

TB2020 Bremsstrahlung Study

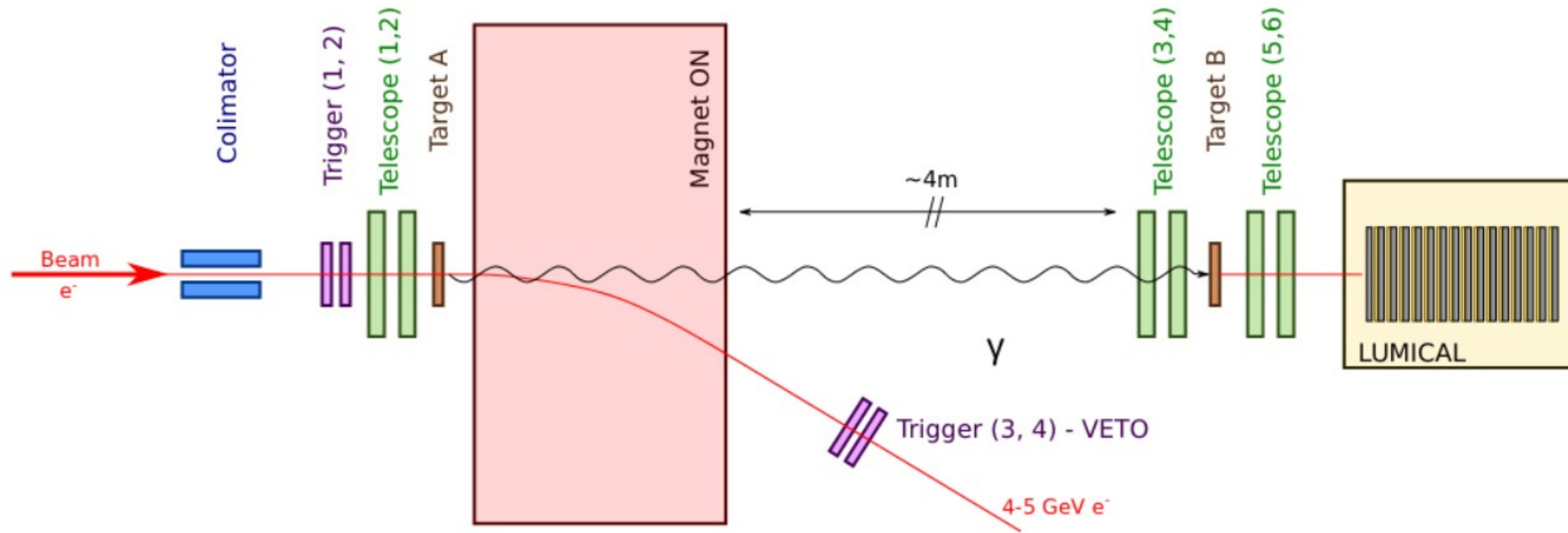
John Hallford

University College London

01/09/2022

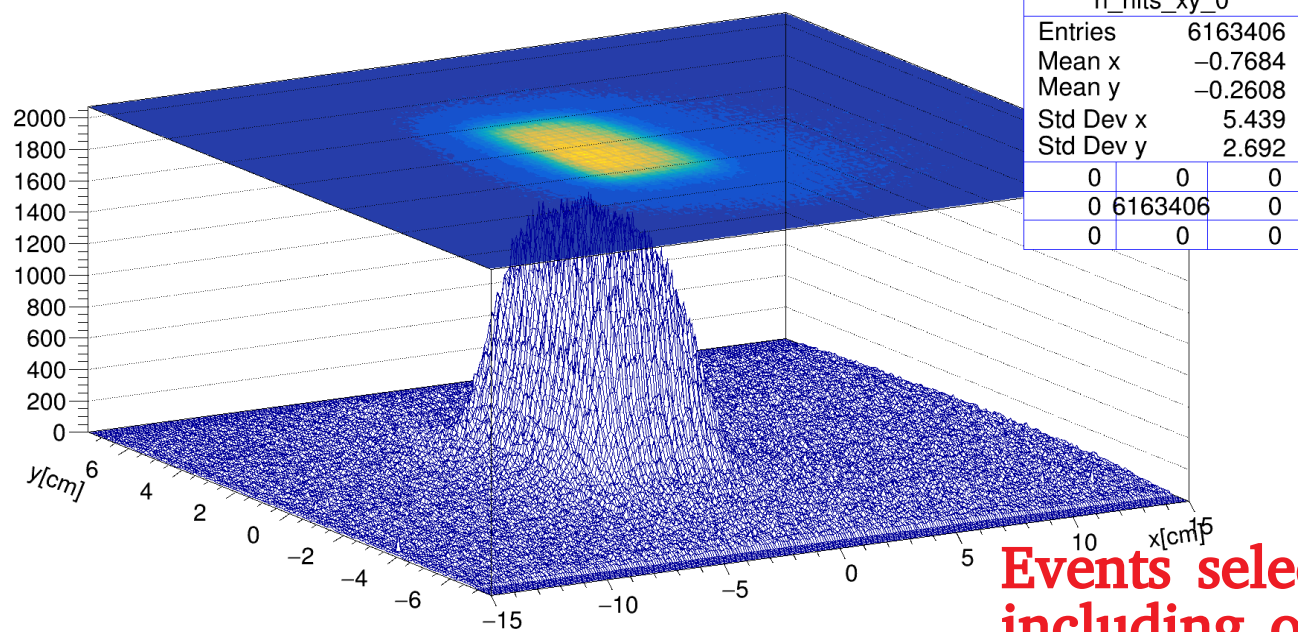
The logo for the LUXE experiment, featuring the word "LUXE" in a bold, blue, sans-serif font. The letter "X" is stylized with a white starburst or spark-like shape in the center.

TB2020 Alpide Telescope Alignment



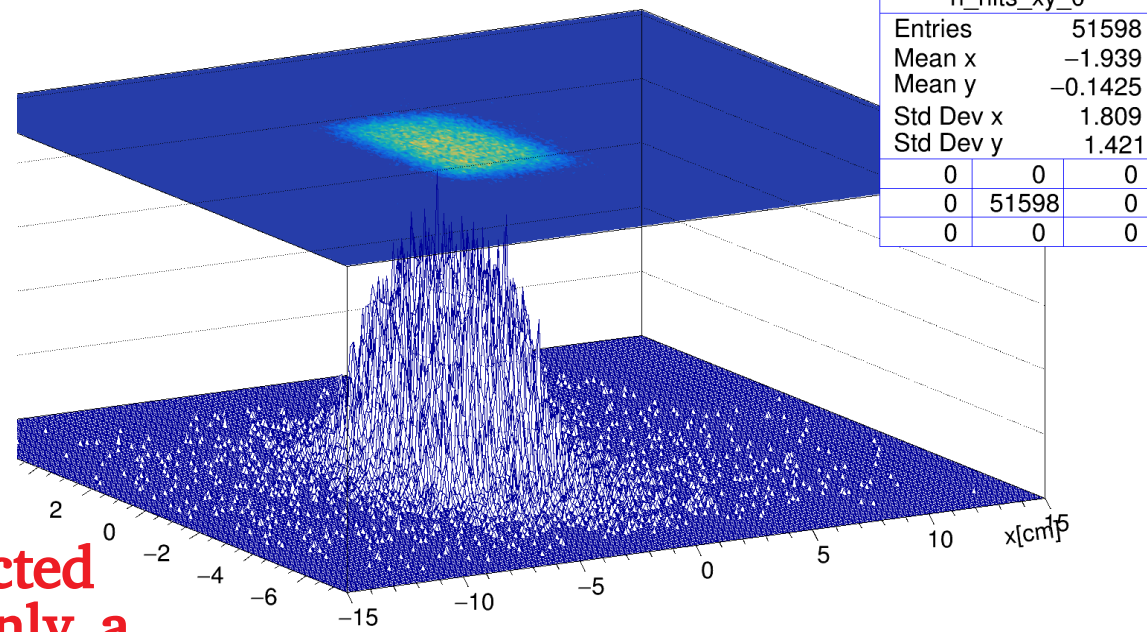
Idea is to use this data to reconstruct the dispersion of bremsstrahlung photons, in particular the polar angle.

Telescope Plane 0 - Pre-target1 - z=0



h_hits_xy_0		
Entries	6163406	
Mean x	-0.7684	
Mean y	-0.2608	
Std Dev x	5.439	
Std Dev y	2.692	
0	0	0
0	6163406	0
0	0	0

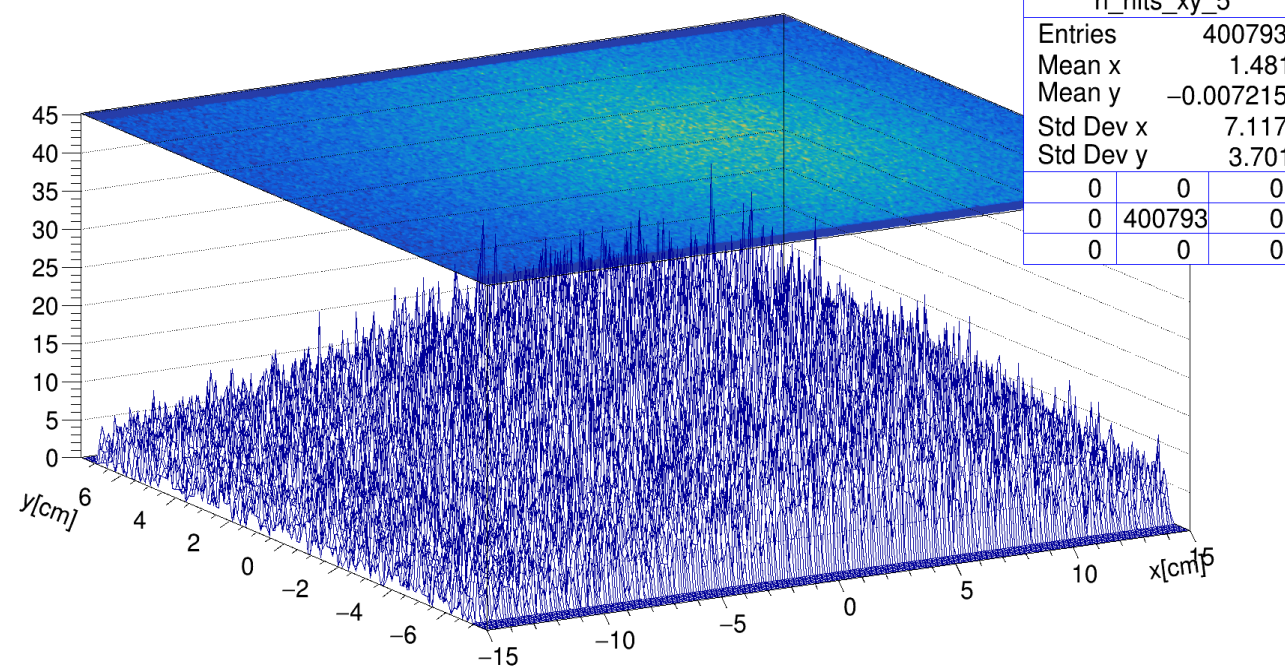
Telescope Plane 0 - Pre-target1 - z=0



h_hits_xy_0		
Entries	51598	
Mean x	-1.939	
Mean y	-0.1425	
Std Dev x	1.809	
Std Dev y	1.421	
0	0	0
0	51598	0
0	0	0

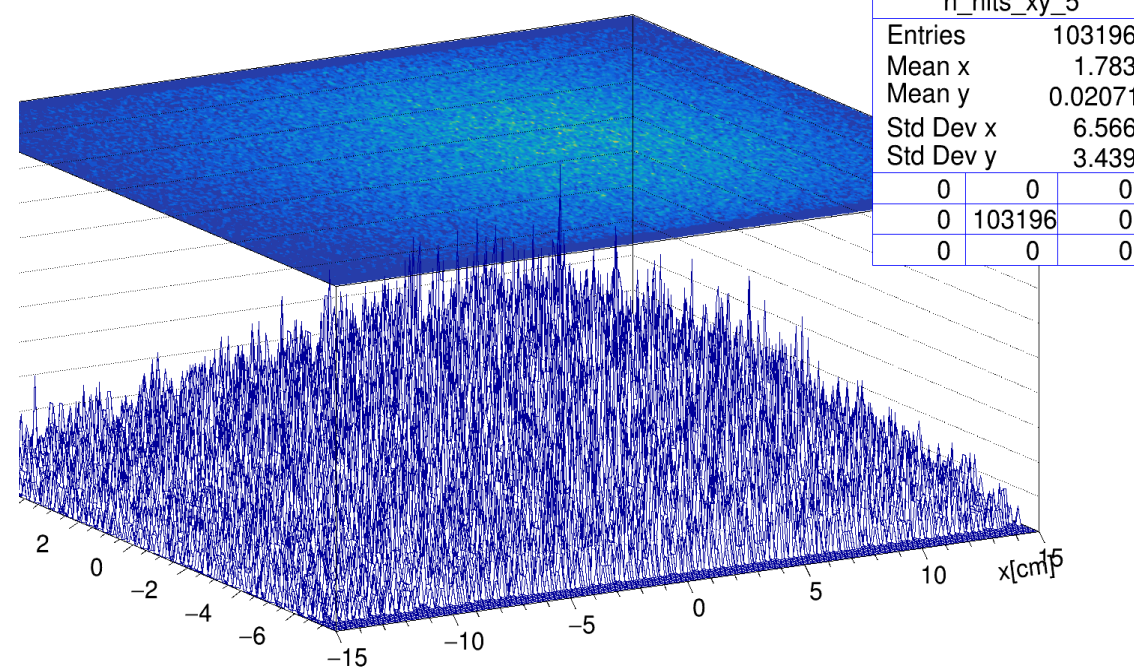
Events selected including only a 1:1:0:0:2:2 hit pattern

Telescope Plane 5 - Post-target2 - z=7988

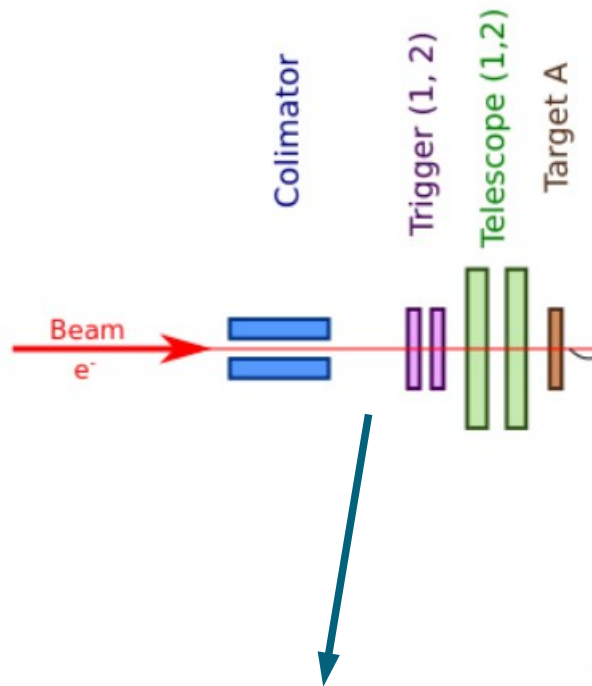


h_hits_xy_5		
Entries	400793	
Mean x	1.481	
Mean y	-0.007215	
Std Dev x	7.117	
Std Dev y	3.701	
0	0	0
0	400793	0
0	0	0

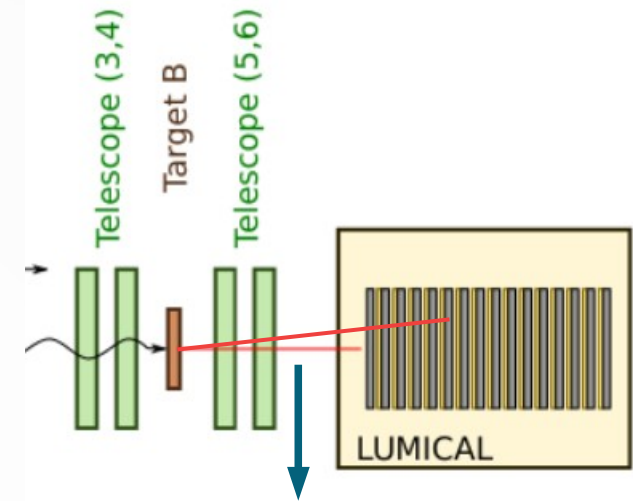
Telescope Plane 5 - Post-target2 - z=7988



h_hits_xy_5		
Entries	103196	
Mean x	1.783	
Mean y	0.02071	
Std Dev x	6.566	
Std Dev y	3.439	
0	0	0
0	103196	0
0	0	0



Alignment is important!
and this has been
attempted with a
multitude of techniques



ETO

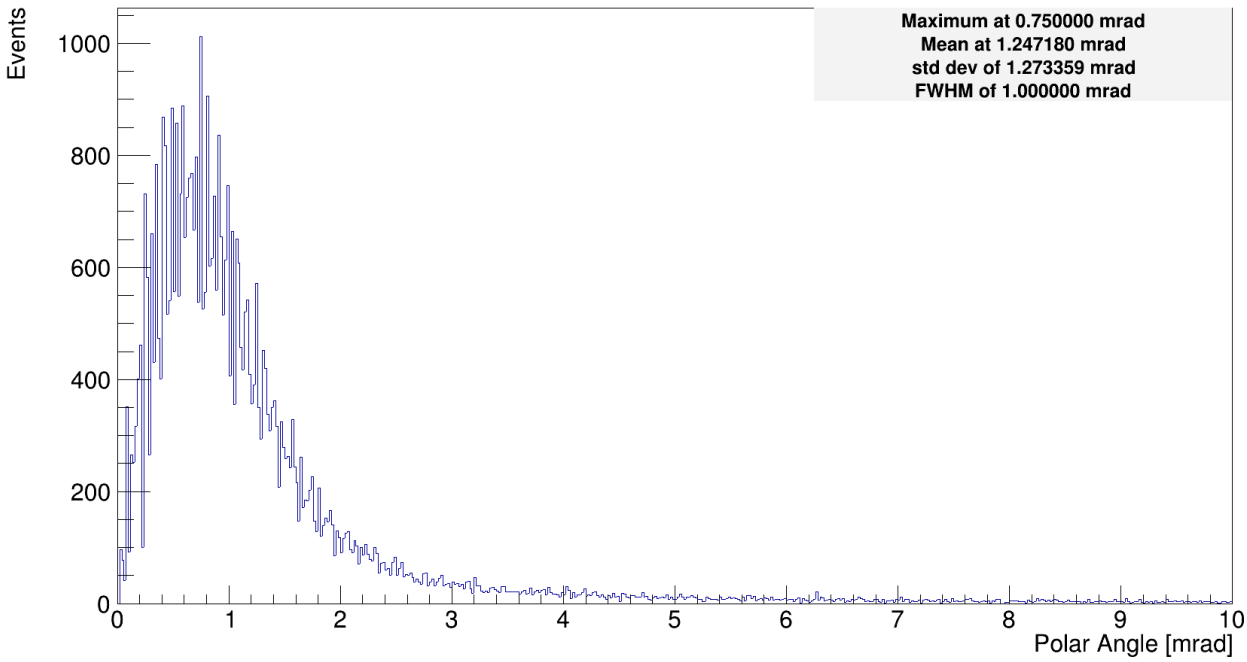
Reconstruct gamma
incidence on target 2
using two hits of each
of e-/e+ pair

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

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

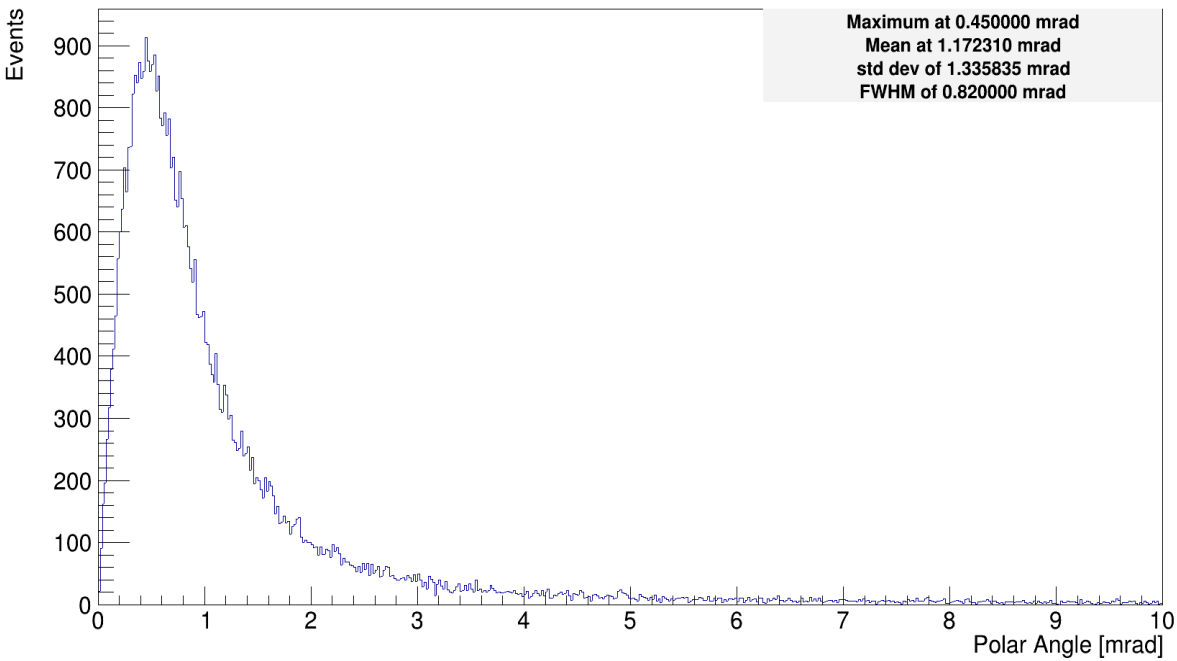
Track + correlate hits to correct
tracks by extrapolating to target
2, choosing minimal distance
between tracks

Initial Electron Polar Angle

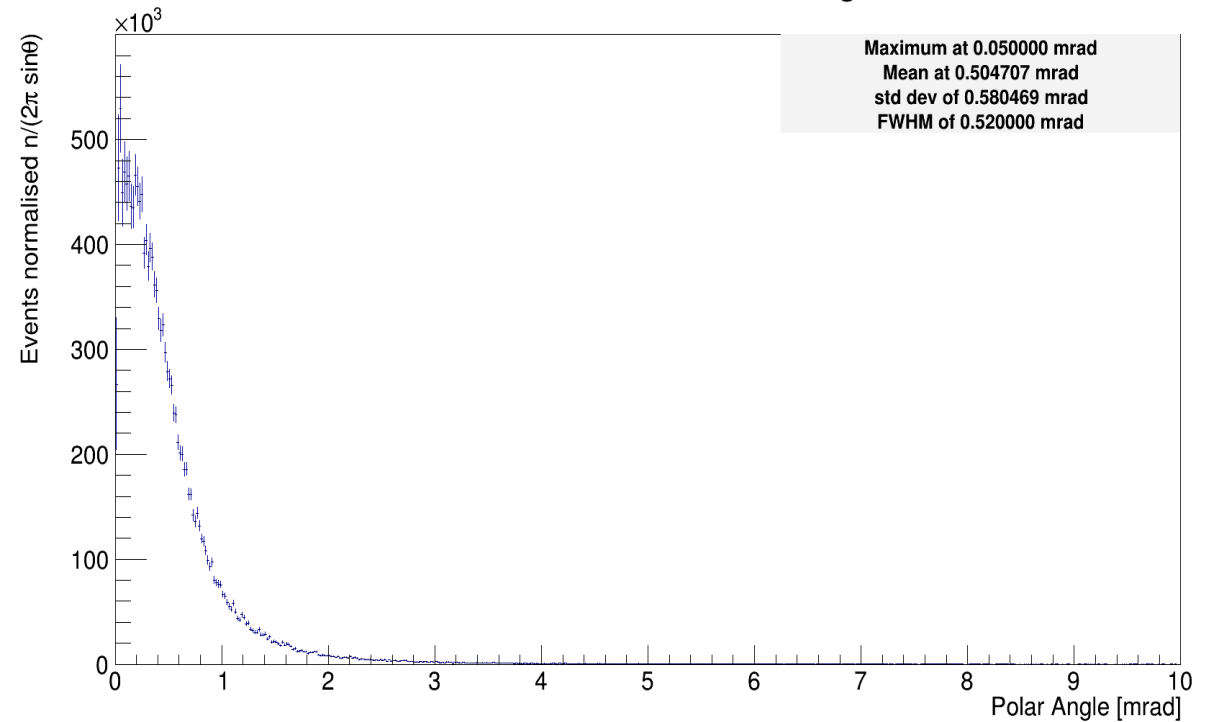


So we find a Brem emission profile of theta with peak 0.45 mrad, FWHM 0.82 mrad

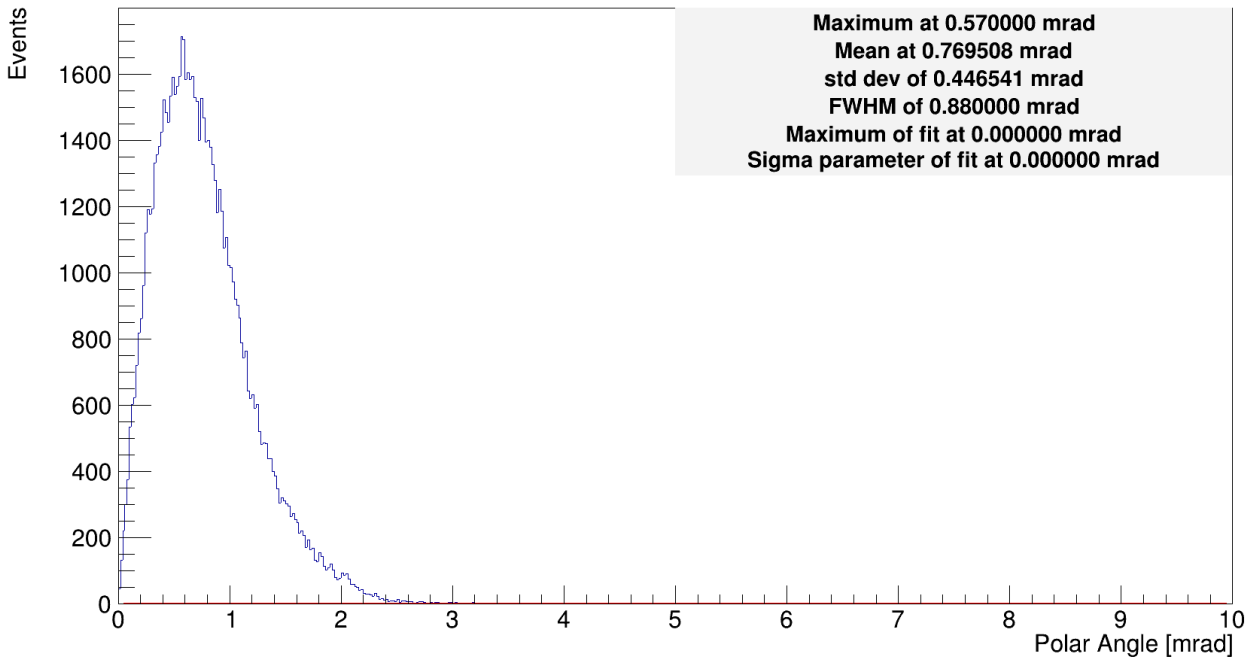
Intermediate Brem Gamma Polar Angle



Intermediate Brem Gamma Polar Angle Fluence



Monte Carlo Initial Electron Polar Angle

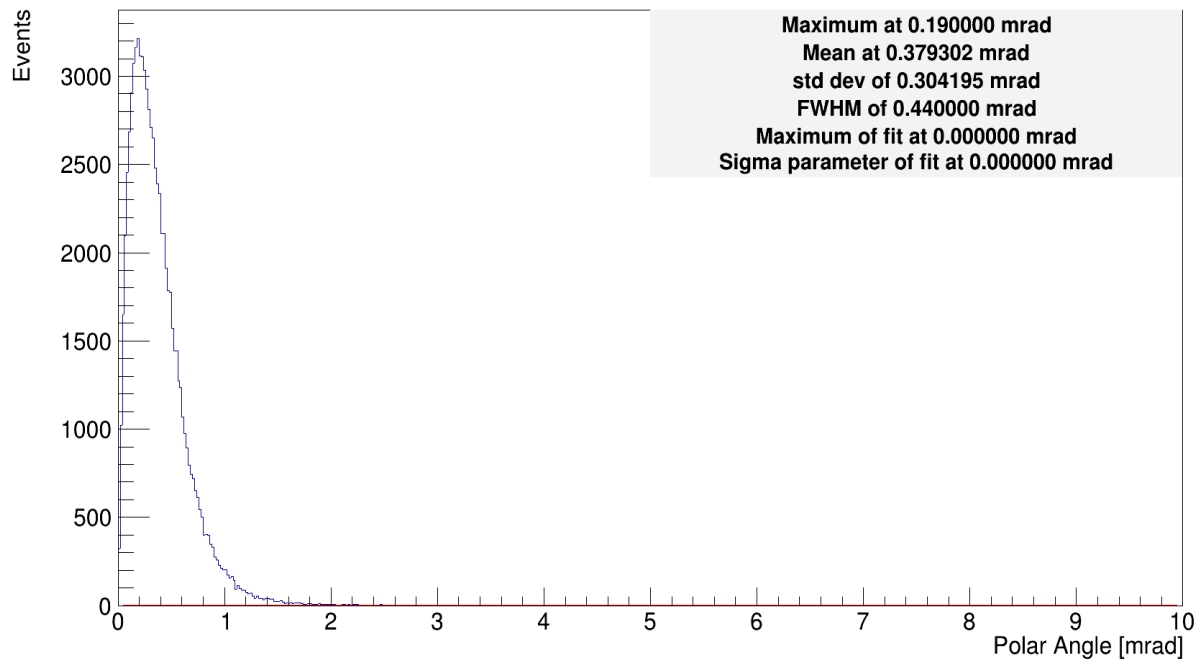


But we also have a more complete Monte Carlo! Including measurement of the plane hits (e-,e+ with $E > 2\text{MeV}$), a complete reconstruction using the same analysis technique is performed

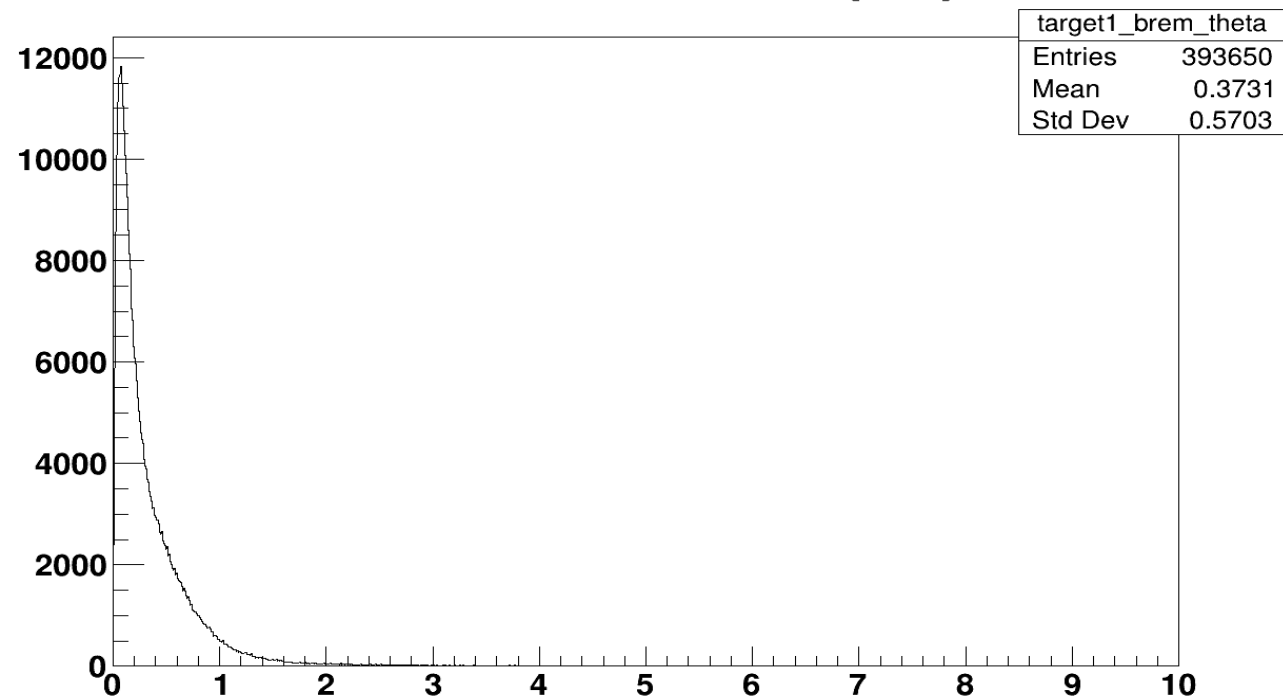
Specifically telescope resolution ($\sim 2.88\mu\text{m}$) and multiple scattering in the environment are modelled

Reconstructed theta distribution is half the size of the real data

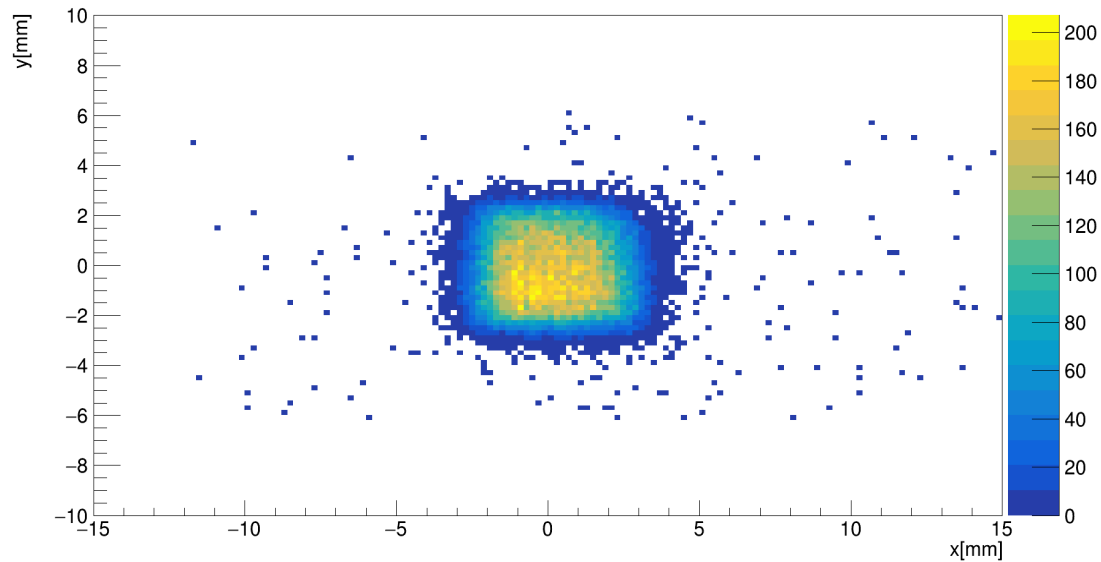
Monte Carlo Intermediate Brem Gamma Polar Angle



Monte Carlo Inst. Brem Photon Theta; θ [mrad]; Events



Monte Carlo Plane 0 hits xy

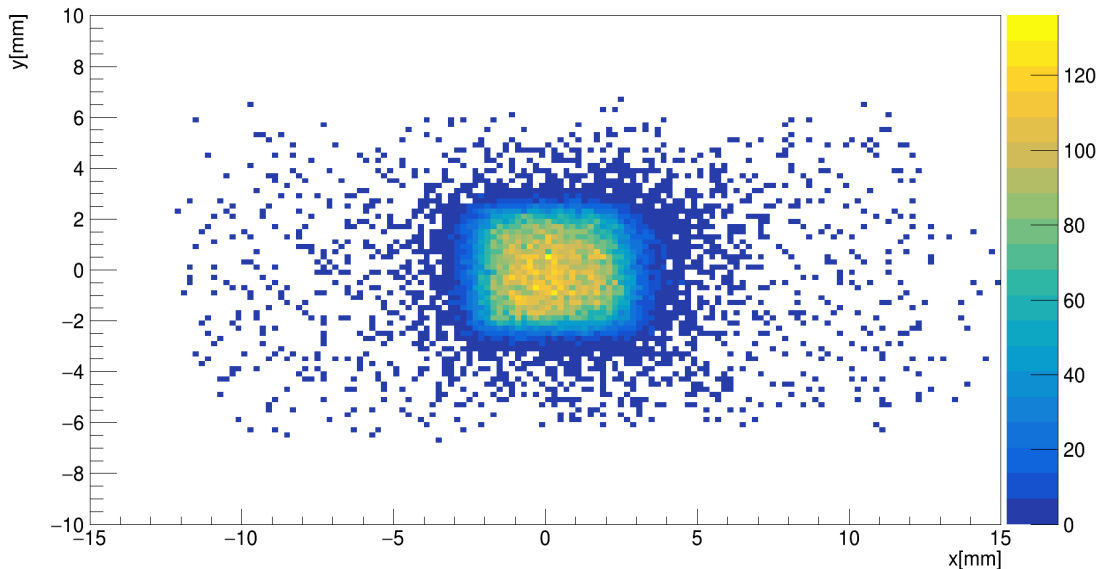


Was trying to remove all other variables by using the initial e- beam direct from the data in simulation

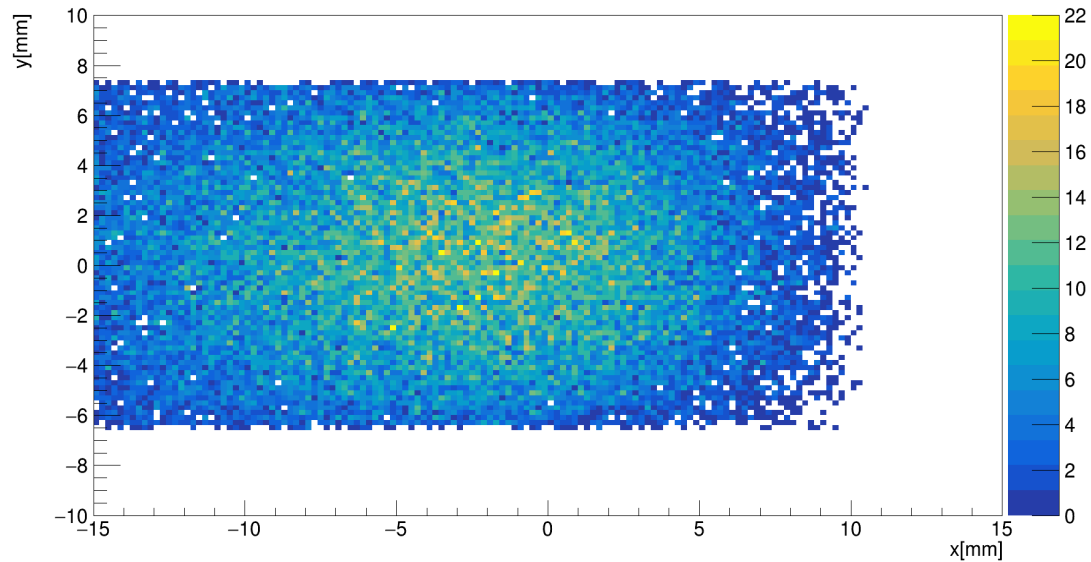
In this setup, we can fix the alignment of the first two planes, so those correlate perfectly

Another alignment technique of forcing the x,y, maximum of data to meet that of the MC is possible

Plane 0 hits xy



Monte Carlo Plane 4 hits xy

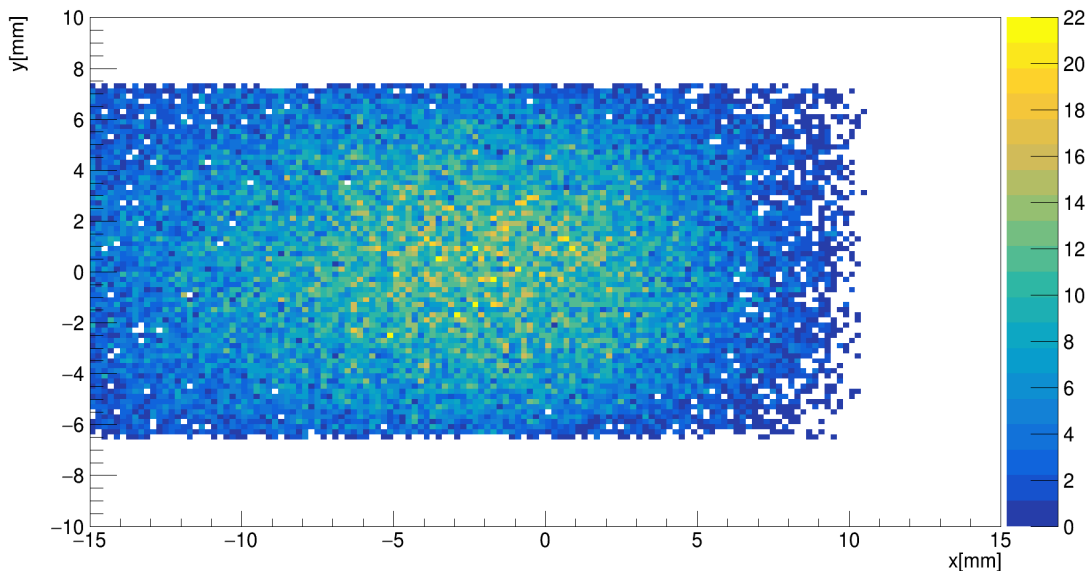


Was trying to remove all other variables by using the initial e- beam direct from the data in simulation

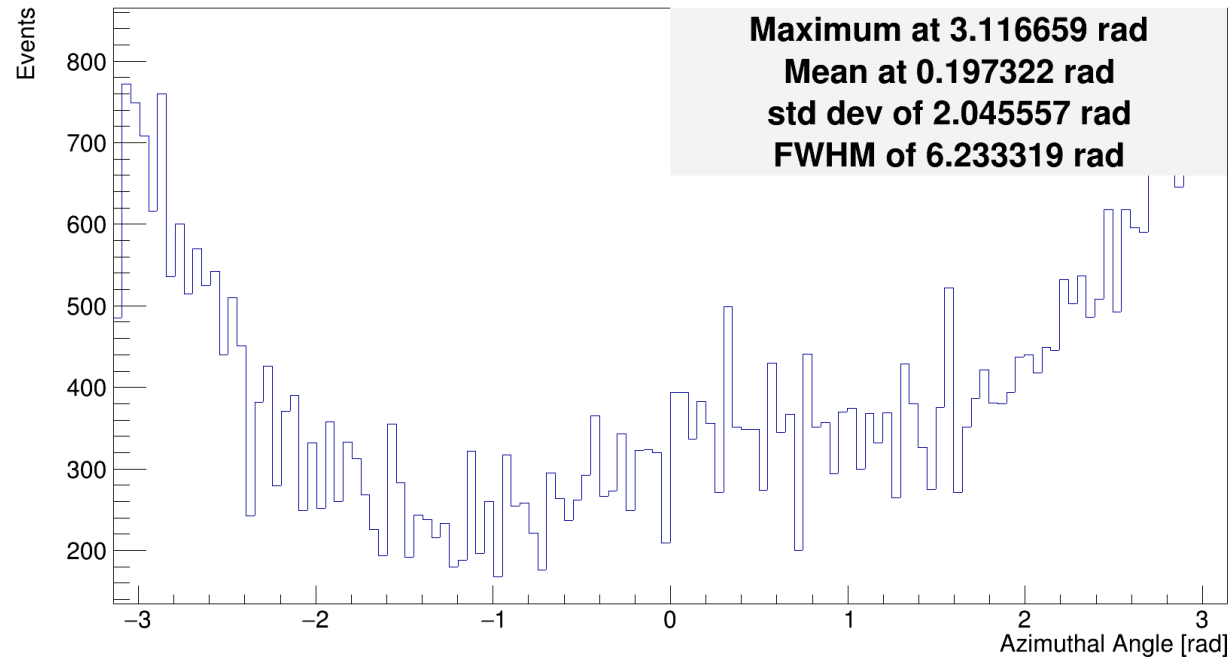
In this setup, we can fix the alignment of the first two planes, so those correlate perfectly

Another alignment technique of forcing the x,y, maximum of data to meet that of the MC is possible

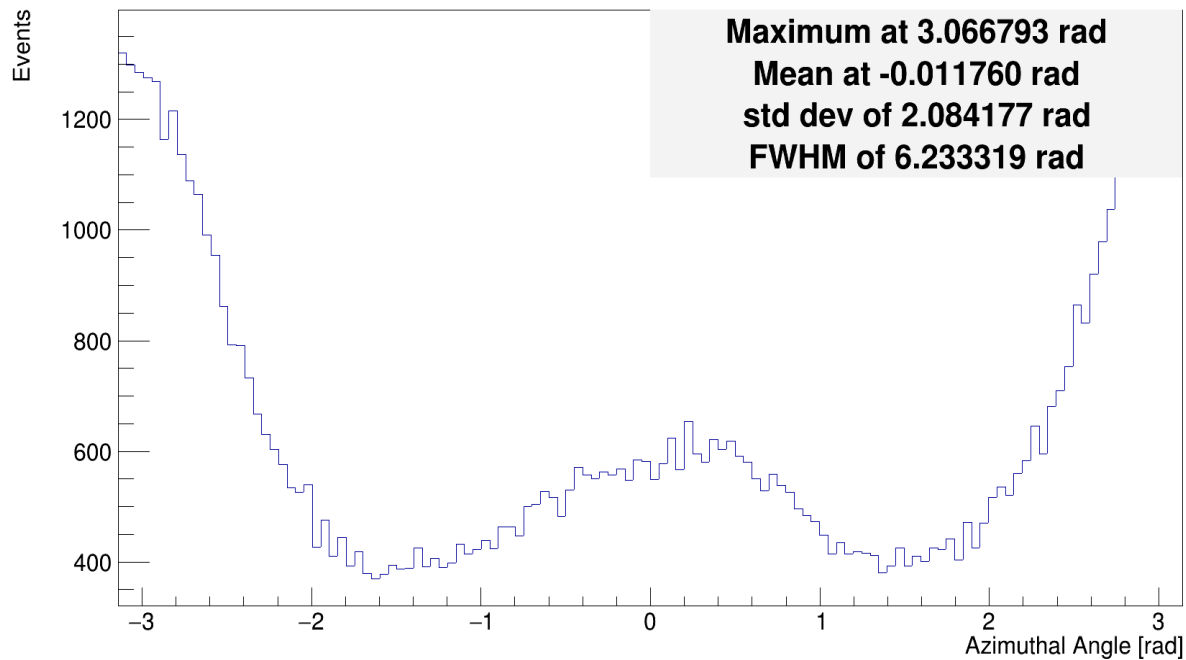
Plane 4 hits xy



Initial Electron Azimuthal Angle

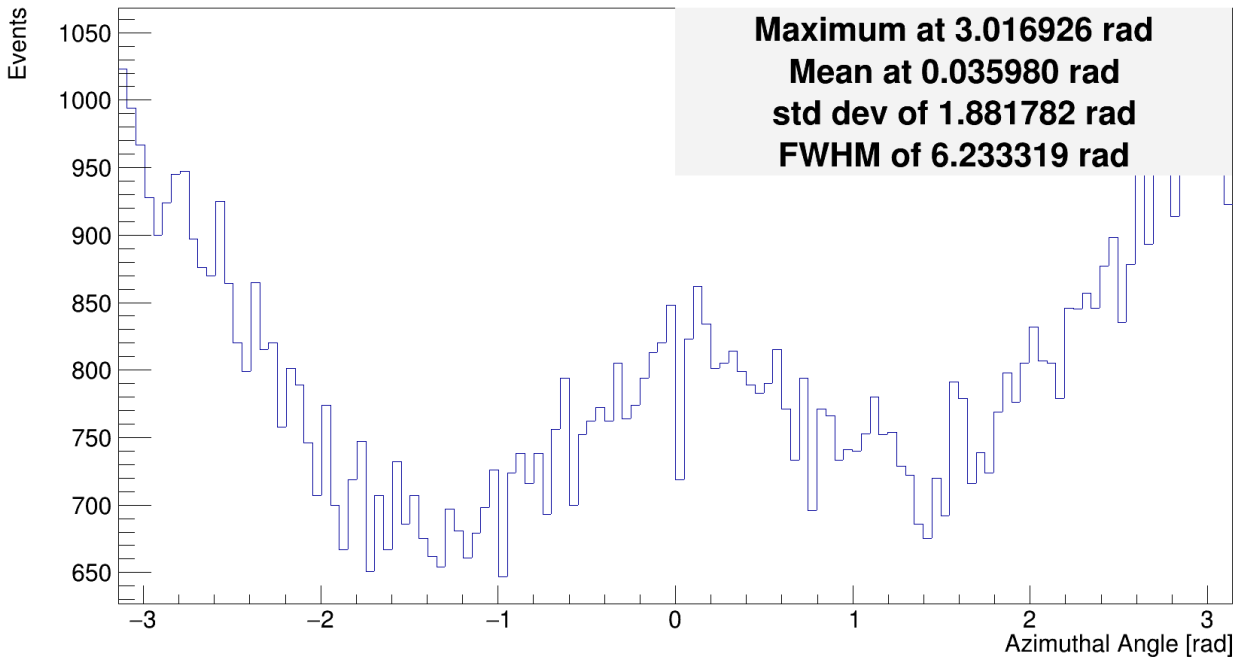


Monte Carlo Initial Electron Azimuthal Angle

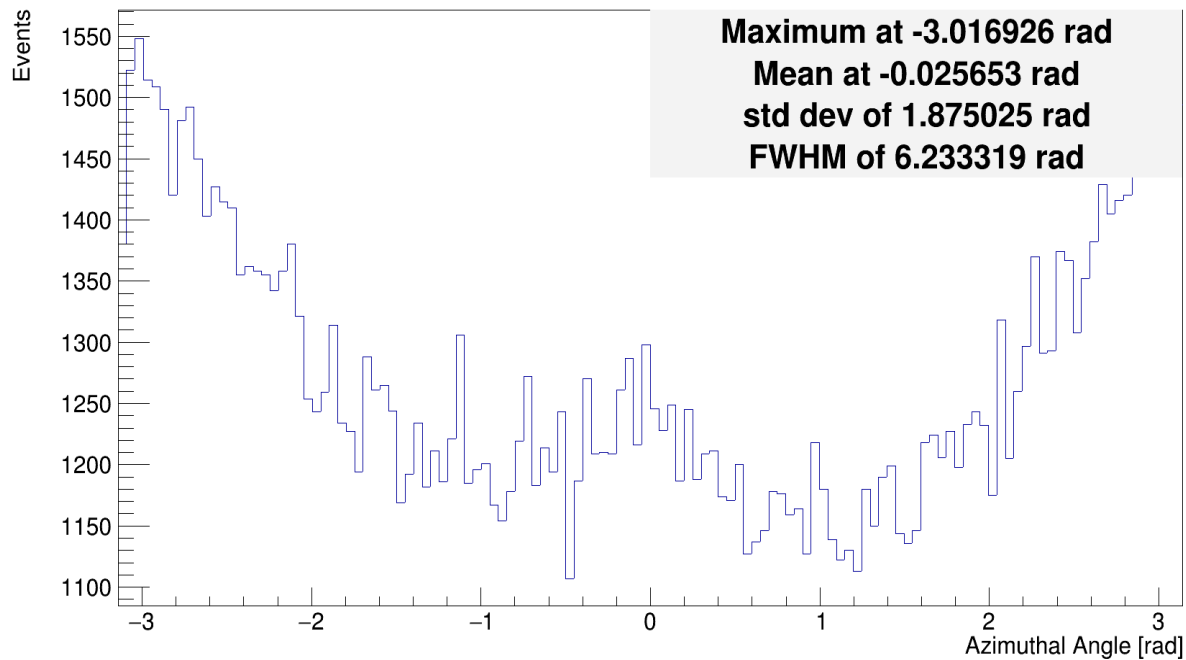


Was looking to match e.g. distributions in azimuthal angle to have data match MC

Final Lepton Azimuthal Angle wrt Z axis

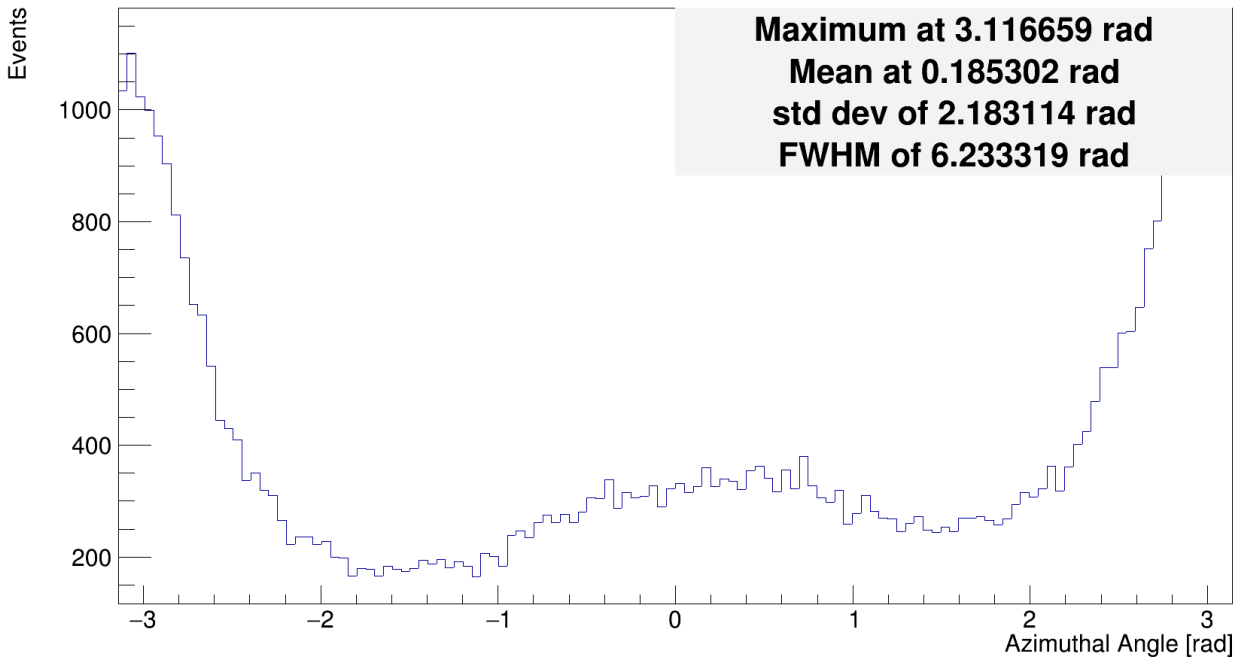


Monte Carlo Final Lepton Azimuthal Angle wrt Z axis

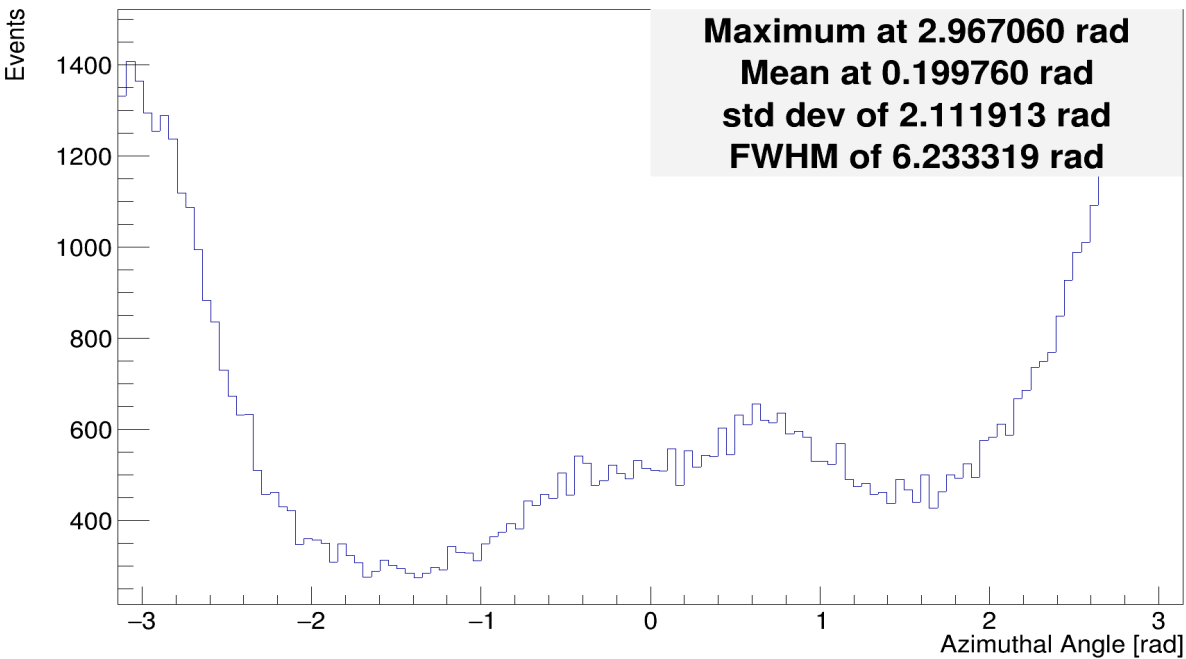


Was looking to match e.g. distributions in azimuthal angle to have data match MC

Intermediate Brem Gamma Azimuthal Angle wrt z axis

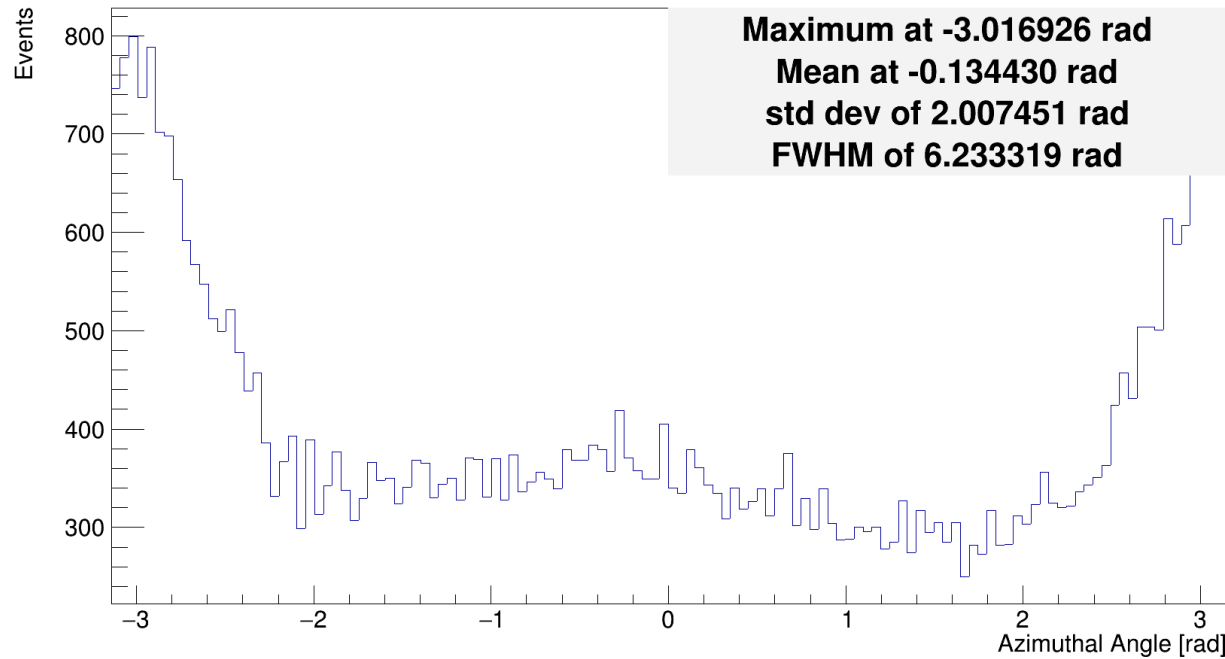


Monte Carlo Intermediate Brem Gamma Azimuthal Angle wrt z axis

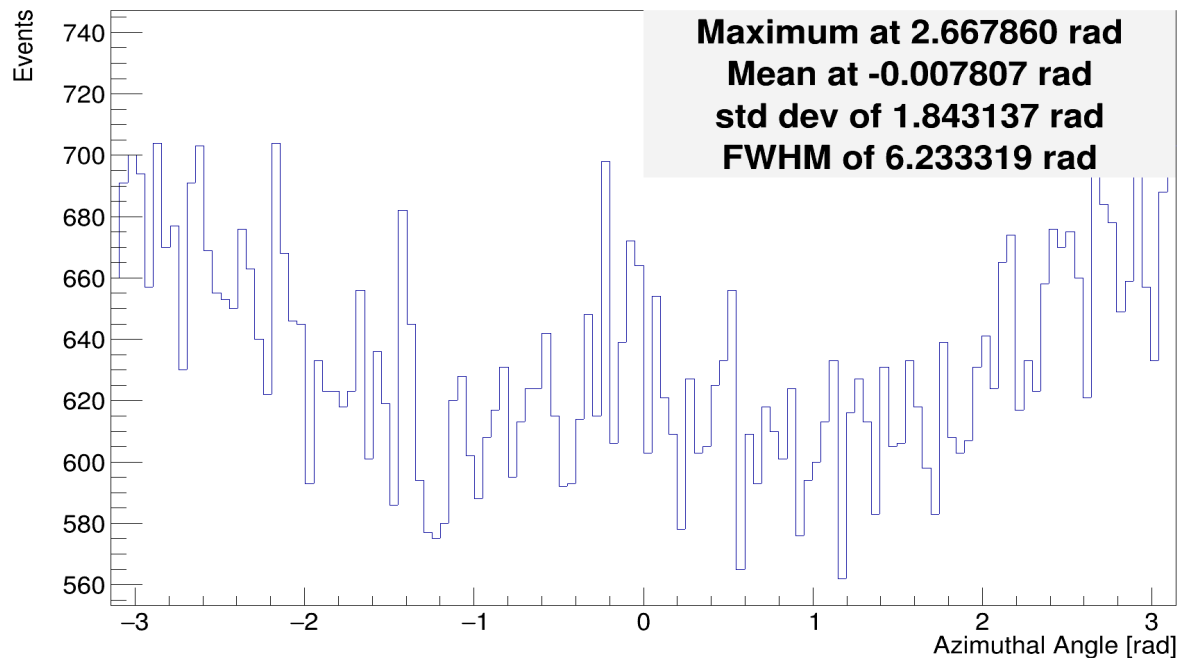


Was looking to match e.g. distributions in azimuthal angle to have data match MC

Intermediate Brem Gamma Delta Azimuthal Angle wrt e-



Monte Carlo Intermediate Brem Gamma Delta Azimuthal Angle wrt e-



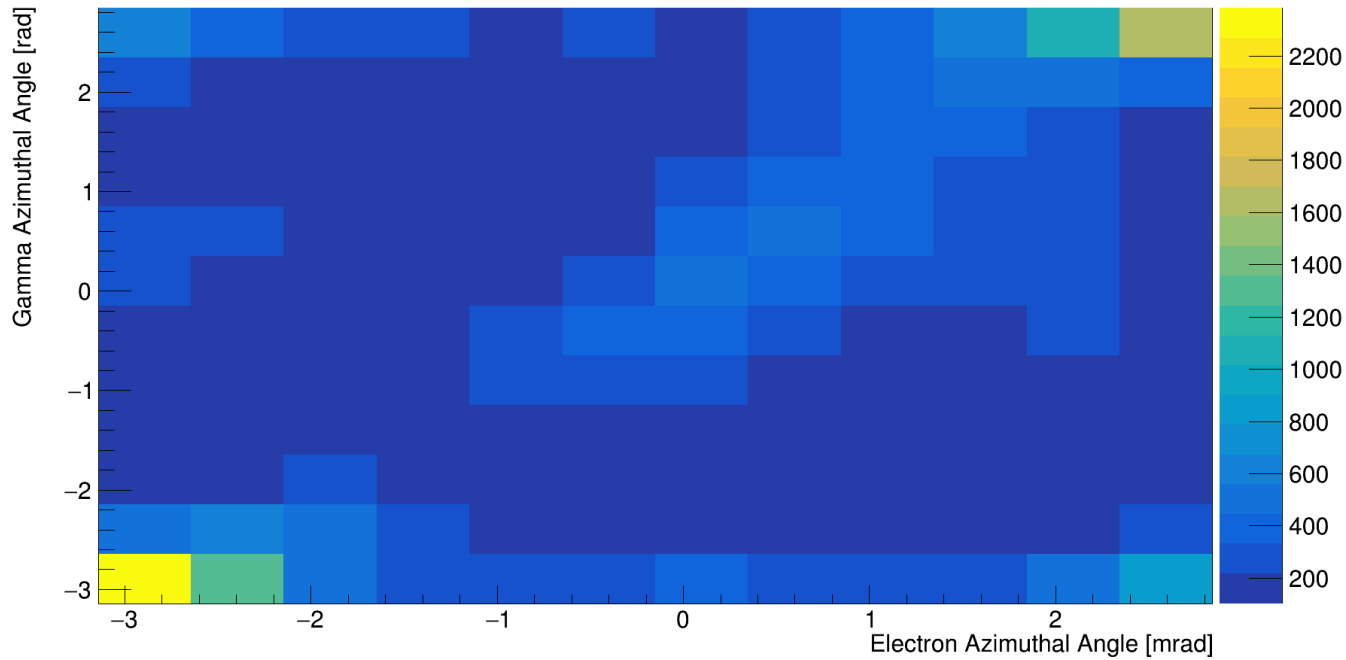
Was looking to match e.g. distributions in azimuthal angle to have data match MC

This is the azimuthal angle with respect to initial e- vector

This is the only difference, to my eye, between MC and TB data

Could be explained by real brems emission, generally higher theta, preferring the 'x' direction where the acceptance is larger

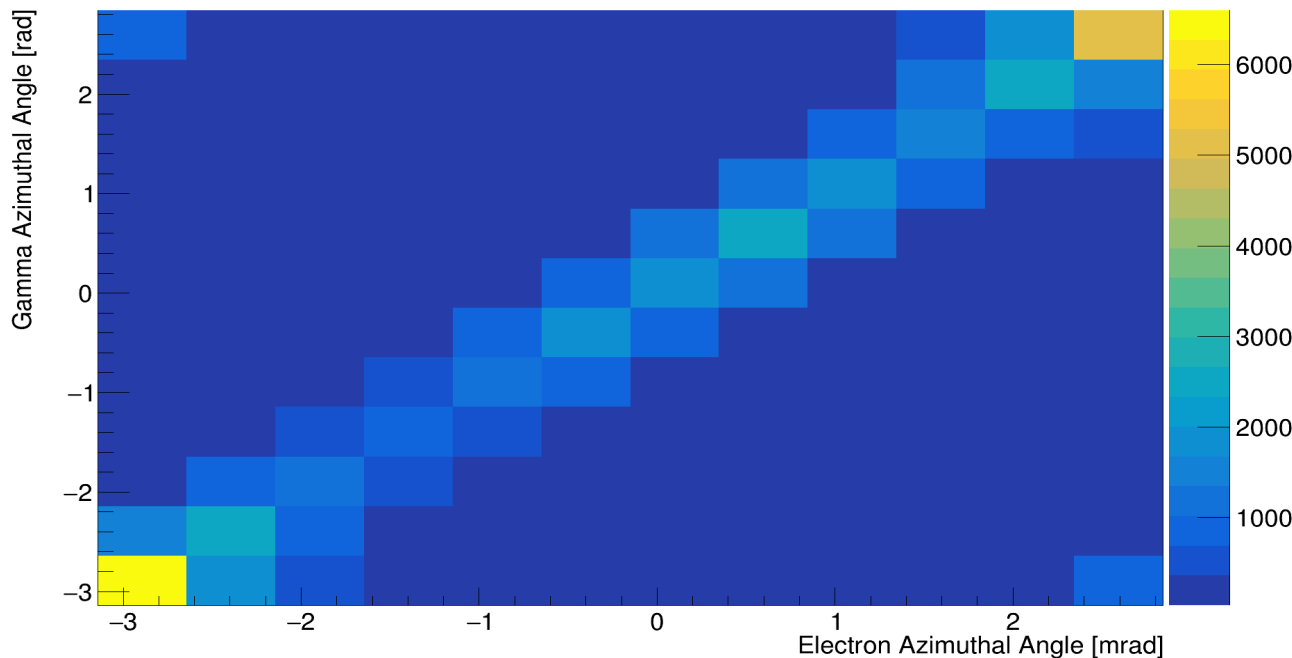
Initial Electron and Intermediate Photon Azimuthal Angle wrt Z axis



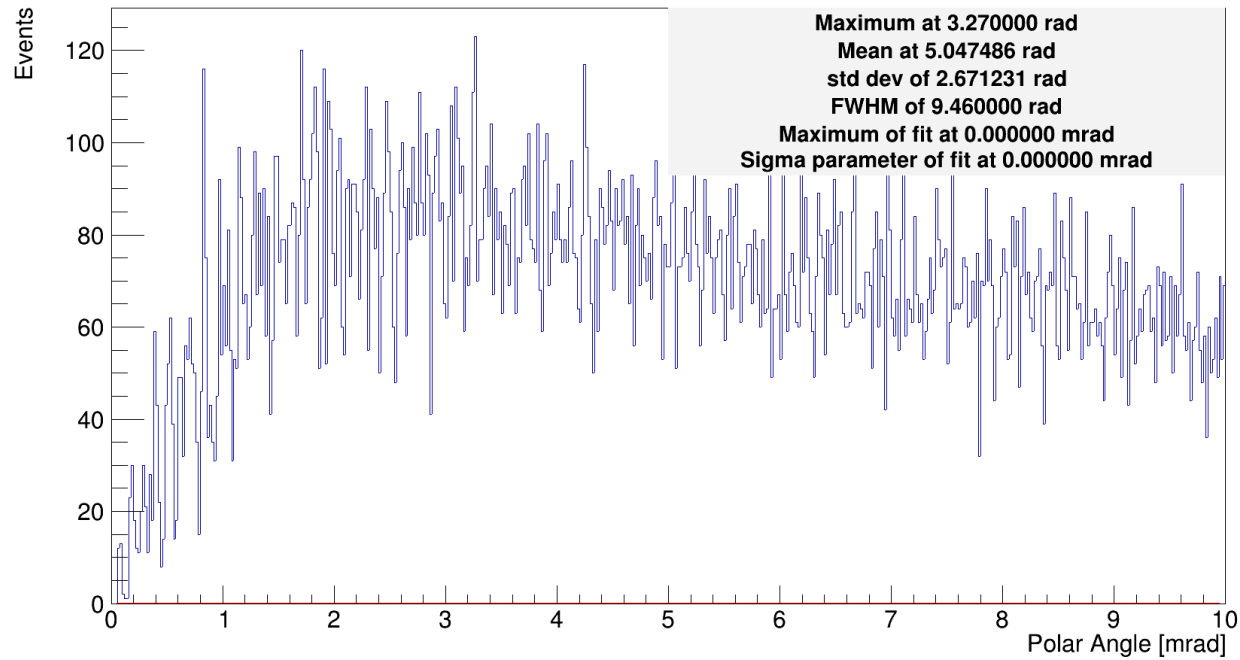
Looking at correlation between azimuth (w.r.t. z axis) of initial electron and photon

This tells us in the real data the photon emission is less preferentially emitted in same direction as initial electron

Monte Carlo Initial Electron and Intermediate Photon Azimuthal Angle wrt Z axis

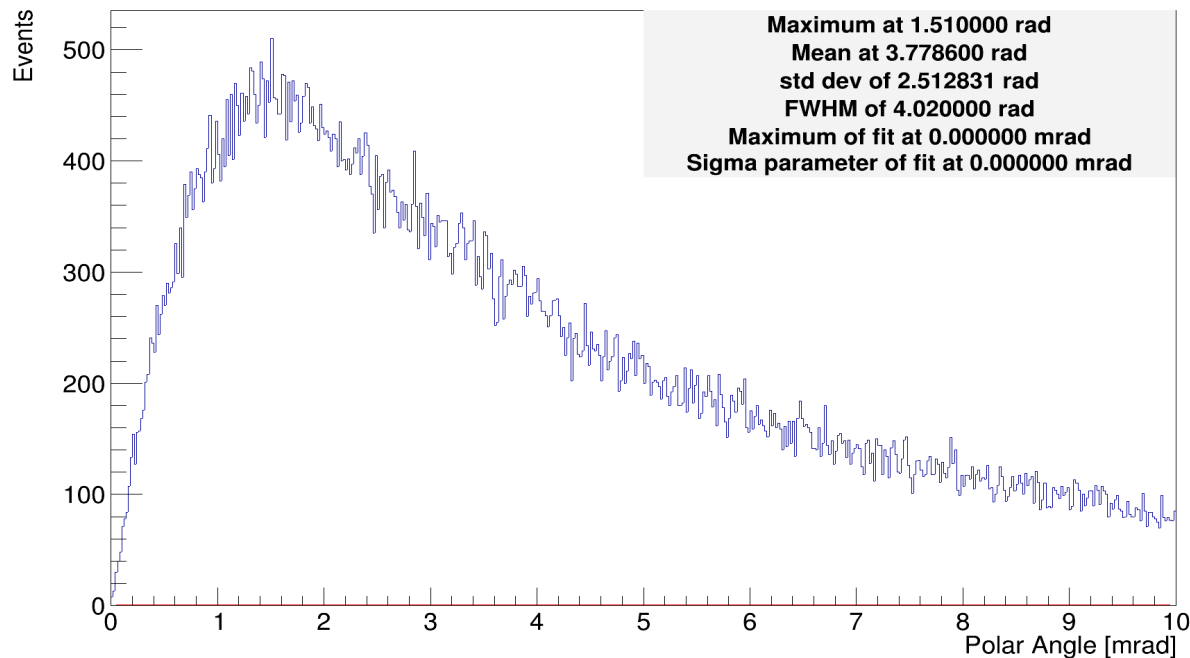


Final Lepton Polar Angle wrt Z axis

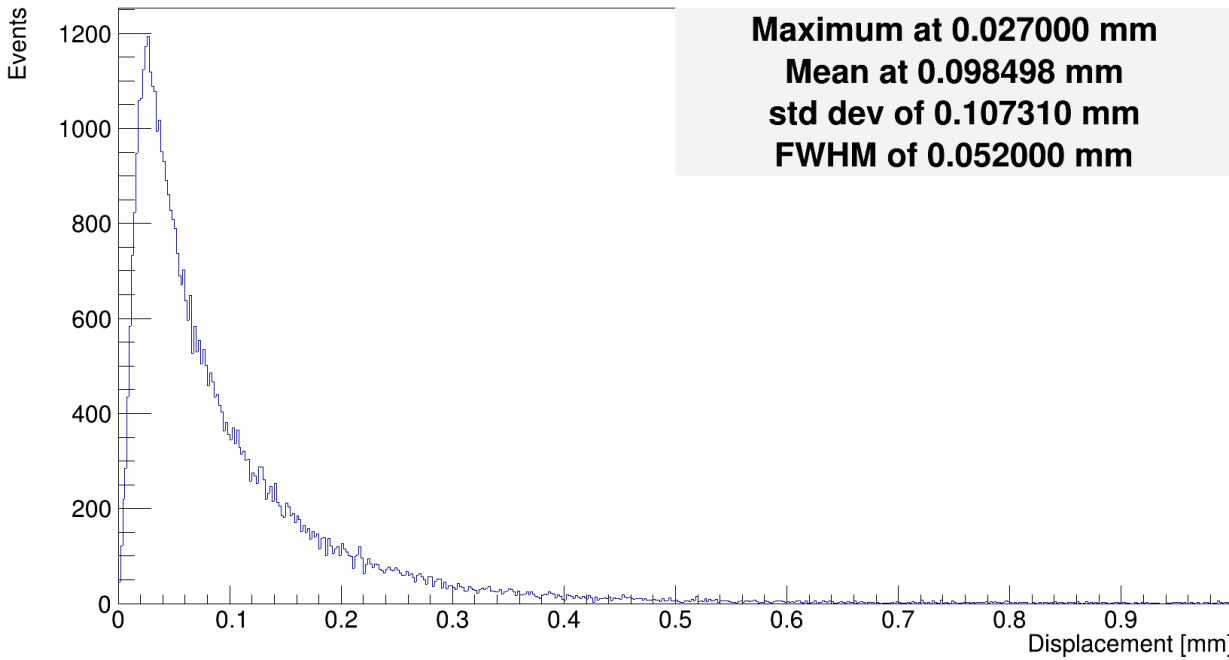


Final lepton theta w.r.t. z axis, looks like the real data again is larger, making sense with the brem divergence

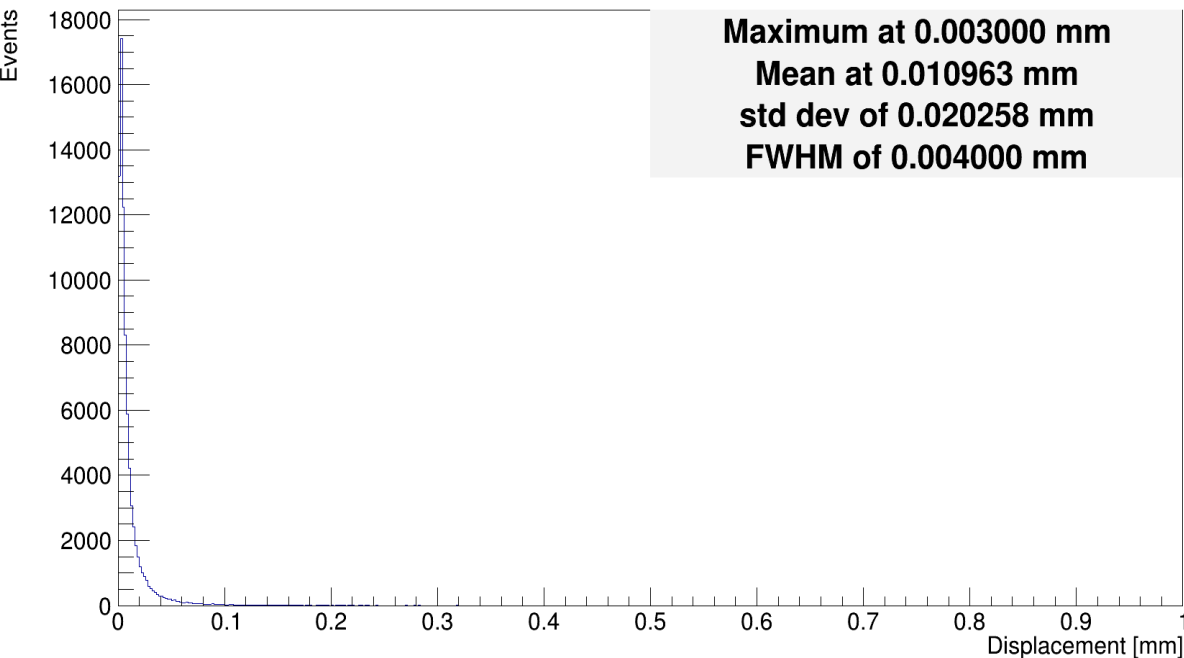
Monte Carlo Final Lepton Polar Angle wrt Z axis



Best Tracking Solution e- e+ vertex displacement

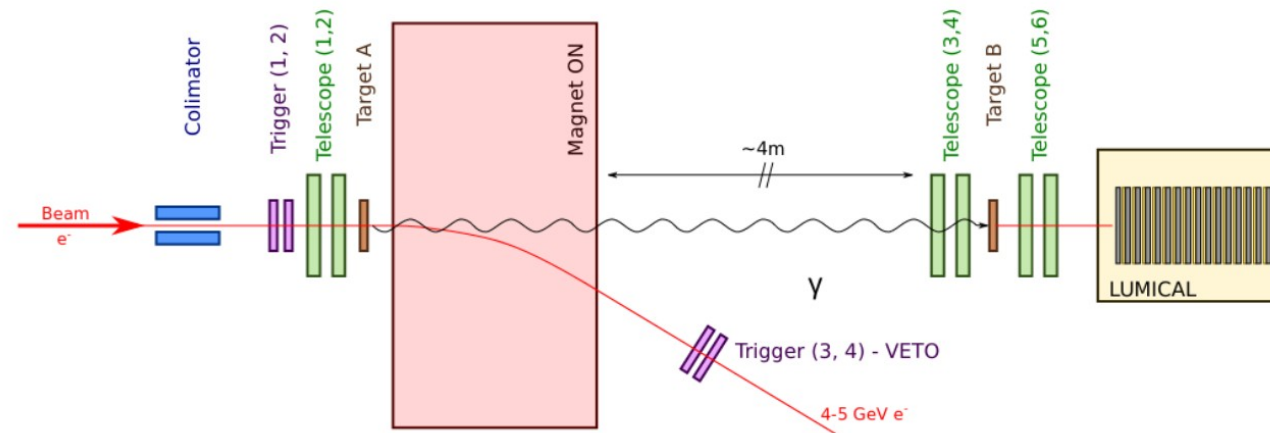


Monte Carlo Best Tracking Solution e- e+ vertex displacement



Stranger asymmetry.. when matching tracks for the final leptons, the MC reconstruction gives much closer track vertices

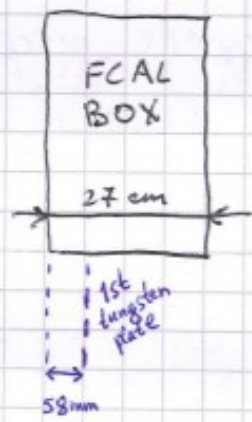
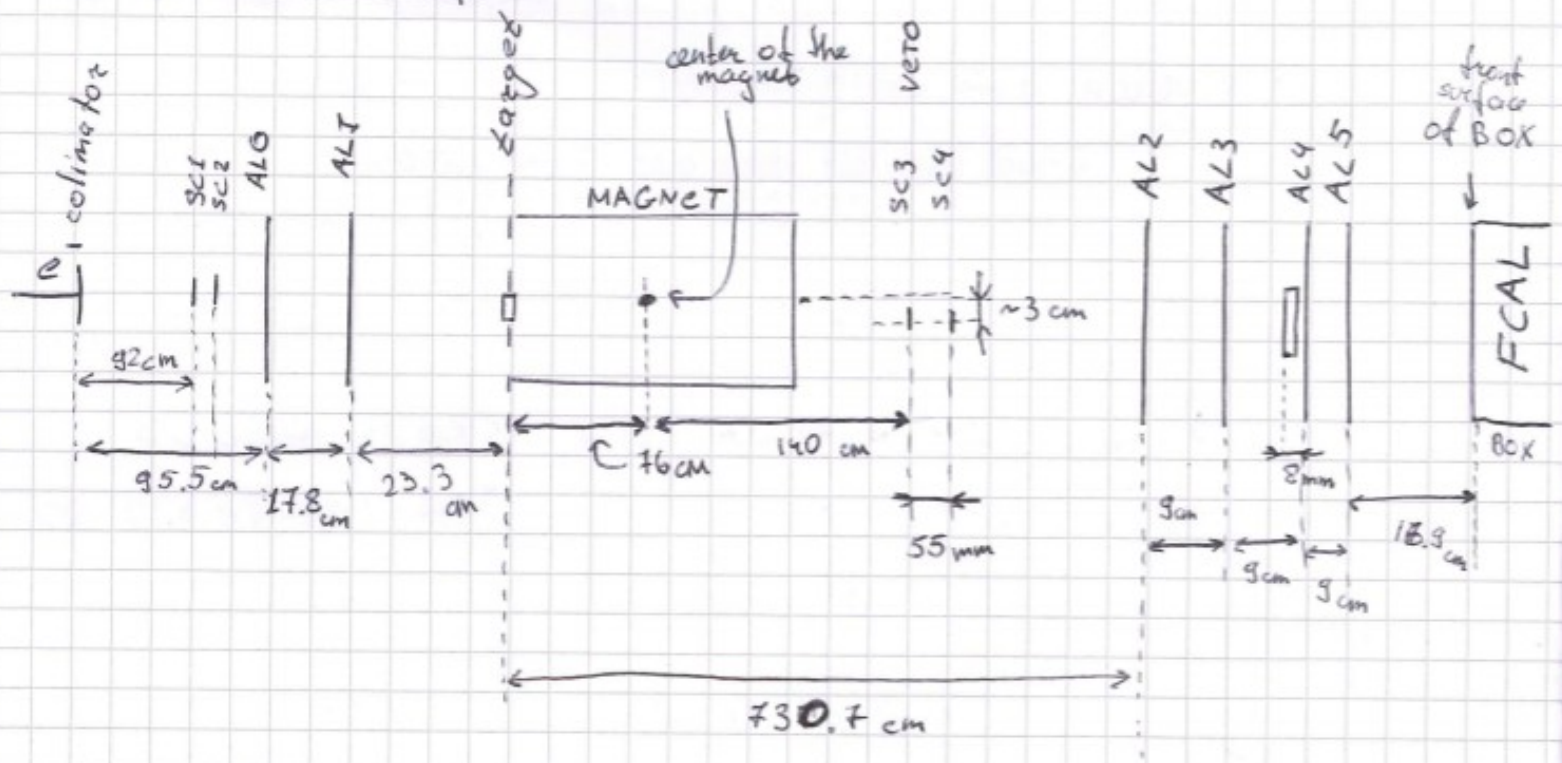
TB2020 Alpeide Telescope Alignment



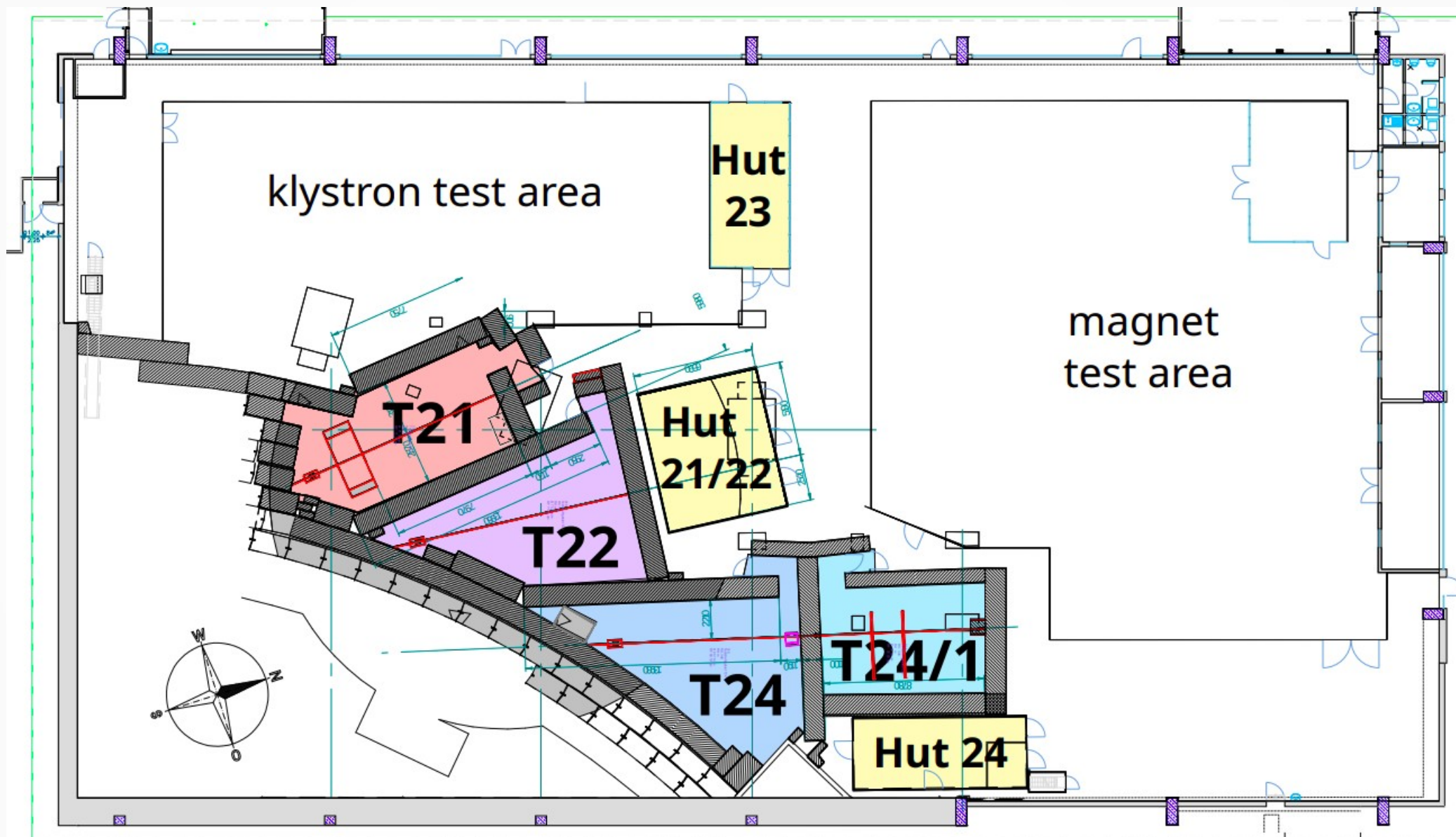
- Accounting for the discrepancy in short future:
- Uncertainty in hit position due to detector uncertainty
- Possible simple mistakes in model e.g. target thickness (but not z distance)
- Differing physics lists
- no-target runs – comparison to MC could be useful, evaluate effect of air-scattering on e-

backup

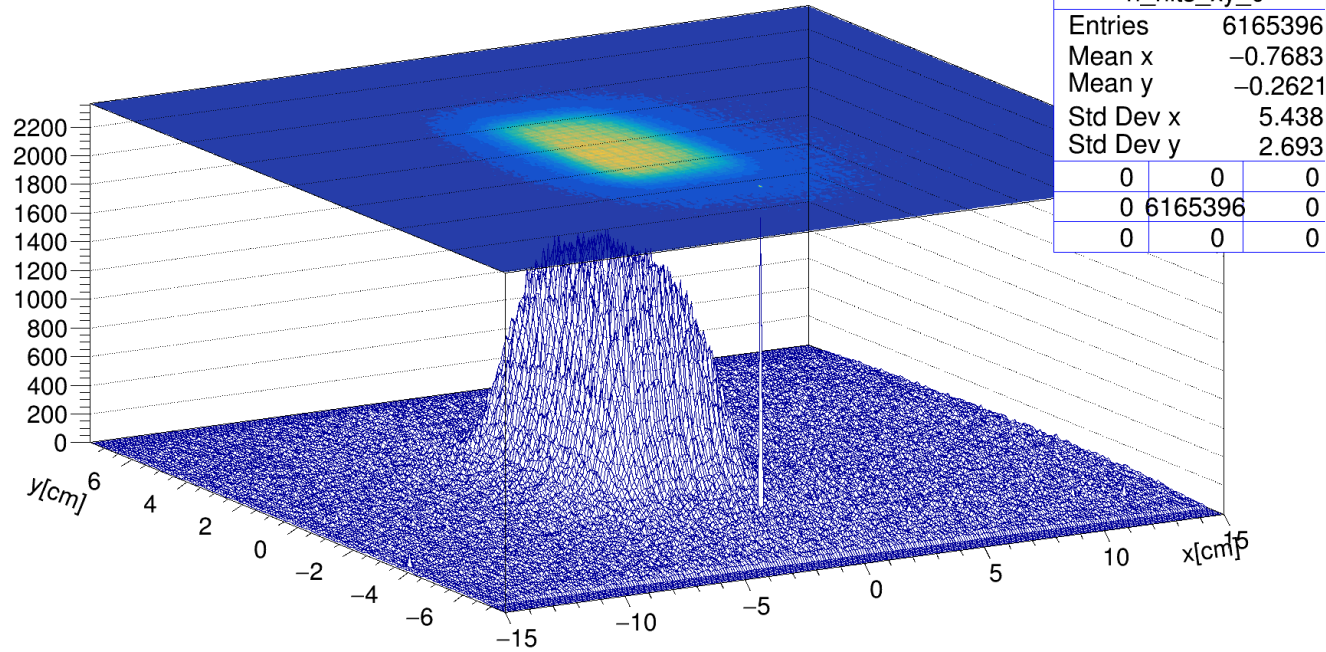
Experimental Setup



14.03.2020 (5:36)
 Ji-day



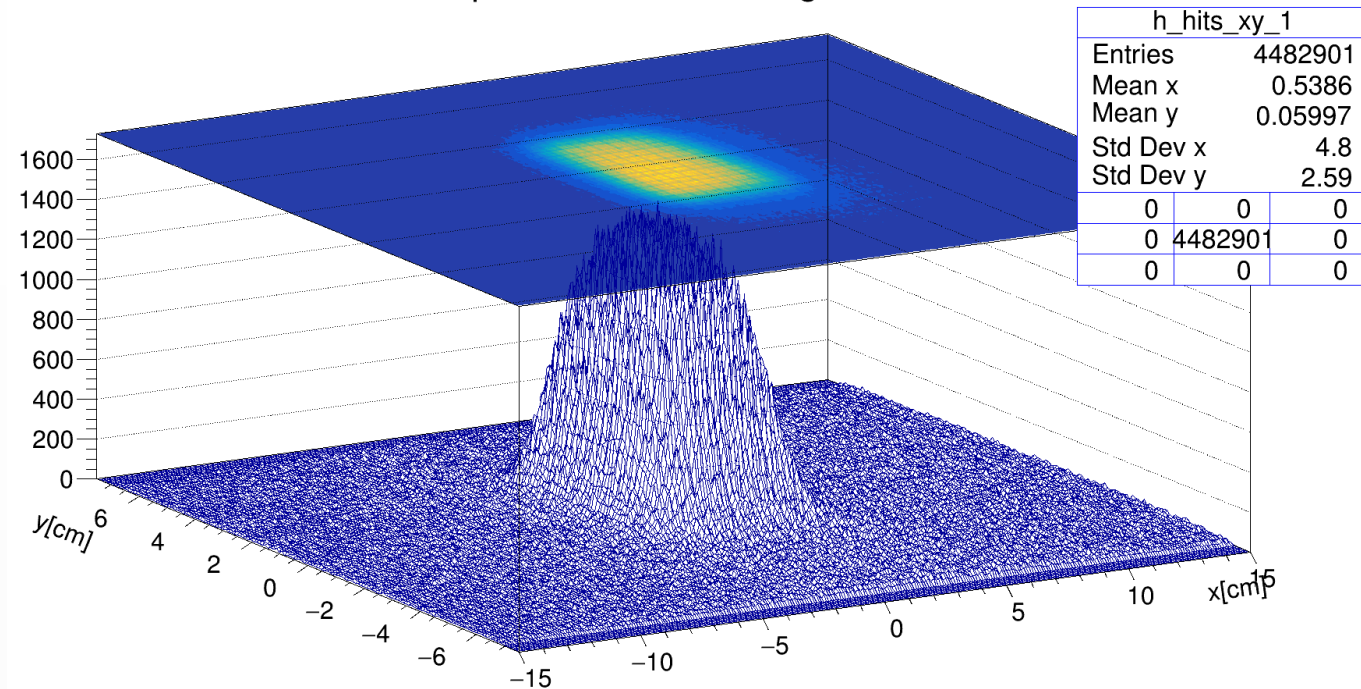
Telescope Plane 0 - Pre-target1 - z=0



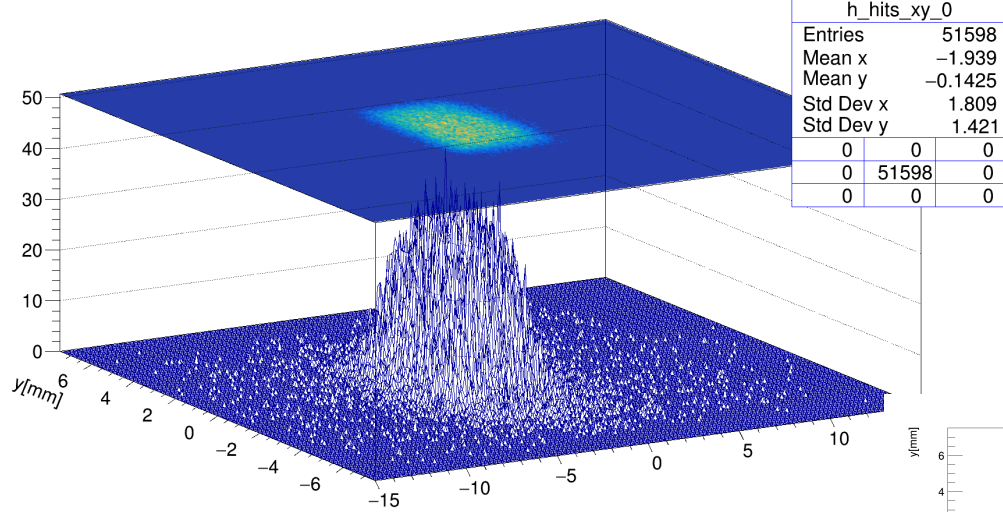
Have cleaned data of hot pixels

Resulting analysis could exclude real data within these 'hot' pixels but this result is likely small

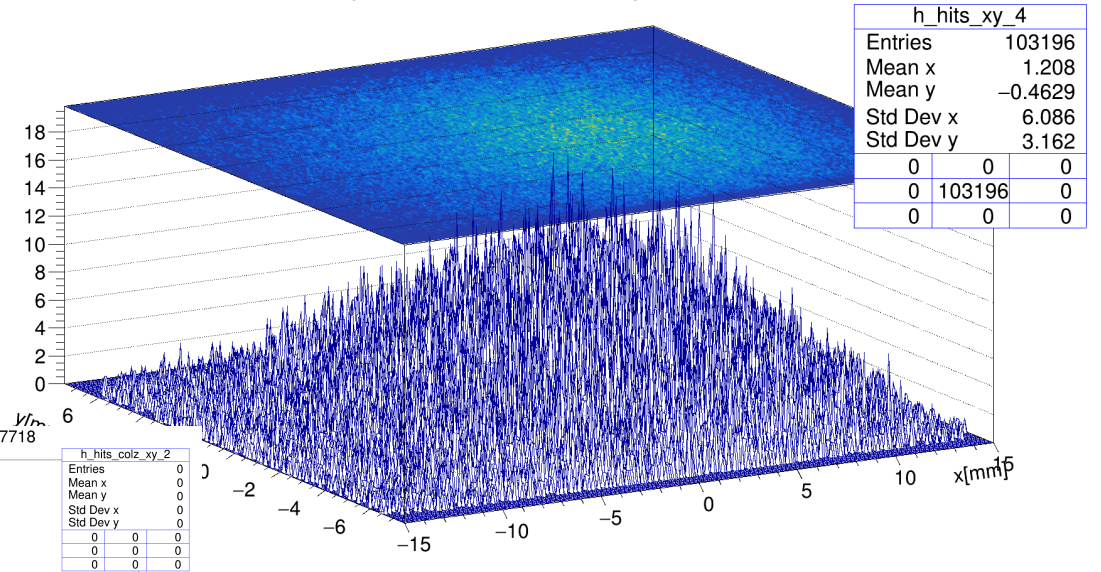
Telescope Plane 1 - Pre-target1 - z=178



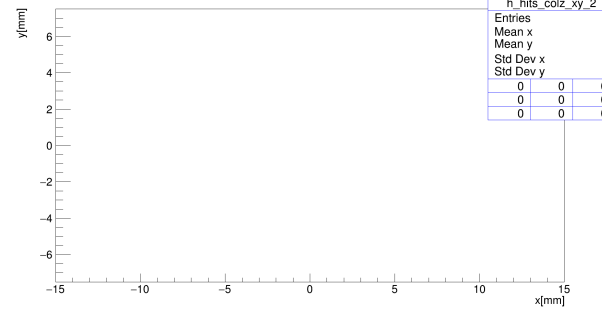
Telescope Plane 0 - Pre-target1 - z=0



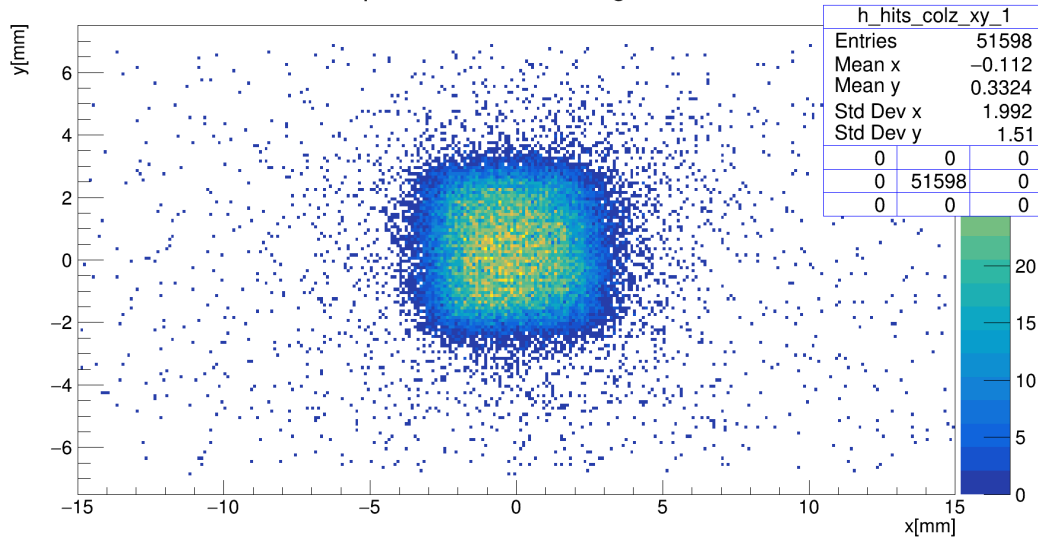
Telescope Plane 4 - Post-target2 - z=7898



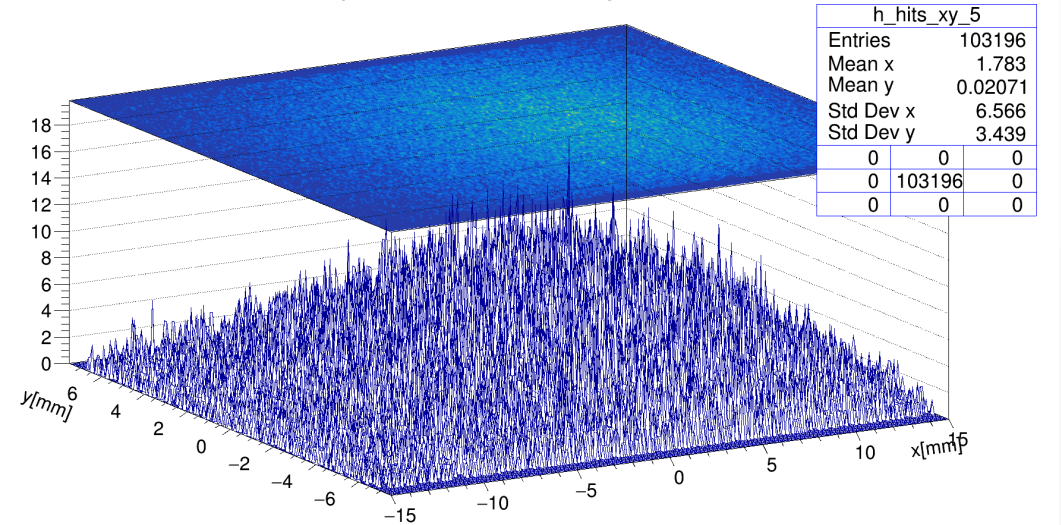
Telescope Plane 2 - Pre-target2 - z=7718



Telescope Plane 1 - Pre-target1 - z=178

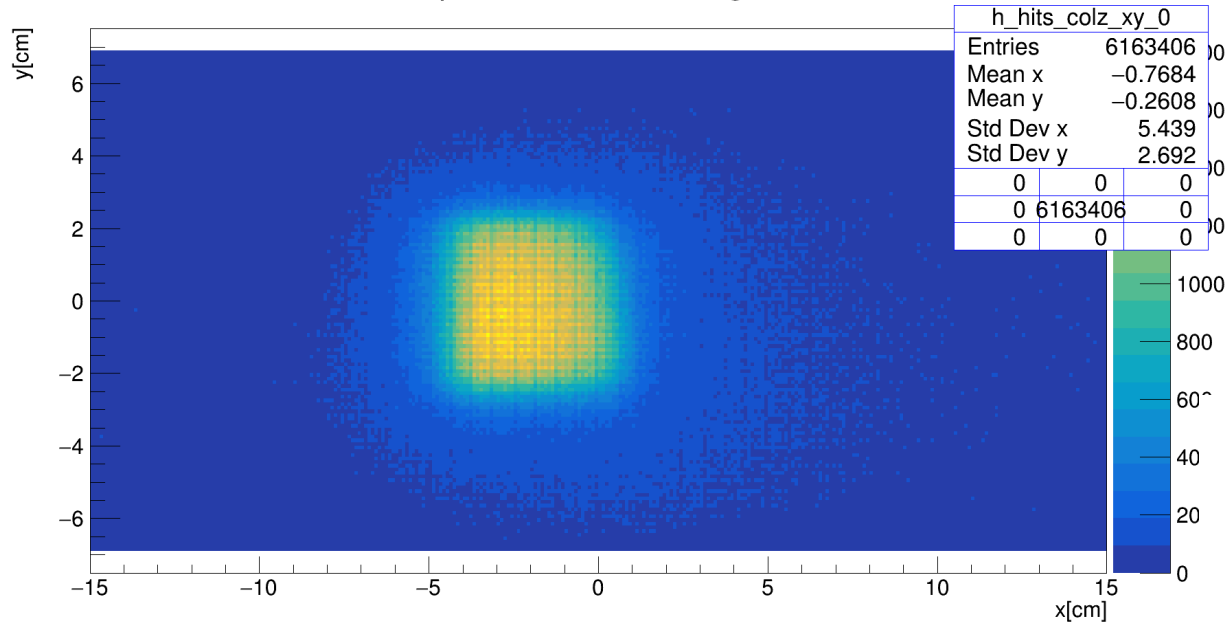


Telescope Plane 5 - Post-target2 - z=7988

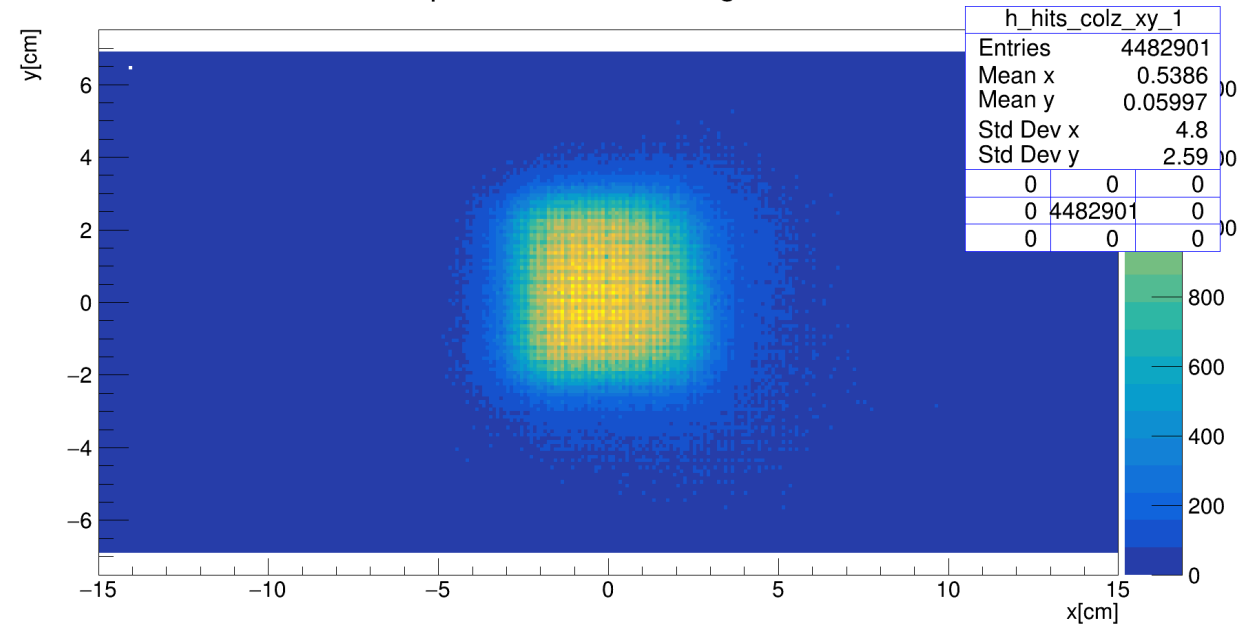


Look for
110022 hit
pattern

Telescope Plane 0 - Pre-target1 - z=0

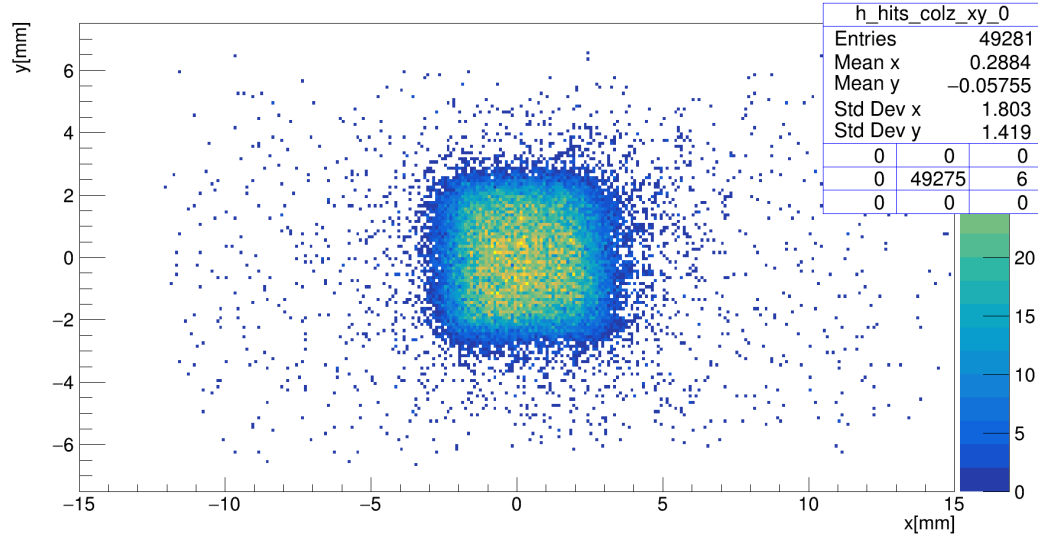


Telescope Plane 1 - Pre-target1 - z=178

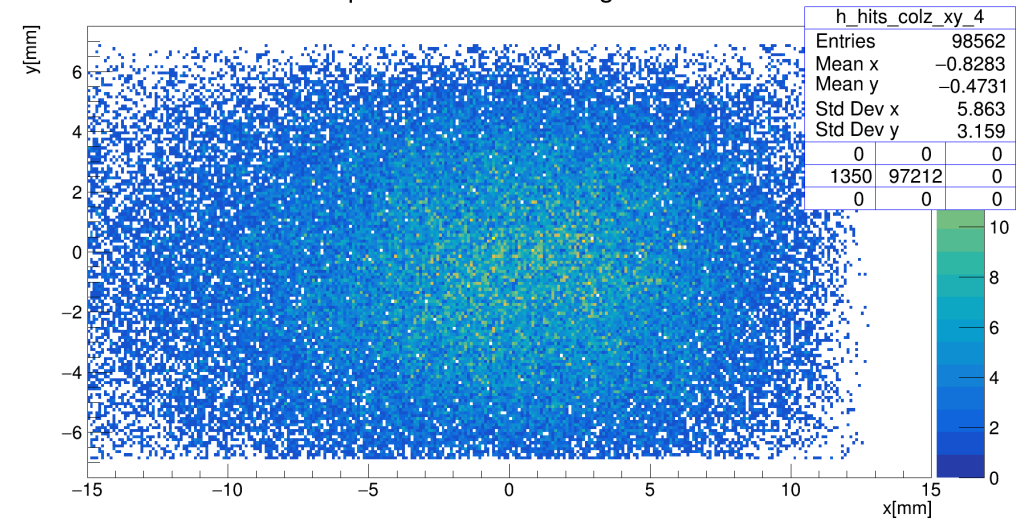


This needs above all,
good alignment!

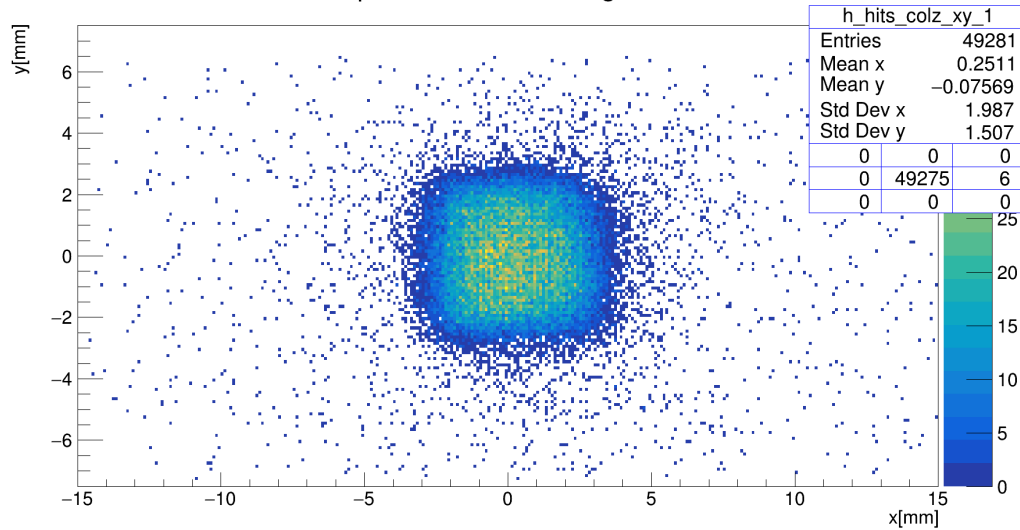
Telescope Plane 0 - Pre-target1 - z=0



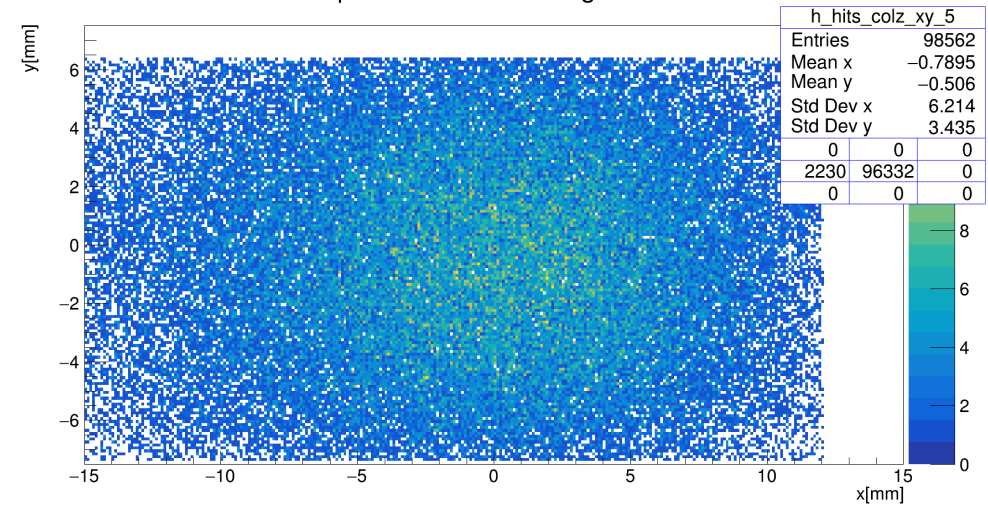
Telescope Plane 4 - Post-target2 - z=7898



Telescope Plane 1 - Pre-target1 - z=178



Telescope Plane 5 - Post-target2 - z=7988



There are runs with no targets, no B-field, with telescope planes in place; use mean position of distribution for alignment

