Simple GEM Analysis

Shyam Chauhan and P. A. Souder

Syracuse University

Simulation Details

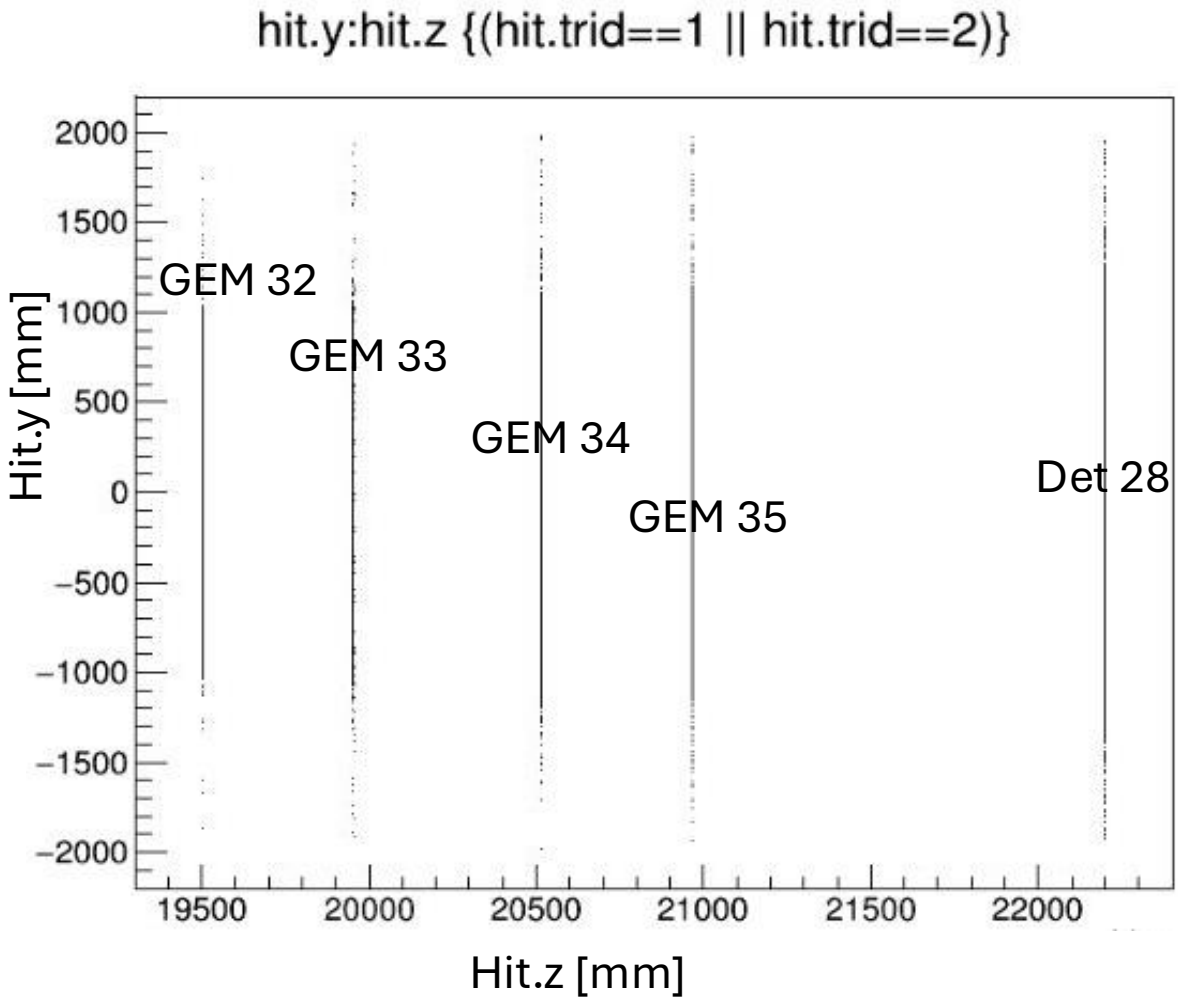
- ***Data location:***
  - */lustre24/expphy/volatile/halla/moller12gev/ktevans1/Pass5_LH2_sieveOUT_moller_4M_09222025.root*
  - */lustre24/expphy/volatile/halla/moller12gev/ktevans1/Pass5_Optics2_sieveOUT_elasticC12_4M_09222025.root*
- ***11 GeV ev.beamp*** *: Beam momentum magnitude at primary vertex*
- ***4 million Events***

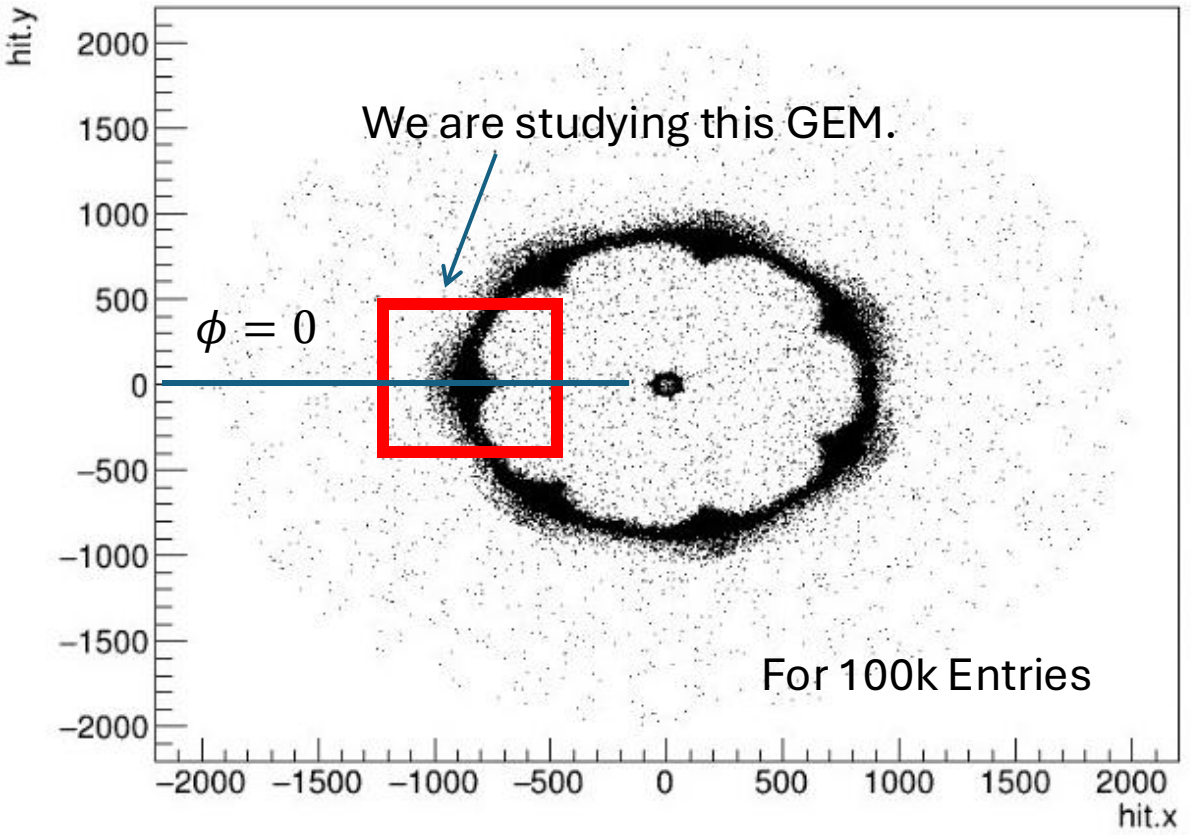
Thanks to **David Armstrong** and **Kate Evans** for providing us with simulation data

https://github.com/JeffersonLab/remoll/blob/develop/README.variables.md

For Moller Events

- Track ID 1 and 2 are two Moller electrons generated

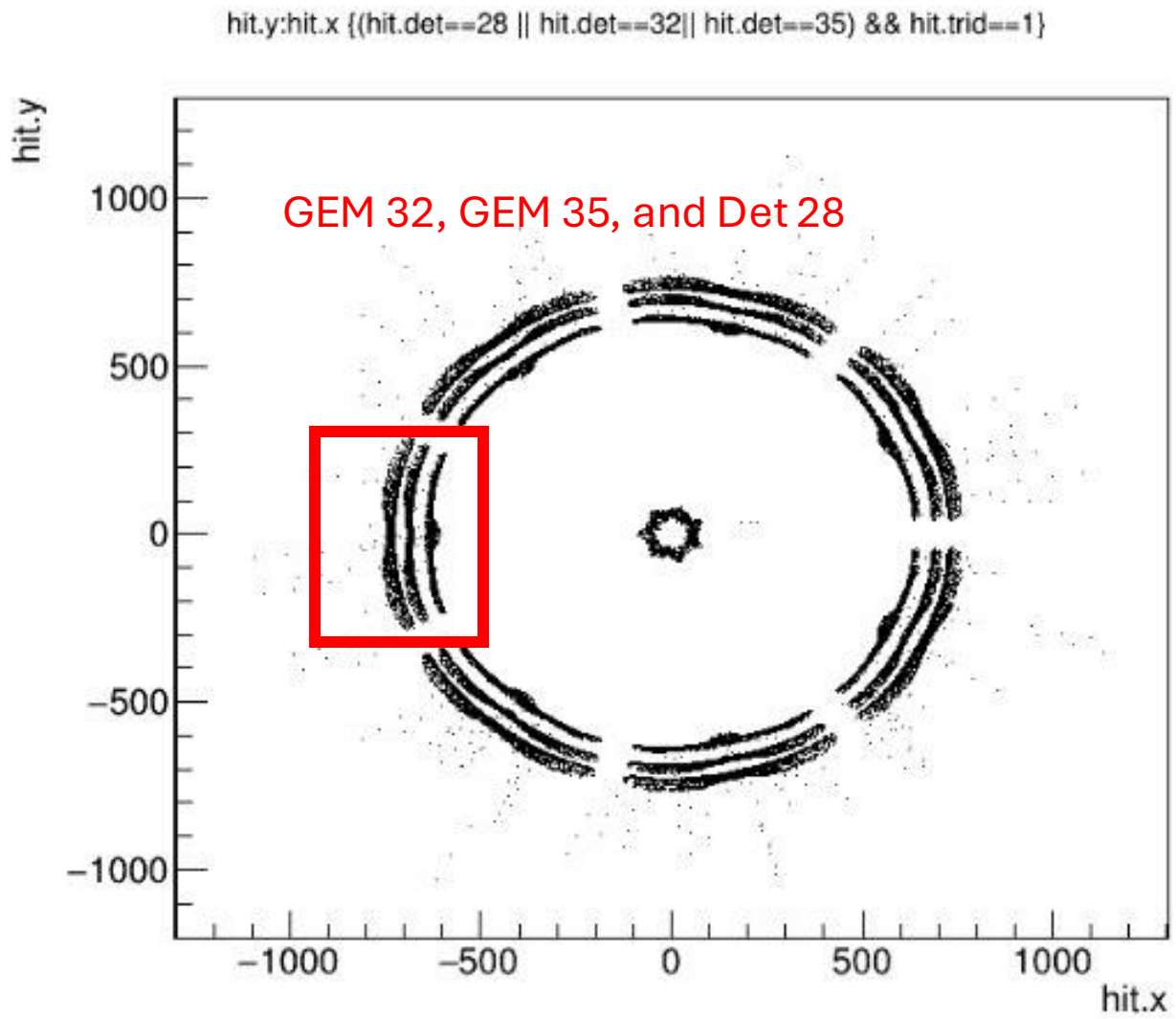




Ranges we are interested most of the times (one Septant)

Hit.x = [-1300, -500]
Hit.y = [-500, 500]

For Carbon Events



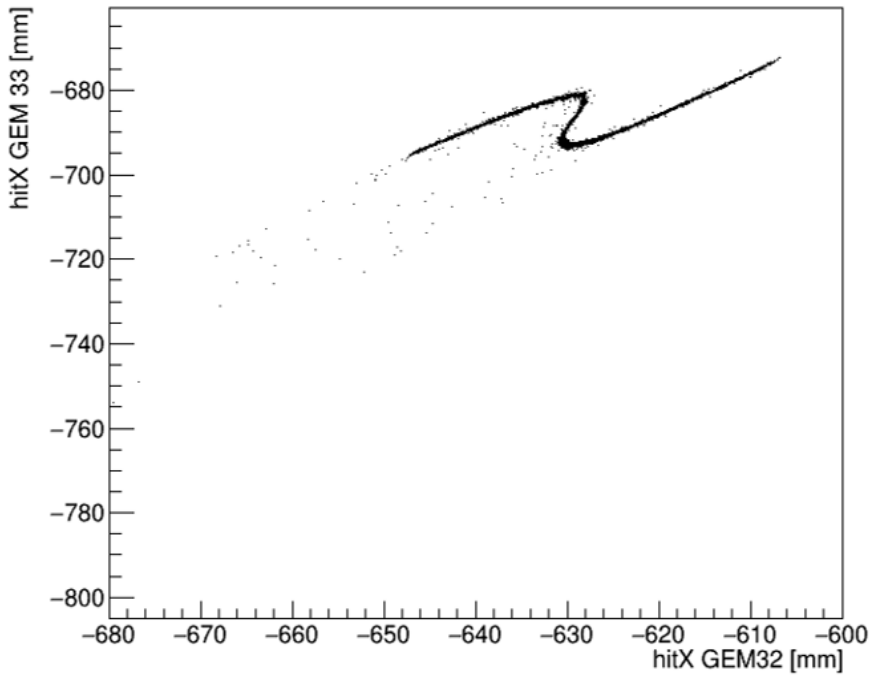
Motivation

Use GEMs hit information (e.g., x, y, z coordinates) to make plots that will tell us about the features/performance of the spectrometer like its resolution, focusing, etc.

Basic Idea: Thin Targets

- Moller and carbon events are elastic -> P=P(θ)
- Consider ϕ=0 (Y=0) events: Any two GEM X-coordinates X_i depend on θ only -> $X_i=X_i(\theta)$ -> $X_i=X_i(X_j)$. Thus elastic events plotted on a graph of X for two different GEM's fall on a curve parameterized by θ.
- The plotted function X_i(Xj) depends on the magnetic fields in the spectrometer.

GEM 33 X versus GEM 32 X for Y~0.



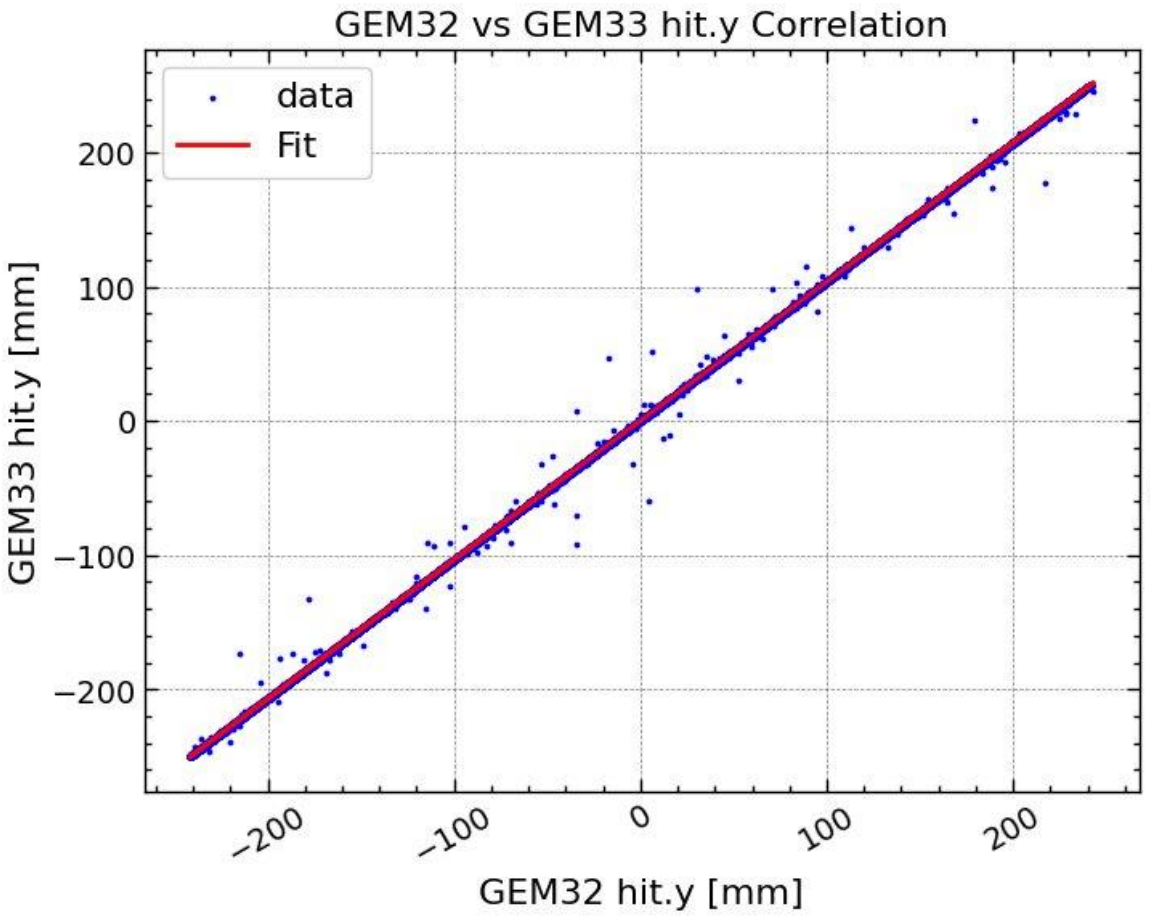
Note: X is radial (θ) direction

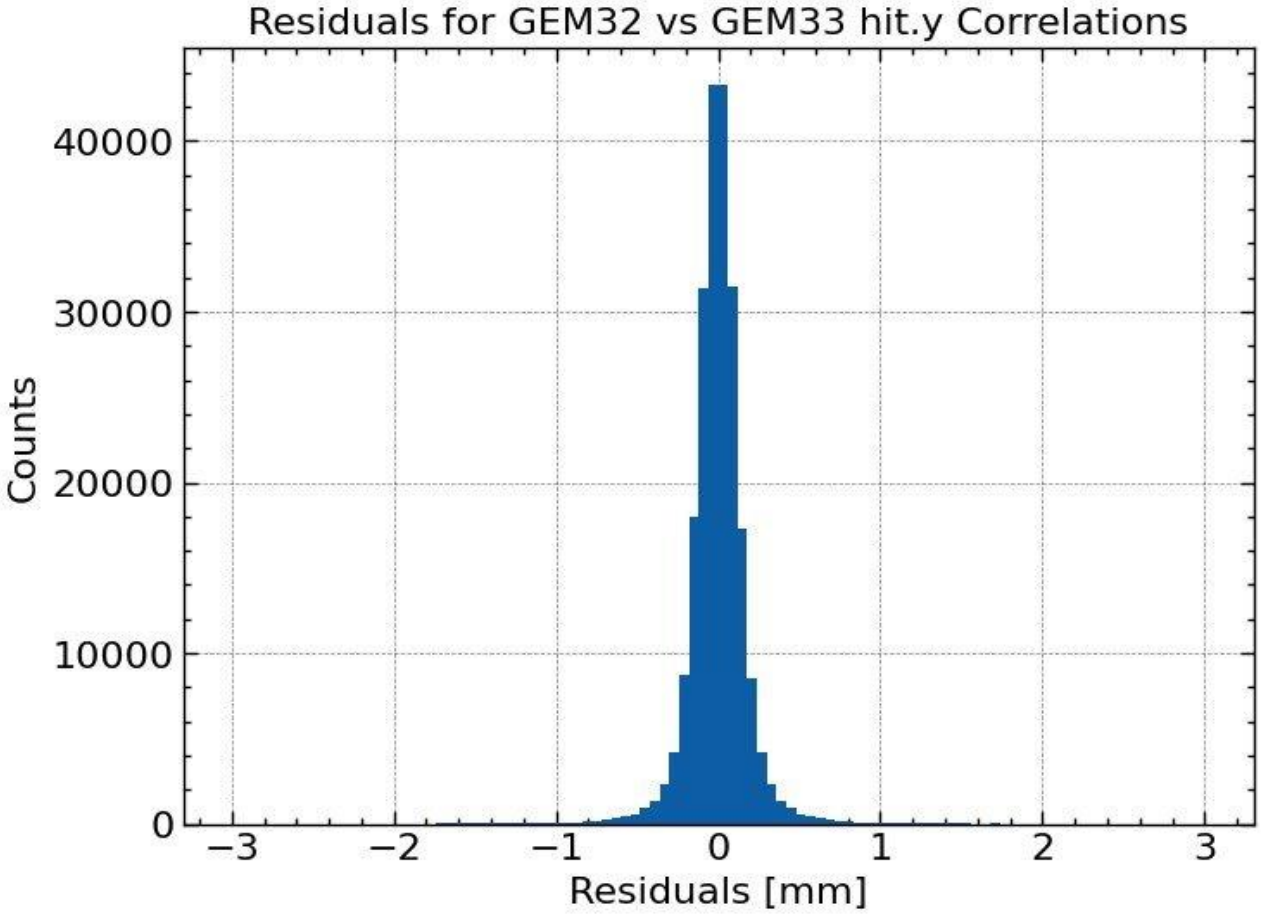
More General Analysis

- For a thin target, elastic events are defined by two parameters θ and ϕ. The momentum P is determined from kinematics.
- GEM's in the spectrometer determine three parameters, P, θ, and ϕ. (Radiative events fall off the elastic curve.)
- Thus far any 3D plot of three GEM coordinates, such as GEM 32 X and Y, and GEM 35 Y, elastic events fall on a two-dimensional surface.
- With a narrow cut on GEM 32 Y, a plot of GEM 32 X versus GEM 35 X will give a narrow curve (see later slides).

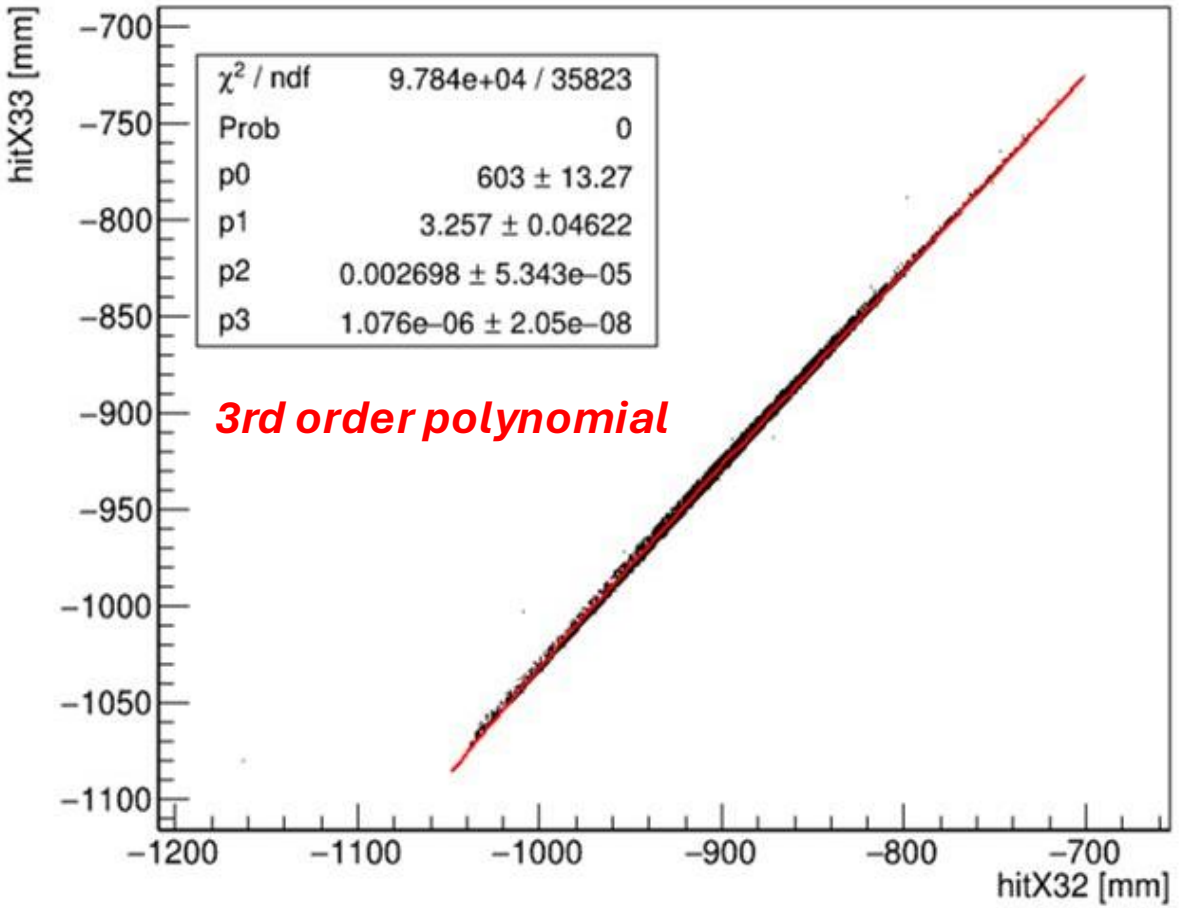
Gem 33 Y versus Gem 32 Y: Moller

Line is perfectly straight

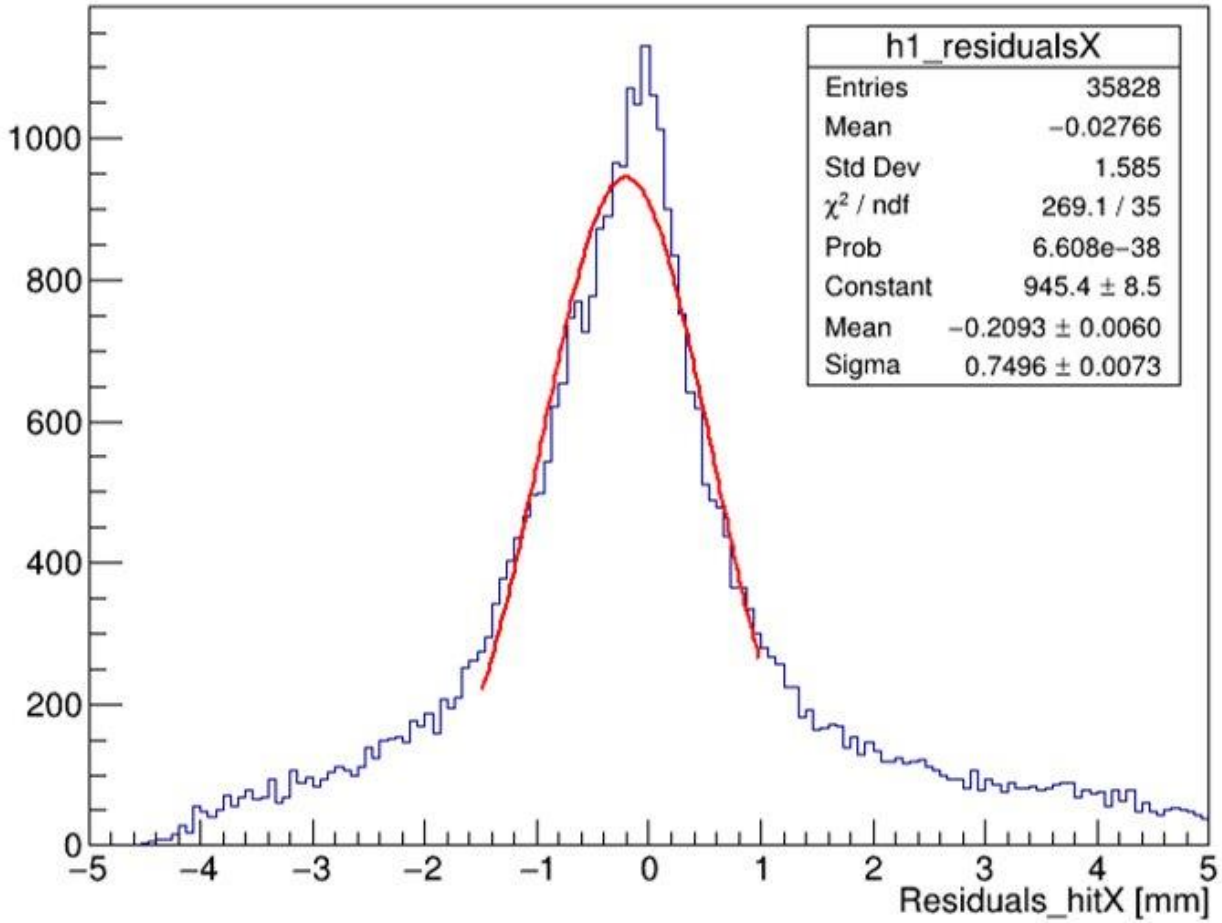




Gem 33 X versus Gem 32 X: Moller



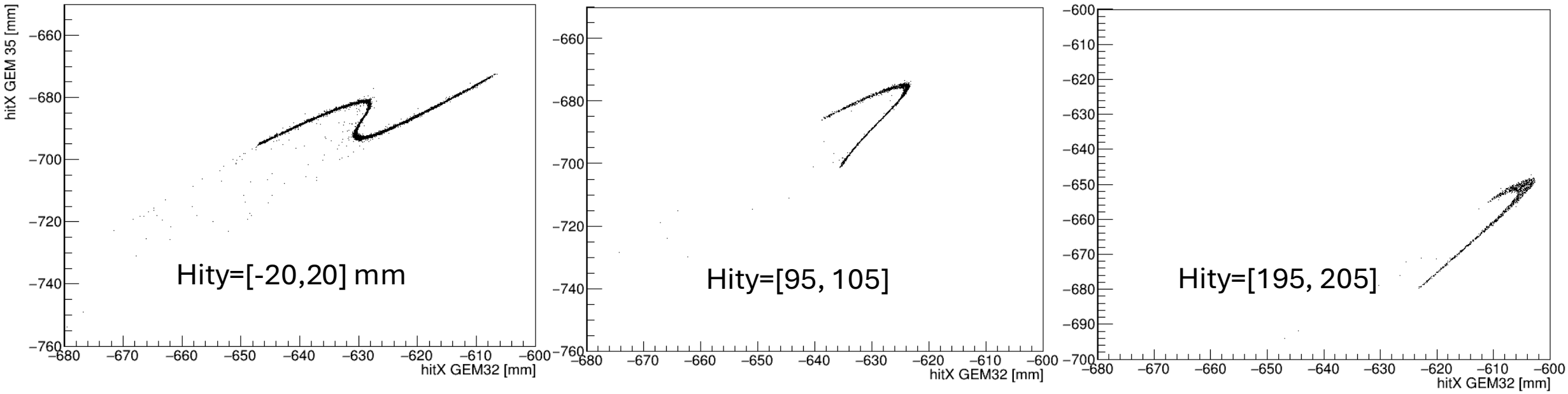
Curve is only approximately a straight line



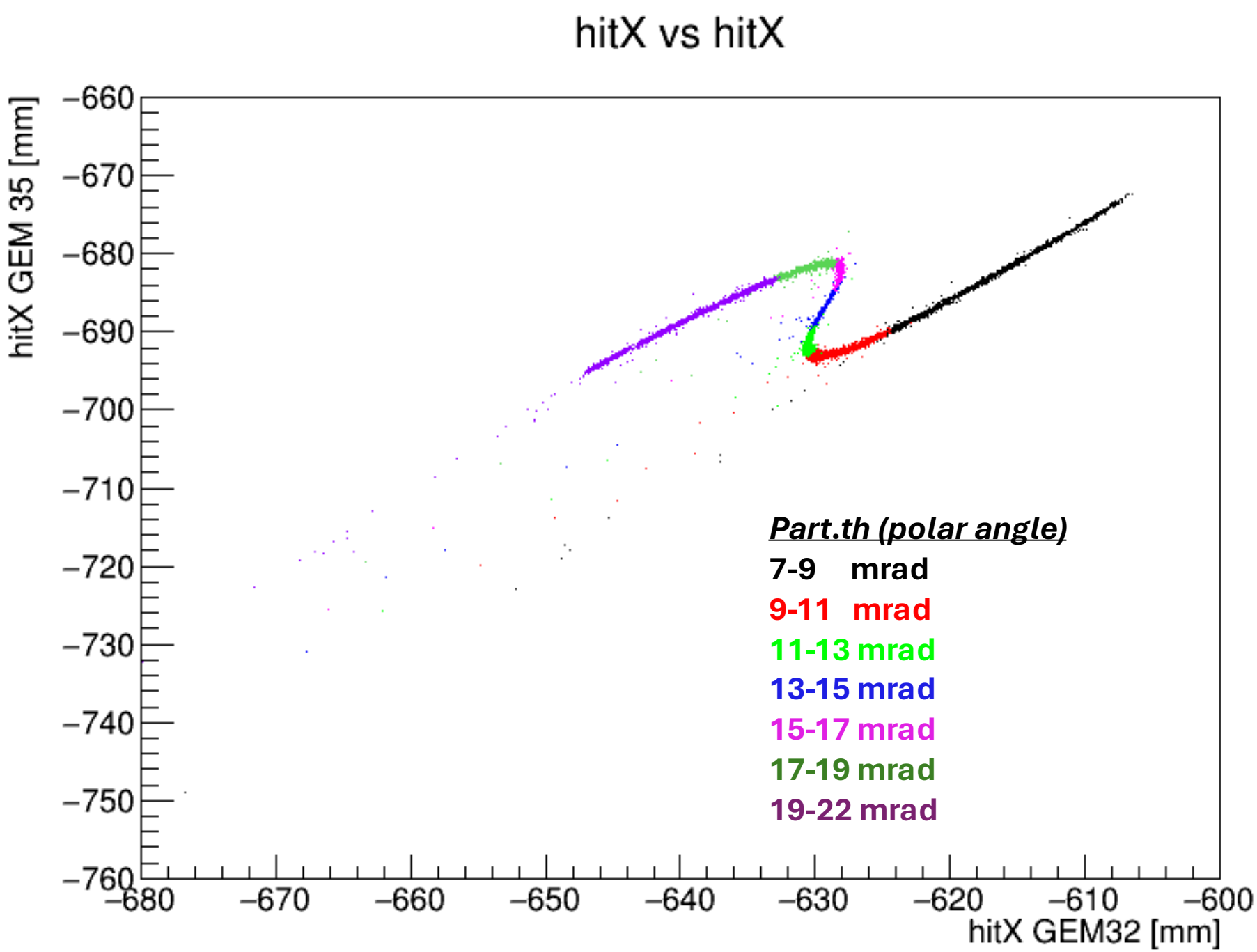
Width of line

Gem 35 X versus Gem 32 X: Carbon

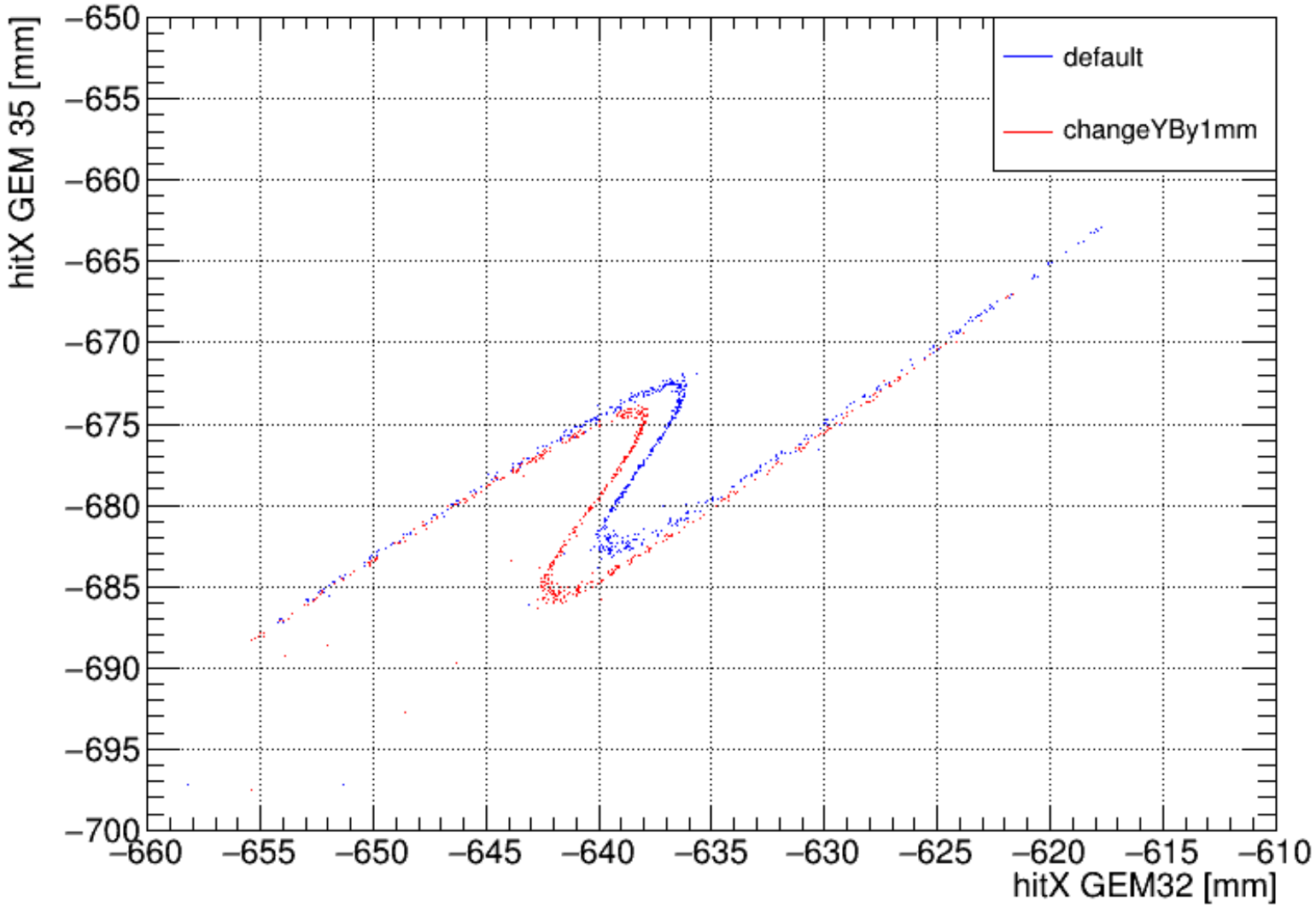
Lines are curved



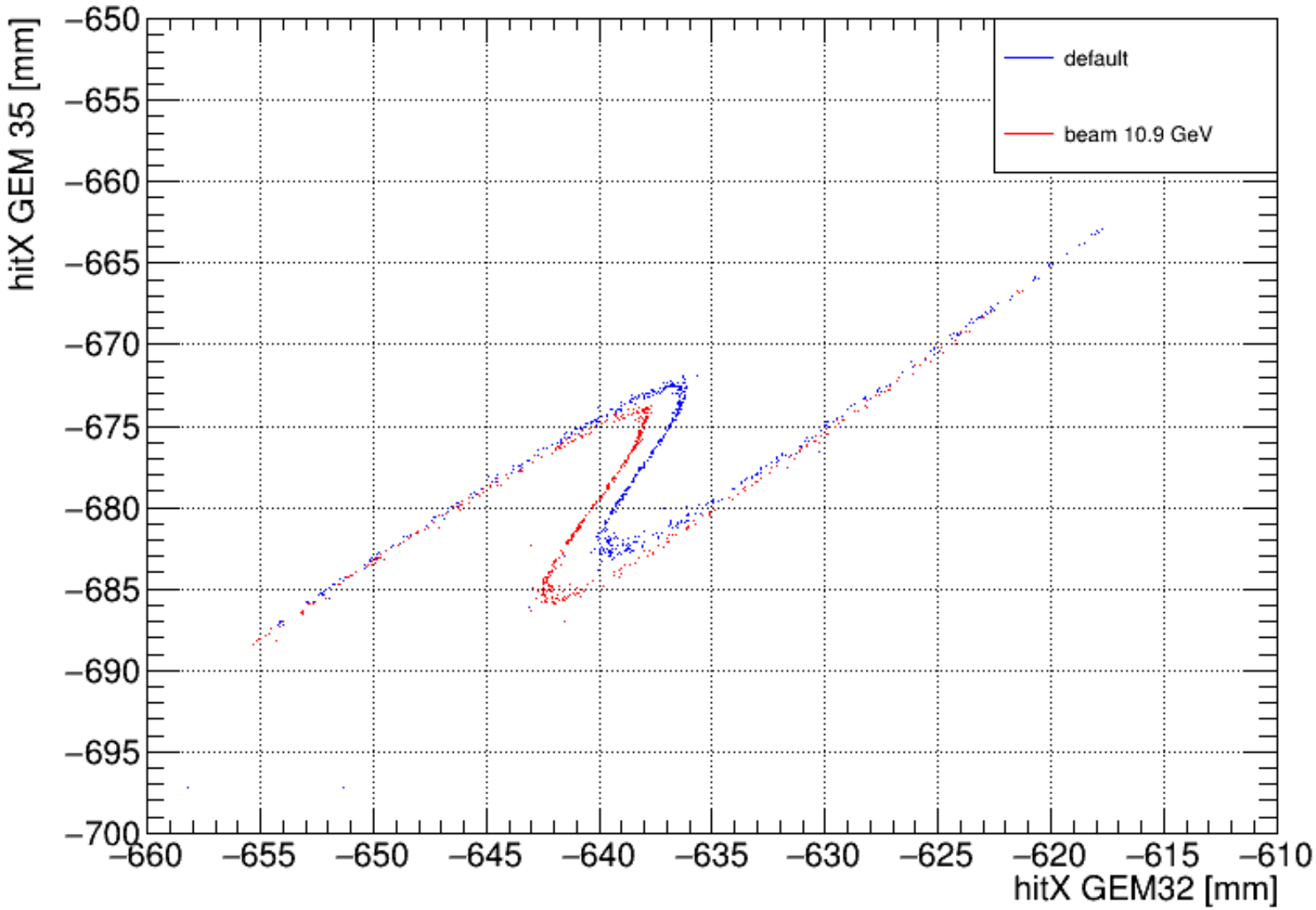
Shape of curve provides a test of focusing properties of MØLLER spectrometer


hitX vs hitX
hitX GEM 35 [mm]
−660
−670
−680
−690
−700
−710
−720
−730
−740
−750
−760
−680
−670
−660
−650
−640
−630
−620
−610
−600
hitX GEM32 [mm]
Part.th (polar angle)
7-9 mrad
9-11 mrad
11-13 mrad
13-15 mrad
15-17 mrad
17-19 mrad
19-22 mrad

HitX by HitX Plot: Changing the beam Y position by 1 mm



HitX by HitX Plot: Changing the beam E 10.9 GeV



Features

- Analysis requires no alignment or calibration.
- Elastic events for tuning the GEM parameters can be identified because they all lie on a thin curve. Background and radiative events lie off the curve.
- Especially for Carbon, the curves provide detailed information about the performance of the spectrometer. This can be studied at an early stage of the analysis.
- The curves should be the same for each sector.