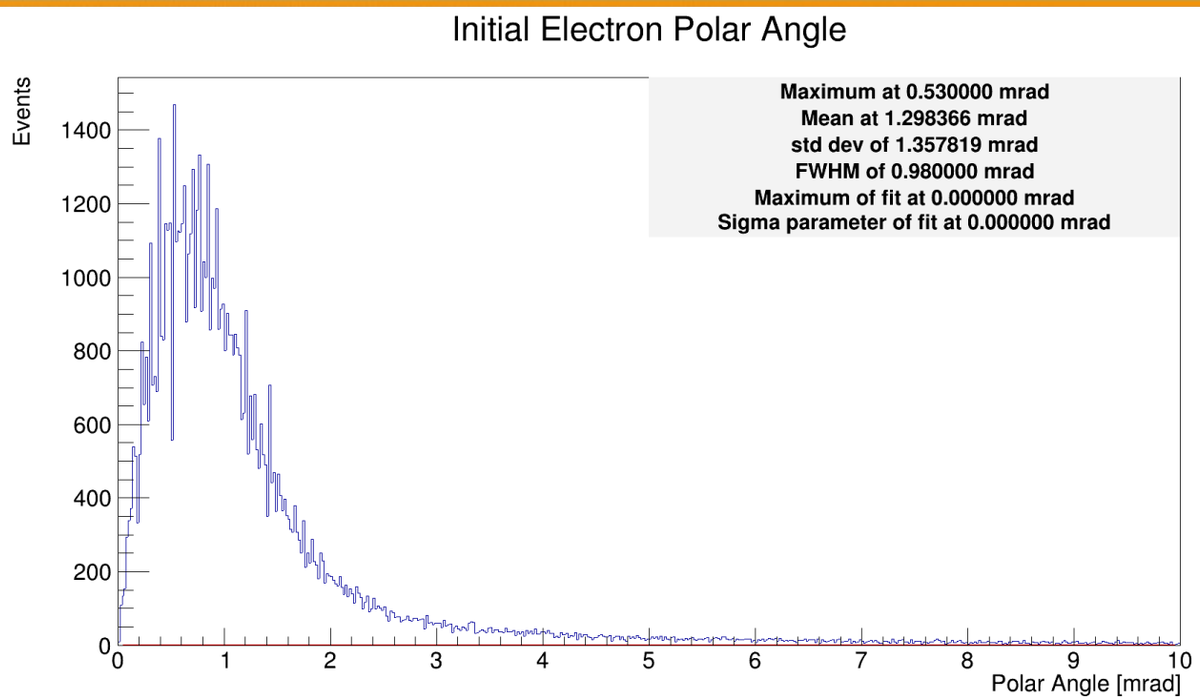


ETO

Reconstruct gamma incidence on target 2 using two hits of each of e-/e+ pair

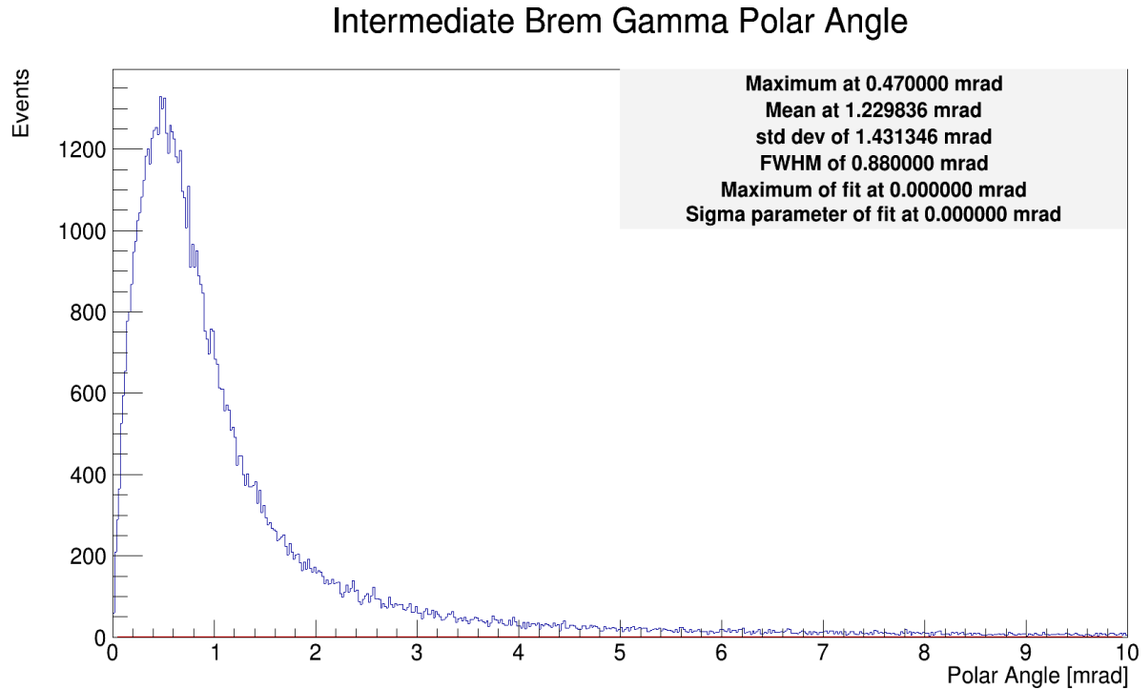
Track + correlate hits to correct tracks by extrapolating to target 2, choosing minimal distance between tracks

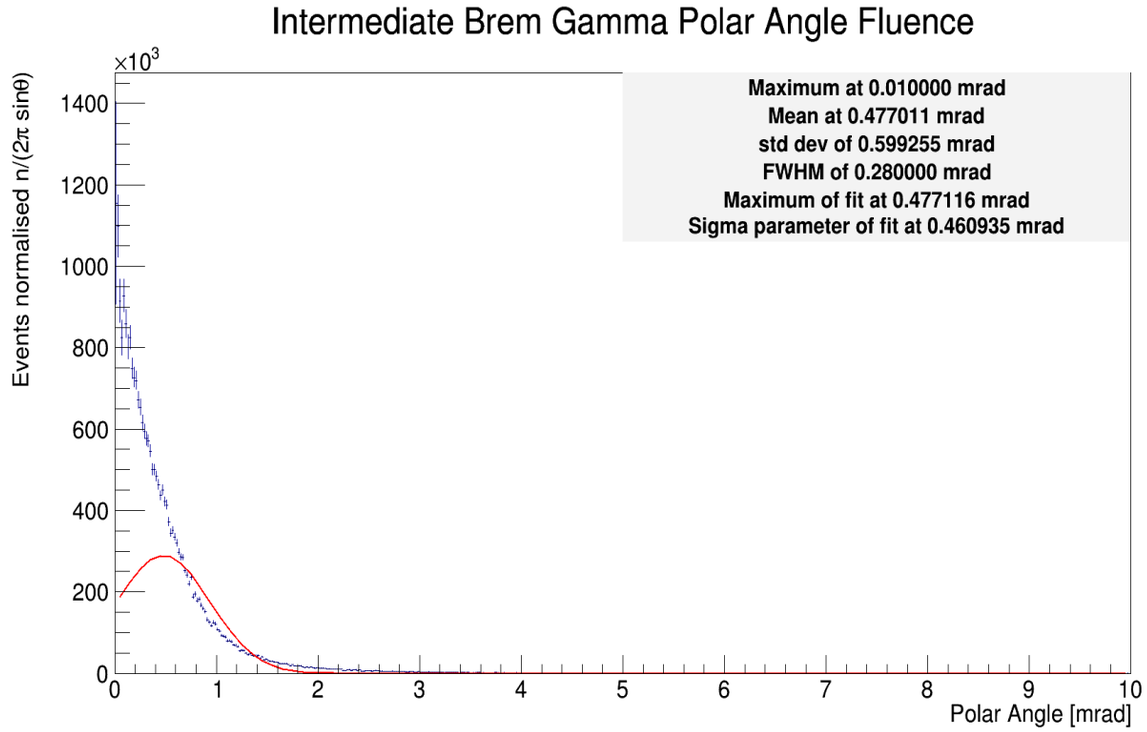
Reconstruct Bremsstrahlung gamma momentum vector, compare to incident e- vector



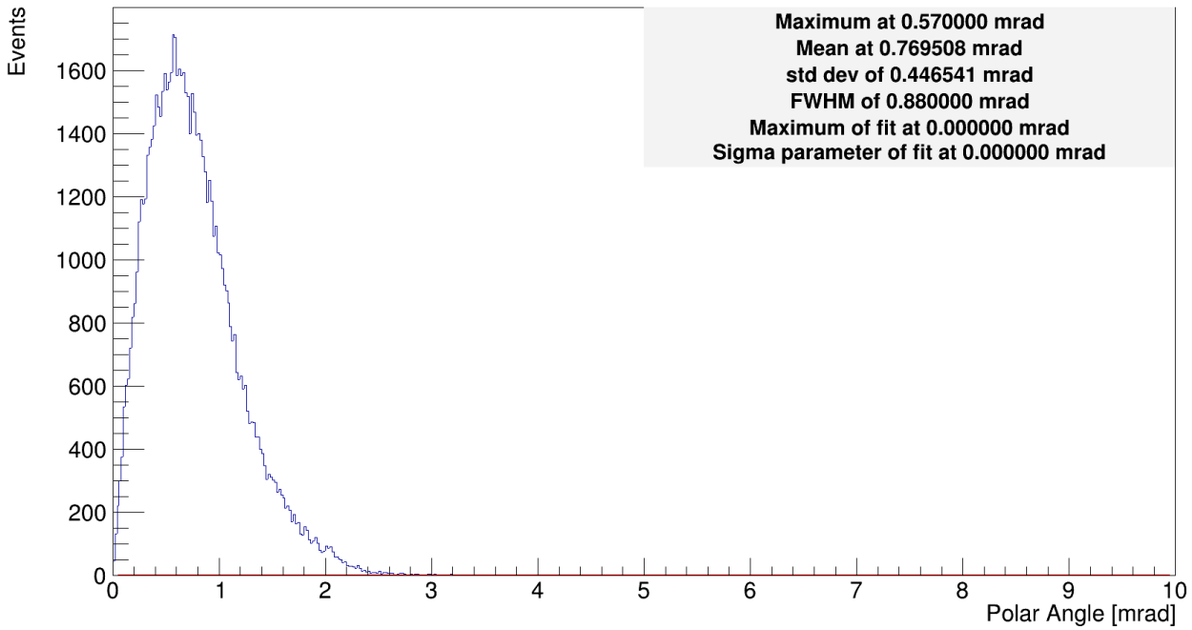
So we find a Brem emission profile of theta with peak 0.47 mrad, FWHM 0.88 mrad

(prefer to use these parameters as a mean is affected by a long tail)





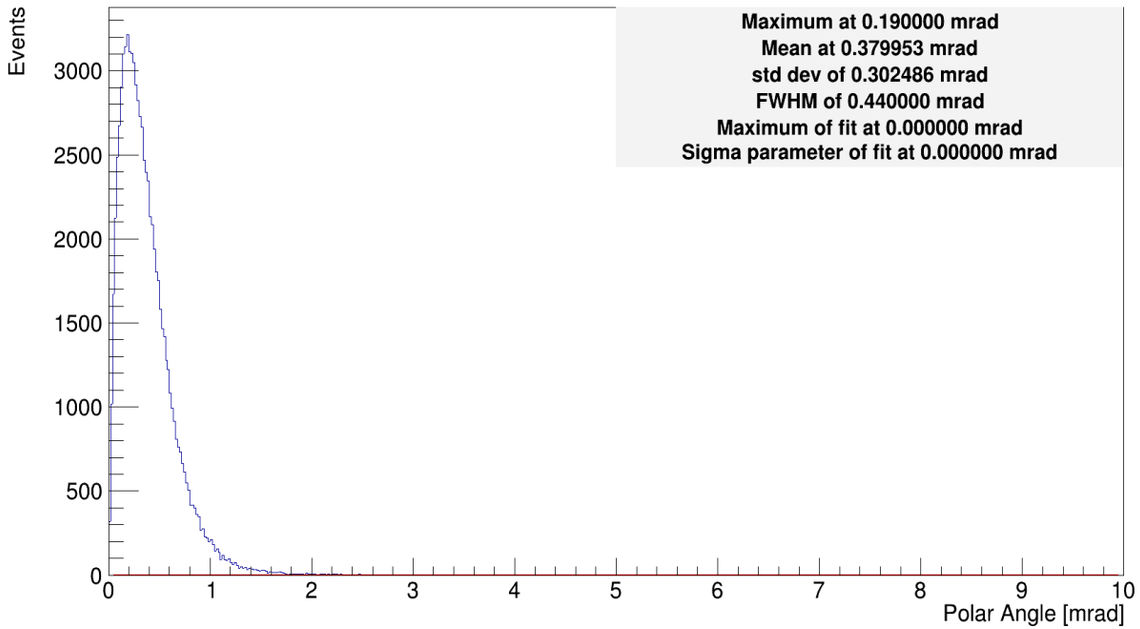
OLD Monte Carlo Initial Electron Polar Angle



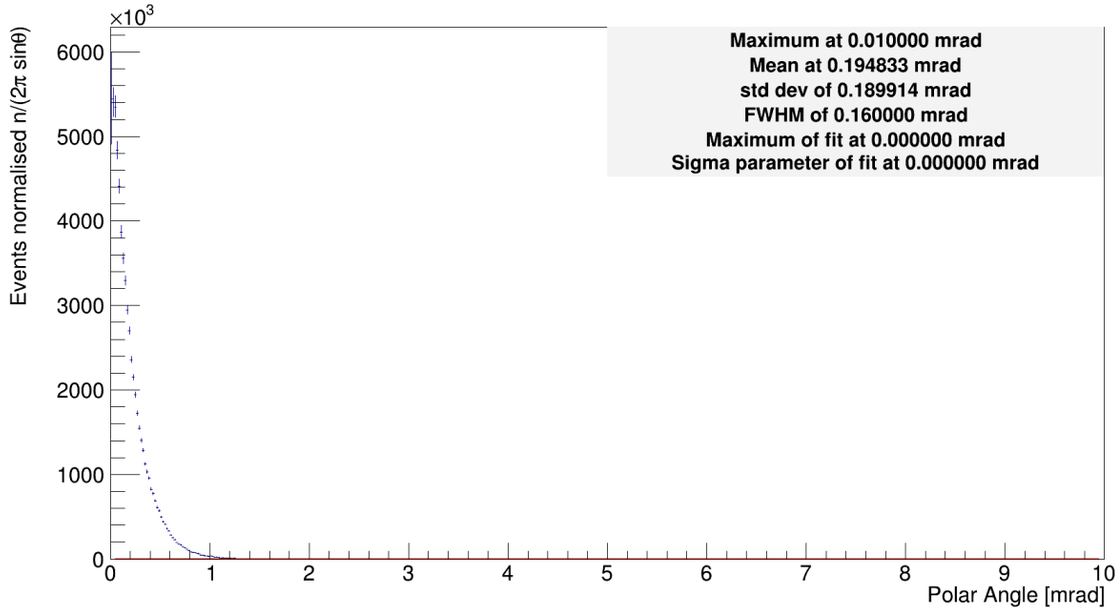
Comparison to Monte Carlo (Geant4)

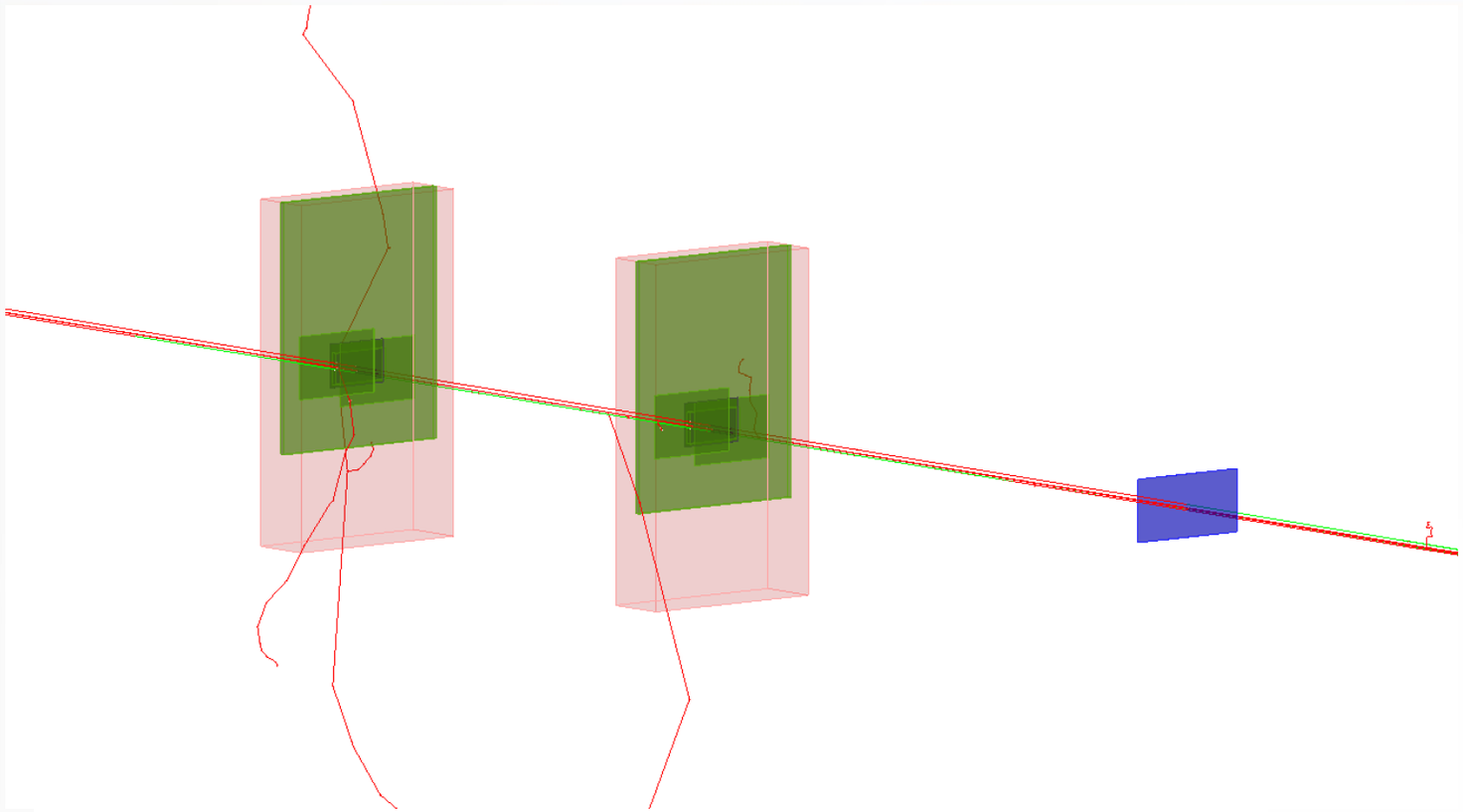
Previously in this analysis… there has been at least a factor of 2 difference between MC and Data, in terms of the divergence of the bremsstrahlung Opening angle

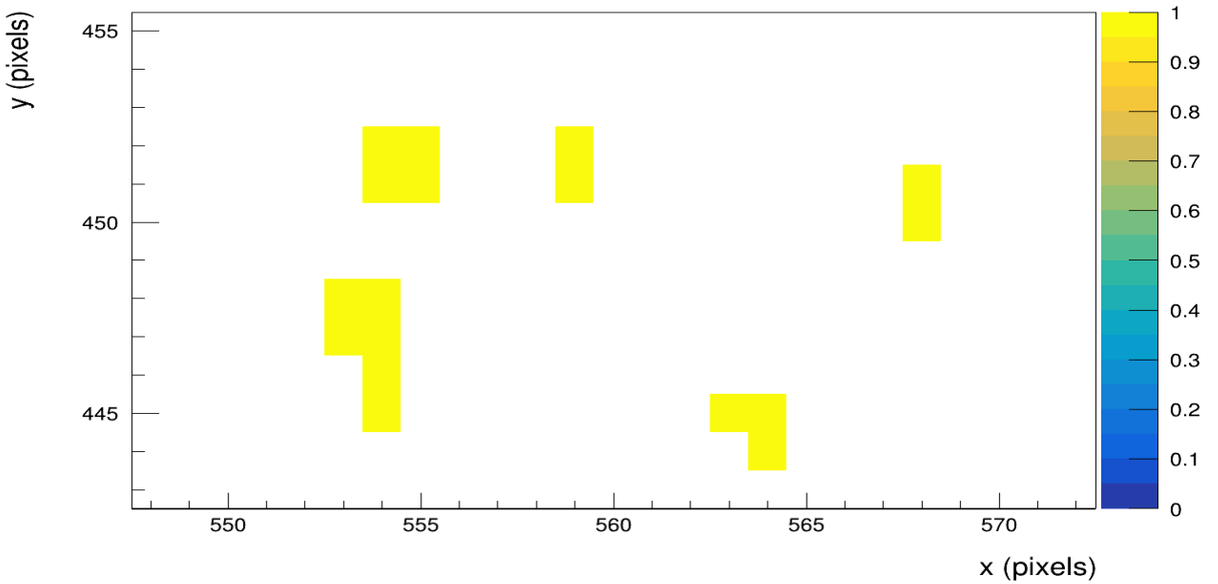
OLD Monte Carlo Intermediate Brem Gamma Polar Angle



OLD Monte Carlo Intermediate Brem Gamma Polar Angle Fluence



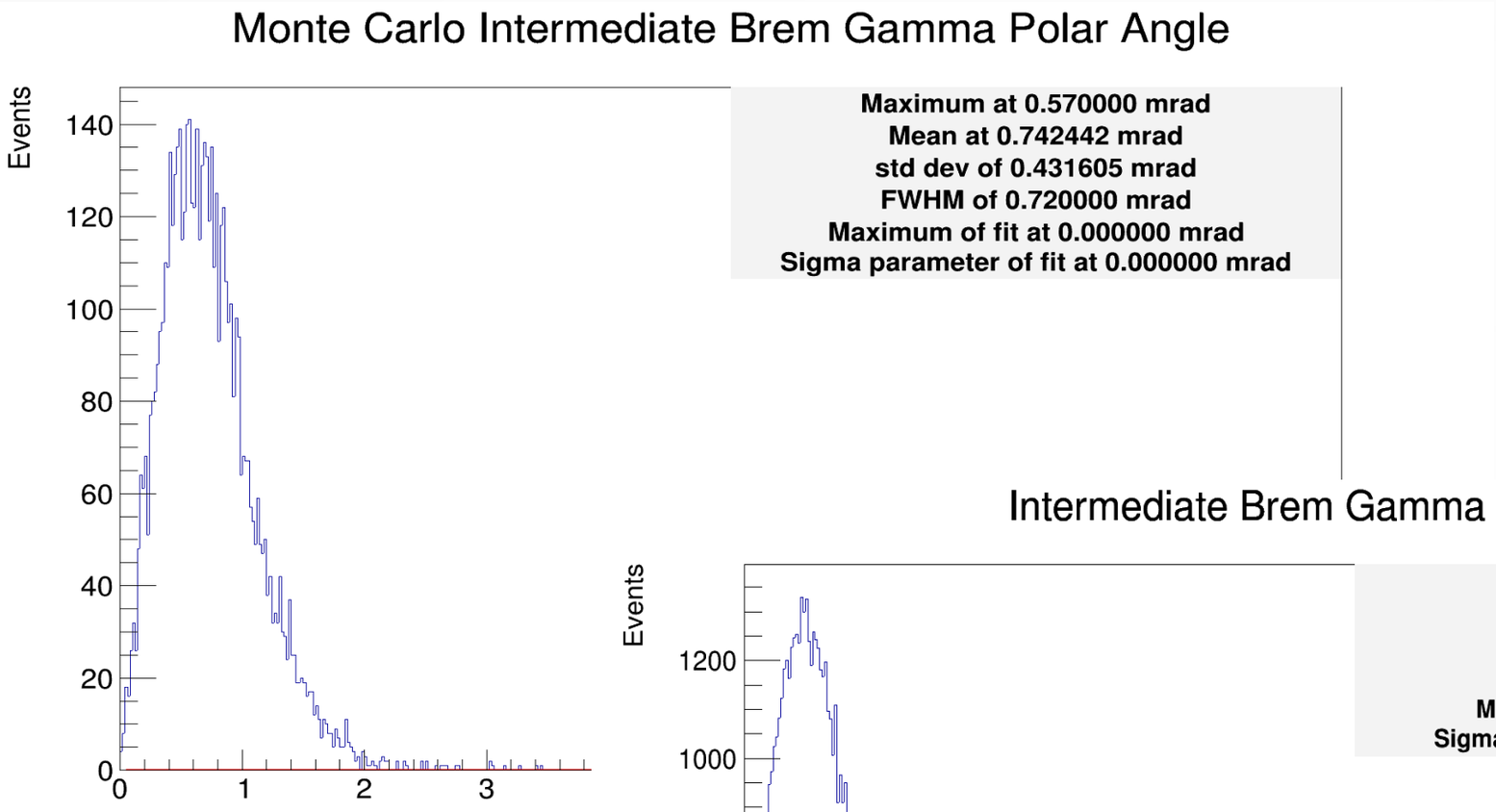




Now have a more complete Monte Carlo! Includes full charge deposition, propagation and digitisation treatment and a clustering algorithm equivalent to that applied to the real data

Clustering means all adjacent (touching) pixel hits are grouped, then the mean position is returned

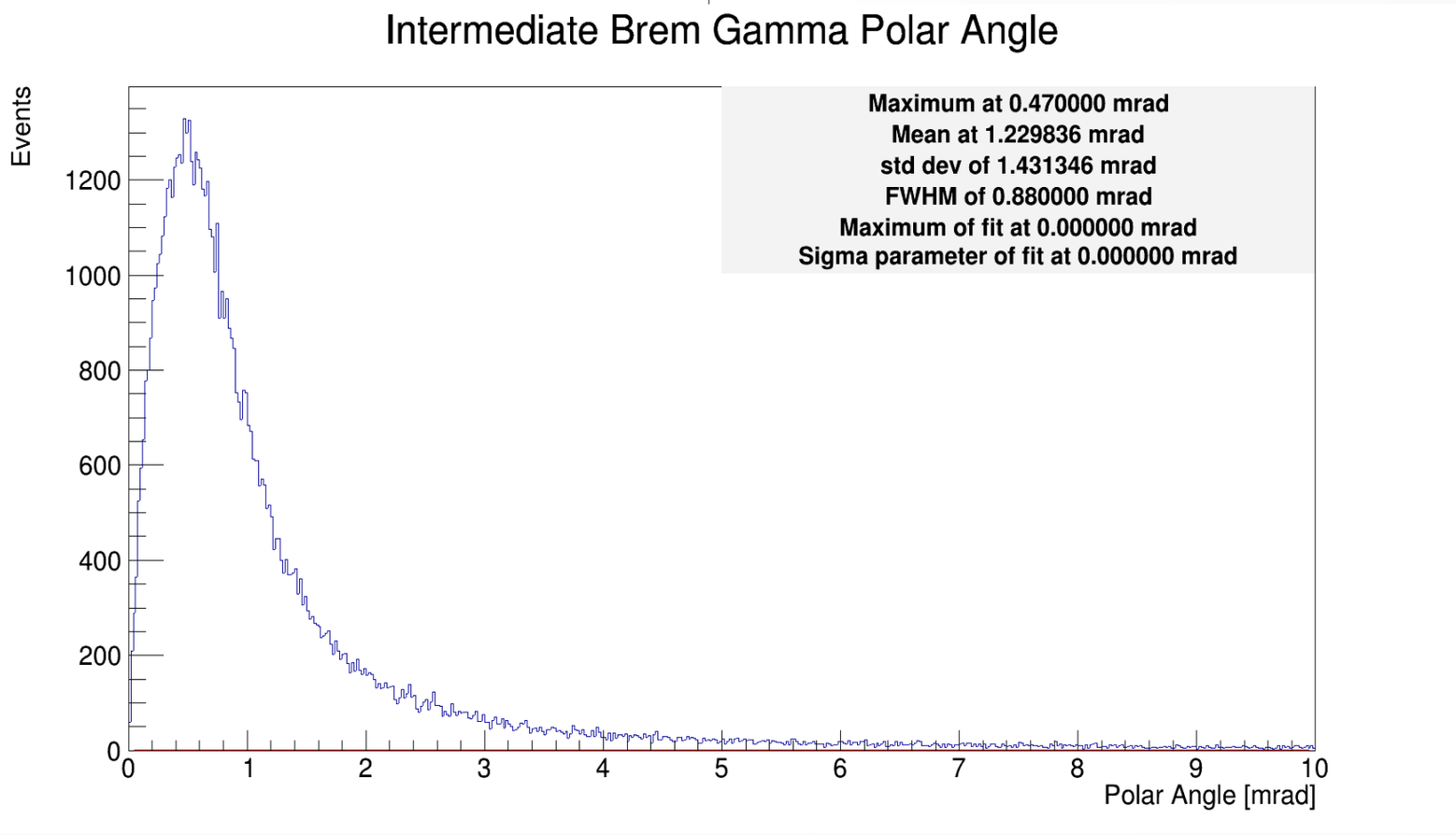
→ more realistic single-event one-plane resolution



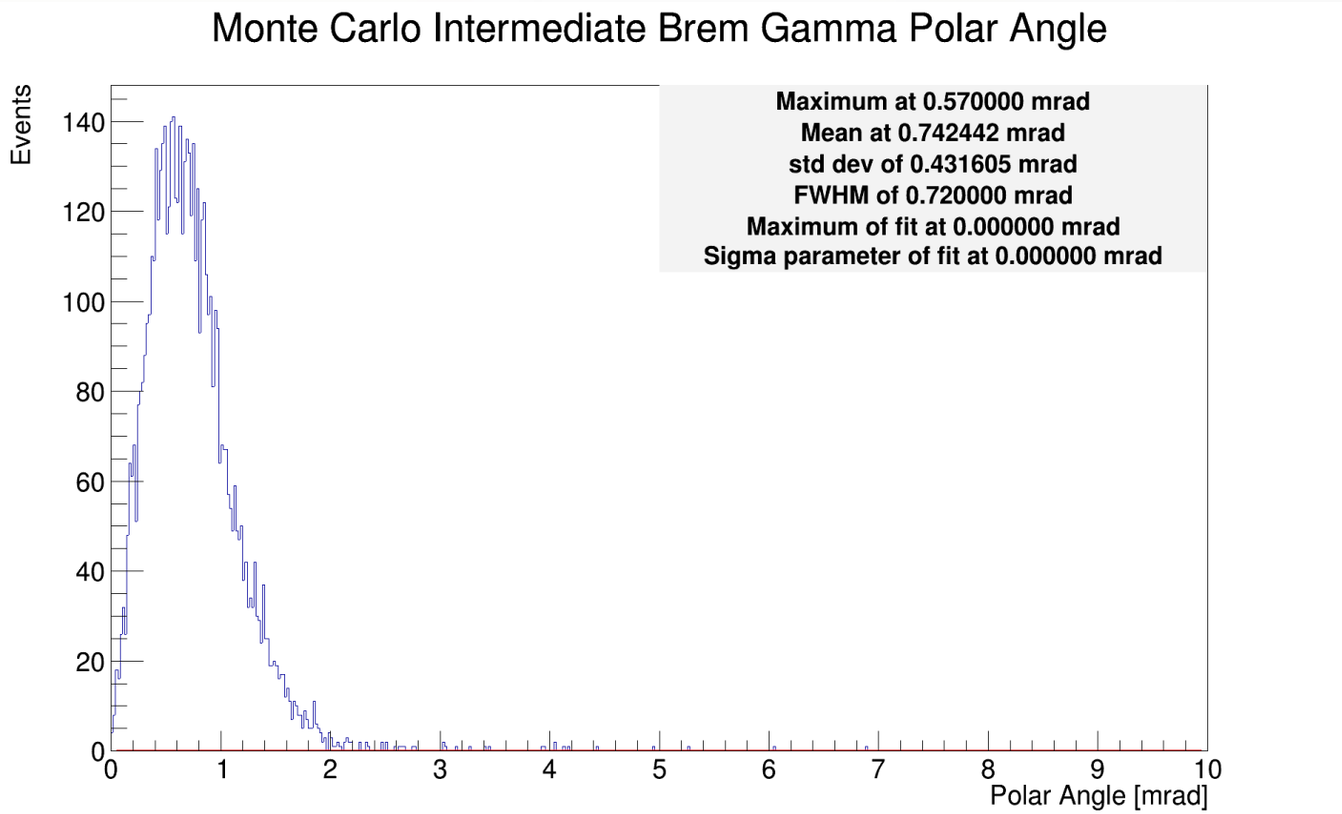
Focus on 1:1 analysis between newly generated MC and data…

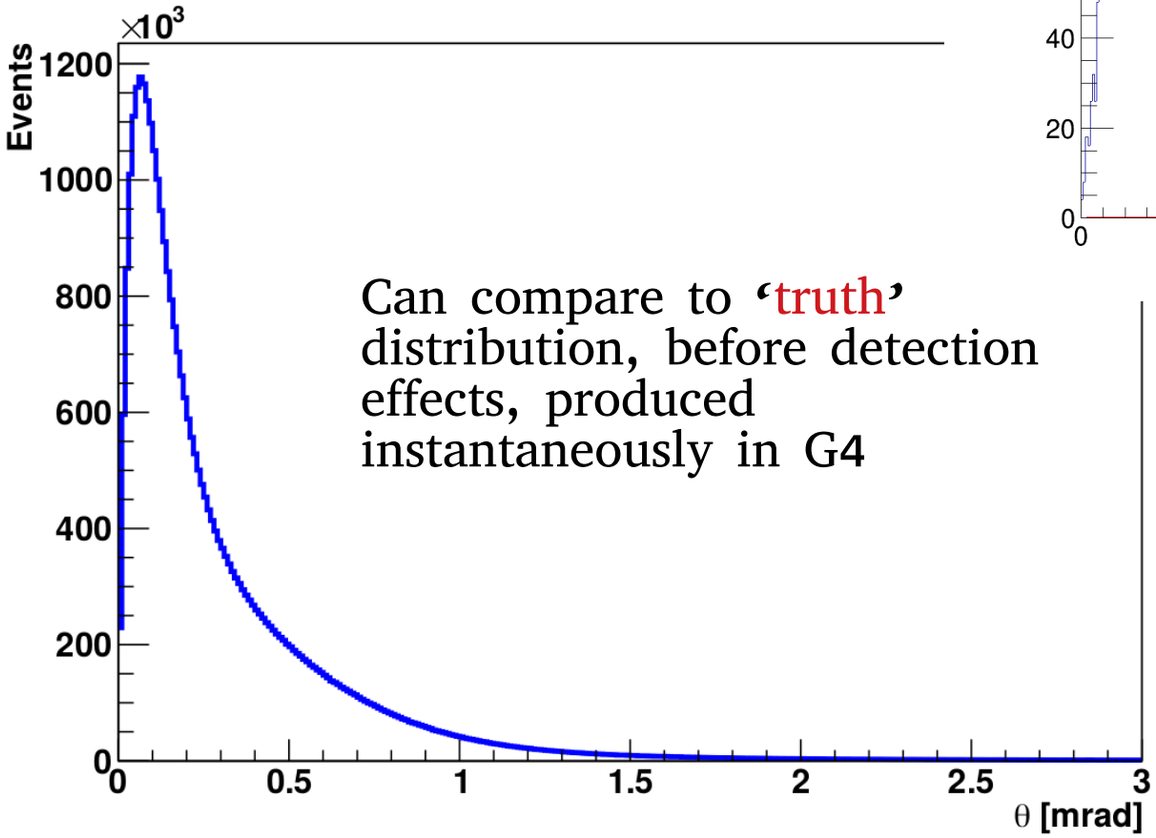
Much more in agreement!

Simulation did not include e.g. concrete walls so expect longer tails in testbeam data



More stats from simulation needed too..





Can compare to ‘truth’ distribution, before detection effects, produced instantaneously in G4

Make fits from approximative function for θ found in the physics reference for Geant4:

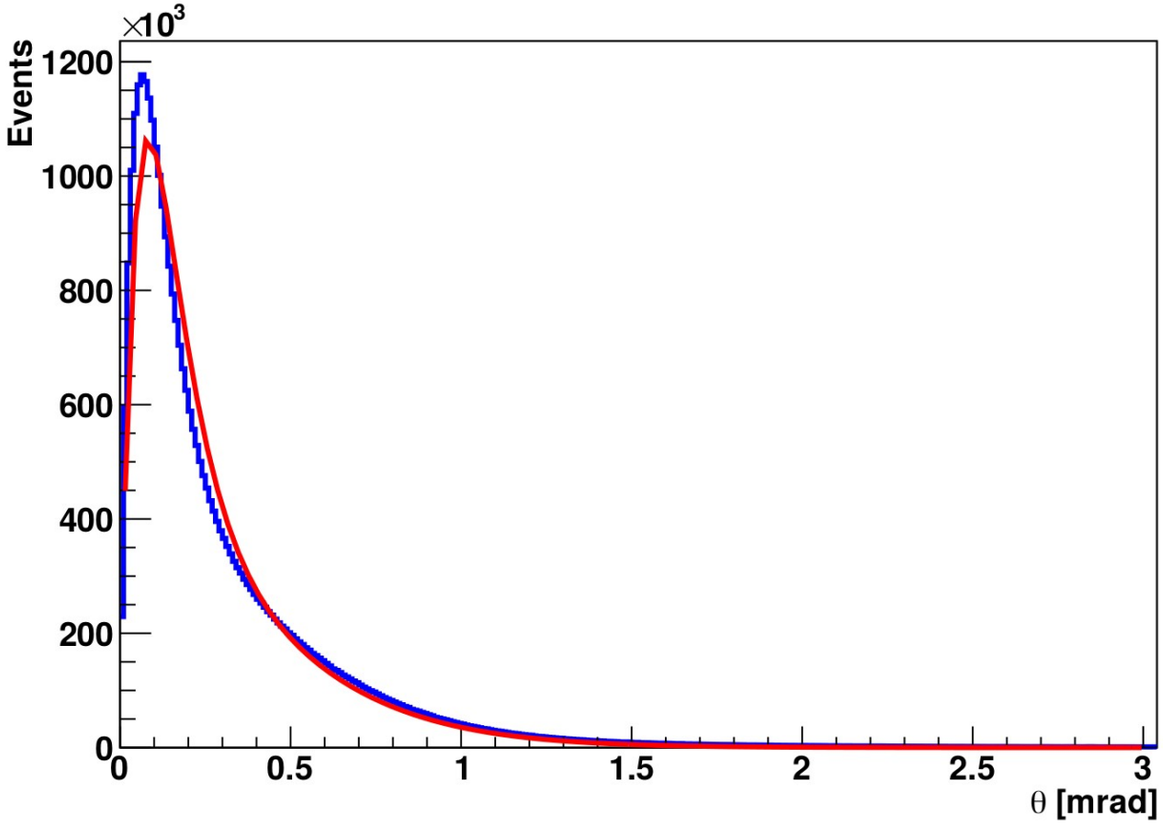
The sampling of this distribution is complicated. It is also only an approximation to within a few percent, due at least to the presence of the atomic form factors. The angular dependence is contained in the variable $u = E\theta m^{-1}$. For a given value of u the dependence of the shape of the function on Z, E and $\epsilon = k/E$ is very weak. Thus, the distribution can be approximated by a function

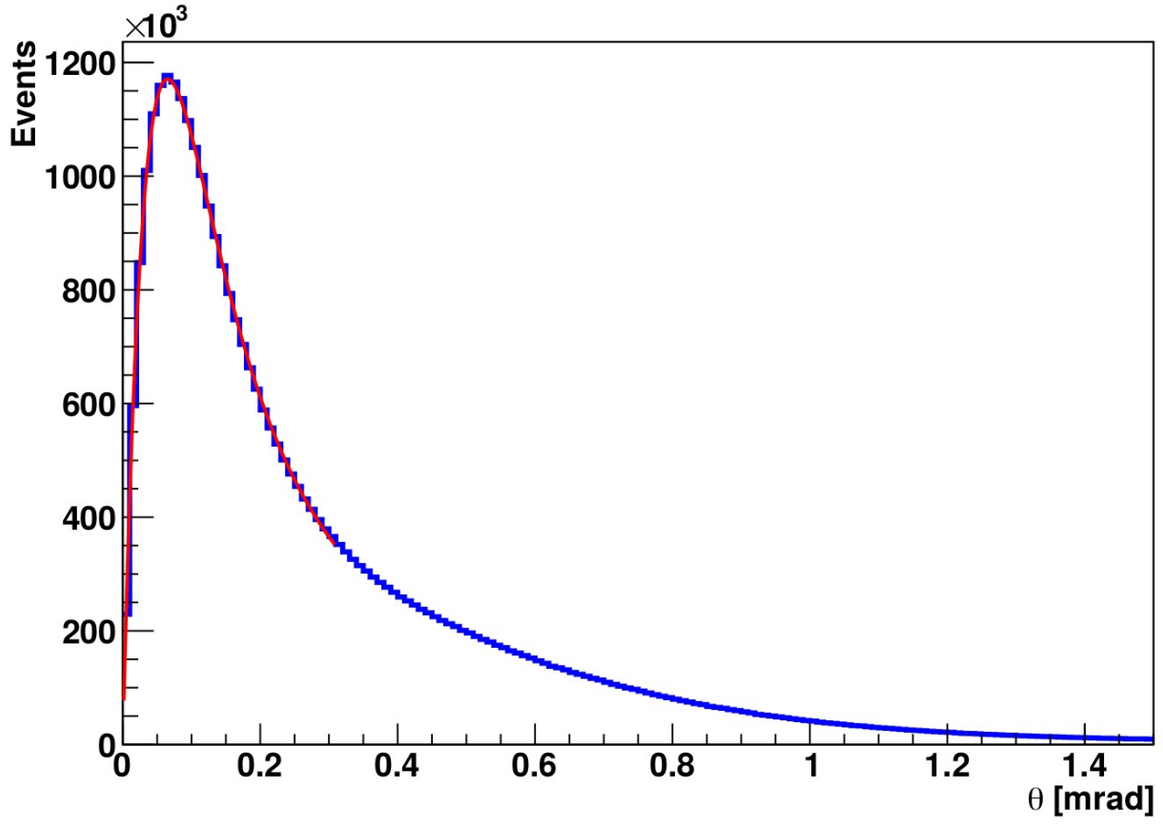
$$f(u) = C\left(ue^{-au} + due^{-3au}\right)$$

where

$$C = \frac{9a^2}{9+d} \qquad a = 0.625 \qquad d = 27$$

where E is in GeV. While this approximation is good at high energies, it becomes less accurate around a few MeV. However in that region the ionisation losses dominate over the radiative losses. The sampling of the function $f(u)$ can be done with three random numbers r_i, uniformly distributed on the interval [0,1]:

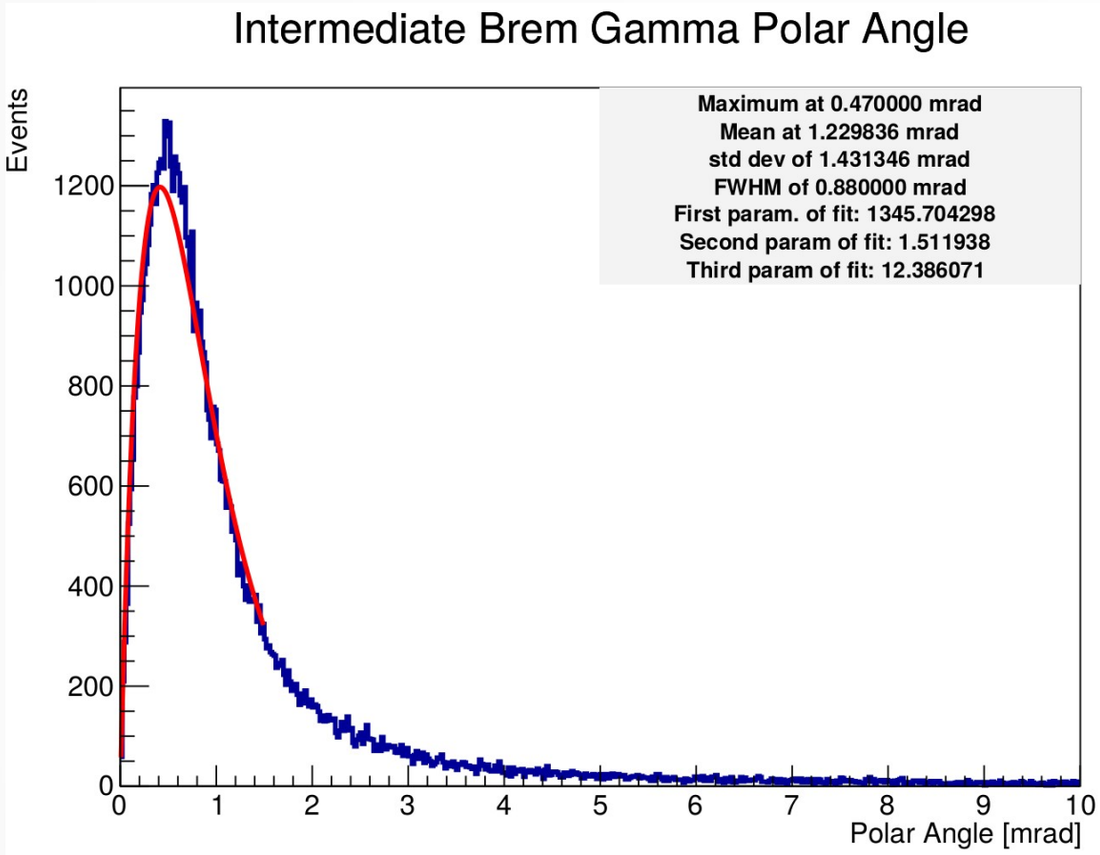


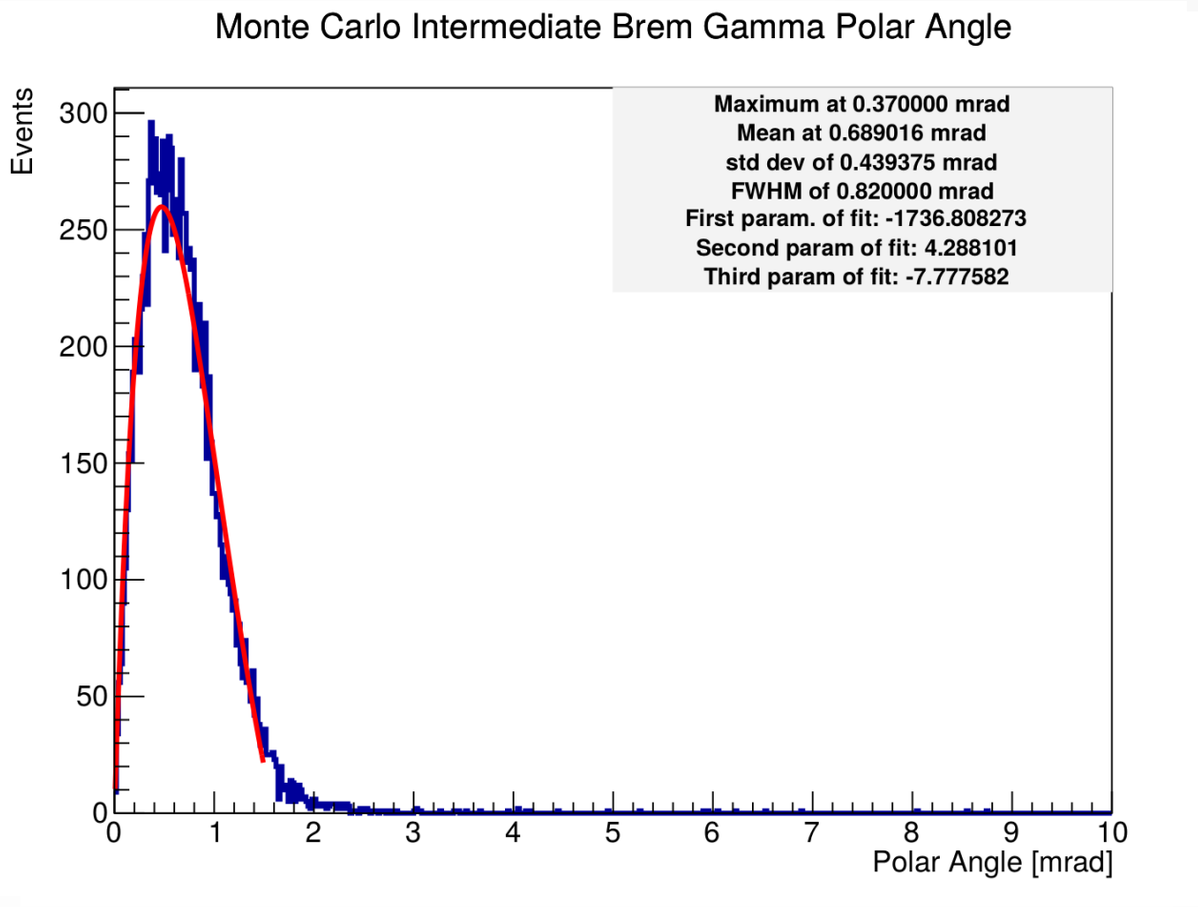


The fit is not great, until one restricts fitting only to the initial peak (0 – 0.3 mrad)

Choice of the limit of fitting is a bit arbitrary?

Some more complex action affecting the tails?

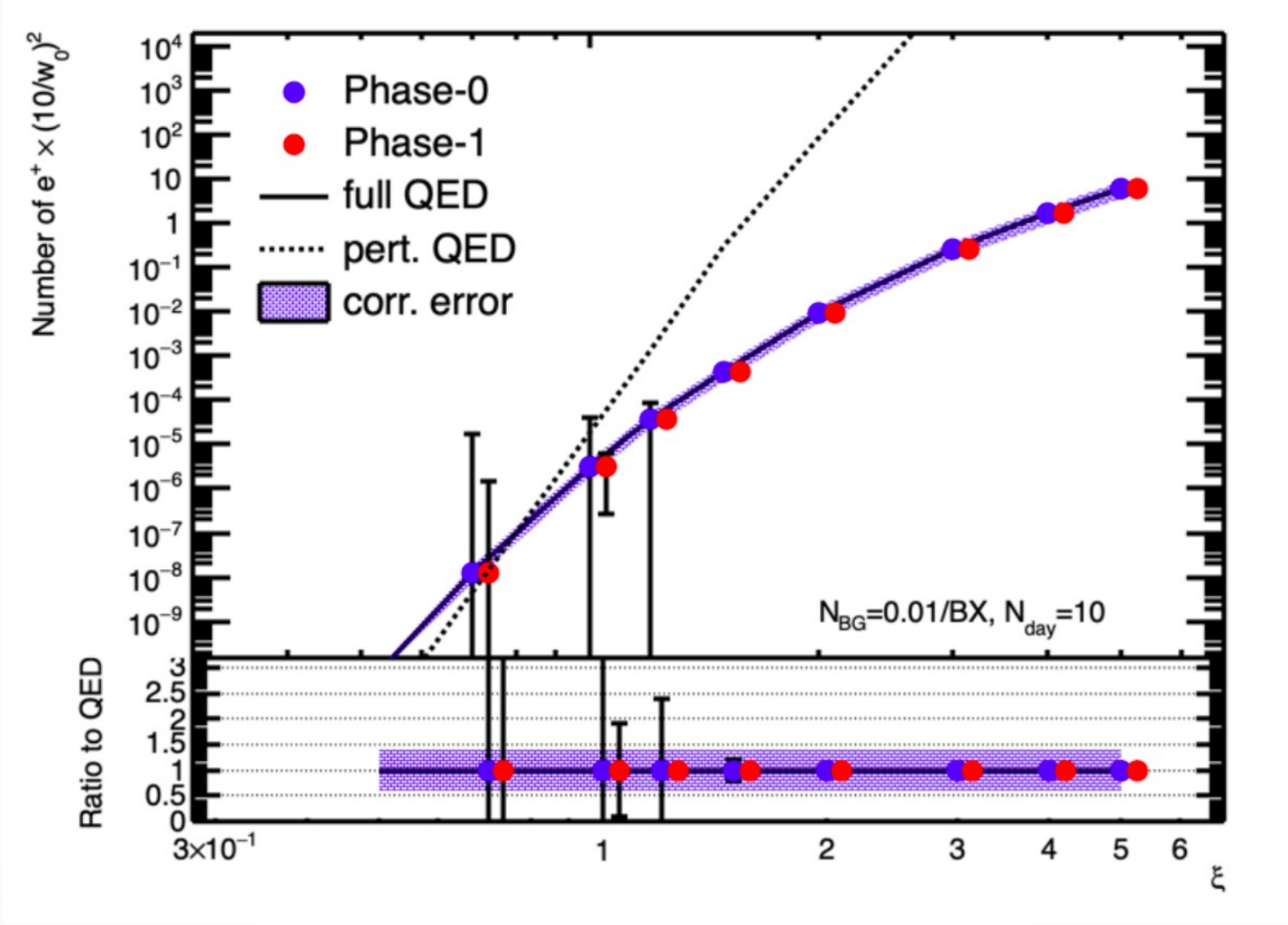




Application to real data! We can extract a maximum & a width, then compare to the full Monte Carlo fit… any difference between these we *may* ascribe to uncertainty on the theoretical theta distribution..

I working with this function to try to fit better where we can parameterise the difference between MC & data as some general factor of θ

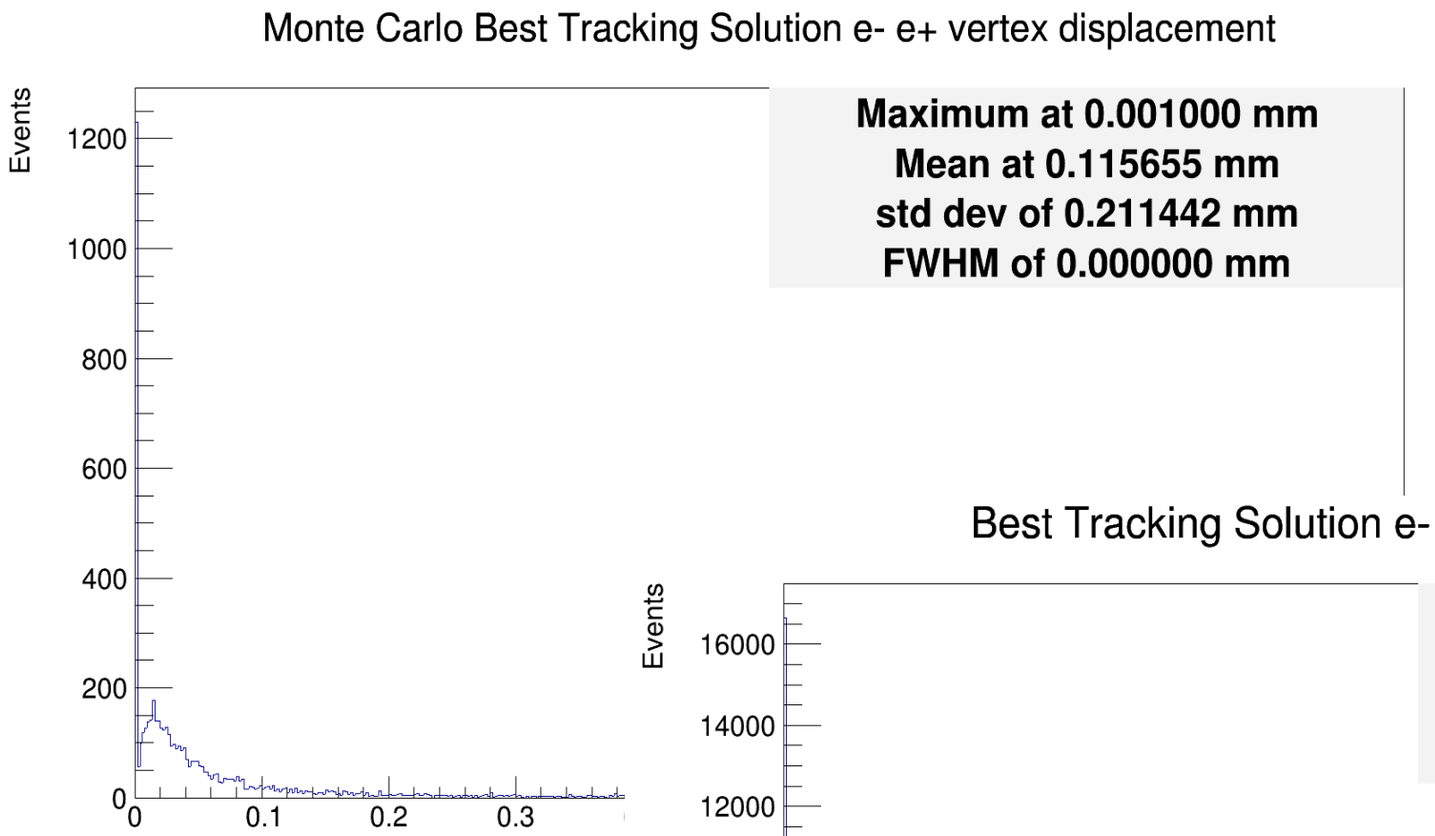
Better statistics for MC in the pipeline…



For a final result, we can take a bounds of the real divergence of the brem mechanism, and with comparison to Geant4, which created this plot, recalculate the yields expected for positrons

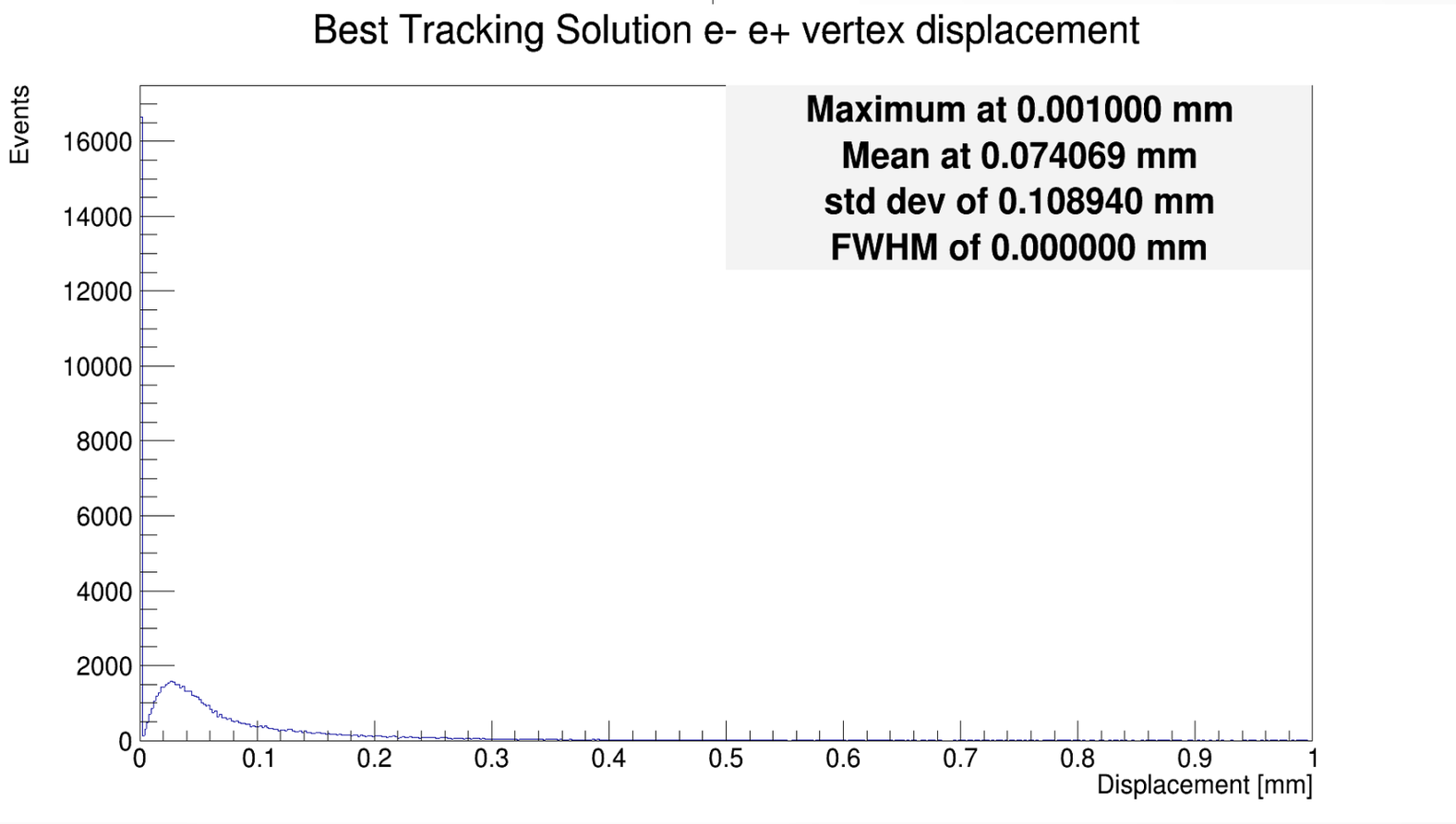
This can be done assuming no dependence on theta with photon energy (true in MC)

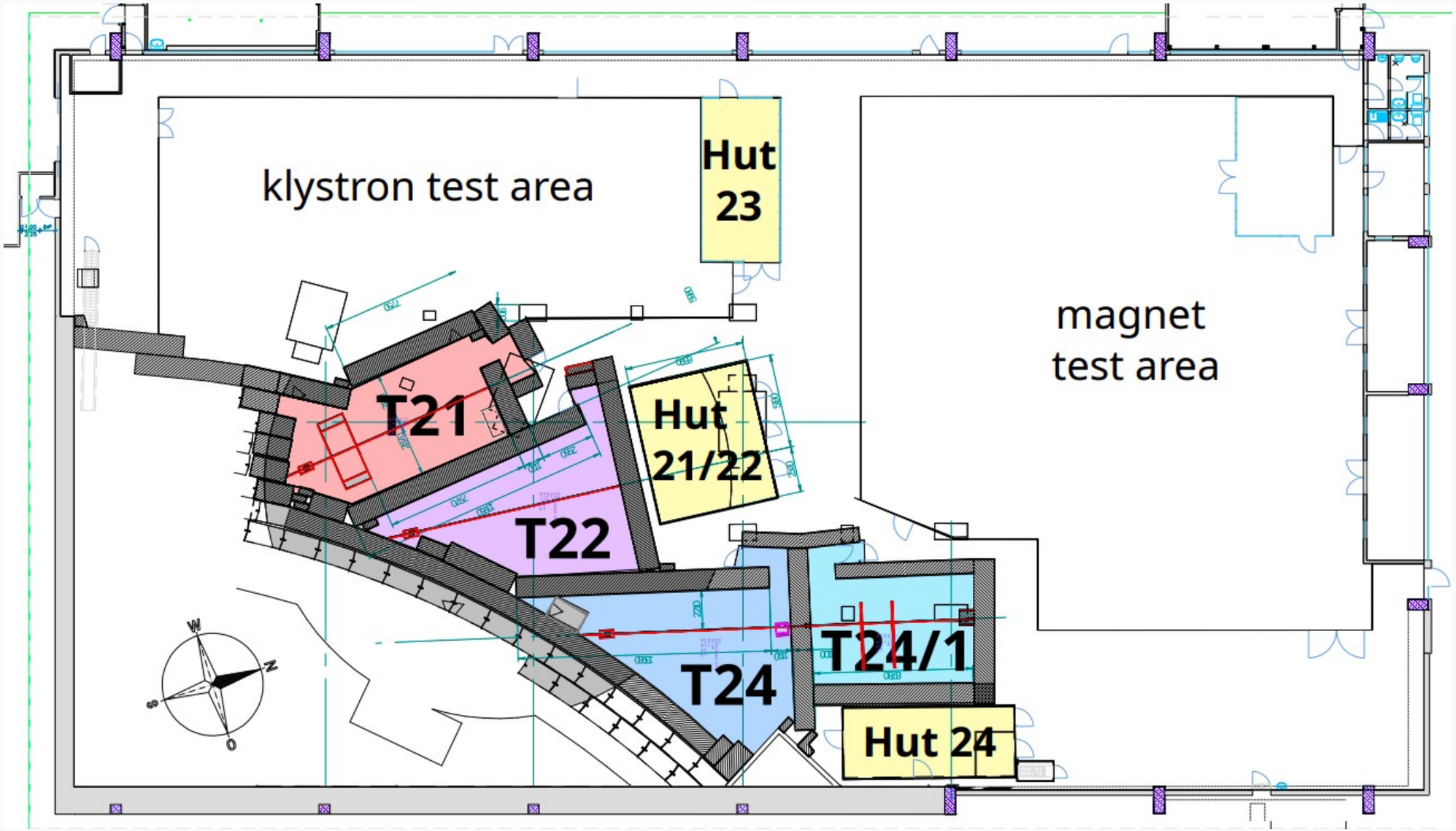
backup

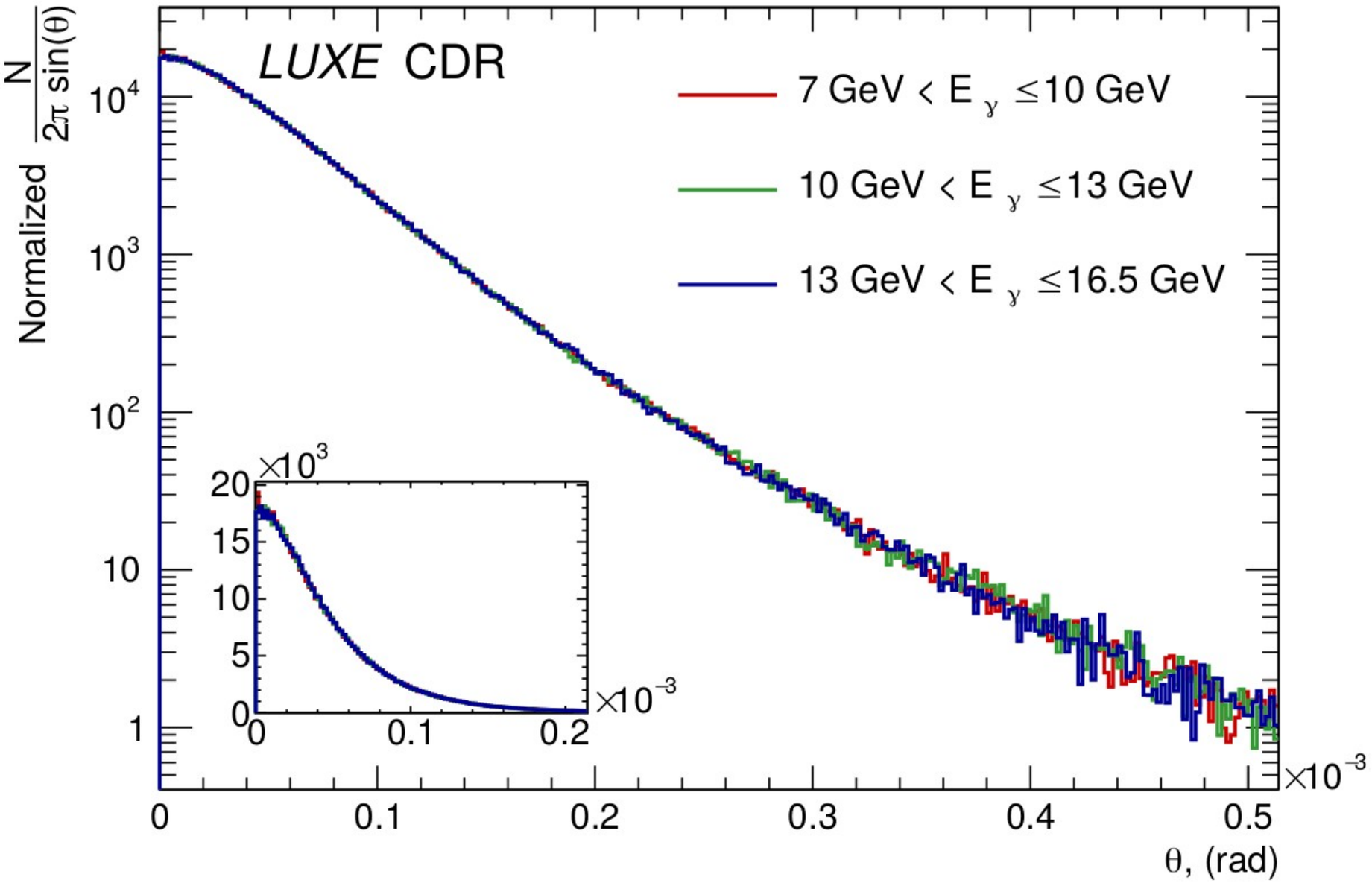


Some other quantities start to agree more too..

Check of input beam necessary, but clearly we are on the right track to say something about the brem. process




klystron test area
Hut 23
magnet test area
T21
Hut 21/22
T22
T24
T24/1
Hut 24


LUXE CDR
7 GeV < E γ ≤10 GeV
10 GeV < E γ ≤13 GeV
13 GeV < E γ ≤16.5 GeV
Normalized N / 2π sin(θ)
θ, (rad)
×10⁻³
×10³