DESY-II TEST BEAM SIMULATION

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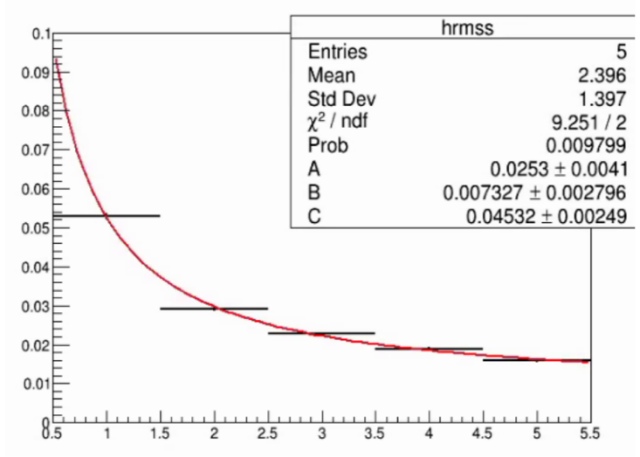
7/10/26

Feb 2025 Resolution – ~4.5-5% / E Resolution Term Meaning

- Resolution fit needed a 1/E term -- meaning?
- Remember but we didn't know what the intrinsic BEAM energy spread was



Reso Fit form

: **A%/√E ⊕ B % ⊕ C % / E**

- A term 2.5%
- B term (floated) 0.7%
- **Noise term 4.5%/E. Large :**

Reso 1GeV :0.0529
Reso 2GeV :0.0290
Reso 3GeV :0.0228
Reso 4GeV :0.0189
Reso 5GeV :0.0158

Graph sourced from Justin Frantz TIC Mtg talk 2/9/26

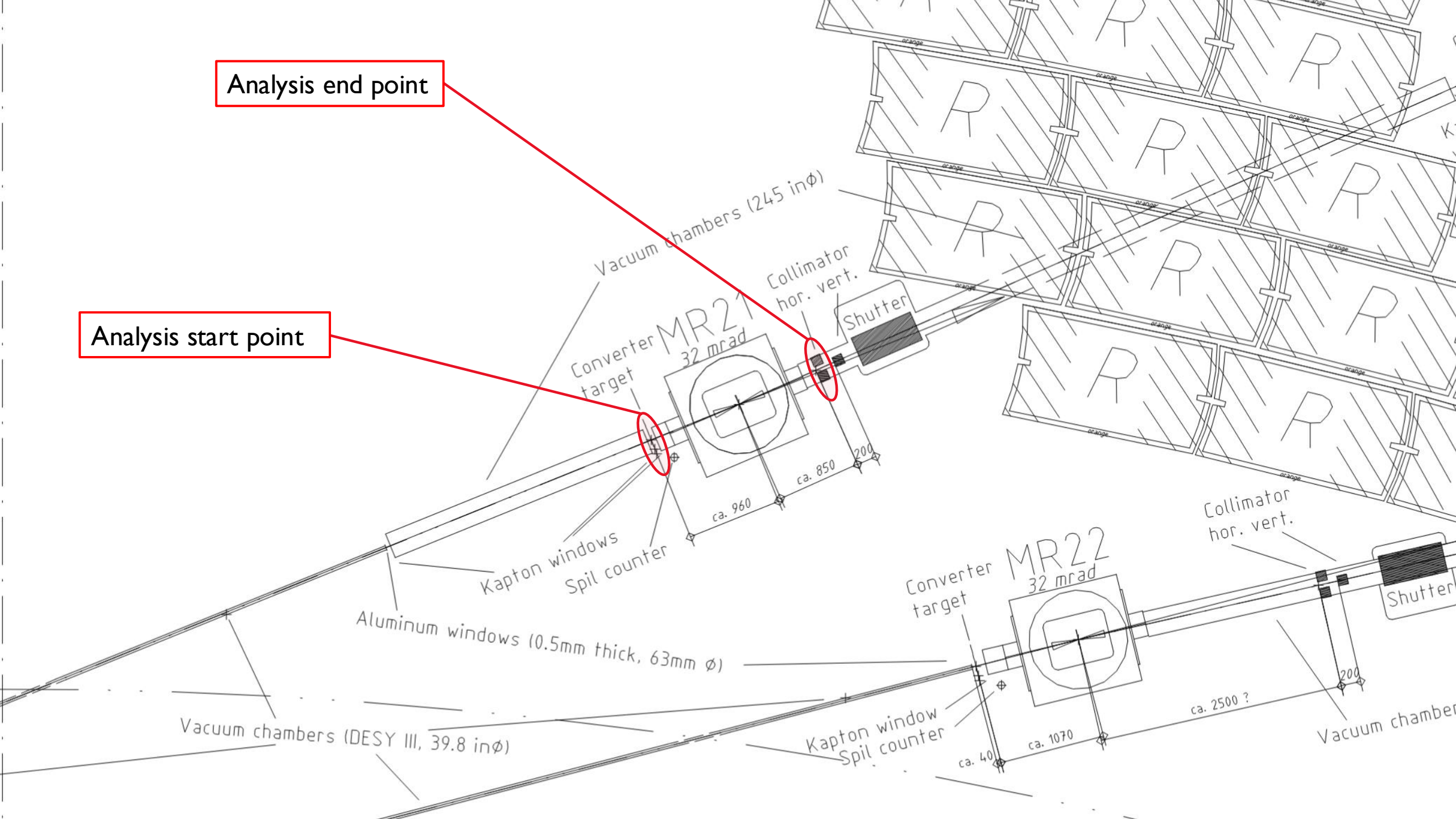
The DESY II Test Beam Experiments

- At DESY a test beam was used to evaluate two readout conditions in the TB24 beamline
  - Both yielded nearly identical results
- Why is the noise term at low energies so large?
  - Is it due to the inherent resolution of the beam?

Simple Beam Optics Calculation

Start analysis with TB21 instead of TB24 beamline

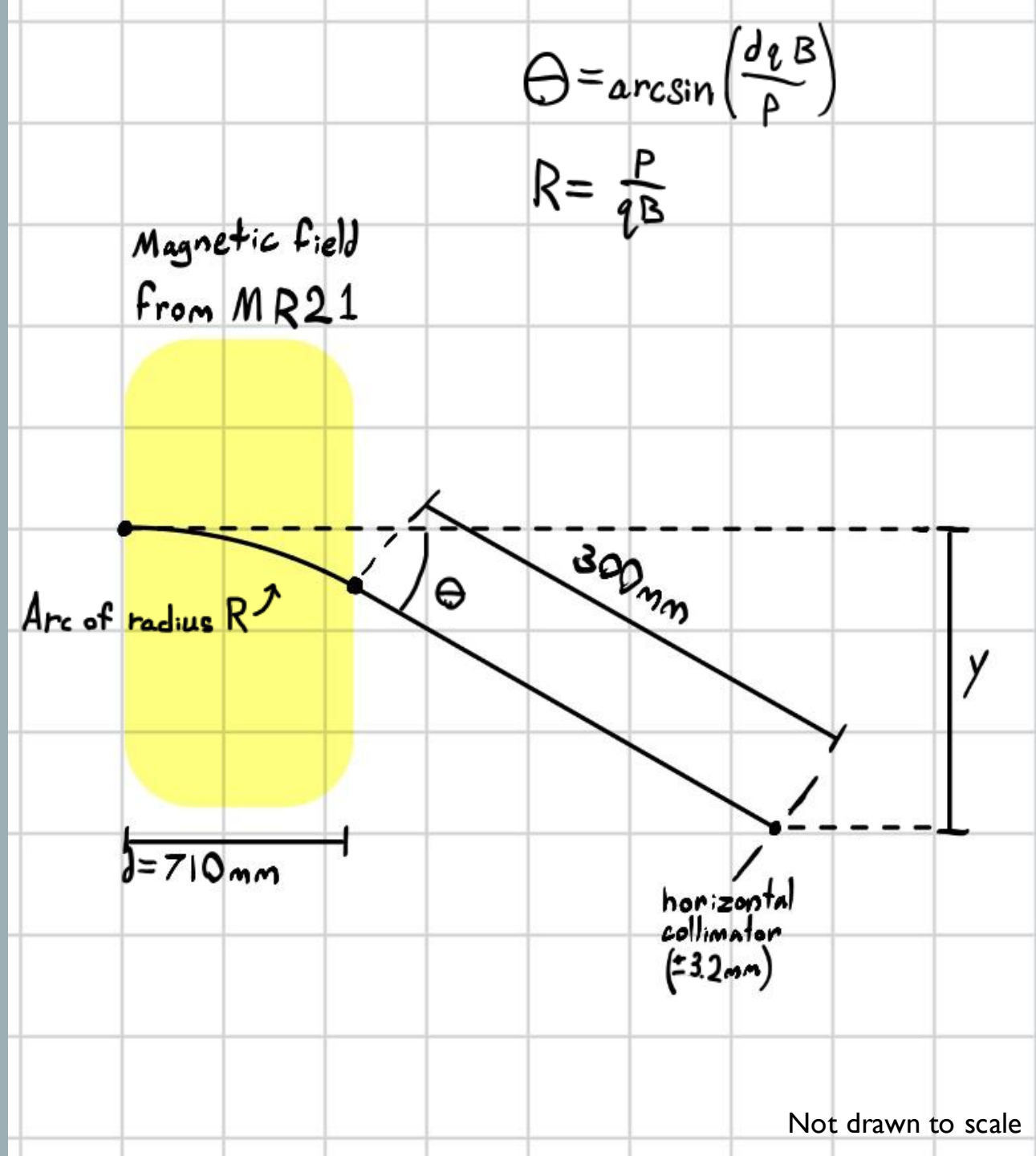
- In NIM A922, 265-286 Δp was quoted to be 158MeV/c with a collimator width of 6.4mm for all momenta in TB21.
- Test this using simple beam optics analysis.
- I_{max} and $B(I_{max})$ are given for magnets. $I \propto B$, so this is used to determine B at given I.
- The design momentum, p, is chosen by fixing B. While holding B constant, we scan p to determine what p values will pass through the collimator.
- While the quoted Δp is consistent for p = 1 GeV, this simple analysis suggests that $\Delta p/p$, rather than Δp should be constant.


Analysis end point
Analysis start point
Vacuum chambers (245 inØ)
Converter target
MR21
32 mrad
Collimator hor. vert.
Shutter
ca. 960
ca. 850
200
Kapton windows
Spil counter
Aluminum windows (0.5mm thick, 63mm Ø)
Vacuum chambers (DESY III, 39.8 inØ)
Converter target
MR22
32 mrad
Collimator hor. vert.
Shutter
Kapton window
Spil counter
ca. 40
ca. 1070
ca. 2500 ?
200
Vacuum chamber

TB21

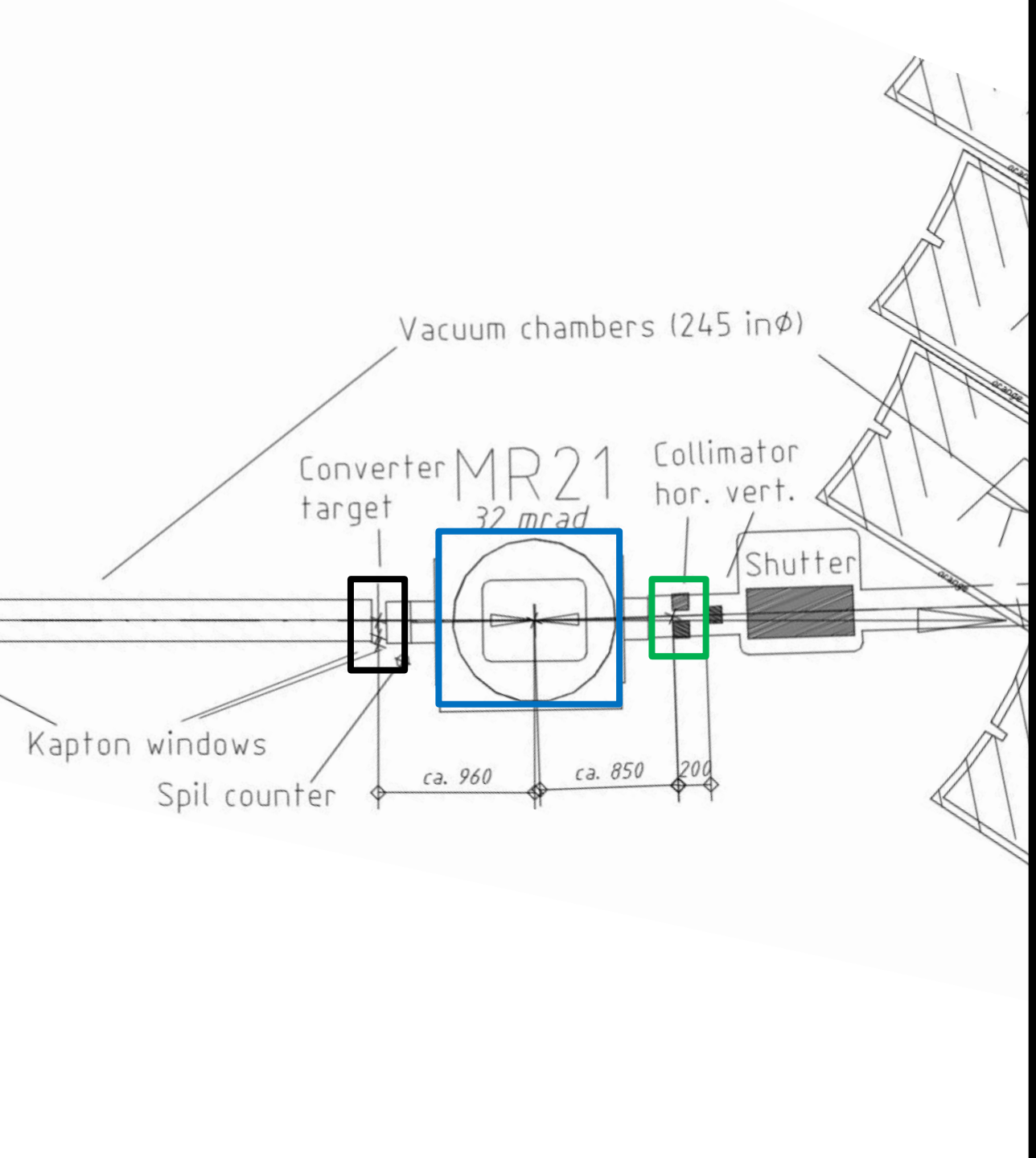
p (GeV/c)	Δp (p-1)	y (mm)	Δy (y(p)-y(1))
1.2	0.2	16.02	3.21
1.158	0.158	16.61	2.62
1	0	19.24	0

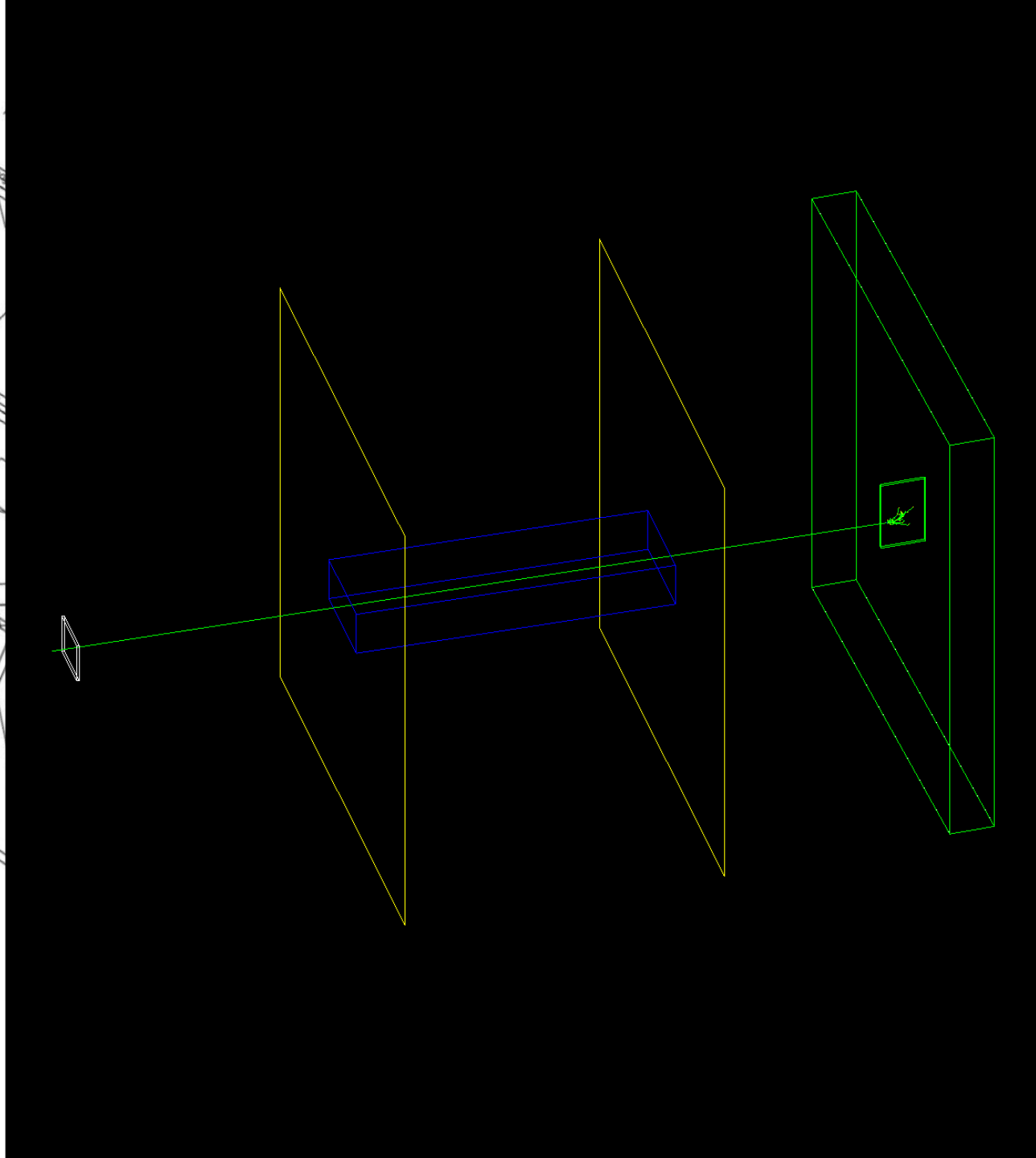
At p=1.2GeV/c, Δy is roughly 3.2mm, hitting the edge of the collimator, indicating the allowed momentum variance. This aligns with the data from NIM A922, 265-286 at 1 GeV/c



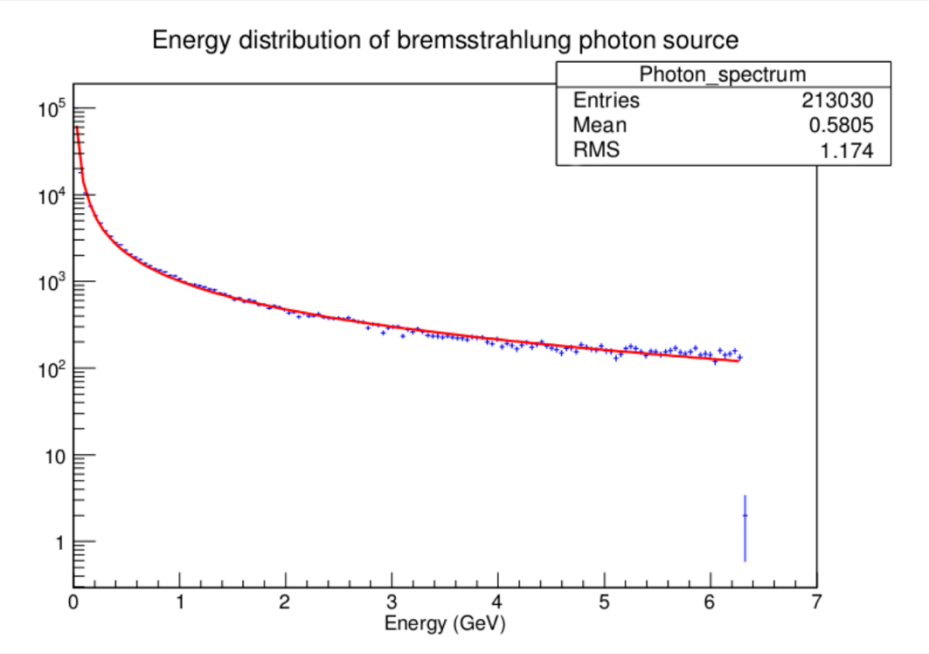
A More Advanced Simulation

- Geant4 is used to model DESY beamlines
- TB21 simulated first to see if results align with the data in NIM A922, 265-286

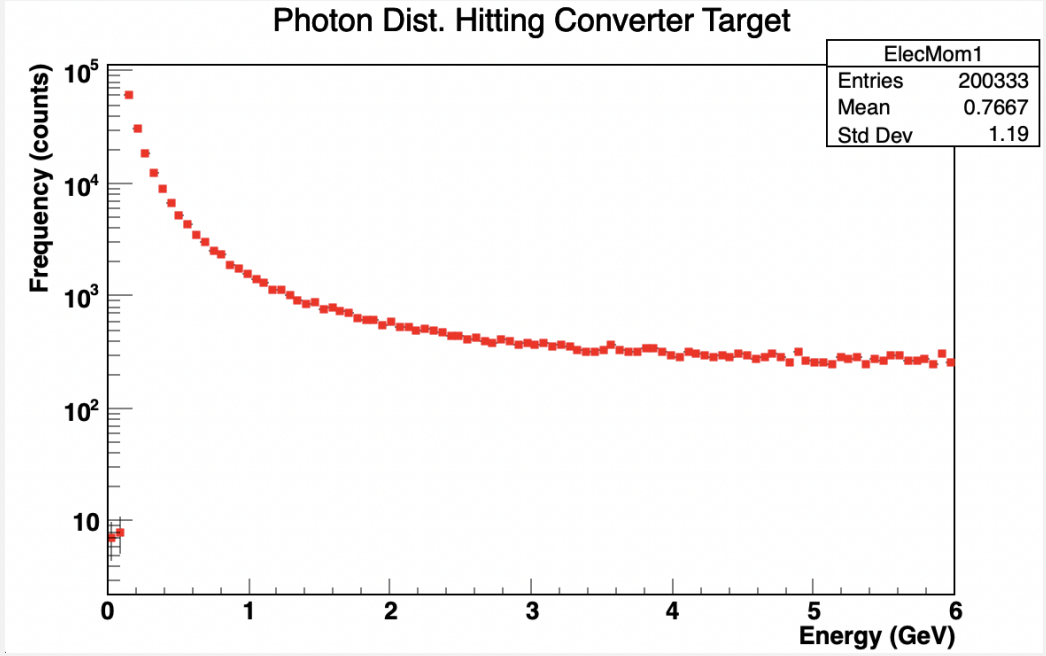

Vacuum chambers (245 inØ)
Converter target
MR21
32 mrad
Collimator hor. vert.
Shutter
Kapton windows
Spil counter
ca. 960
ca. 850
200



The Photon Distribution



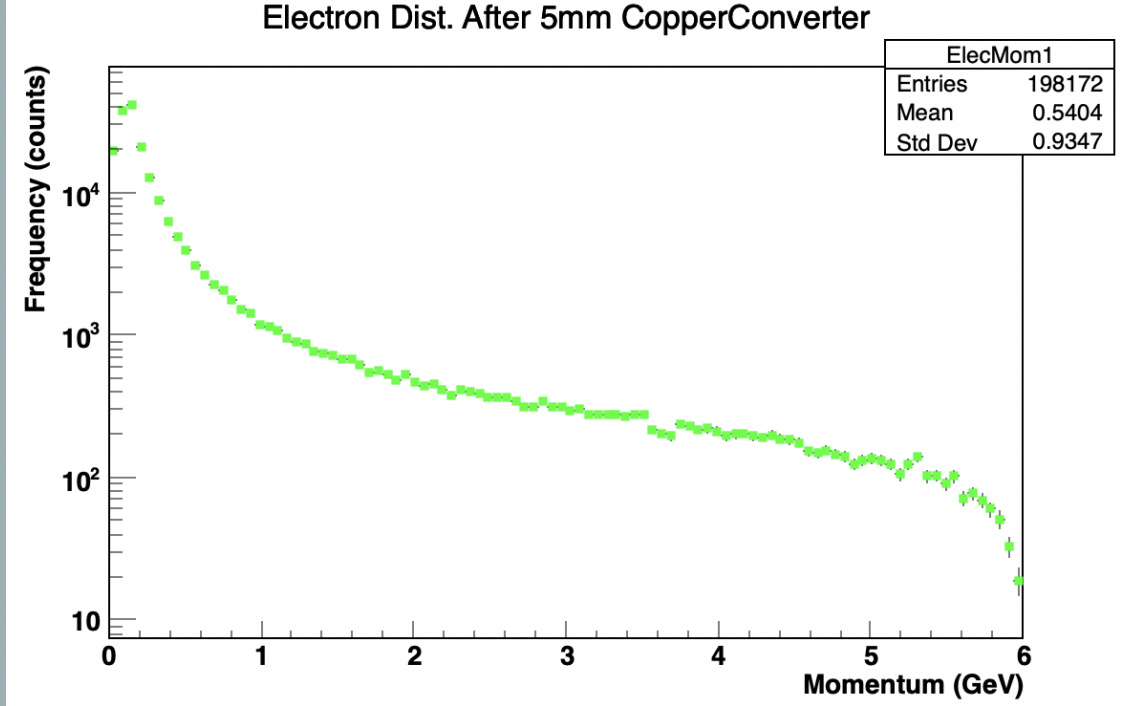
A. Schütz, Master's Thesis, KIT/DESY (2015).

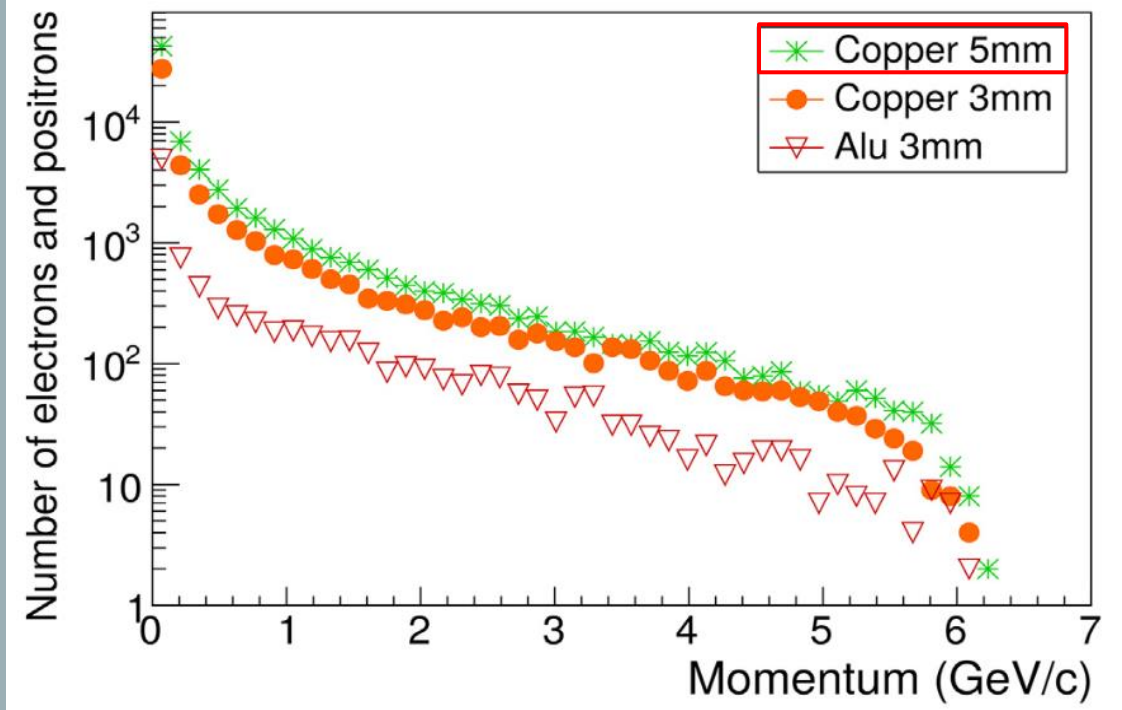


From our GEANT4 simulation.

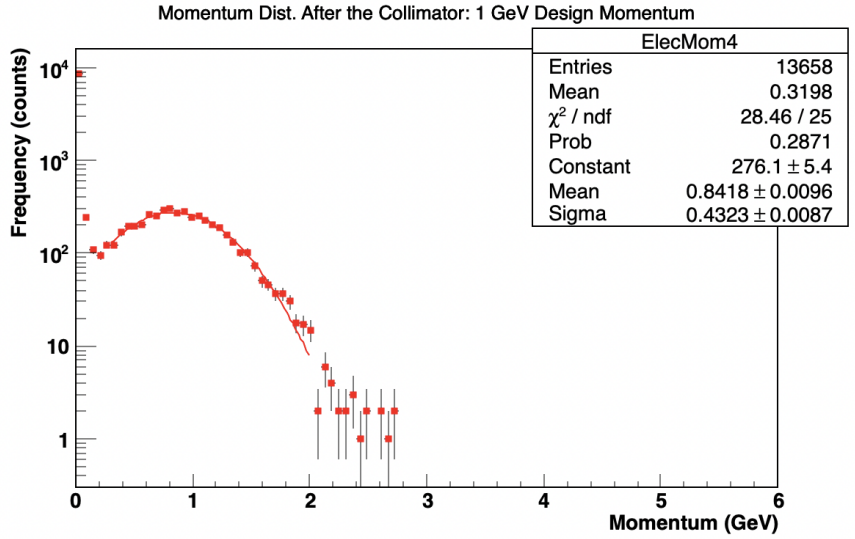
Comparison to Literature

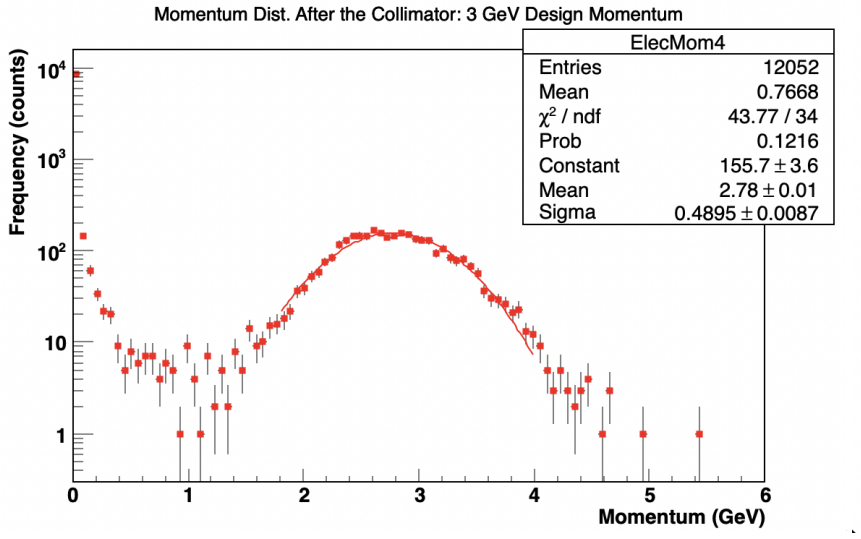
- Our simulation (top) resulted in a nearly identical e- momentum distribution to that of NIM A922, 265-286 (bottom).
- A 5mm copper plate was used in our sim – aligns with the green points in the bottom graph.

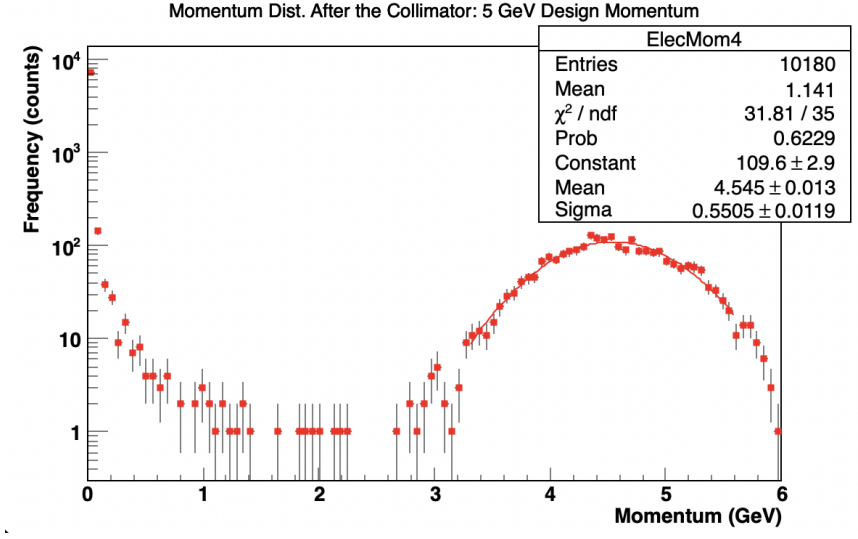


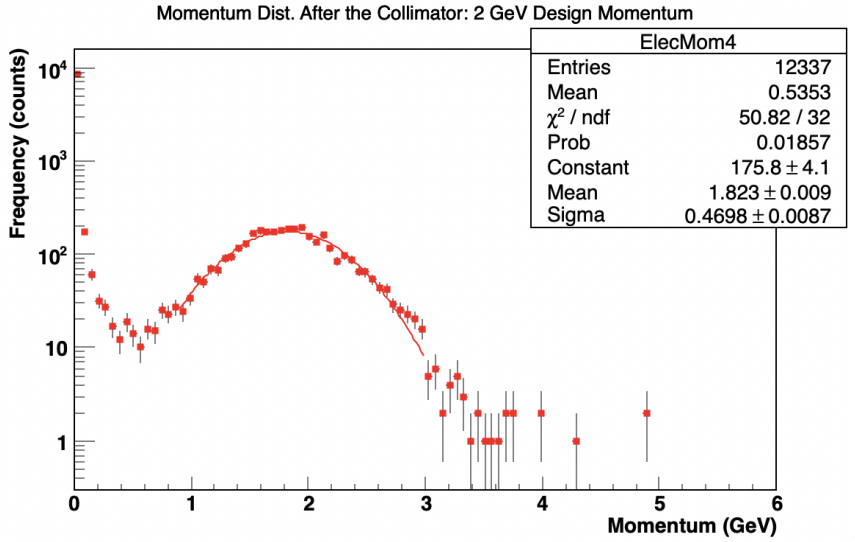


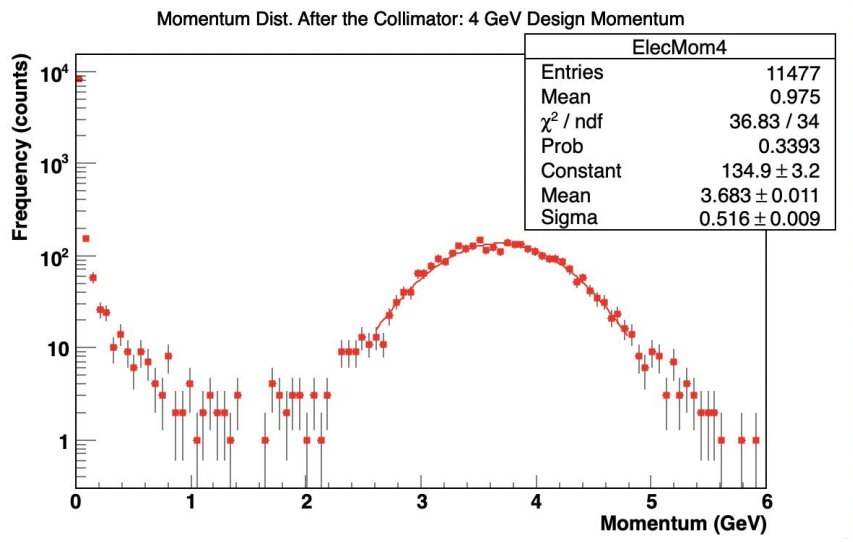
Momentum Dist. After The First Collimator

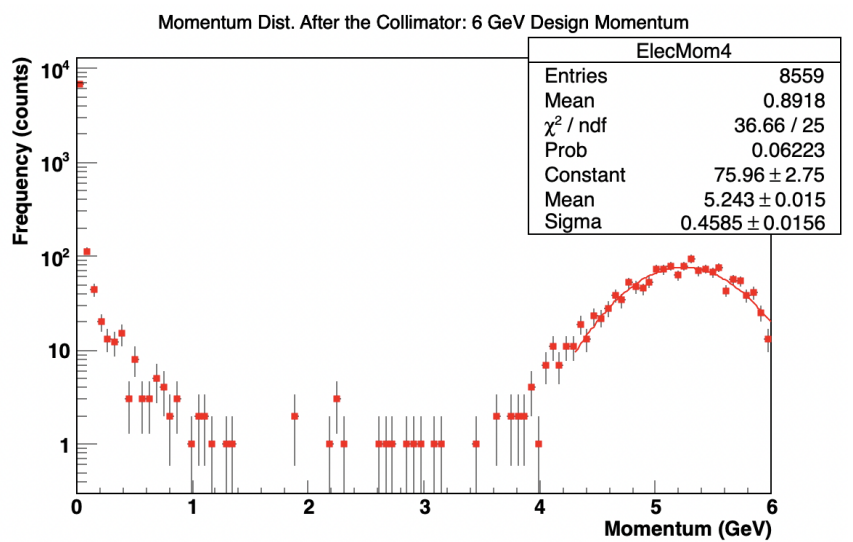












STATUS

As expected, the peak momentum of the electron distribution that passes the collimator shifts with the momentum selection by the magnetic field.

There is a low momentum peak for all B-field selections. This needs more investigation but appears to be associated with scattering from the edges of the collimator.

The gaussian fit is "ok" and the width of the distribution is constant over all momentum ranges.