Dose Profiler status

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Current status

Hardware

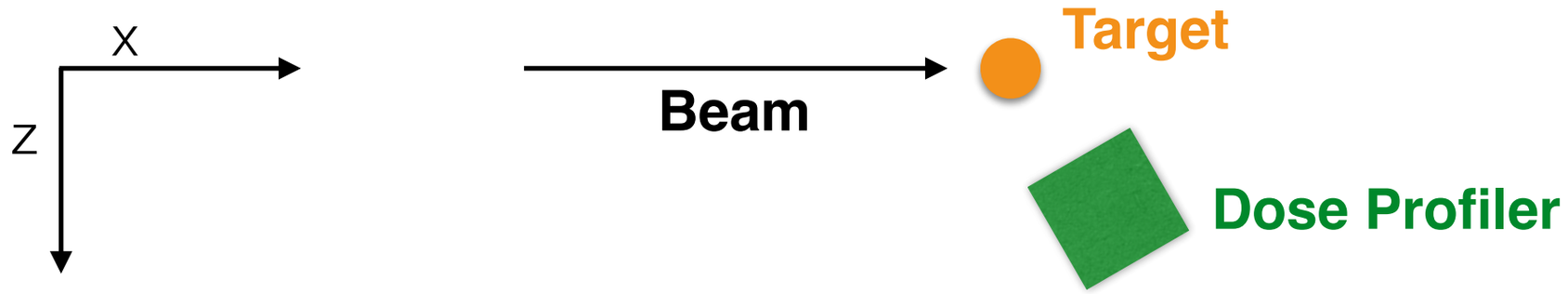
- The Dose Profiler has been disassembled to replace the thick scintillator planes with **2 additional fibres planes** (dead time and back-tracking resolution improvement).
- The new DAQ system with the **off-spill data transfer** implementation and the **dose delivery system information** integration has been developed. It has to be tested @ CNAO —-> Test beam at the end of May.
- The final **cooling system** that meets the CNAO requirements is currently under development.

Software

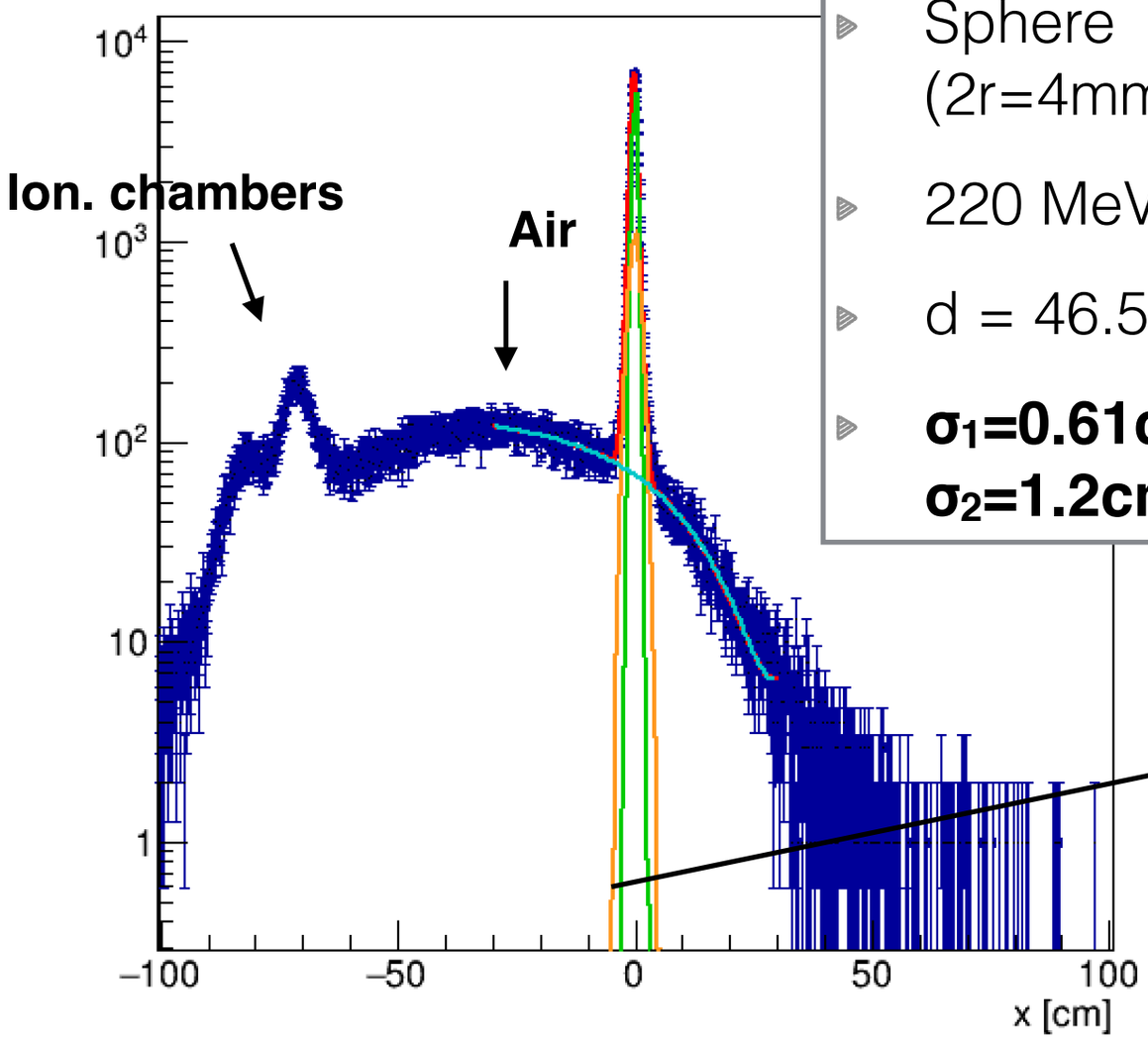
- We restart the data analysis to definitively assess the detector **backtracking resolution** (more info in the presentation)
- We are finalising the '**matter effect' study** to gain access to the secondary emission profile and study the correlation with the Bragg peak position. Two parallel studies: "weight method" and MLEM algorithm.

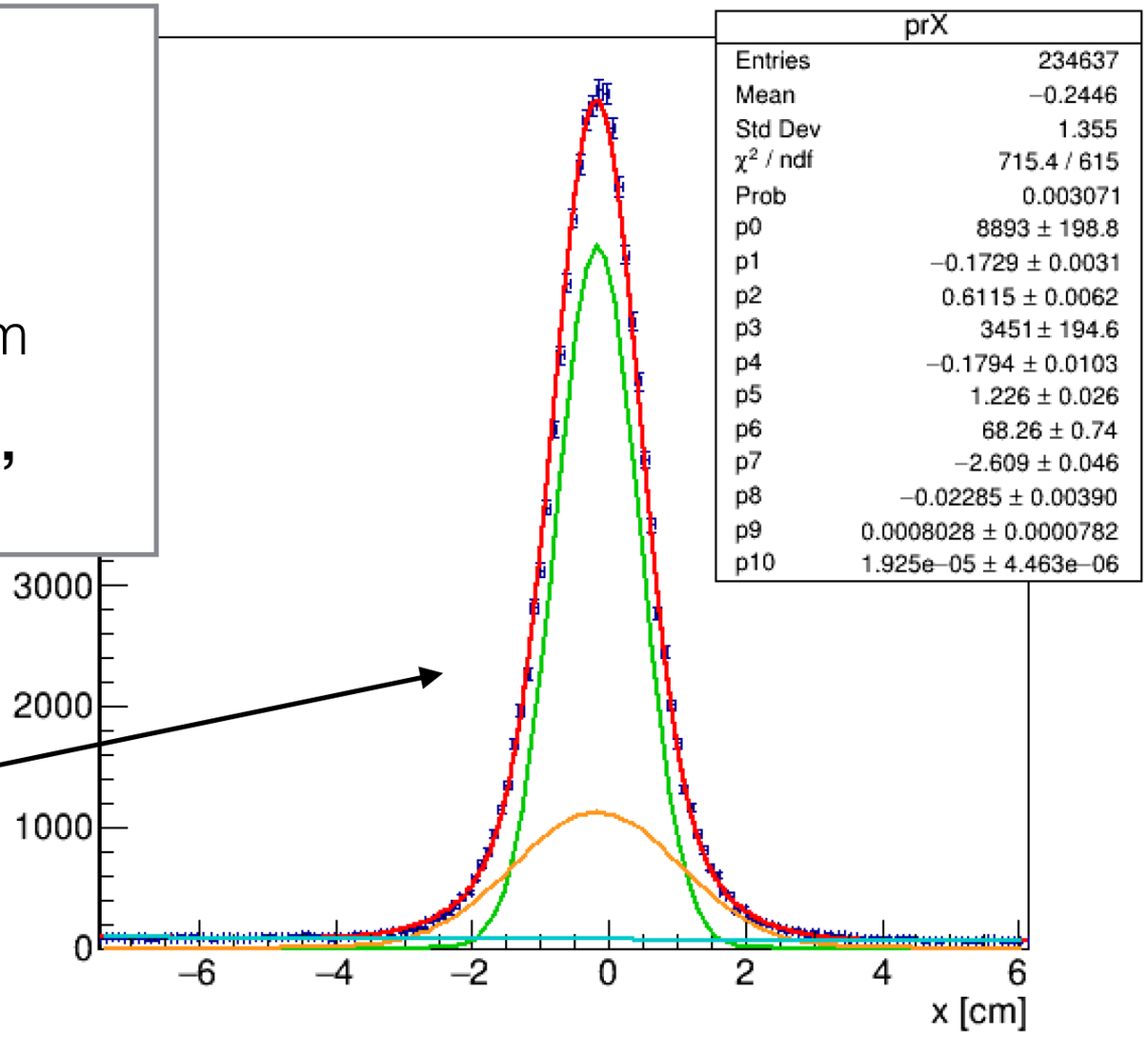
A INSIDE clinical trial is going to start in june —> data from patient

Rec X distribution



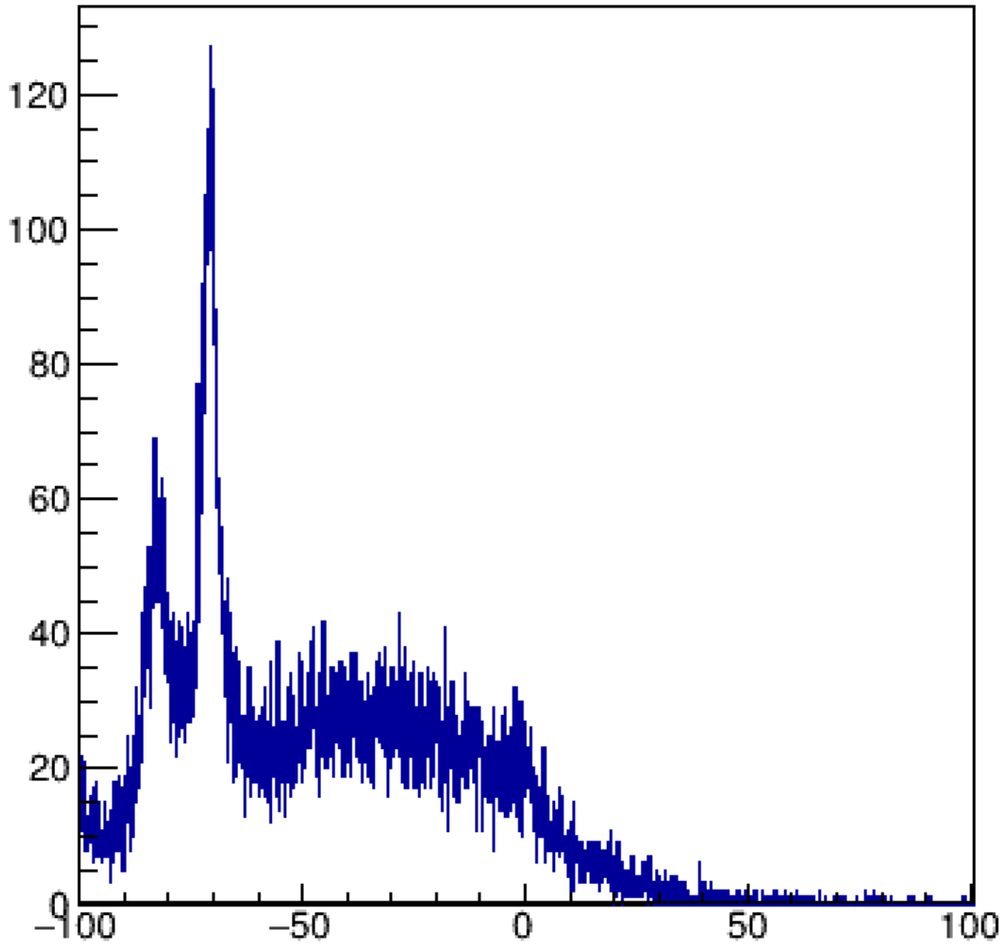
- Sphere (2r=4mm)
- 220 MeV/u
- d = 46.5 cm
- **σ_1=0.61cm, σ_2=1.2cm**

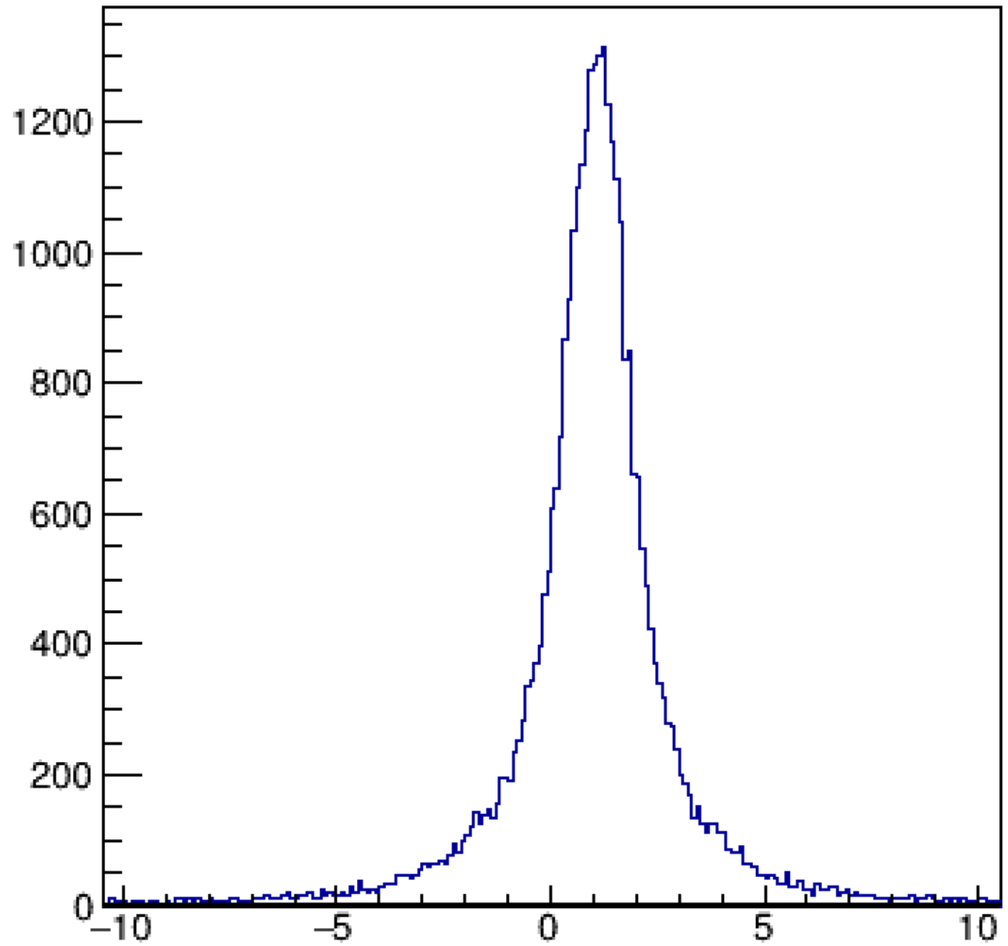




- f(x) = A1*gaus(x, μ1, σ1) + A2*gaus(x, μ2, σ2) + pol4
- How much is the resolution? —> HWHM (half width half maximum) —> **0.68 cm**

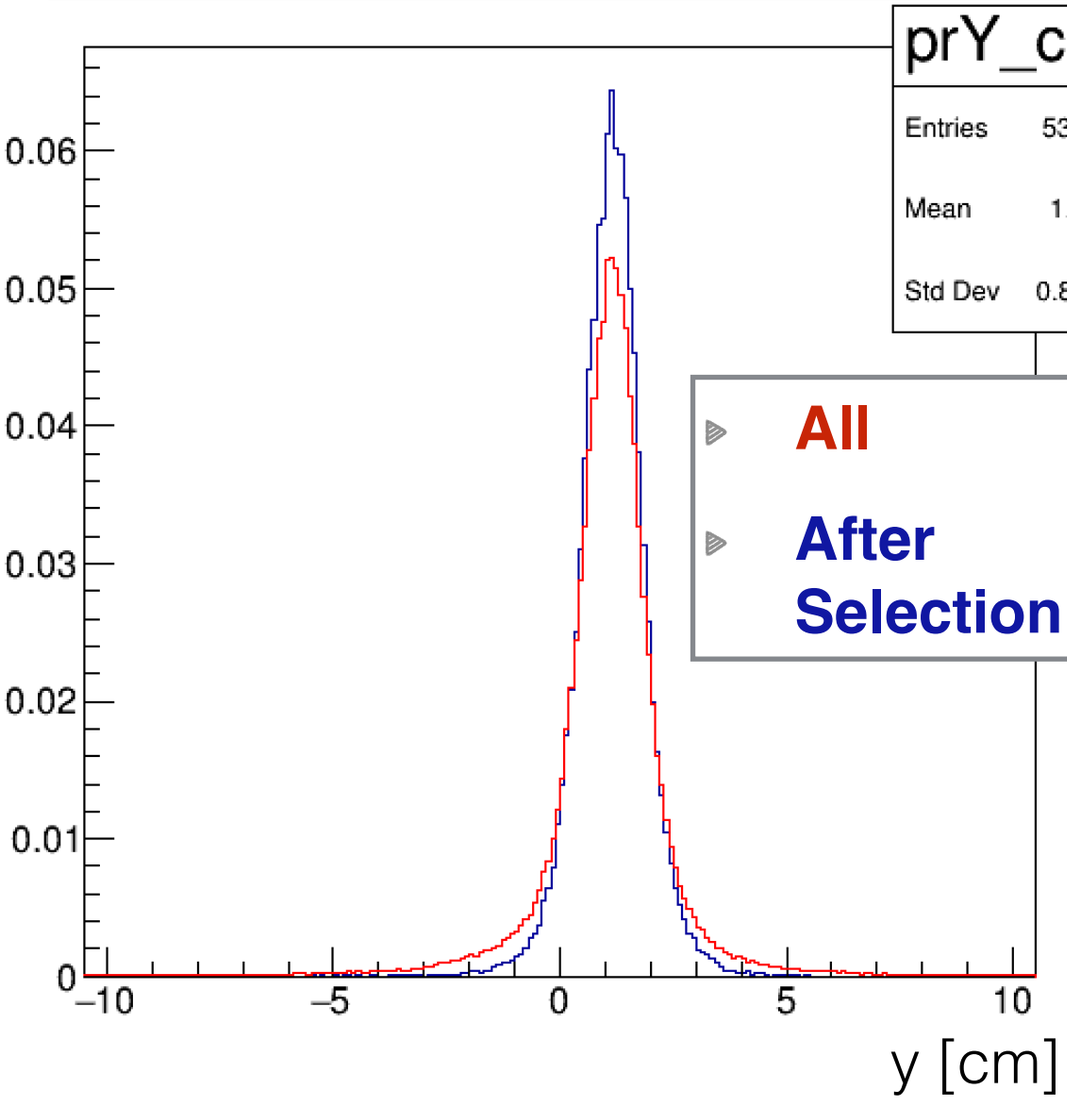
Background

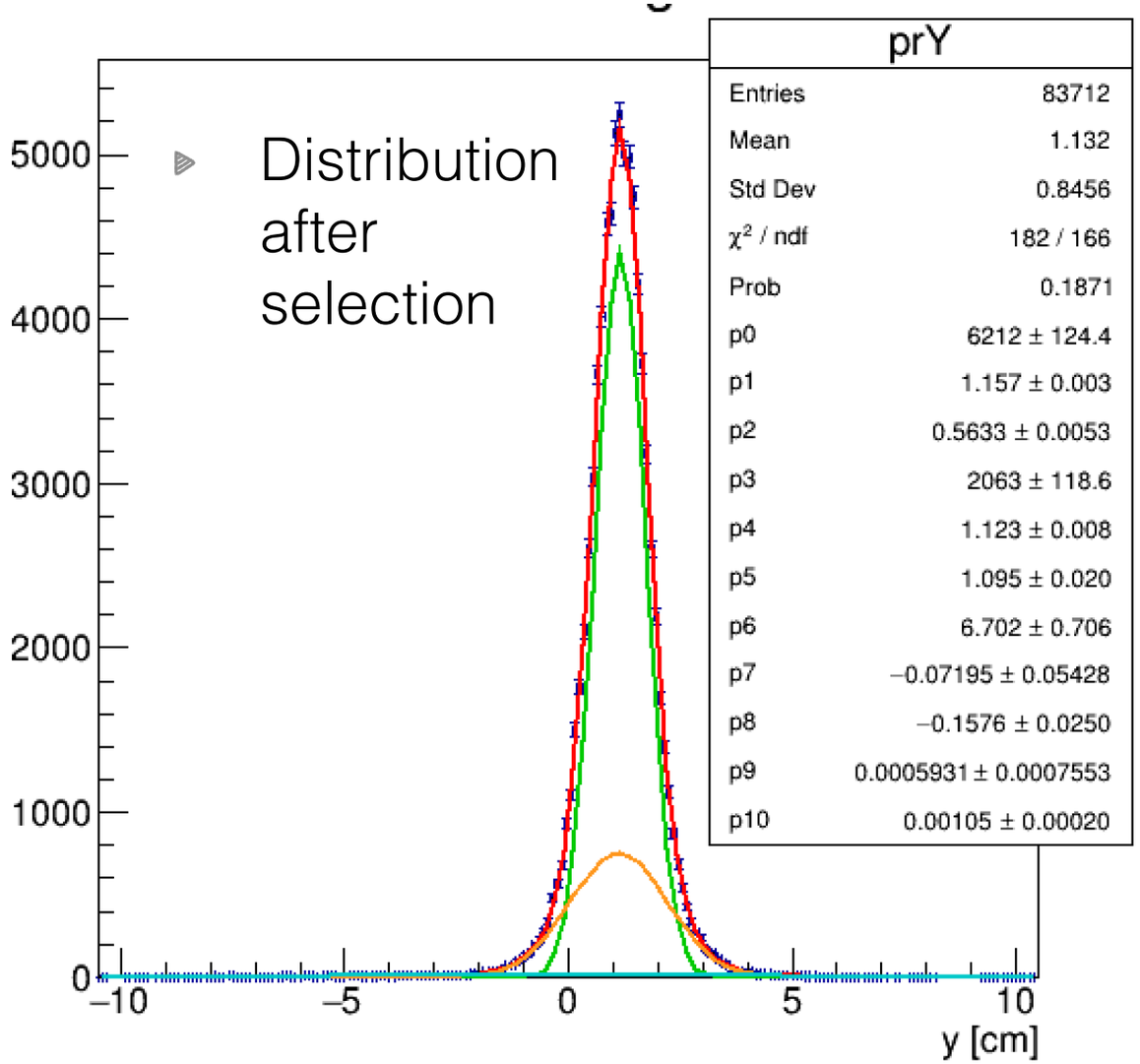




- **NO TARGET!!**
- The background in the y-distribution is inside the target region —> event selection on x-coordinate

Rec Y distribution

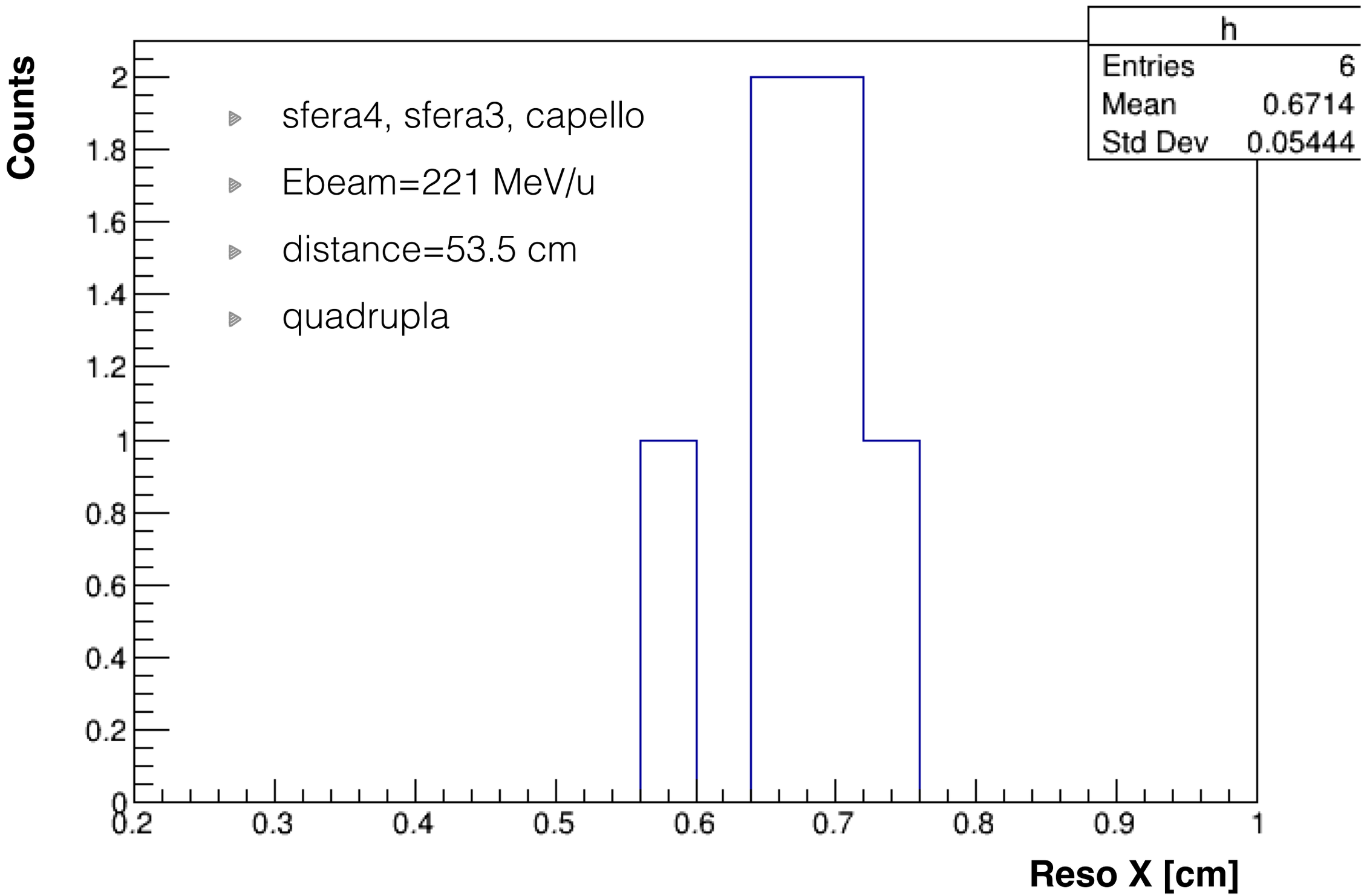




- f(x) = A1*gaus(x, μ1, σ1) + A2*gaus(x, μ2, σ2) + pol4
- How much is the resolution? —> **HWHM —> 0.59 cm**

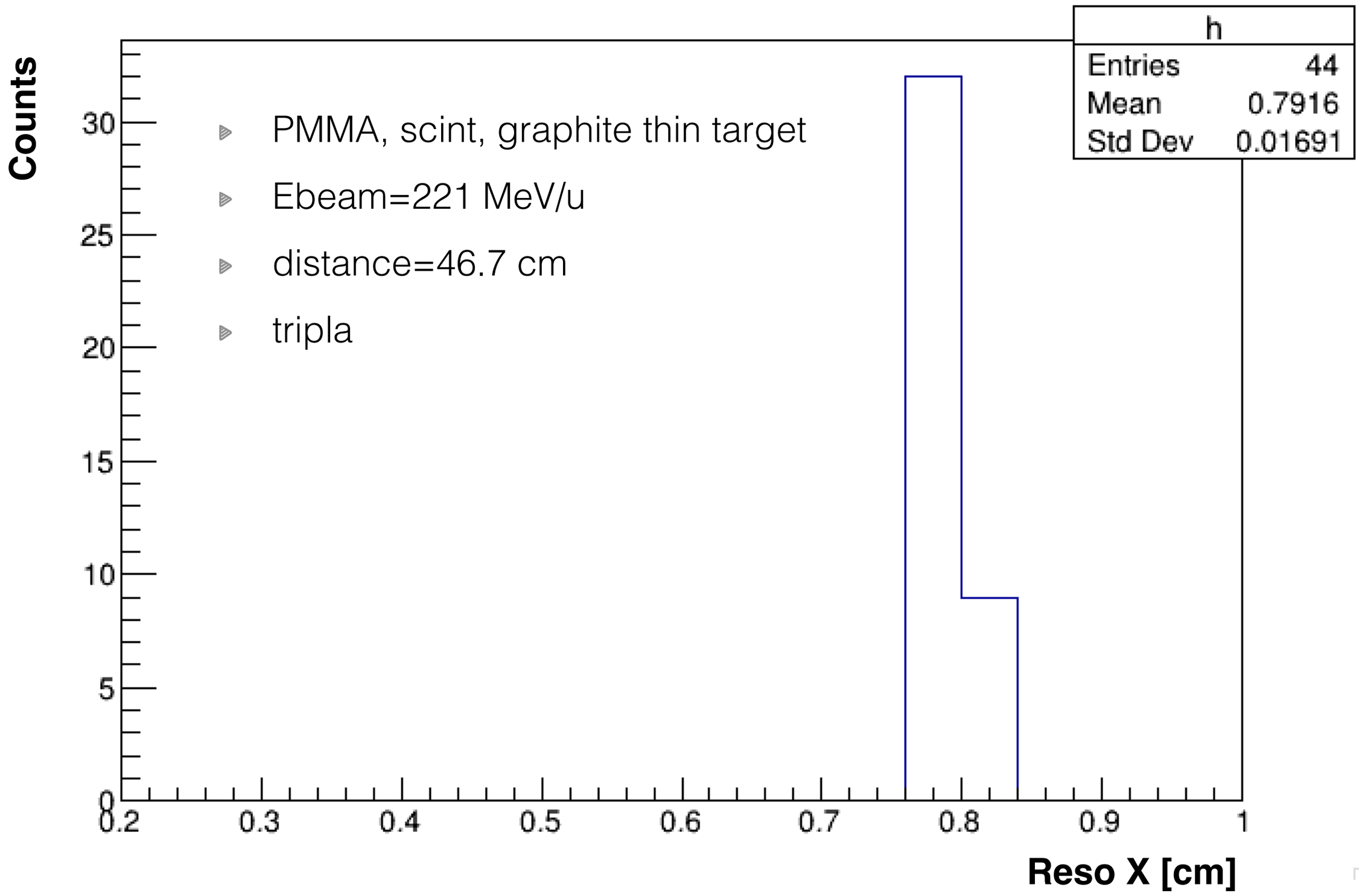
TGT comparison

- sfera4, sfera3, capello
- Ebeam=221 MeV/u
- distance=53.5 cm
- quadrupla

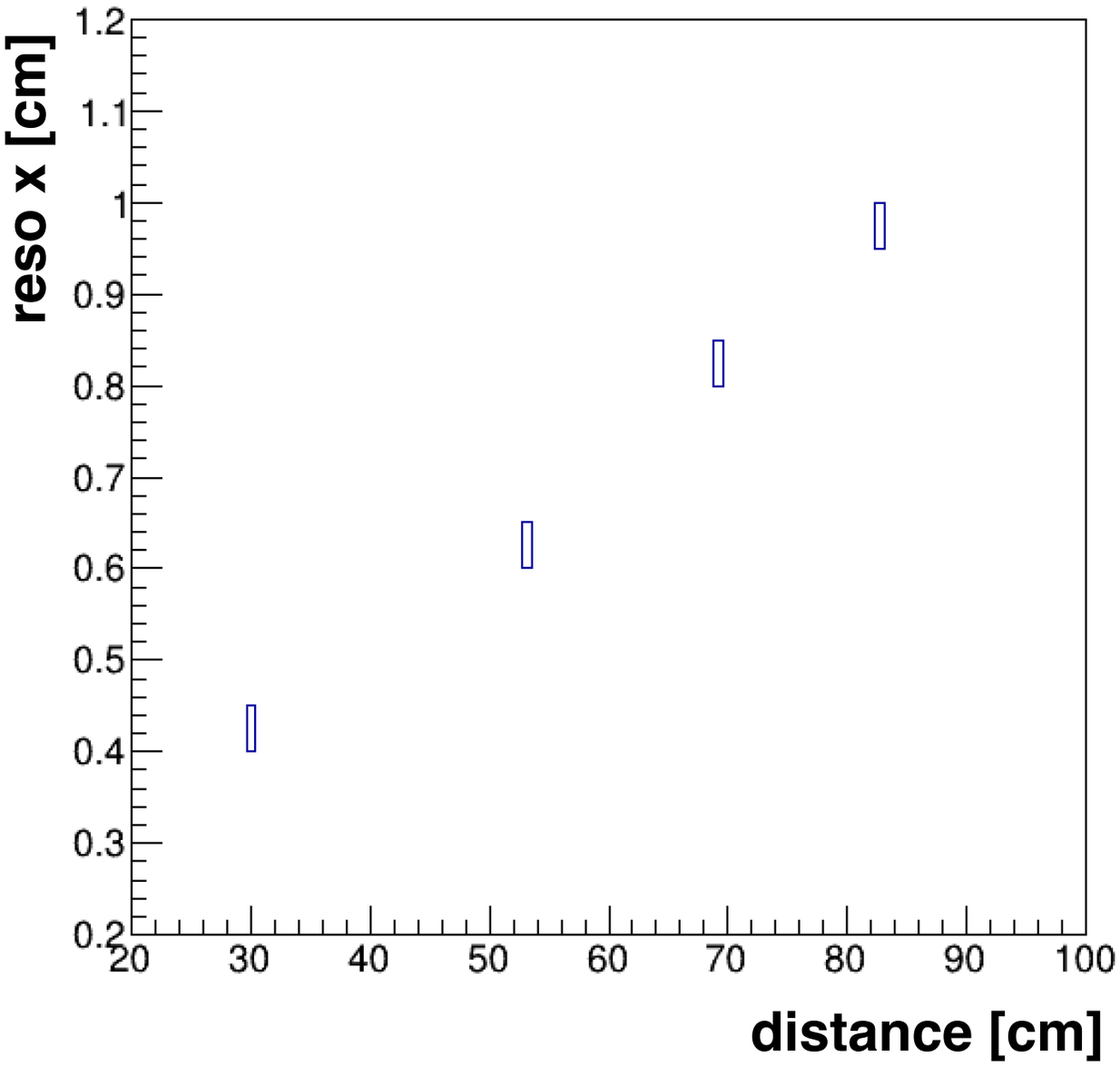


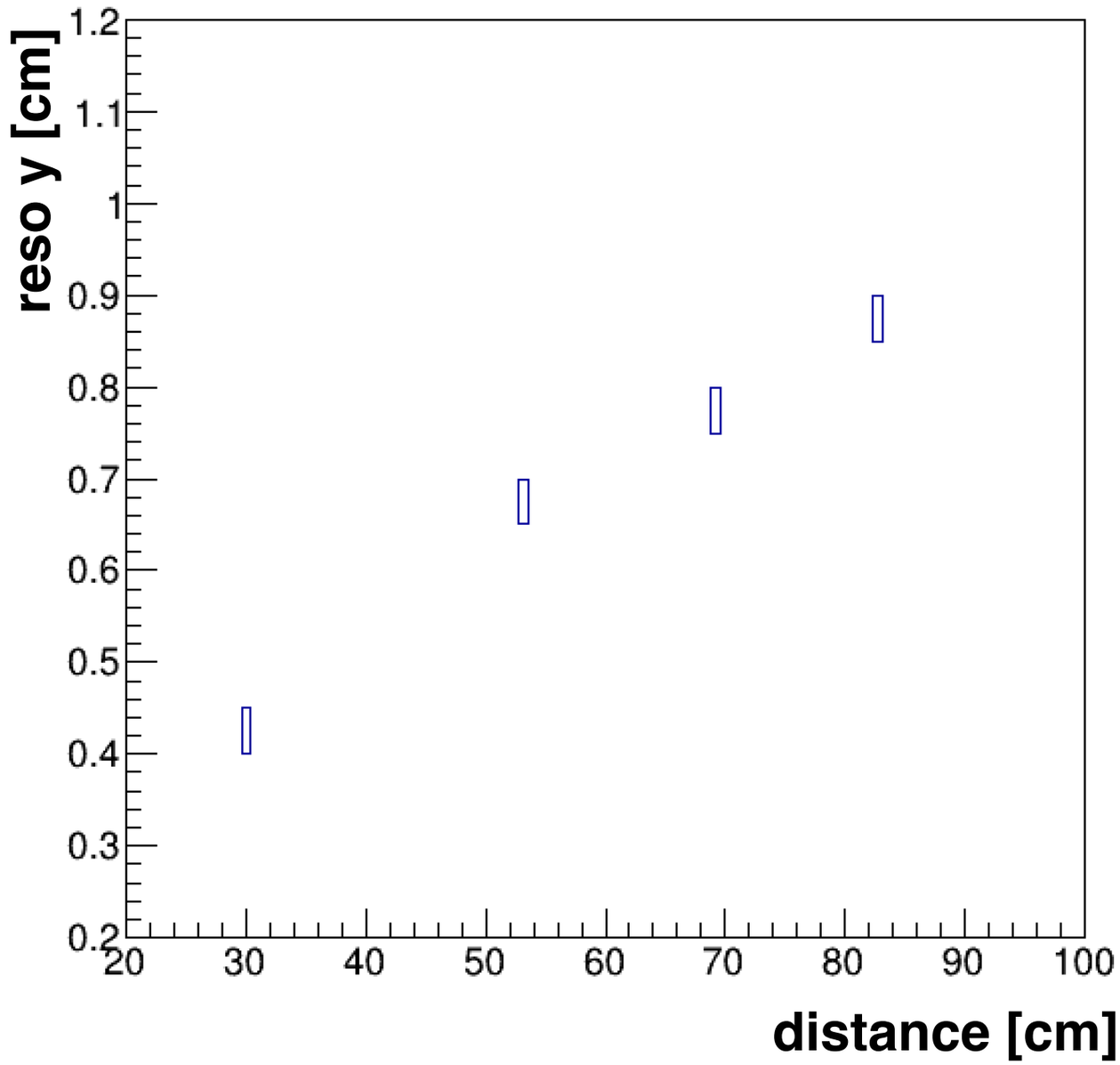
TGT comparison

- PMMA, scint, graphite thin target
- Ebeam=221 MeV/u
- distance=46.7 cm
- tripla



HWHM vs distance

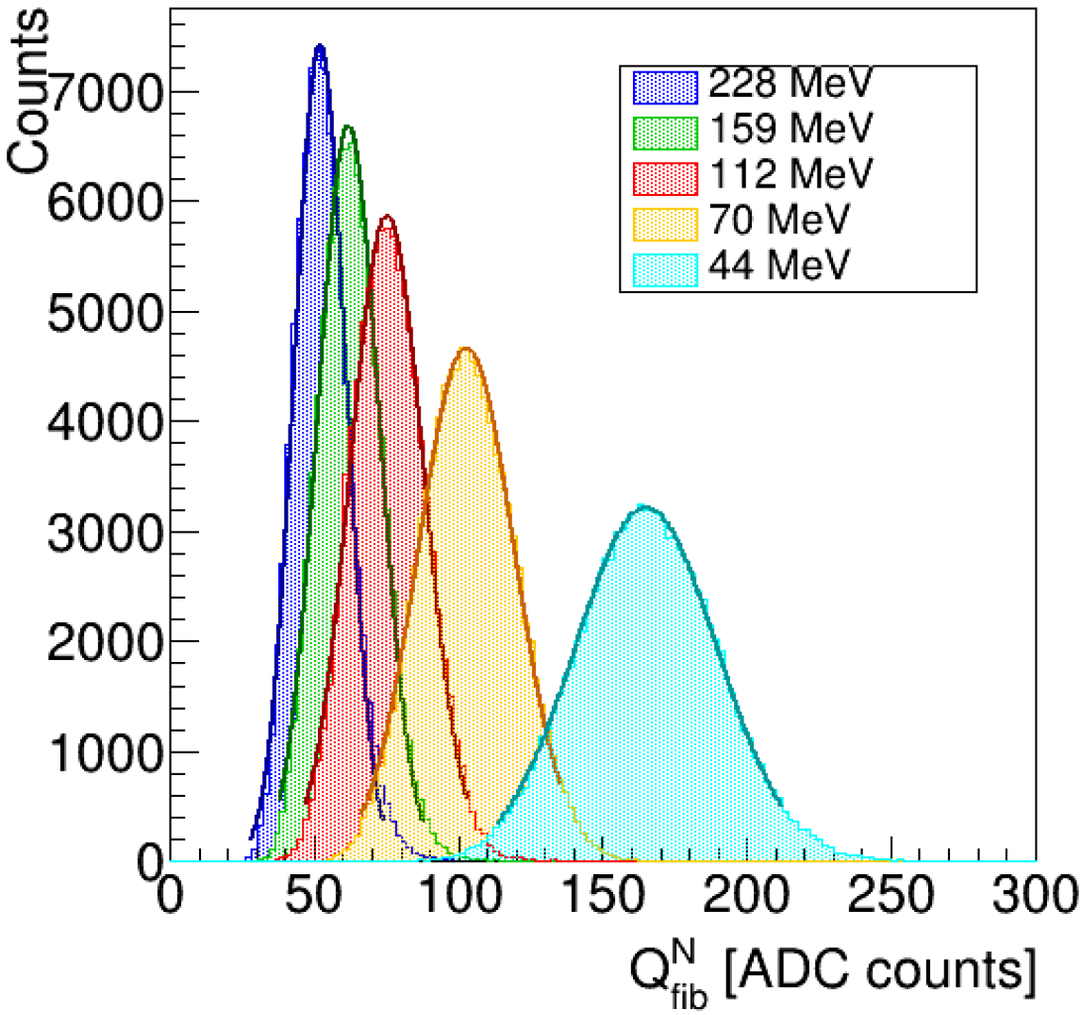


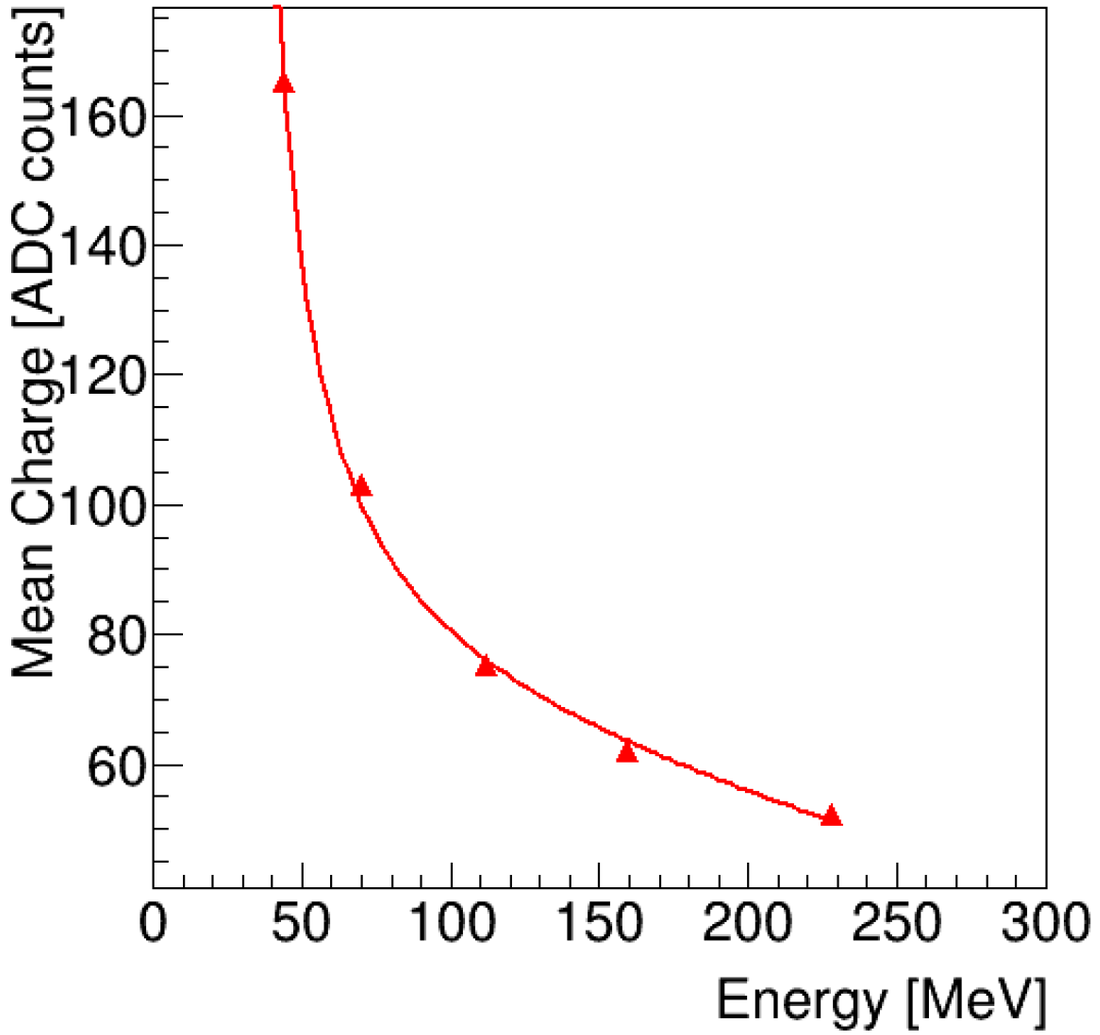


- E_beam = 221 MeV/u
- Trigger Quadrupla

Slight x-y asymmetry, to be still understood

Energy calibration

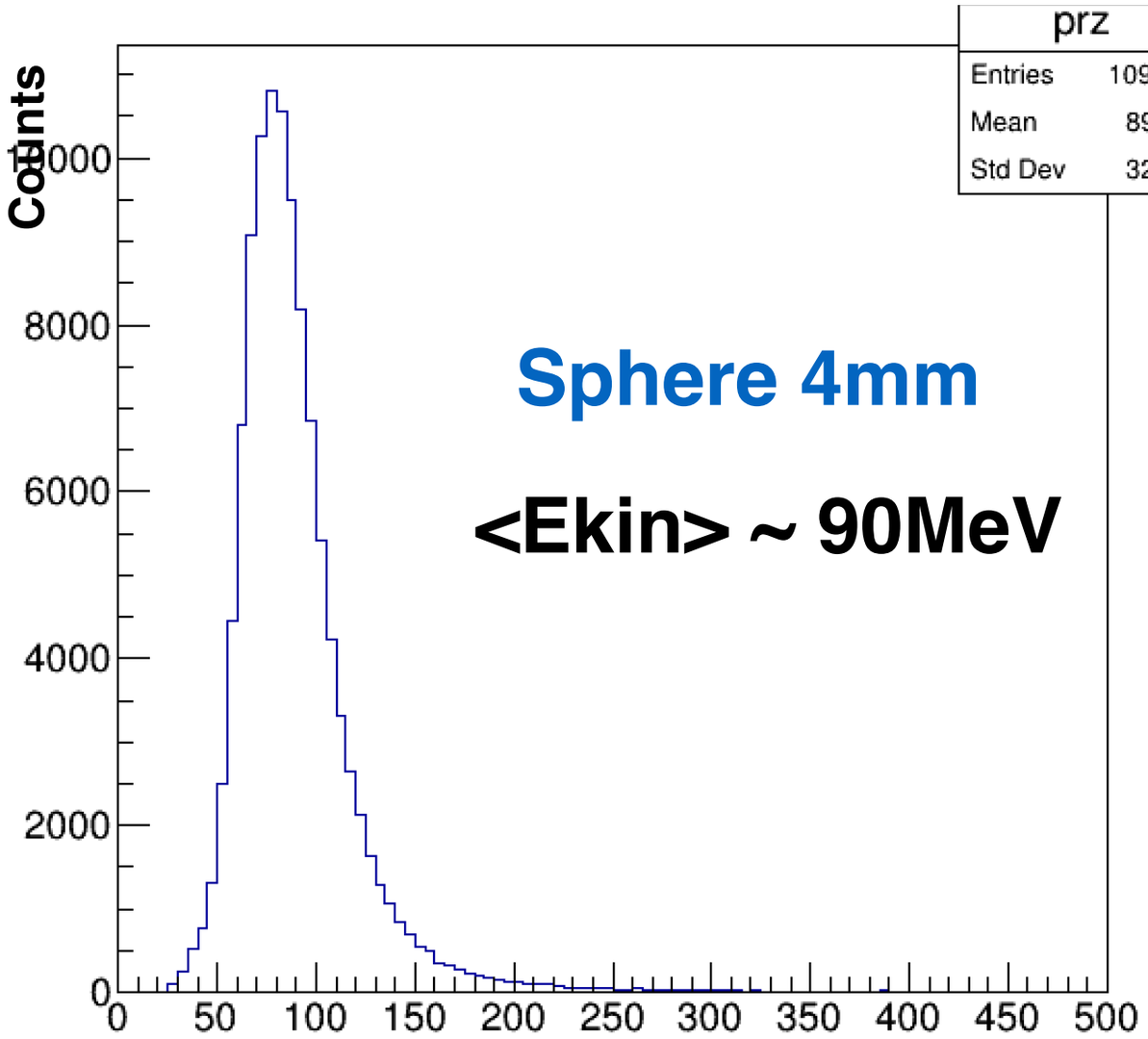




- Fit = [0]+[1]/x+[2]*x
- Resolution: 14-18 %

- We used the data taken @Trento with the monochromatic proton beam

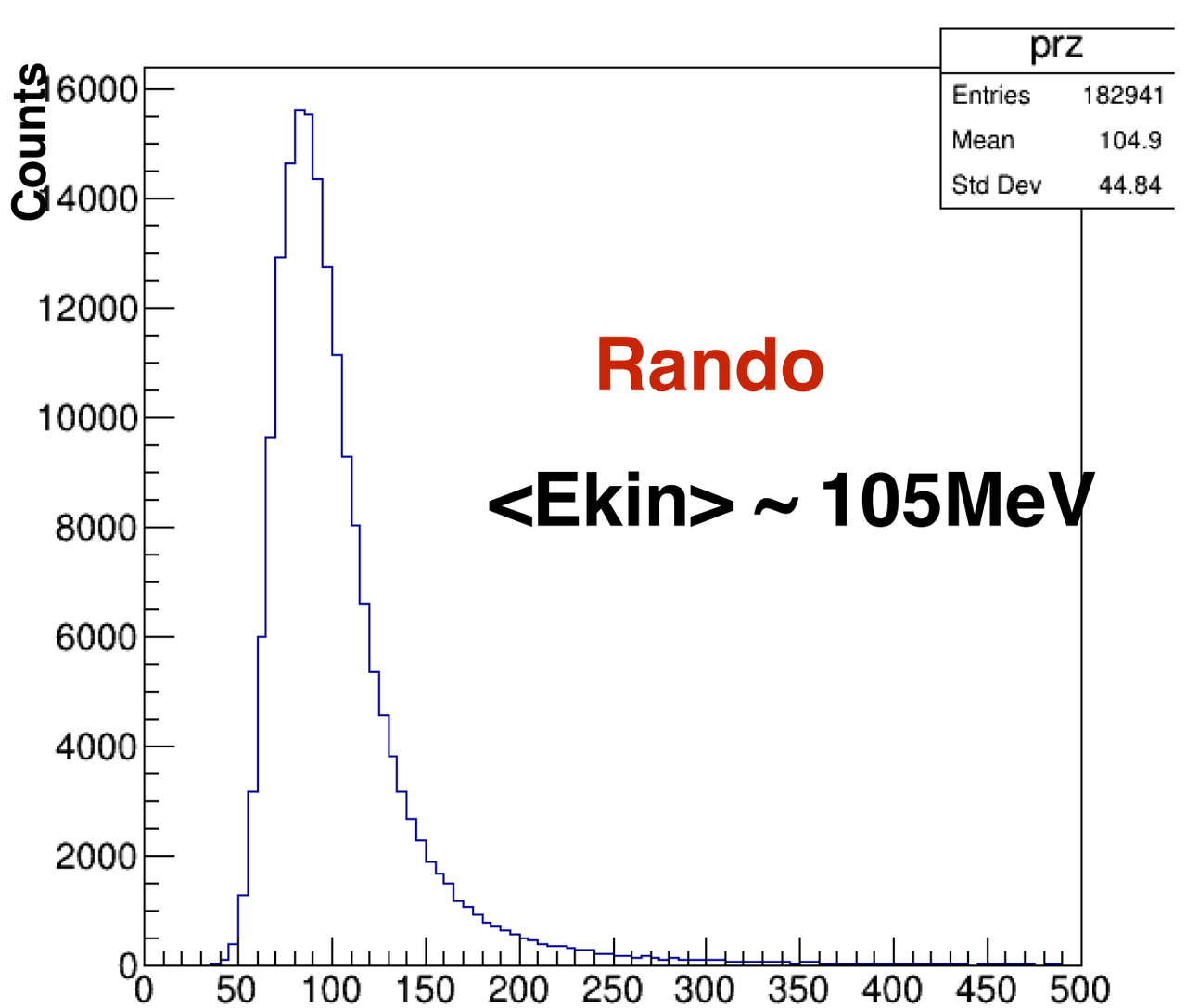
Energy spectrum



Sphere 4mm

<Ekin> ~ 90MeV

Secondary proton energy [MeV]

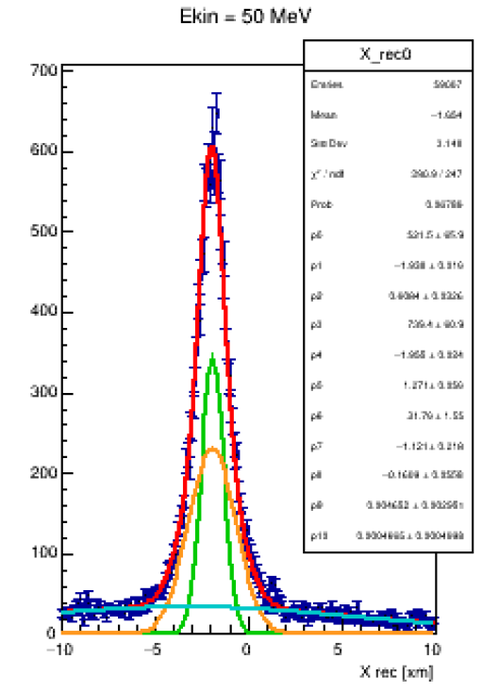


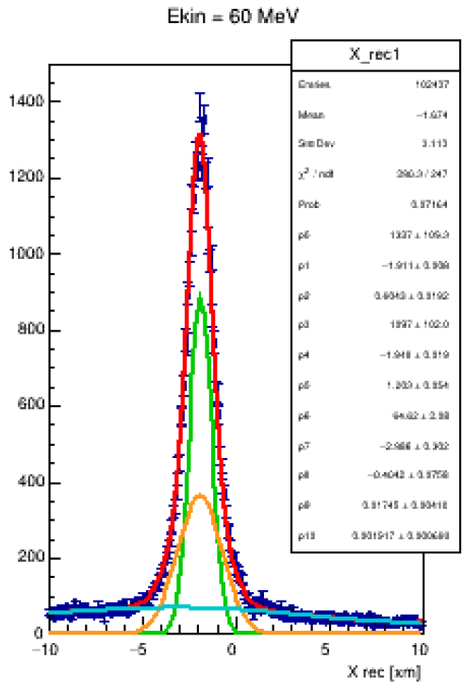
Rando

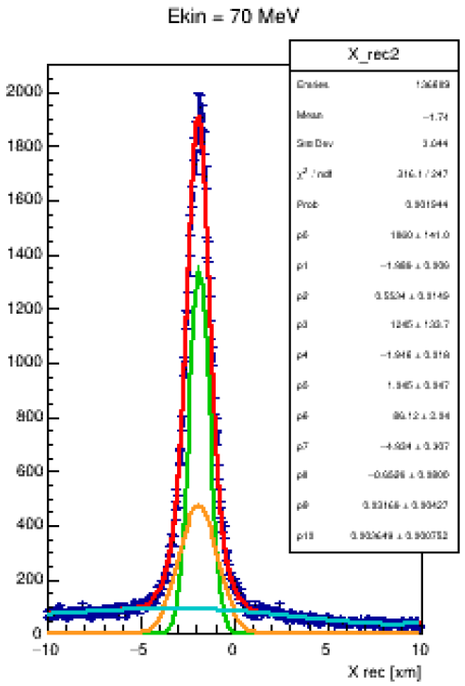
<Ekin> ~ 105MeV

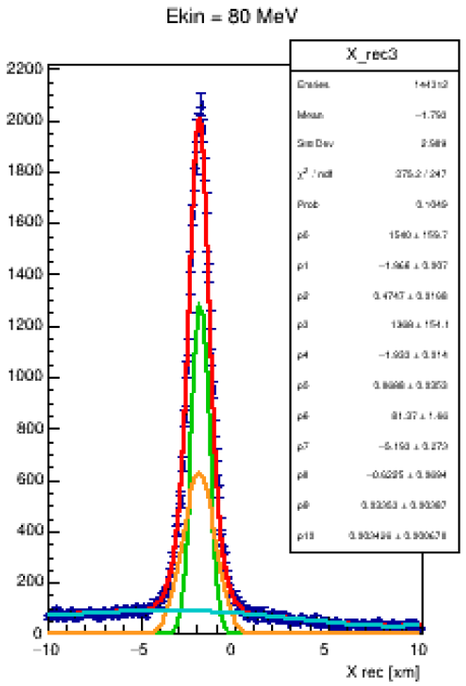
Secondary proton energy [MeV]

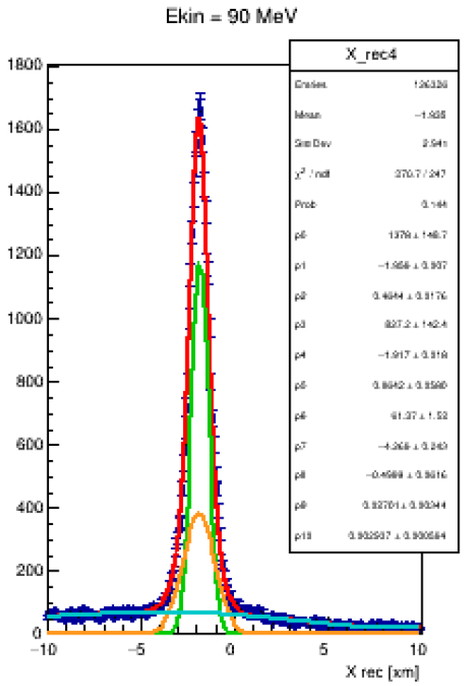
HWHM vs Ekin

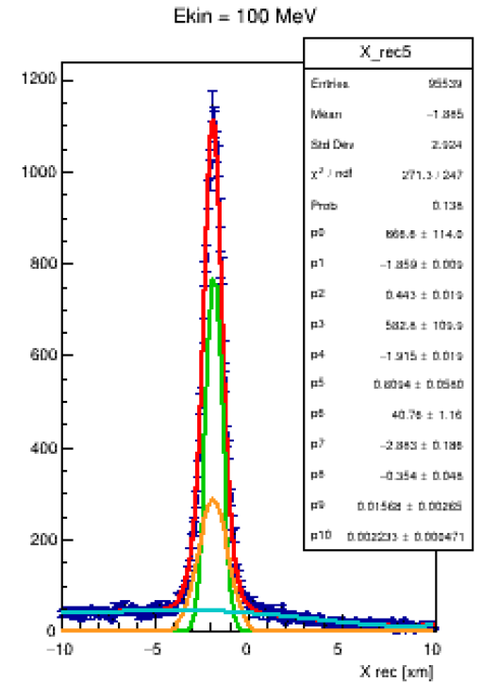

Ekin = 50 MeV
X_rec0
Entries 59067
Mean −1.654
Std Dev 3.148
χ² / ndf 260.9 / 247
Prob 0.3678
p0 521.5 ± 65.9
p1 −1.938 ± 0.010
p2 0.6994 ± 0.0220
p3 739.4 ± 60.9
p4 −1.955 ± 0.024
p5 1.271 ± 0.050
p6 31.76 ± 1.55
p7 −1.121 ± 0.218
p8 −0.1689 ± 0.0228
p9 0.934652 ± 0.932561
p10 0.9304995 ± 0.9304999
X rec [xm]

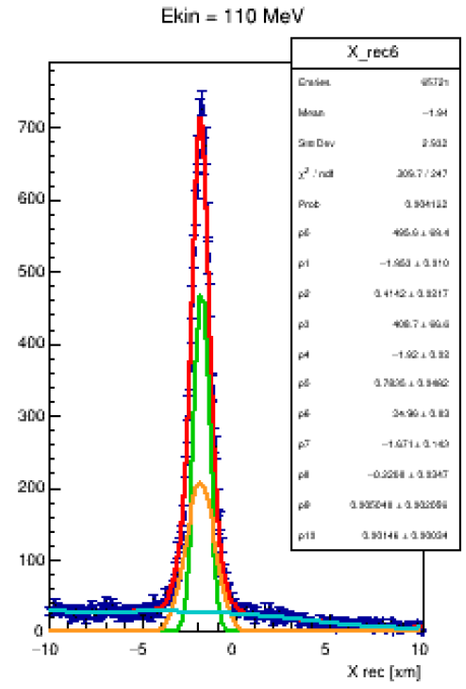

Ekin = 60 MeV
X_rec1
Entries 102437
Mean −1.674
Std Dev 3.113
χ² / ndf 260.3 / 247
Prob 0.37164
p0 1337 ± 105.3
p1 −1.911 ± 0.009
p2 0.6943 ± 0.0192
p3 1997 ± 102.0
p4 −1.948 ± 0.019
p5 1.333 ± 0.054
p6 34.62 ± 2.98
p7 −2.988 ± 0.932
p8 −0.4042 ± 0.9758
p9 0.91745 ± 0.93418
p10 0.931917 ± 0.930699
X rec [xm]

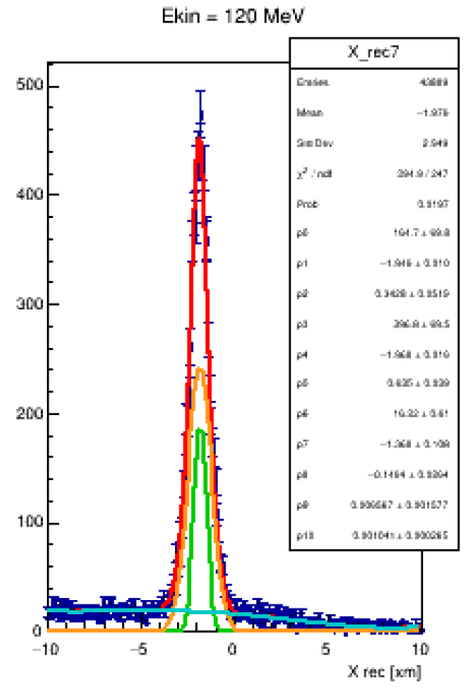

Ekin = 70 MeV
X_rec2
Entries 126869
Mean −1.74
Std Dev 3.044
χ² / ndf 316.1 / 247
Prob 0.931944
p0 1890 ± 141.0
p1 −1.966 ± 0.009
p2 0.5524 ± 0.0149
p3 1245 ± 133.7
p4 −1.946 ± 0.019
p5 1.345 ± 0.047
p6 30.12 ± 2.94
p7 −4.934 ± 0.937
p8 −0.6526 ± 0.9800
p9 0.93168 ± 0.93422
p10 0.933649 ± 0.930752
X rec [xm]

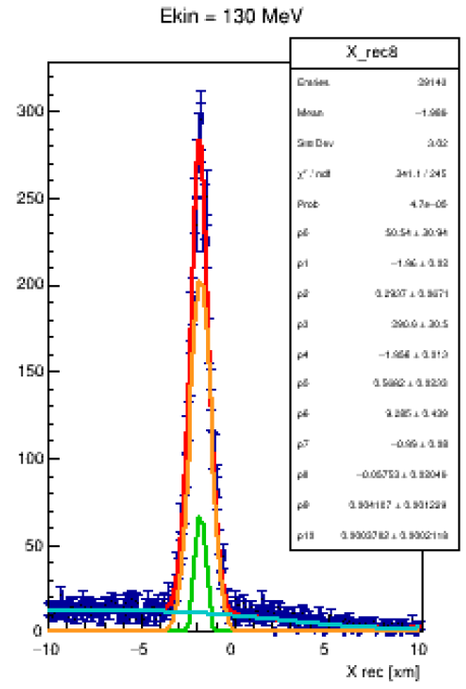

Ekin = 80 MeV
X_rec3
Entries 144312
Mean −1.793
Std Dev 2.989
χ² / ndf 275.2 / 247
Prob 0.1349
p0 1580 ± 159.7
p1 −1.966 ± 0.007
p2 0.4747 ± 0.0168
p3 1399 ± 154.1
p4 −1.933 ± 0.014
p5 0.8888 ± 0.0253
p6 31.37 ± 1.66
p7 −5.153 ± 0.273
p8 −0.6295 ± 0.9894
p9 0.93263 ± 0.93367
p10 0.933436 ± 0.930678
X rec [xm]

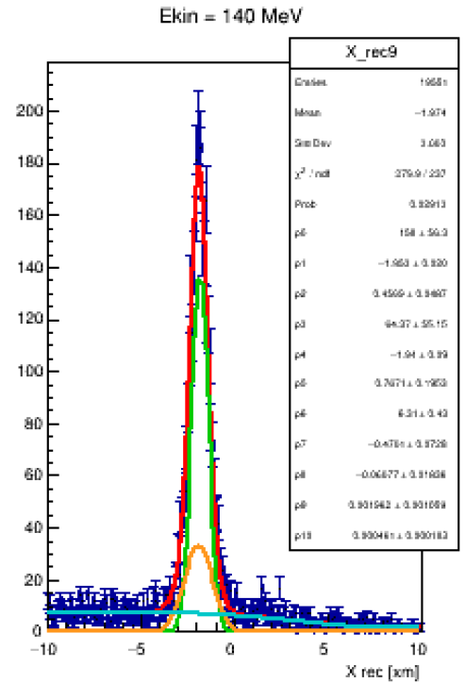

Ekin = 90 MeV
X_rec4
Entries 126326
Mean −1.935
Std Dev 2.941
χ² / ndf 270.7 / 247
Prob 0.148
p0 1378 ± 148.7
p1 −1.956 ± 0.007
p2 0.4644 ± 0.0176
p3 837.2 ± 142.4
p4 −1.917 ± 0.019
p5 0.8642 ± 0.0260
p6 31.37 ± 1.52
p7 −4.269 ± 0.243
p8 −0.4569 ± 0.9816
p9 0.92701 ± 0.93244
p10 0.932937 ± 0.930584
X rec [xm]


Ekin = 100 MeV
X_rec5
Entries 95529
Mean −1.885
Std Dev 2.934
χ² / ndf 271.3 / 247
Prob 0.135
p0 866.8 ± 114.0
p1 −1.859 ± 0.009
p2 0.443 ± 0.019
p3 582.8 ± 109.9
p4 −1.915 ± 0.019
p5 0.8094 ± 0.0560
p6 40.76 ± 1.16
p7 −2.883 ± 0.185
p8 −0.354 ± 0.048
p9 0.01568 ± 0.00265
p10 0.002233 ± 0.000471
X rec [xm]

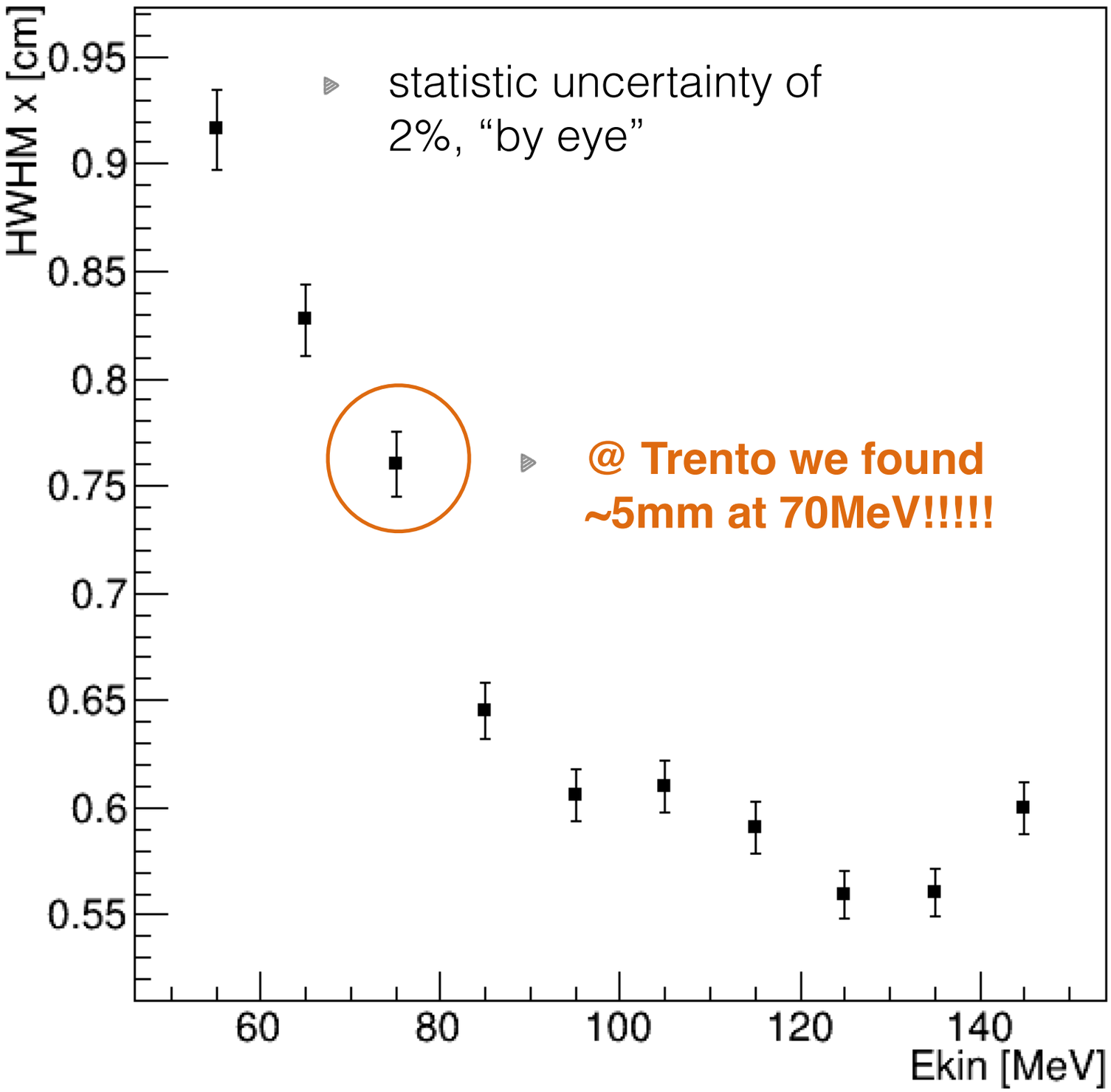

Ekin = 110 MeV
X_rec6
Entries 95721
Mean −1.94
Std Dev 2.932
χ² / ndf 309.7 / 247
Prob 0.004152
p0 495.0 ± 99.4
p1 −1.953 ± 0.010
p2 0.4142 ± 0.0217
p3 408.7 ± 99.6
p4 −1.92 ± 0.02
p5 0.7835 ± 0.0462
p6 34.99 ± 0.83
p7 −1.071 ± 0.143
p8 −0.2268 ± 0.0347
p9 0.935048 ± 0.932069
p10 0.93146 ± 0.93034
X rec [xm]


Ekin = 120 MeV
X_rec7
Entries 43889
Mean −1.975
Std Dev 2.949
χ² / ndf 294.9 / 247
Prob 0.0197
p0 164.7 ± 99.8
p1 −1.949 ± 0.010
p2 0.3428 ± 0.0519
p3 396.8 ± 99.5
p4 −1.958 ± 0.019
p5 0.635 ± 0.039
p6 10.22 ± 0.61
p7 −1.368 ± 0.159
p8 −0.1464 ± 0.0264
p9 0.935567 ± 0.931577
p10 0.931041 ± 0.930285
X rec [xm]


Ekin = 130 MeV
X_rec8
Entries 29143
Mean −1.986
Std Dev 3.02
χ² / ndf 341.1 / 245
Prob 4.7e−06
p0 50.54 ± 30.94
p1 −1.96 ± 0.02
p2 0.2937 ± 0.0671
p3 390.0 ± 30.5
p4 −1.956 ± 0.012
p5 0.5882 ± 0.0233
p6 3.285 ± 0.429
p7 −0.99 ± 0.98
p8 −0.05753 ± 0.02049
p9 0.934187 ± 0.931299
p10 0.9303782 ± 0.9302119
X rec [xm]

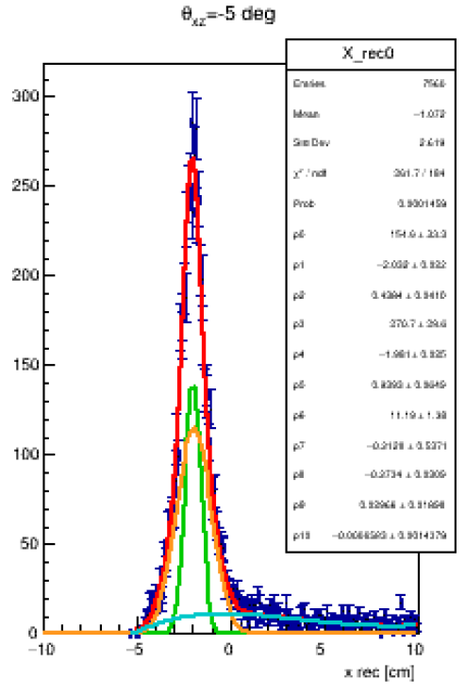

Ekin = 140 MeV
X_rec9
Entries 19581
Mean −1.974
Std Dev 3.063
χ² / ndf 279.9 / 237
Prob 0.02913
p0 158 ± 56.3
p1 −1.953 ± 0.020
p2 0.4569 ± 0.0467
p3 64.37 ± 55.15
p4 −1.94 ± 0.09
p5 0.7671 ± 0.1953
p6 6.31 ± 0.43
p7 −0.476 ± 0.8726
p8 −0.06677 ± 0.01638
p9 0.931562 ± 0.931059
p10 0.93046 ± 0.930183
X rec [xm]

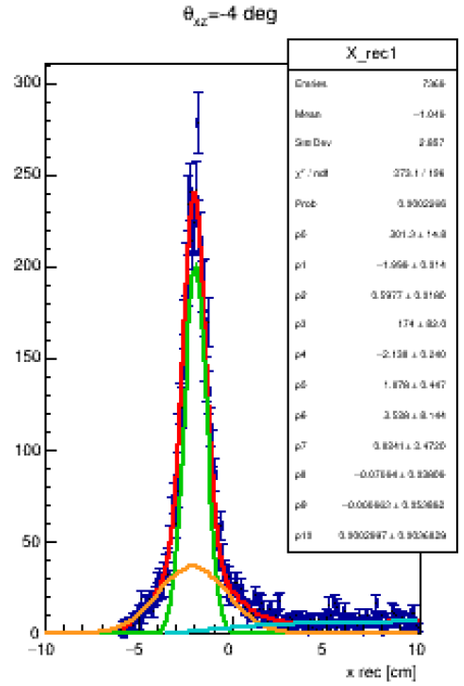
HWHM vs Ekin

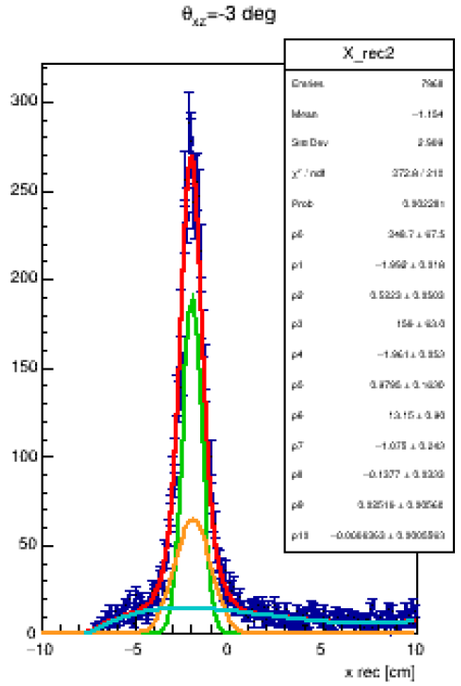


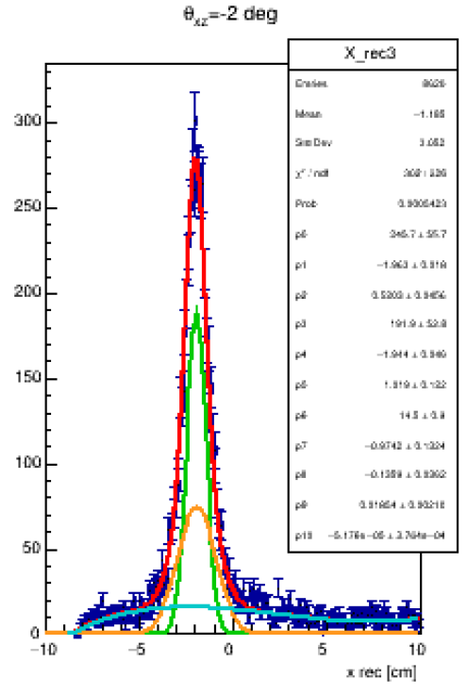
- statistic uncertainty of 2%, “by eye”
- **@ Trento we found ~5mm at 70MeV!!!!!**

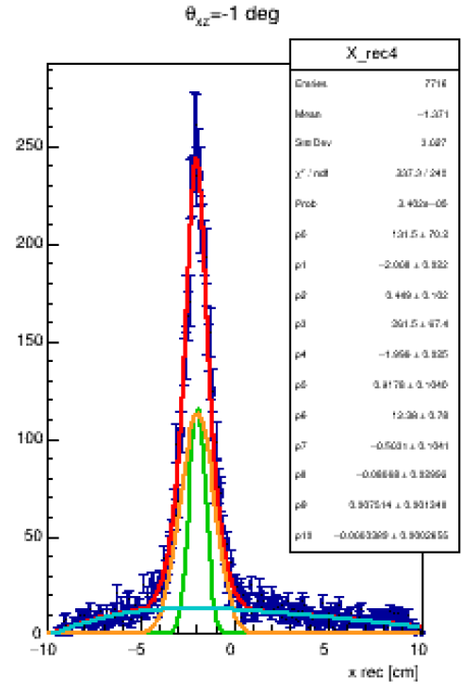
HWHM vs θ

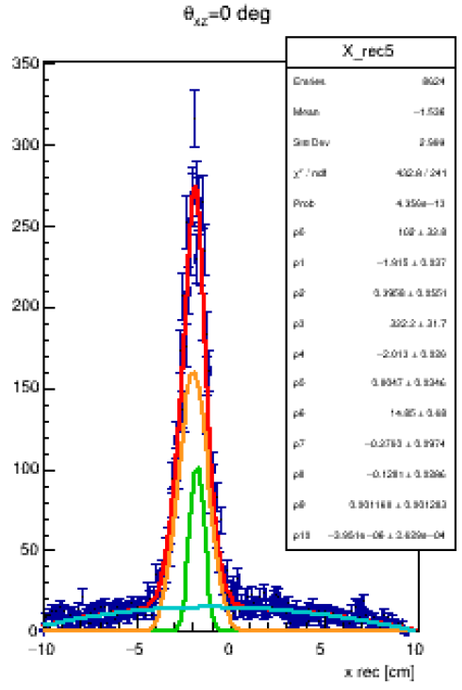

θxz=-5 deg
X_rec0
x rec [cm]

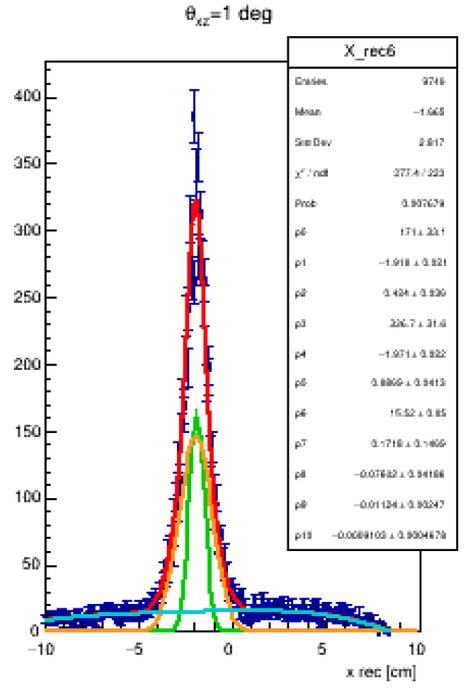

θxz=-4 deg
X_rec1
x rec [cm]

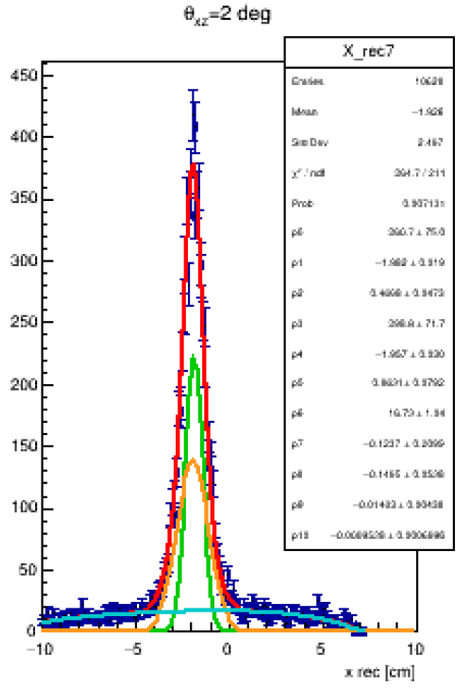

θxz=-3 deg
X_rec2
x rec [cm]

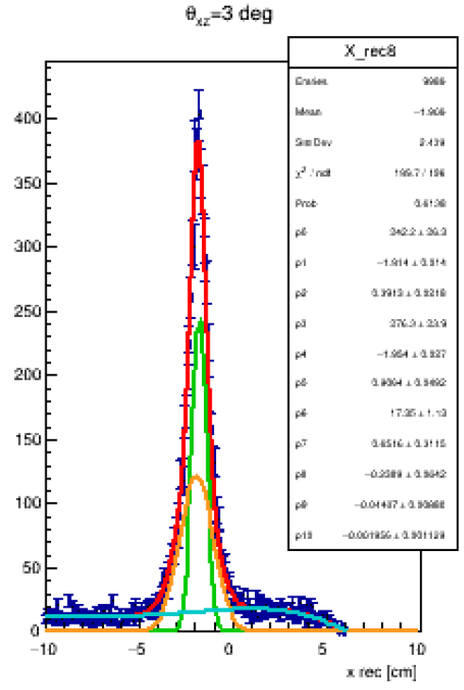

θxz=-2 deg
X_rec3
x rec [cm]

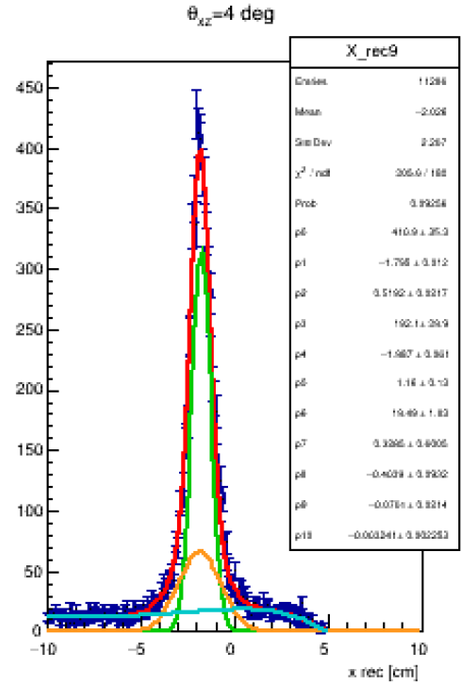

θxz=-1 deg
X_rec4
x rec [cm]


θxz=0 deg
X_rec5
x rec [cm]

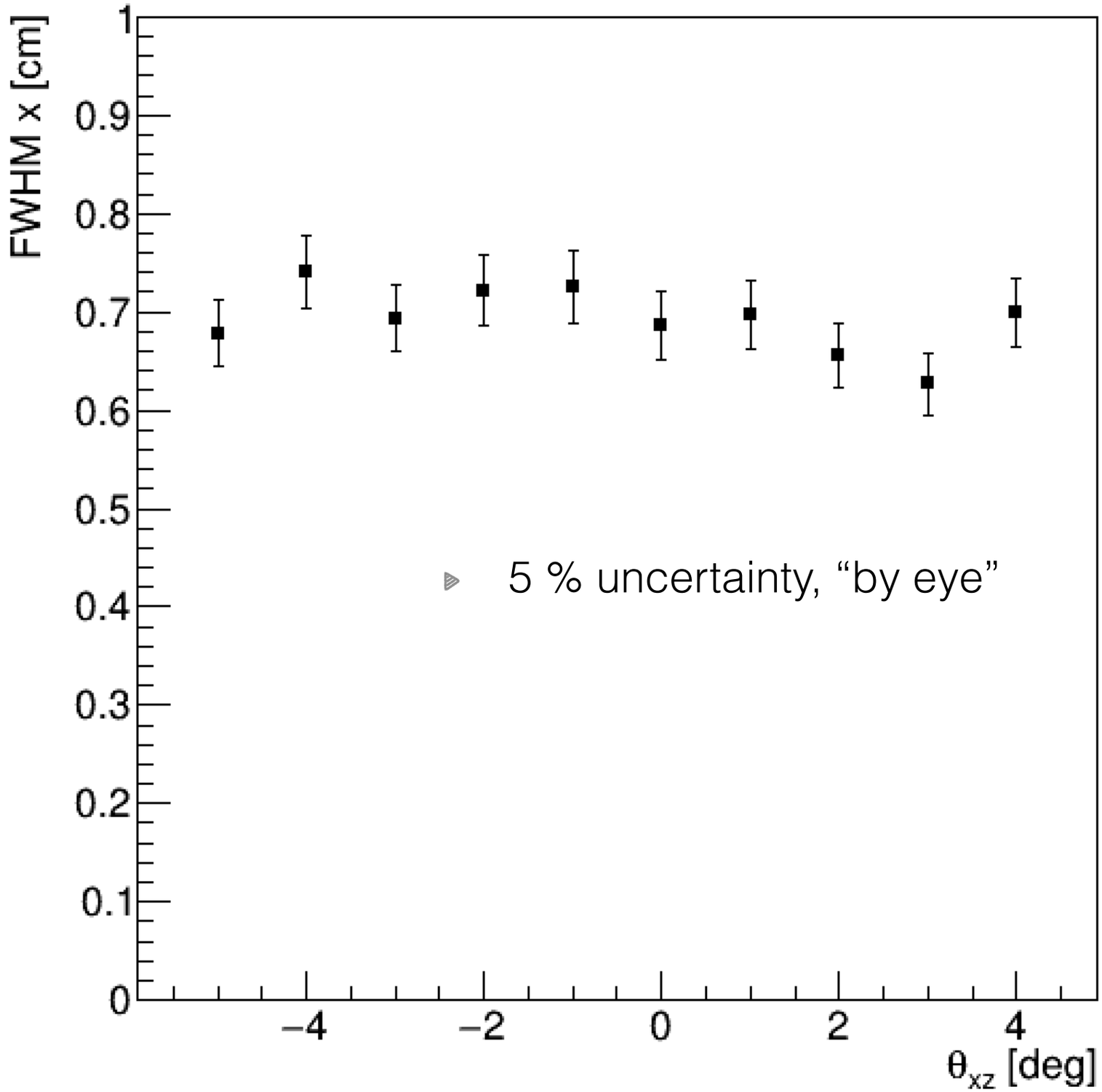

θxz=1 deg
X_rec6
x rec [cm]


θxz=2 deg
X_rec7
x rec [cm]


θxz=3 deg
X_rec8
x rec [cm]


θxz=4 deg
X_rec9
x rec [cm]

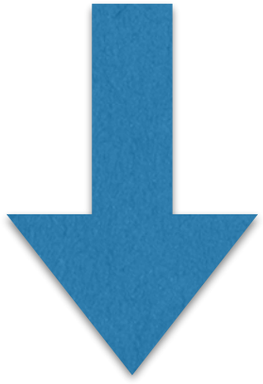
HWHM vs θ



- 5 % uncertainty, “by eye”

Next steps

- Why such discrepancy between CNAO snd Trento?
- Why do we observe the x-y asymmetry ?



- Residuals analysis.
- Study the cluster size impact on the resolution by means an updated version of the Monte Carlo simulation, that includes the SiPM read-out.