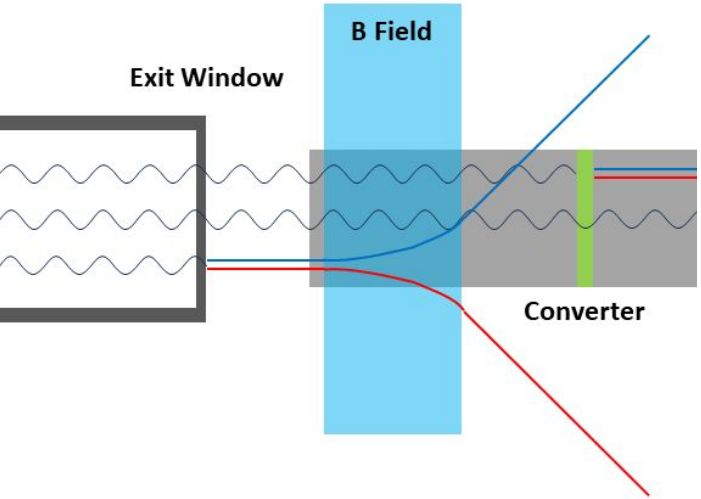
Simulation Studies of Diamond Exit Window

Luminosity Group Meeting 19/03/25

Alex Smith
University of York
alex.smith3@york.ac.uk

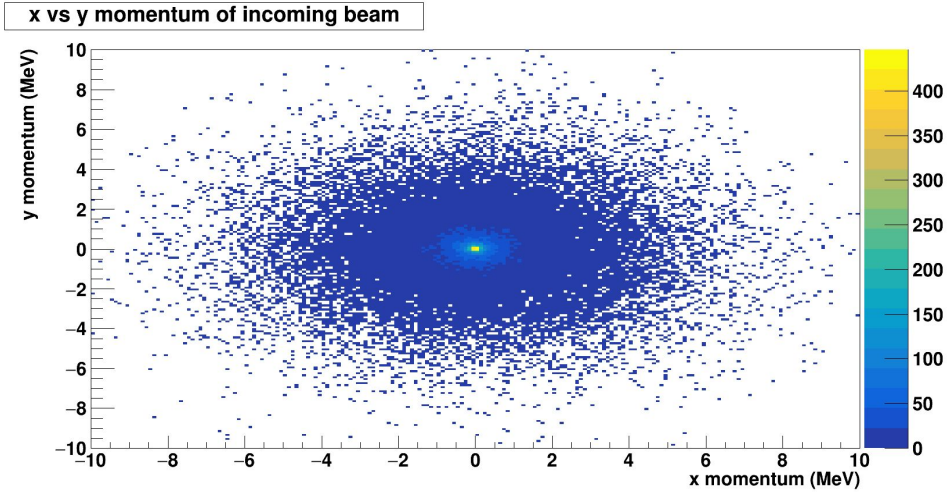
Simulation setup

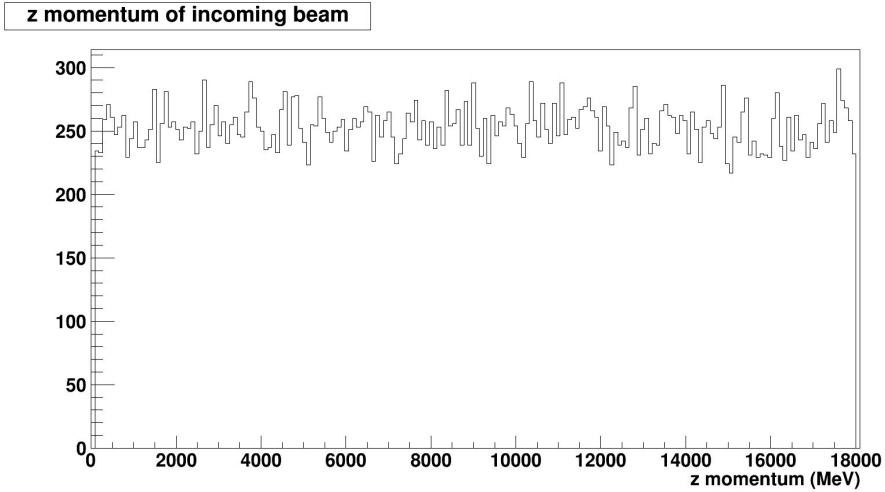


- Study the effect of the diamond window on a propagated bremsstrahlung beam
- Simulated window thicknesses of 1 mm, 2 mm, and 5 mm.
- Beam energy was uniformly distributed up to 18 GeV.
- 18x275 beam conditions
  - Divergence, crabbing, etc.

Input beam

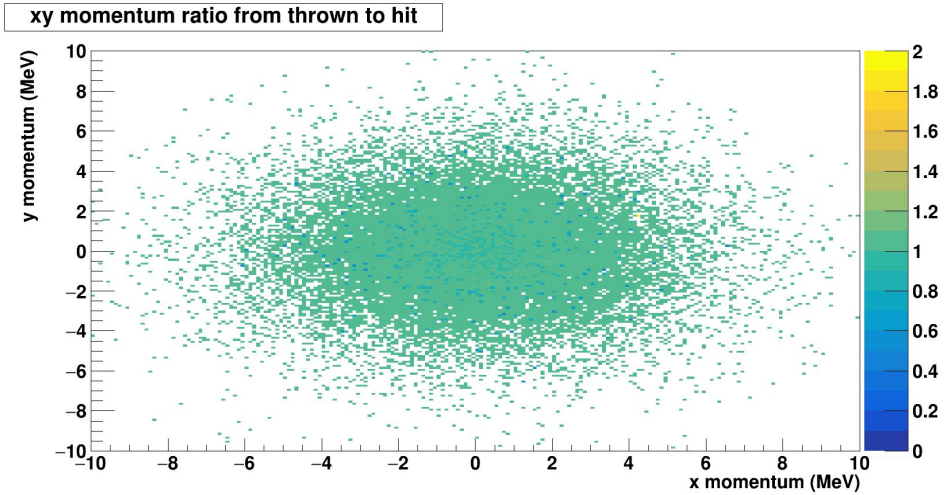
- Beam properties at interaction point
- These are propagated 20 m to the exit window

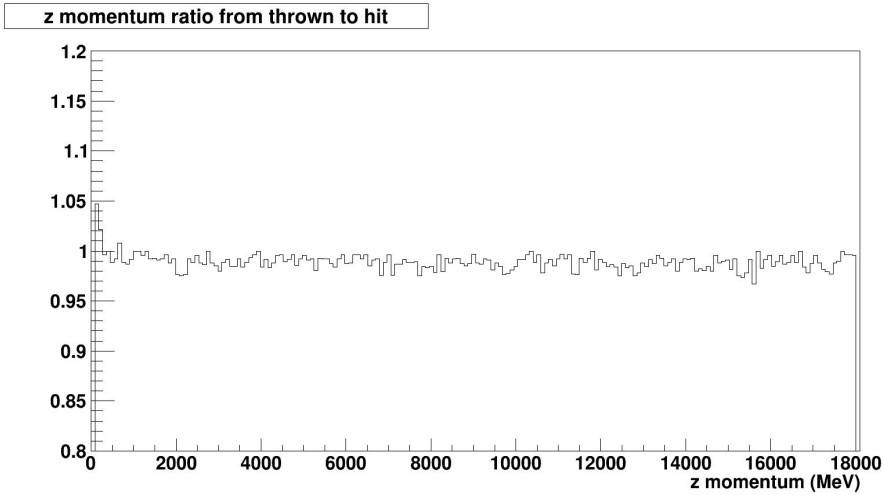




1 mm Window

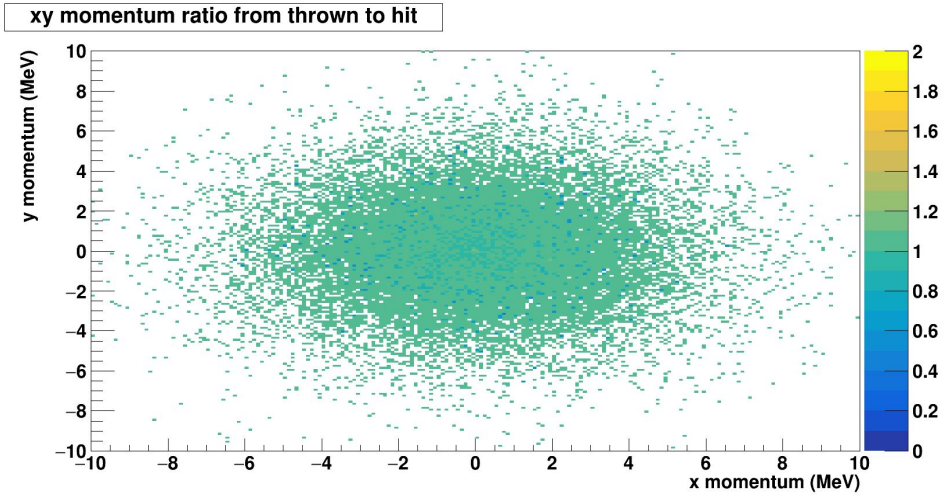
- Events that don't interact: 99.0 ± 0.6 %
- Pair production rate:
- 0.94 ± 0.04 %

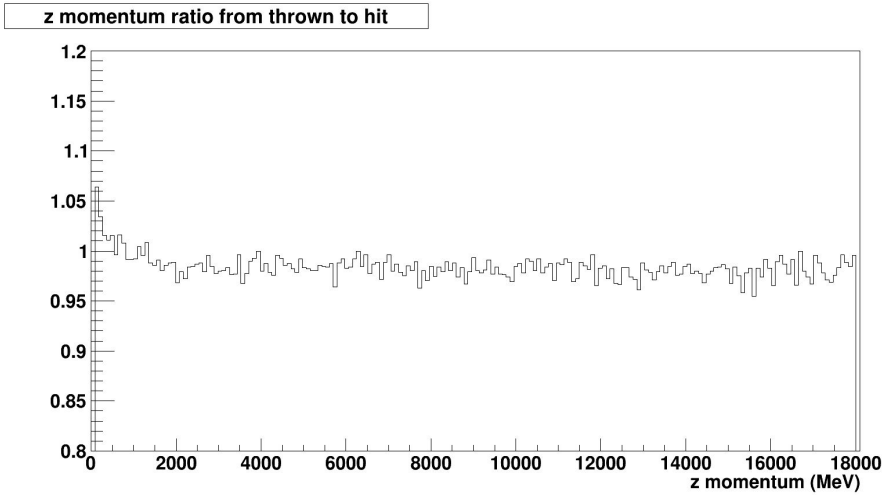




2 mm Window

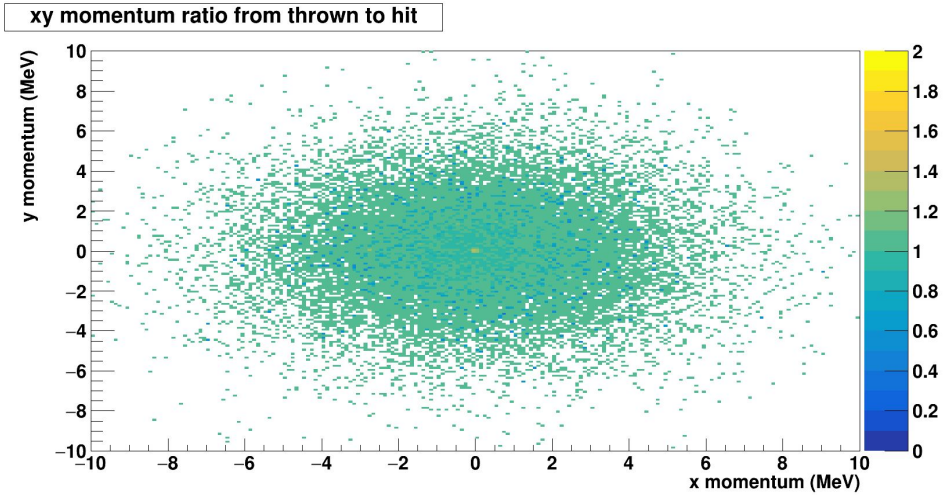
- Events that don't interact: 98.6 ± 0.6 %
- Pair production rate:
- 1.32 ± 0.05 %

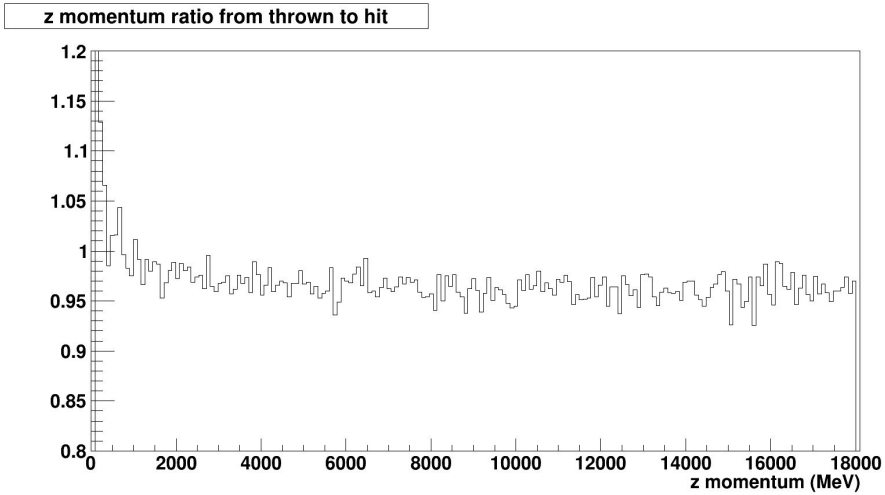




5 mm Window

- Events that don't interact: 97.8 ± 0.6 %
- Pair production rate:
- 2.24 ± 0.06 %





Mean Free Path Calculation

Assume the dominant background is pair production for photon energies > 100 MeV.

$$\Rightarrow X_0/\rho \approx {}^{7}/_{9}\ \lambda \qquad [1]$$

$$X_0/\rho = 42.7 / 3.52 = 12.1 \text{ cm} \qquad [2]$$

$$\lambda = 15.6 \text{ cm}$$

$$P(\text{interaction in distance } L) = 1 - e^{-L/\lambda} \qquad [1]$$

[1] https://cas.web.cern.ch/sites/default/files/lectures/erice-2017/lechner.pdf
[2] https://pdg.lbl.gov/2009/reviews/rpp2009-rev-atomic-nuclear-prop.pdf

Mean Free Path Comparison

Thickness	MFP Probability	Simulated Probability
0.95 mm	99.4%	
1 mm	99.4 %	99.0 ± 0.6 %
1.05 mm	99.3 %	
2 mm	98.7 %	98.6 ± 0.6 %
5 mm	96.8 %	97.8 ± 0.6 %

- Adding or subtracting 50 μm has an effect on the order of 0.05 %