GEM Update
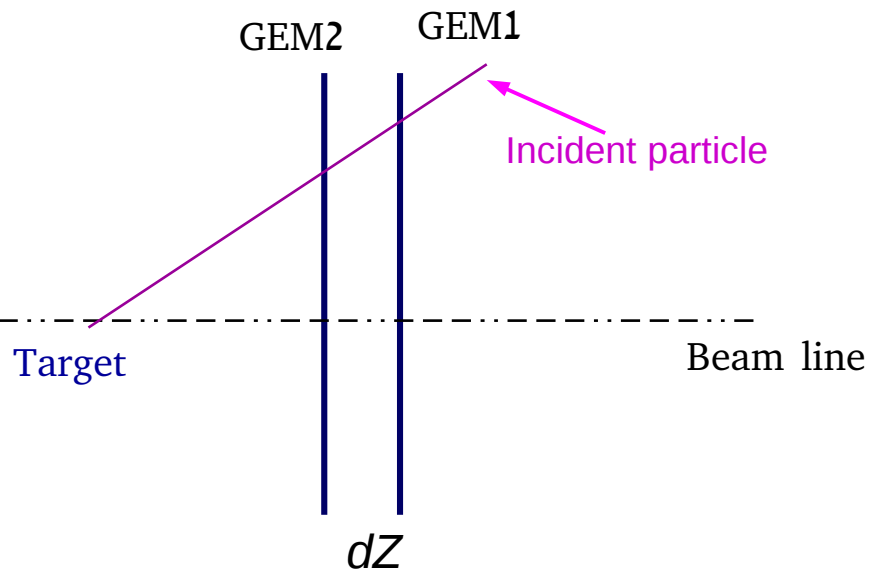
Using overlap GEM clusters to reconstruct Target Z

GEM2 GEM1

Incident particle

Target   Beam line

dZ

- To check the source of background in e-p yield
- To check the bump of e-p yield in lower scattering bin

- Using GEM overlap area e-p events
- Using two GEM clusters to find Z position

h_zvertex_ep_r from 0.60deg to 0.62deg

h_zvertex_ep_r_0.60_0.62	
Entries	1295912
Mean	-567
RMS	1838
χ^2 / ndf	1966 / 321
Constant	3827 ± 5.5
Mean	73.16 ± 1.47
Sigma	956 ± 1.7

entries

position of z vertex (mm)

h_zvertex_ep_r from 1.40deg to 1.42deg

h_zvertex_ep_r_1.40_1.42	
Entries	38184
Mean	-106.5
RMS	787.4
χ^2 / ndf	341.4 / 207
Constant	267.8 ± 1.9
Mean	13.68 ± 3.12
Sigma	465.8 ± 2.8

entries

position of z vertex (mm)
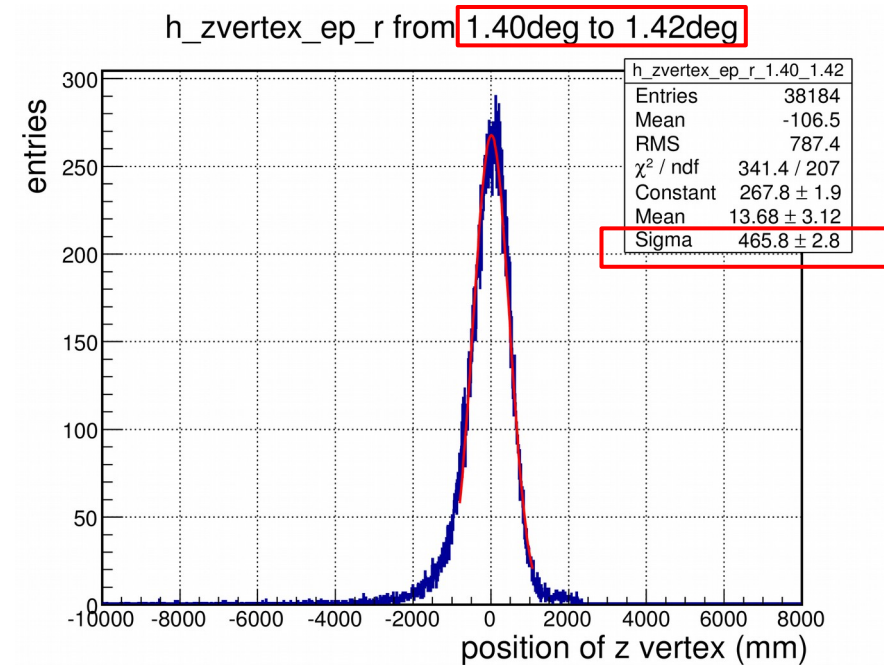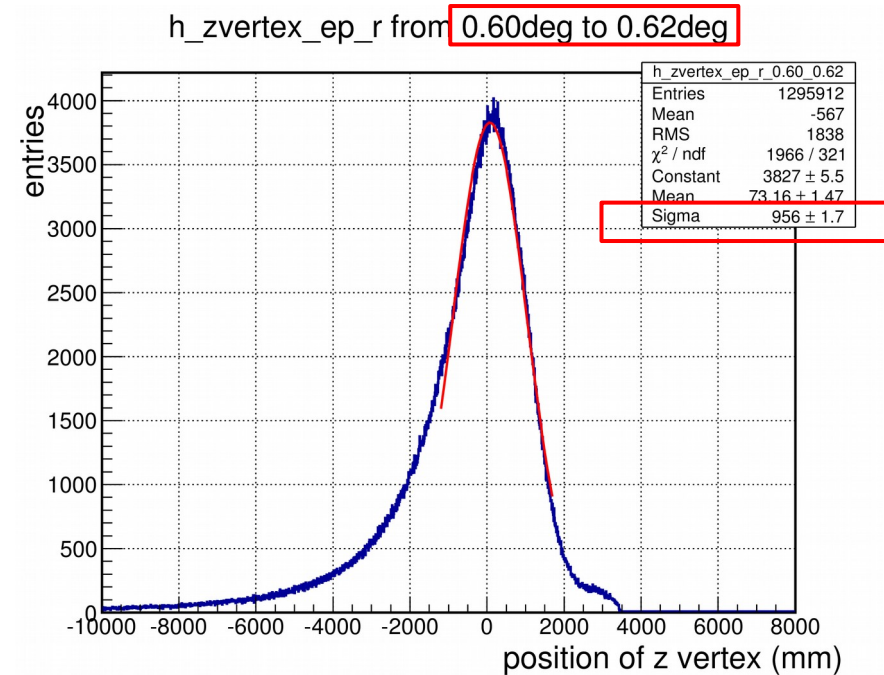
Reconstructed z vertex sigma in different angle bins

Combined 85 production runs

Very low statistic area
A few entries to several hundreds entries
~~Fitting is not reliable at all.~~
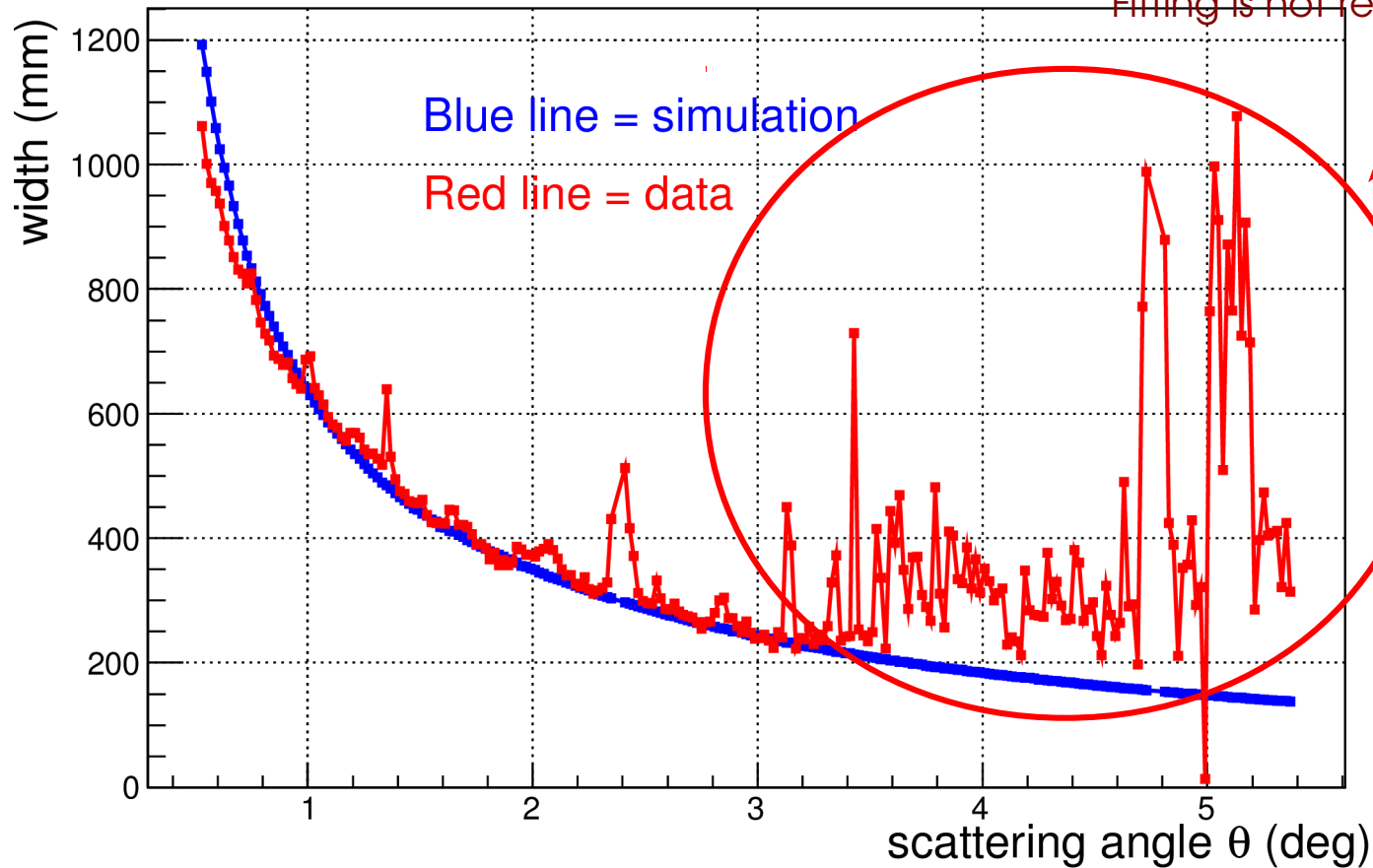
Blue line = simulation

Red line = data
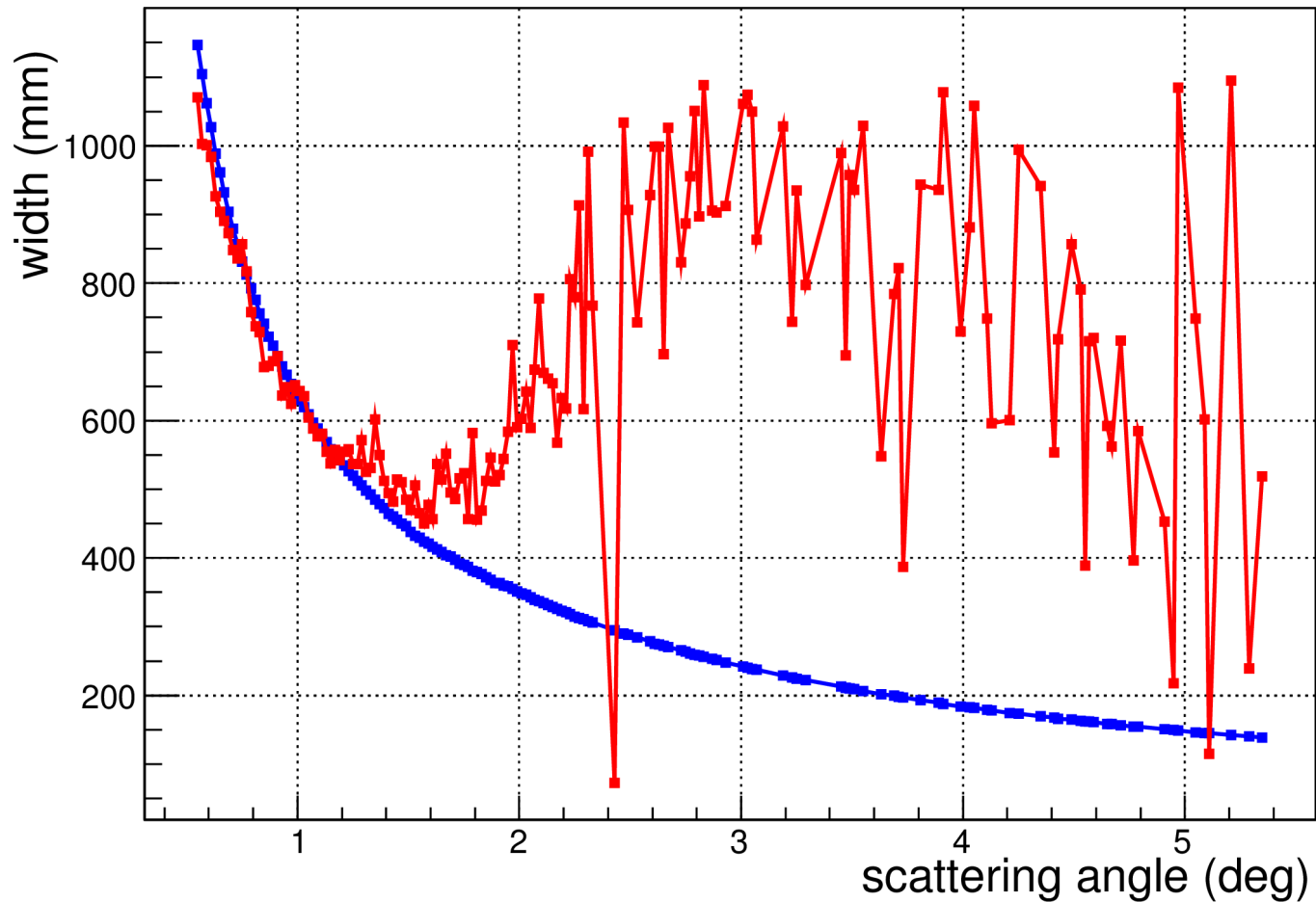
- **In simulation, suppose GEM native resolution = 70 microns**

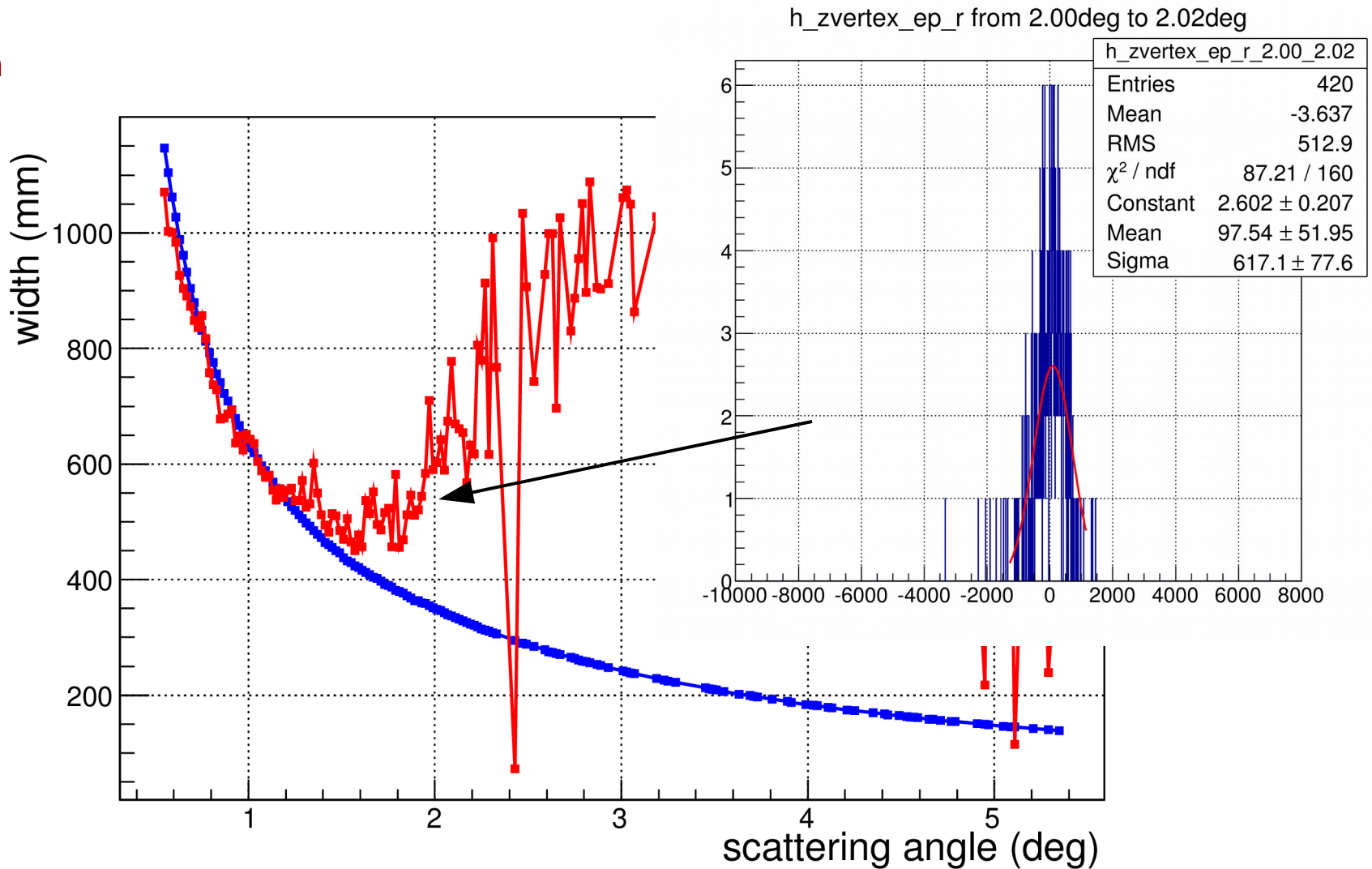# Reconstructed z vertex sigma in different angle bins

¹²C foil run

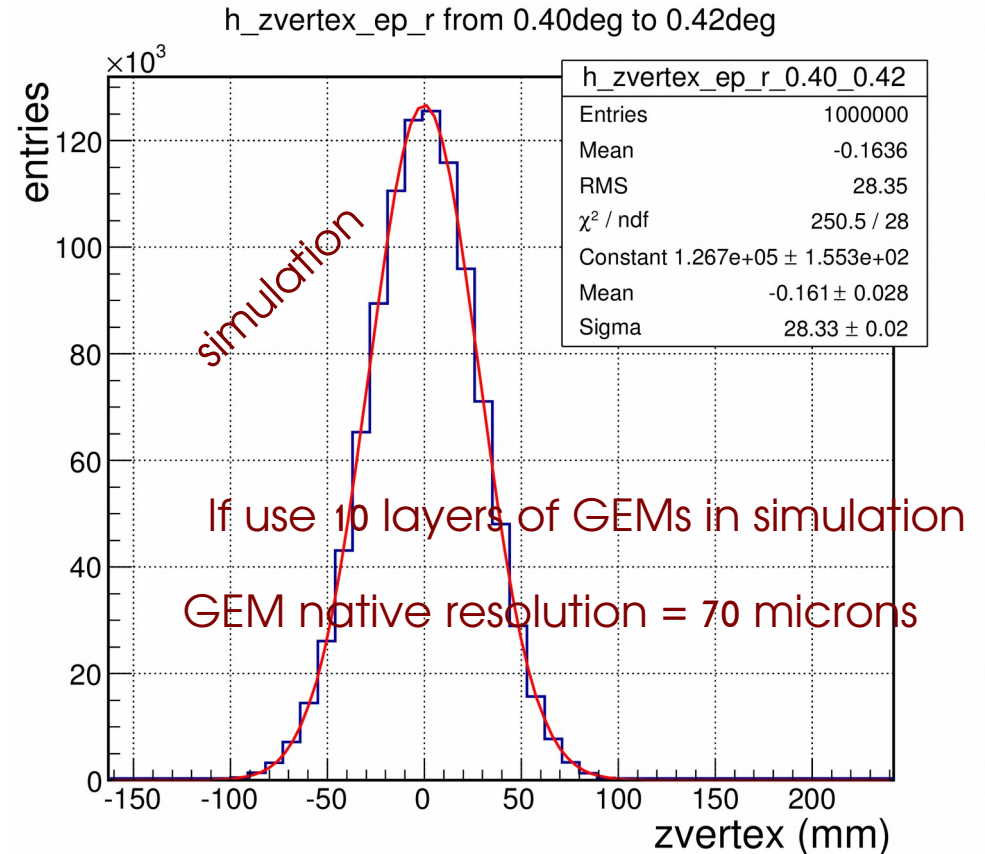- **In simulation, suppose GEM native resolution = 70 microns**

Reconstructed z vertex sigma in different angle bins

^{12}C foil run

h_zvertex_ep_r from 2.00deg to 2.02deg

h_zvertex_ep_r_2.00_2.02	
Entries	420
Mean	-3.637
RMS	512.9
χ^2 / ndf	87.21 / 160
Constant	2.602 ± 0.207
Mean	97.54 ± 51.95
Sigma	617.1 ± 77.6

width (mm)

scattering angle (deg)

- **In simulation, suppose GEM native resolution = 70 microns**

Reconstructed angle sigma in different angle bins

h_zvertex_ep_r from 0.40deg to 0.42deg

h_zvertex_ep_r_0.40_0.42	
Entries	1000000
Mean	-506.5
RMS	2200
χ^2 / ndf	3.743e+04 / 478
Constant	2521 ± 3.7
Mean	412.2 ± 1.8
Sigma	1035 ± 1.2

simulation

If use 2 layers of GEMs in simulation

GEM native resolution = 70 microns

h_zvertex_ep_r from 0.40deg to 0.42deg

h_zvertex_ep_r_0.40_0.42	
Entries	1000000
Mean	-0.1636
RMS	28.35
χ^2 / ndf	250.5 / 28
Constant	1.267e+05 ± 1.553e+02
Mean	-0.161 ± 0.028
Sigma	28.33 ± 0.02

simulation

If use 10 layers of GEMs in simulation

GEM native resolution = 70 microns

- Z vertex distribution have different sigma's in different scattering angle bin (refer to last page).
- Distance between each GEM layer = 40 mm.
- In simulation, angle was uniformly distributed between (0.4, → 0.42) degree. When use 2 layers of GEMs, the reconstructed z vertex has very wide distribution. If increase to 10 layers of GEMs, much narrower.

6

Or increase the distance between two chambers:
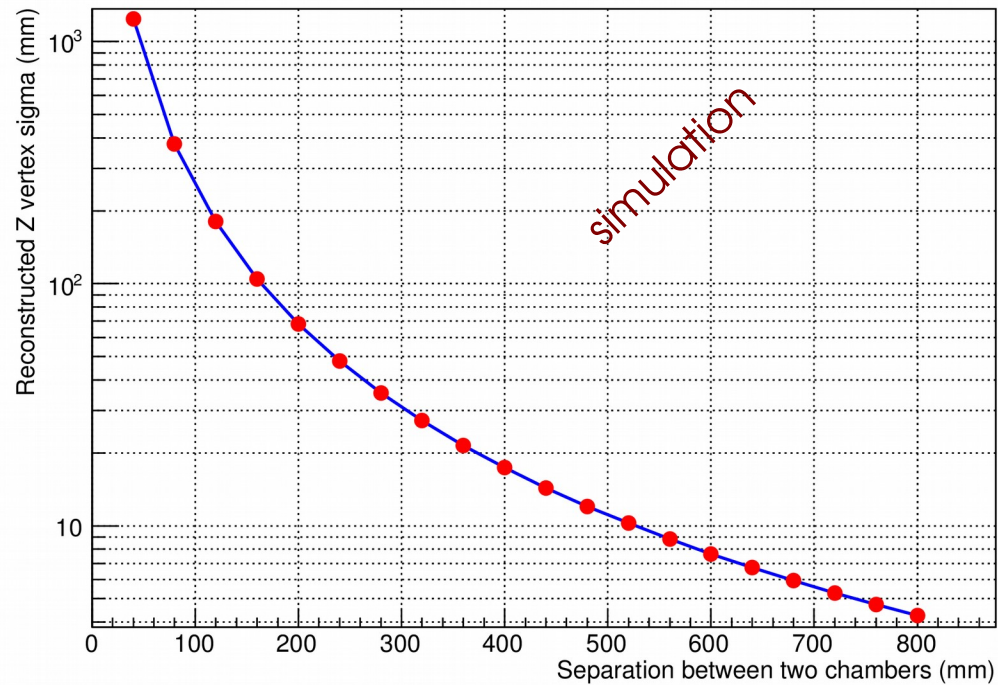
- Angle range : 0.4 – 0.42 deg (same as previous page)
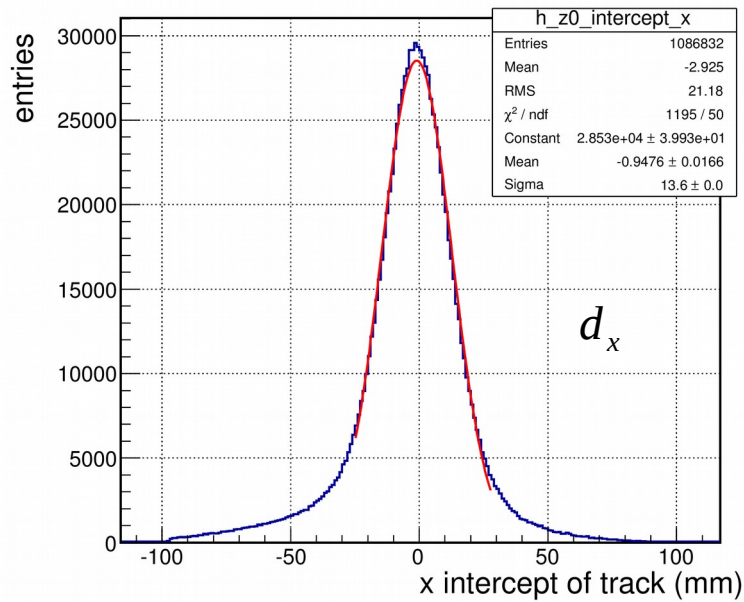- GEM native resolution = 70 microns
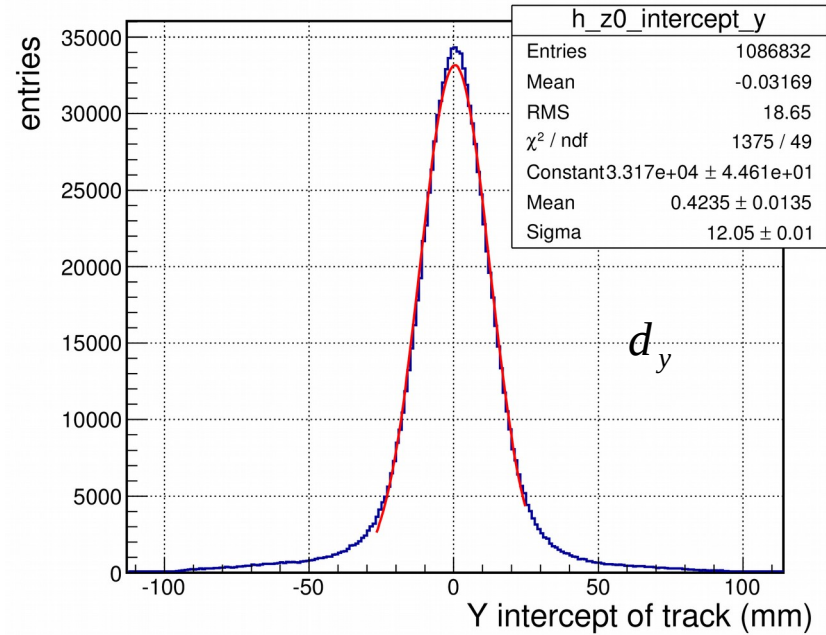
Tracks reconstructed by overlap GEMs
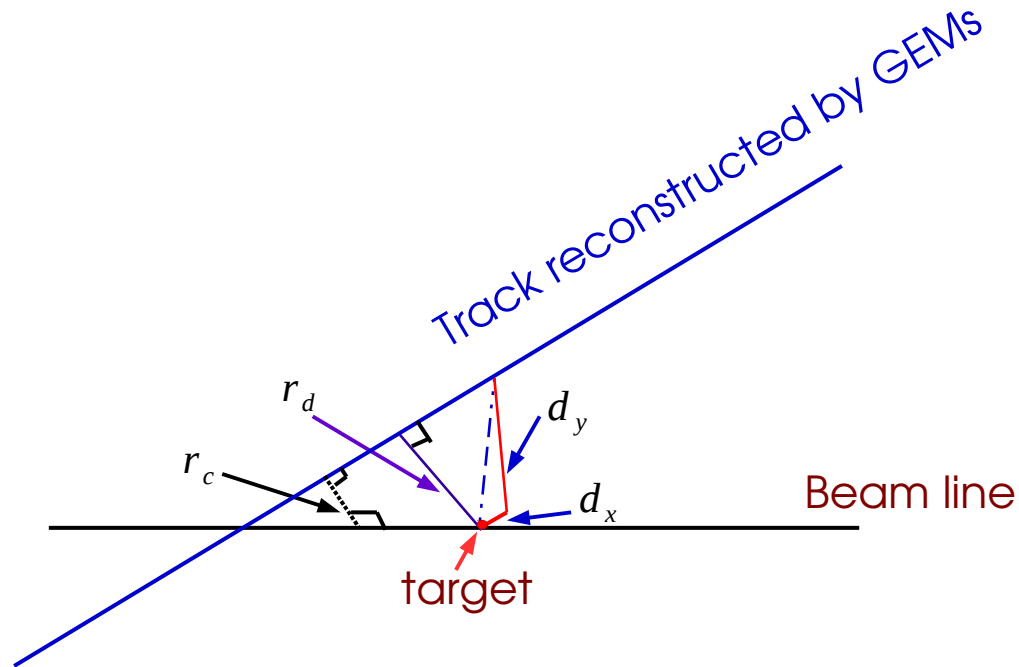
- r_c : the closest distance between beam line and track
- r_d : the distance from target to track
- d_x : X intercept of track at target (z=0)
- d_y : Y intercept of track at target (z=0)
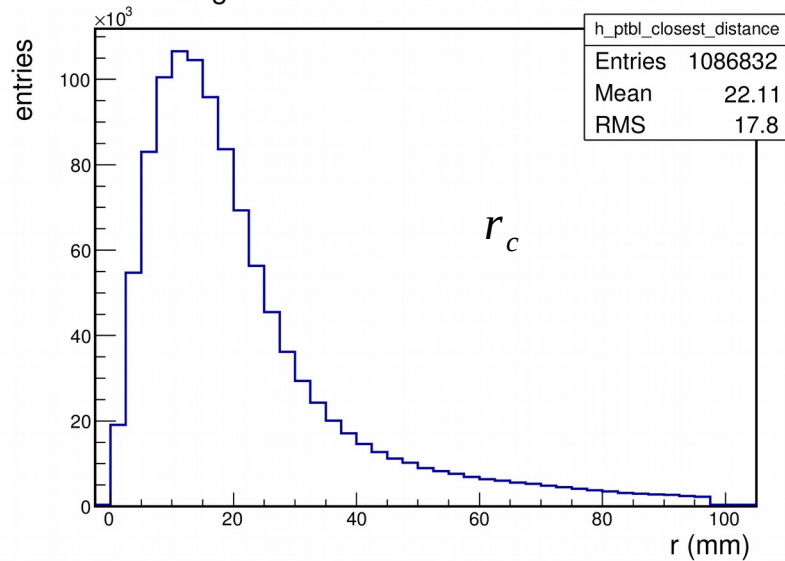
Tracks reconstructed by overlap GEMs ¹²C run

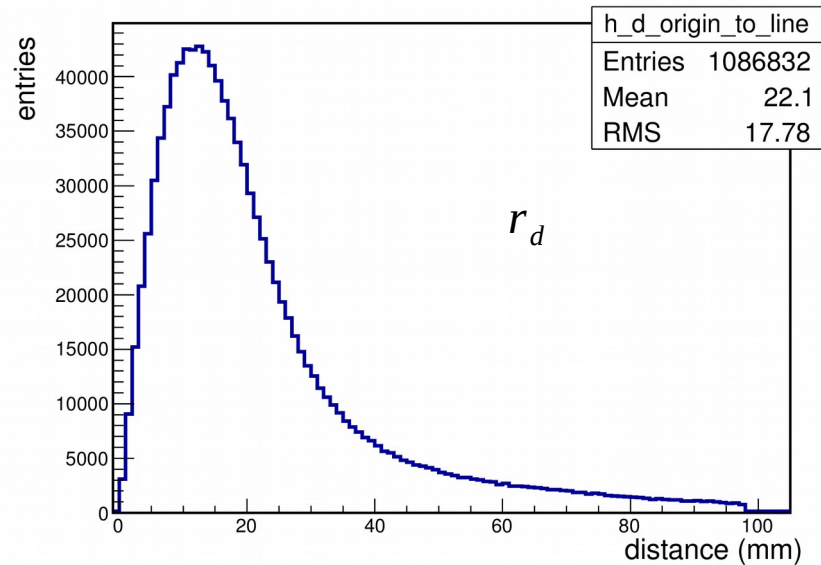### fitting line x value at z = 0 only gem

h_z0_intercept_x	
Entries	1086832
Mean	-2.925
RMS	21.18
χ^2 / ndf	1195 / 50
Constant	2.853e+04 ± 3.993e+01
Mean	-0.9476 ± 0.0166
Sigma	13.6 ± 0.0

d_x

x intercept of track (mm)

fitting line y value at z = 0 only gem

h_z0_intercept_y	
Entries	1086832
Mean	-0.03169
RMS	18.65
χ^2 / ndf	1375 / 49
Constant	3.317e+04 ± 4.461e+01
Mean	0.4235 ± 0.0135
Sigma	12.05 ± 0.01

d_y

Y intercept of track (mm)

fitting line closest distance to beam line

h_ptbl_closest_distance	
Entries	1086832
Mean	22.11
RMS	17.8

r_c

r (mm)

distance between origin and fitting line at z = 0 only gem

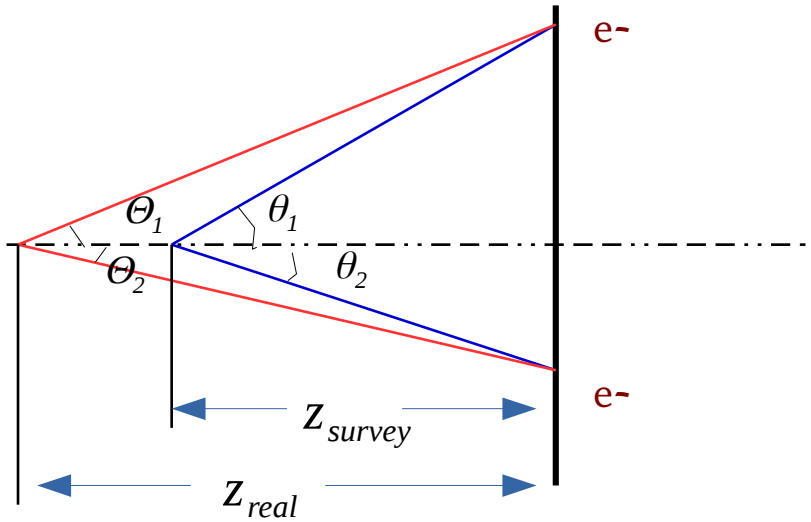| h_d_origin_to_line	
Entries	1086832
Mean	22.1
RMS	17.78

r_d

distance (mm)

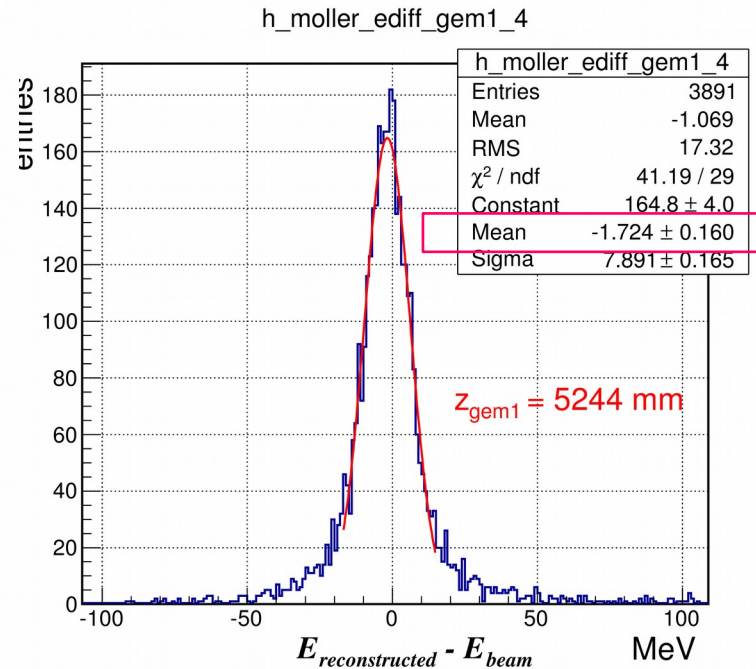# Using overlap area ee events to determine Z for each GEM

Moller events:

$$E_1 = E_1(\theta); \quad E_2 = E_2(\theta)$$

$$E_1 + E_2 = E_{beam}$$

e-

Θ_1 θ_1

Θ_2 θ_2

e-

z_{survey}

z_{real}

GEM

h_moller_ediff_gem1_2

h_moller_ediff_gem1_2	
Entries	3891
Mean	-12.92
RMS	19.43
χ^2 / ndf	48.02 / 36
Constant	144.2 ± 3.4
Mean	-13.53 ± 0.19
Sigma	9.216 ± 0.176

z_{gem1} = **5204 mm**

$E_{reconstructed}$ - E_{beam} MeV

h_moller_ediff_gem1_4

h_moller_ediff_gem1_4	
Entries	3891
Mean	-1.069
RMS	17.32
χ^2 / ndf	41.19 / 29
Constant	164.8 ± 4.0
Mean	-1.724 ± 0.160
Sigma	7.891 ± 0.165

z_{gem1} = 5244 mm

$E_{reconstructed}$ - E_{beam} MeV

2.2 GeV Carbon run

Beam energy = 2141 MeV

Blue= upstream chamber
Red= downstream chamber

1.1 GeV Carbon run

Beam energy = 1100 MeV

Blue= upstream chamber
Red= downstream chamber

$z_{gem1} = 5178.58\,mm$

$z_{gem1} = 5218.89\,mm$
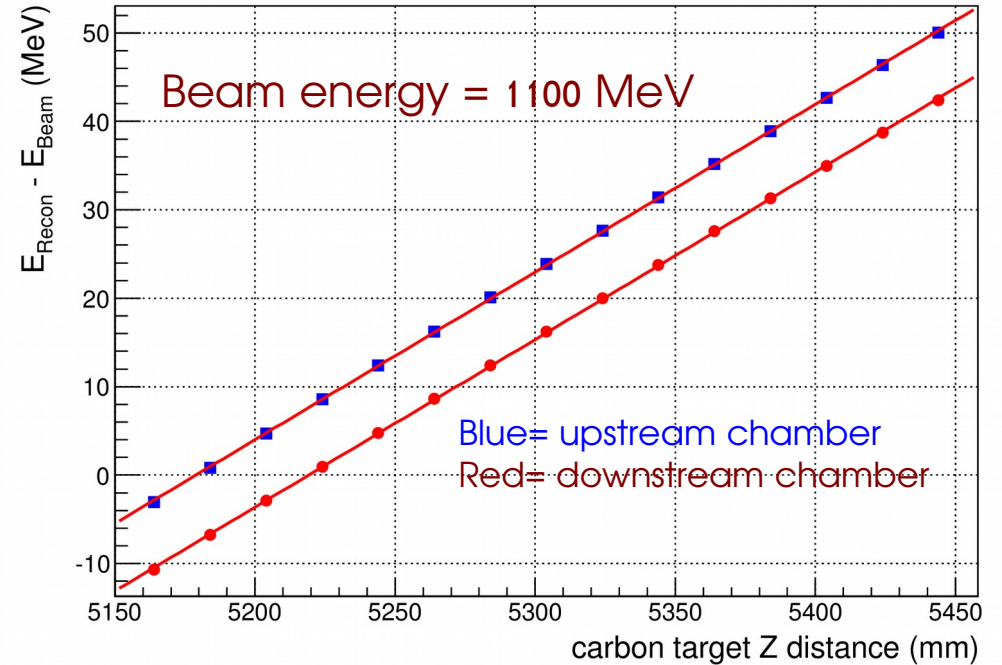
$z_{gem1} = 5178.88\,mm$

$z_{gem1} = 5219.14\,mm$

From survey: $z_{gem1} = 5264\,mm$

$z_{gem1} = 5304\,mm$

Suppose beam energy = 2100MeV

Suppose beam energy = 2212MeV
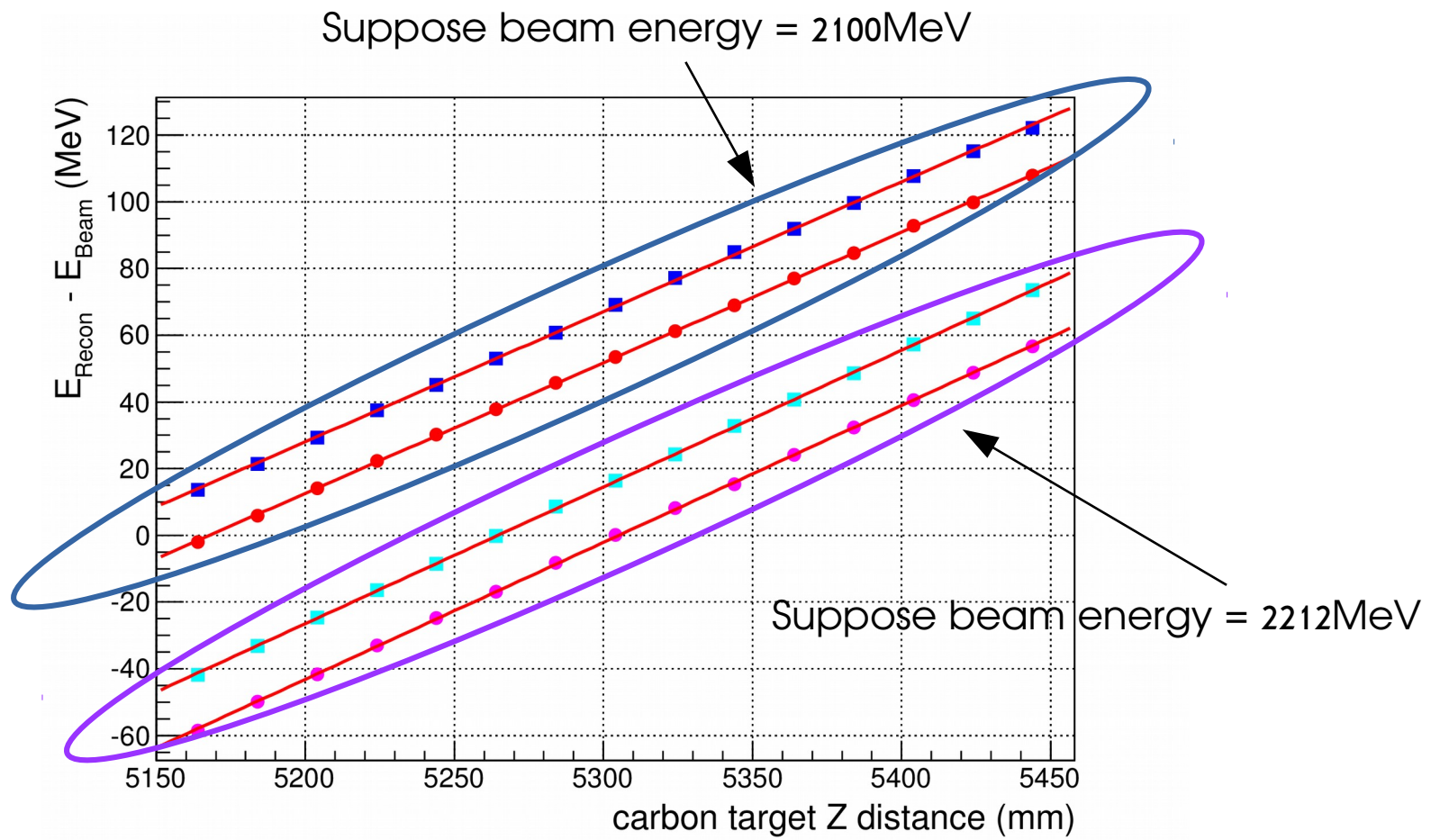
Summary

- Reconstructed Z distance is ~80mm away from Survey data.
- If use different beam energy, will reconstruct different Z distance.
- We can adjust beam energy so that we can generate a Z distance that match Survey Data.
- Or we can adjust Survey data, keep beam energy.