DCH in RUN7: MC vs. data
&
Gem + DCH + tof700 matching with MC data

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Part1: DCH in RUN7: MC vs. data

Drift Chambers Reconstruction Chain

Hit reconstruction on a particular layer

↓

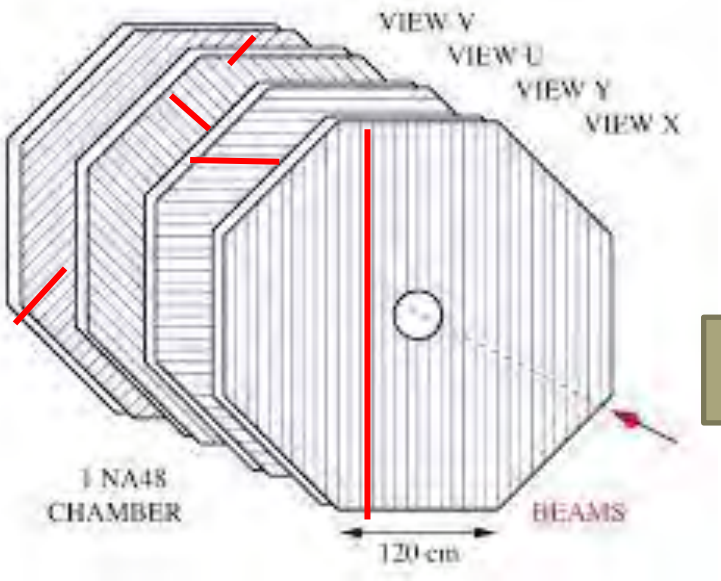
Pair hit assembly

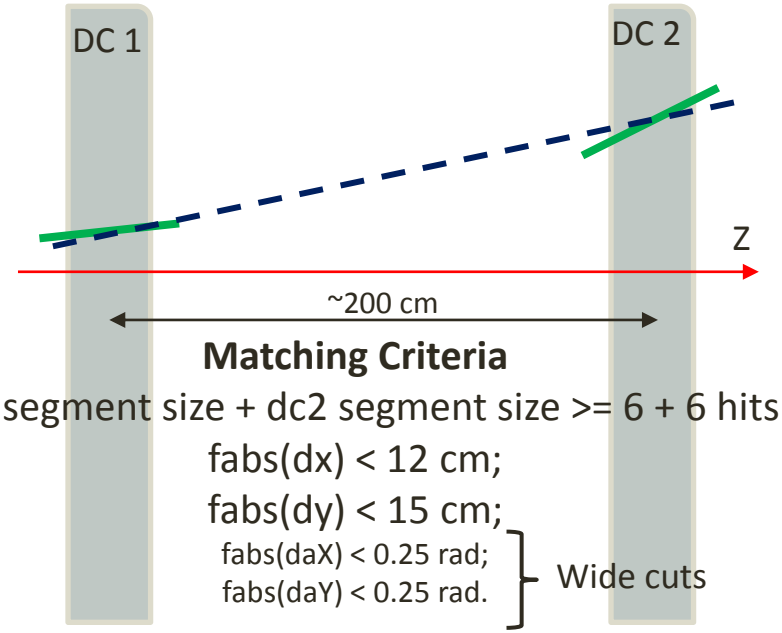
↓

DC1/2 Segment building

↓

DC1+2 track reconstruction





Matching Criteria

dc1 segment size + dc2 segment size >= 6 + 6 hits

fabs(dx) < 12 cm;

fabs(dy) < 15 cm;

fabs(daX) < 0.25 rad;
fabs(daY) < 0.25 rad.
} Wide cuts

MC Points — input — data digis

simulated coordinate smearing

time transformed into distance

MC DchHitProducer

data DchHitProducer

DchTrackFinder

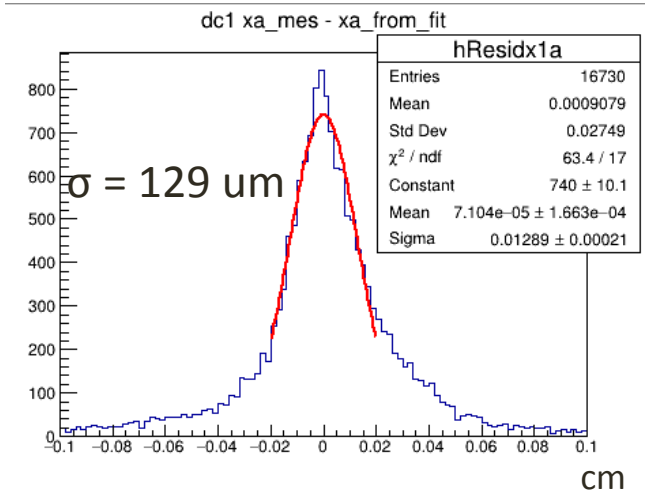
DCH hits on layer + segments + global tracks

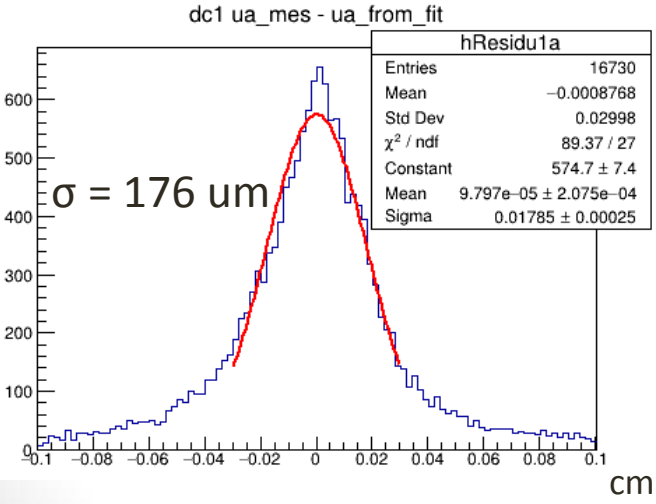
output

Some selected residuals [Measurement – segmentFit]

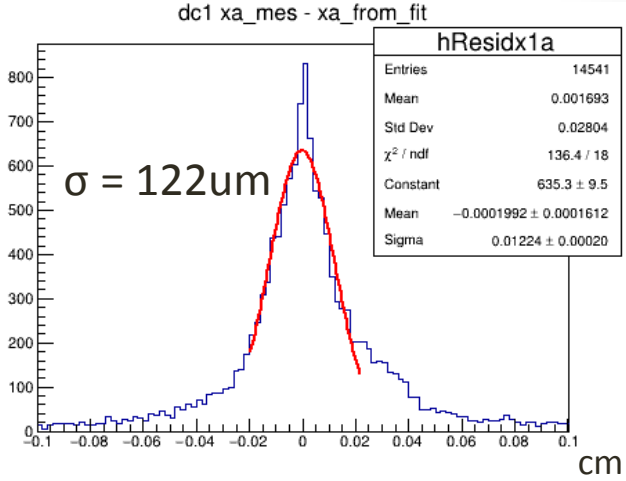
C beam, empty target, B = 1200A

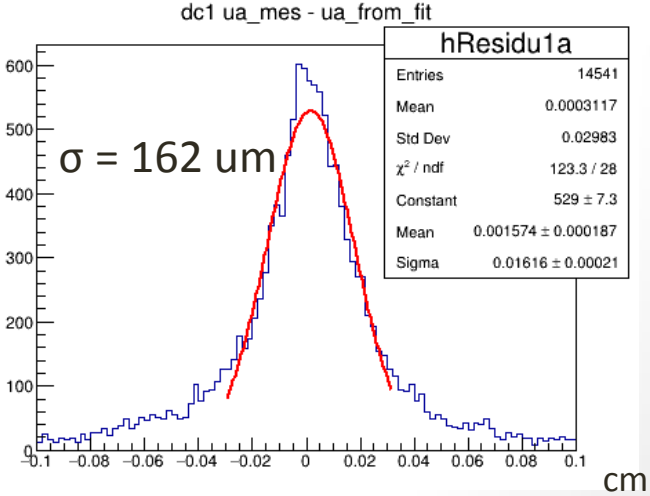
MC segments





Data segments



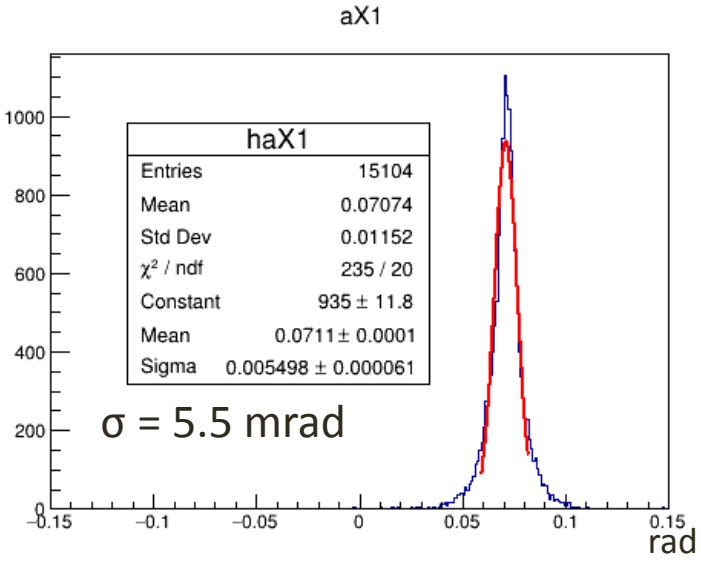


MC and data residuals are in agreement for all coordinates

Angle values and resolution

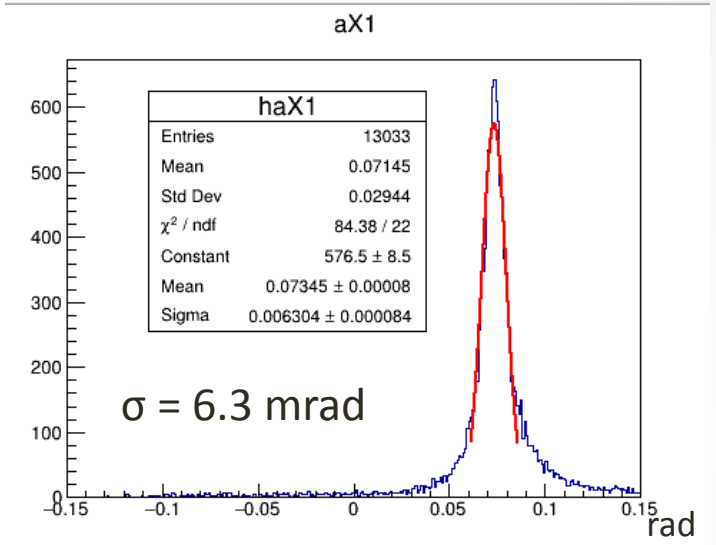
C beam, empty target, B = 1200A

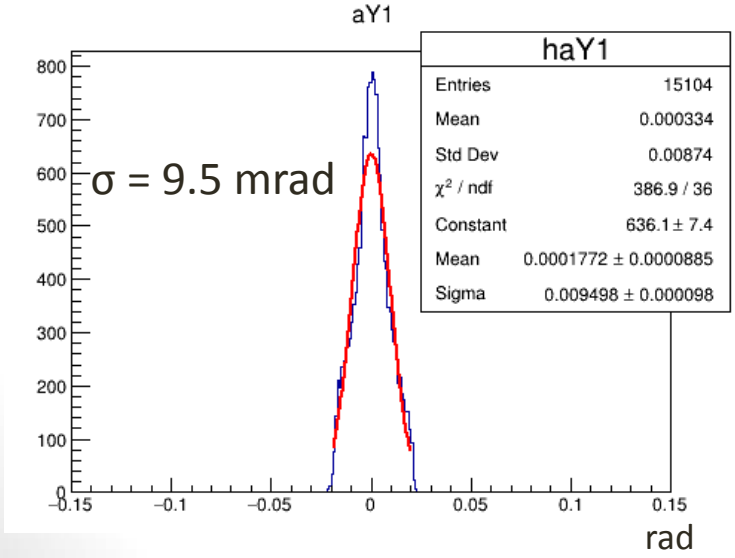
MC segments



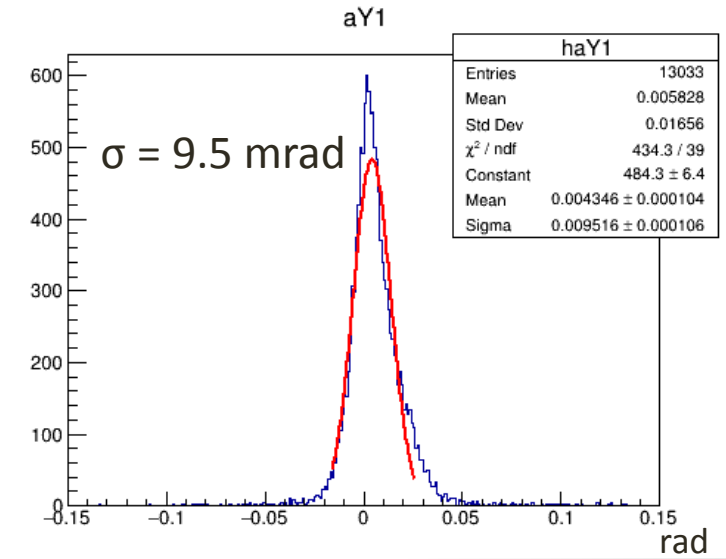
X slope

Data segments





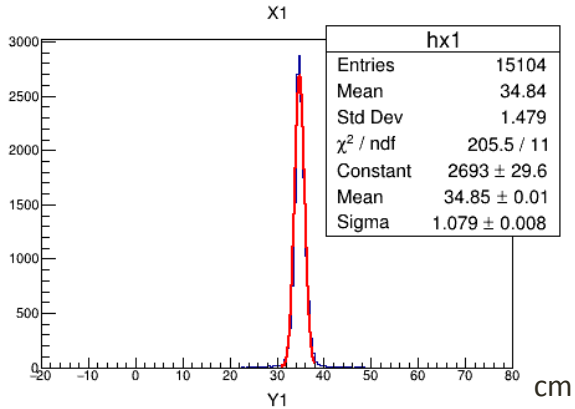
Y slope



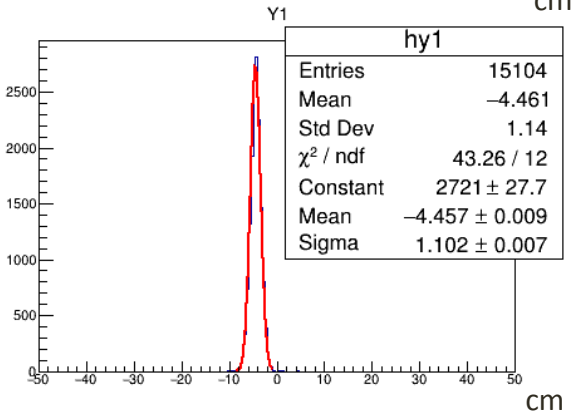
Coordinates values and beam width

C beam, empty target, B = 1200A

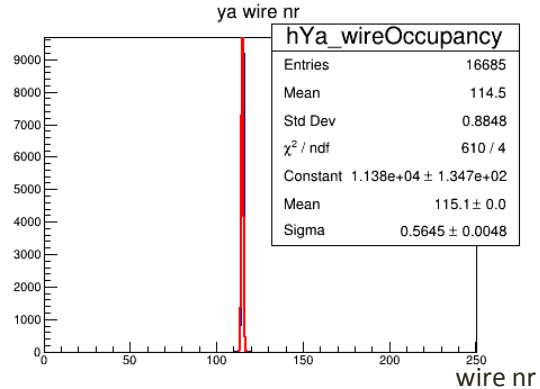
MC segments



X segment coordinate



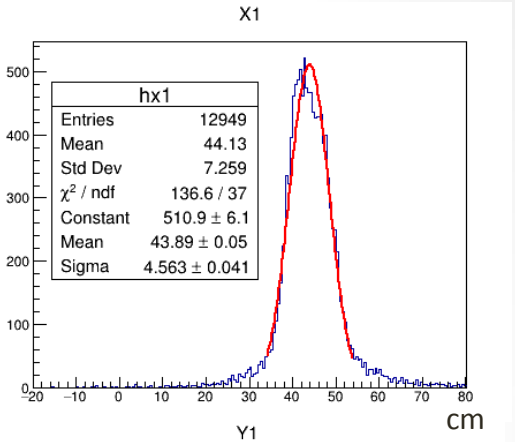
Y segment coordinate

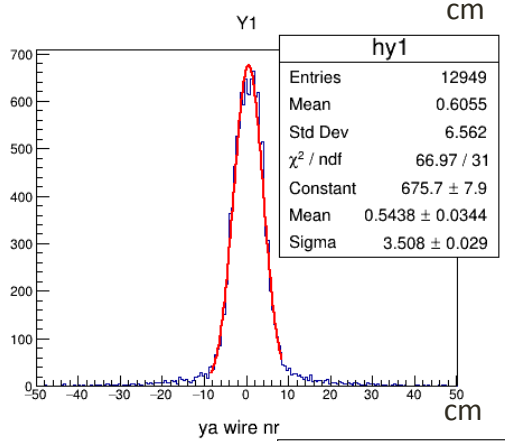


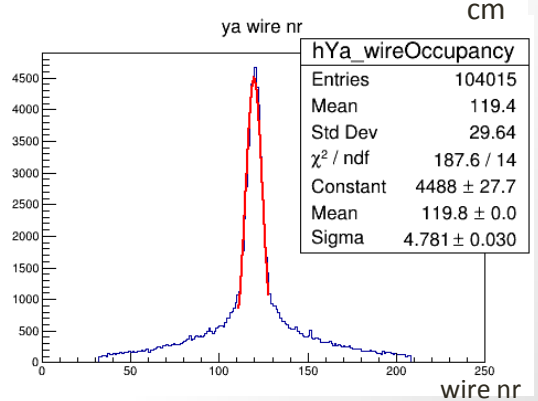
Wire occupancy

The difference is due to the width of the beam

Data segments



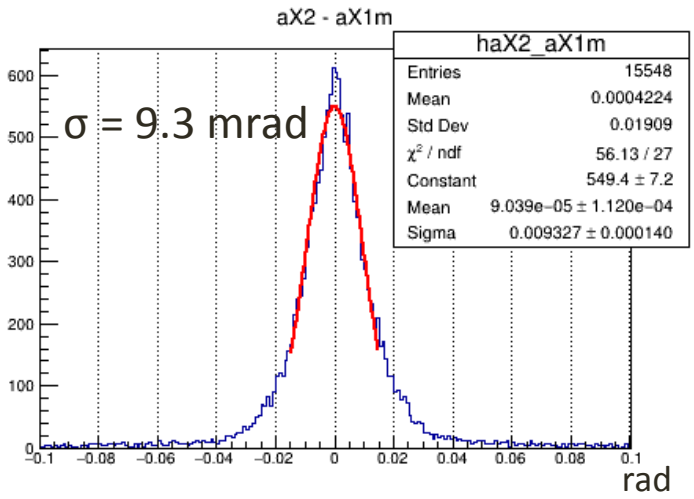




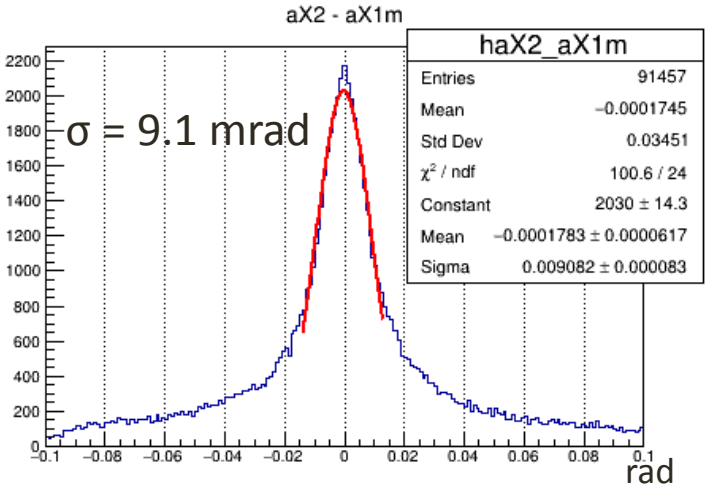
Difference in slopes between DC1 & DC2

C beam, empty target, B = 1200A

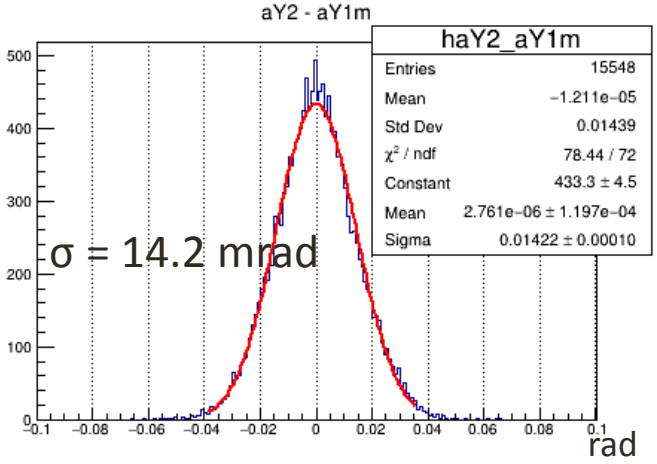
MC reco



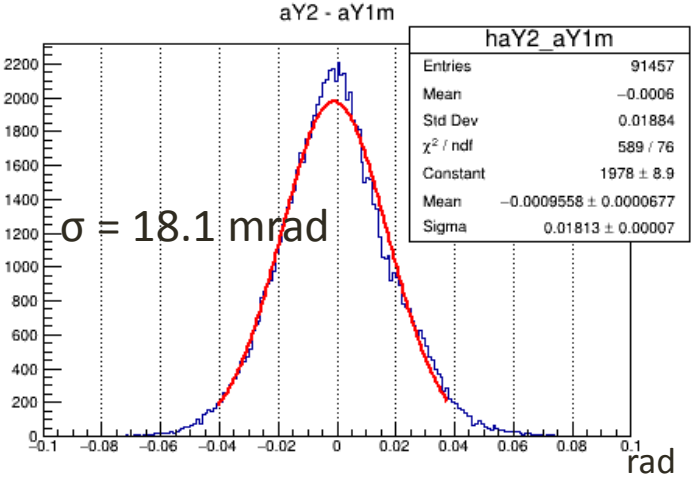
data reco



X slope



Y slope



20K events

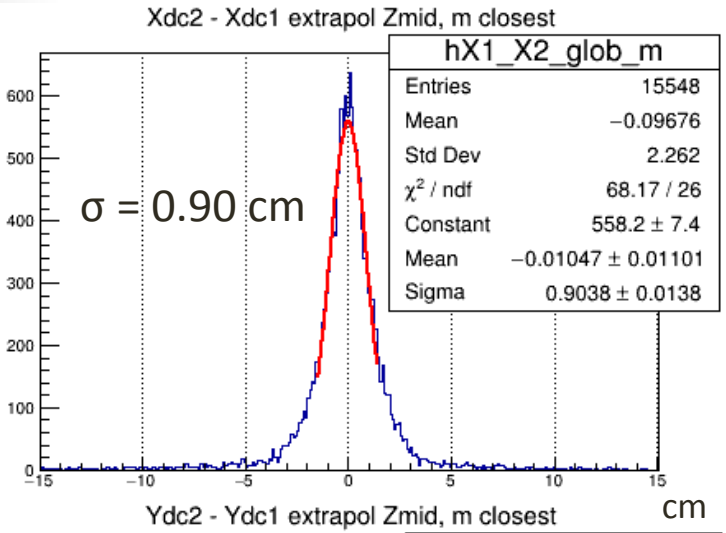
100K events

MC slope difference distributions are adequate to SRC data

Difference in coordinates for matching DC1 with DC2

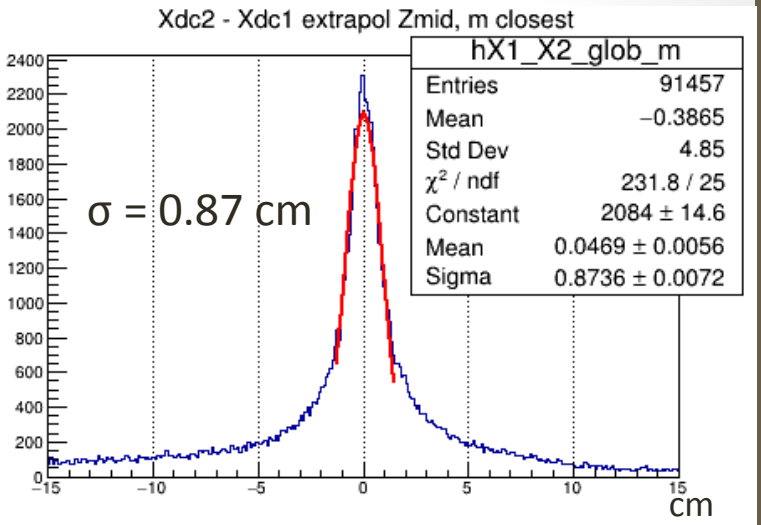
C beam, empty target, B = 1200A

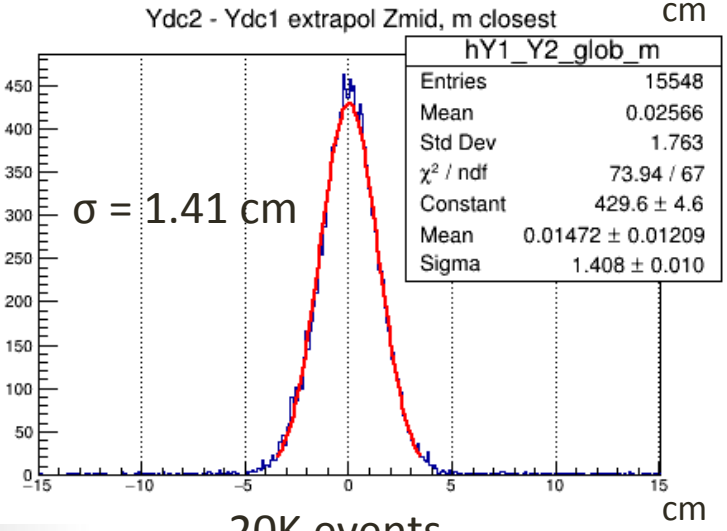
MC reco



X

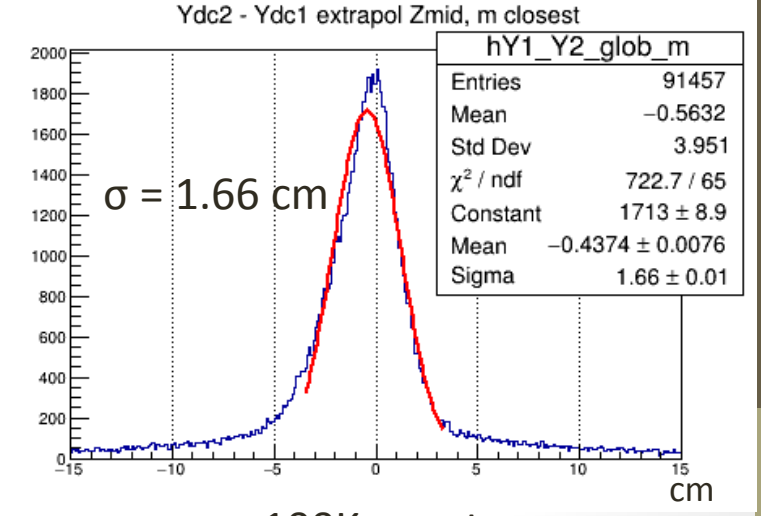
data reco





20K events

Y



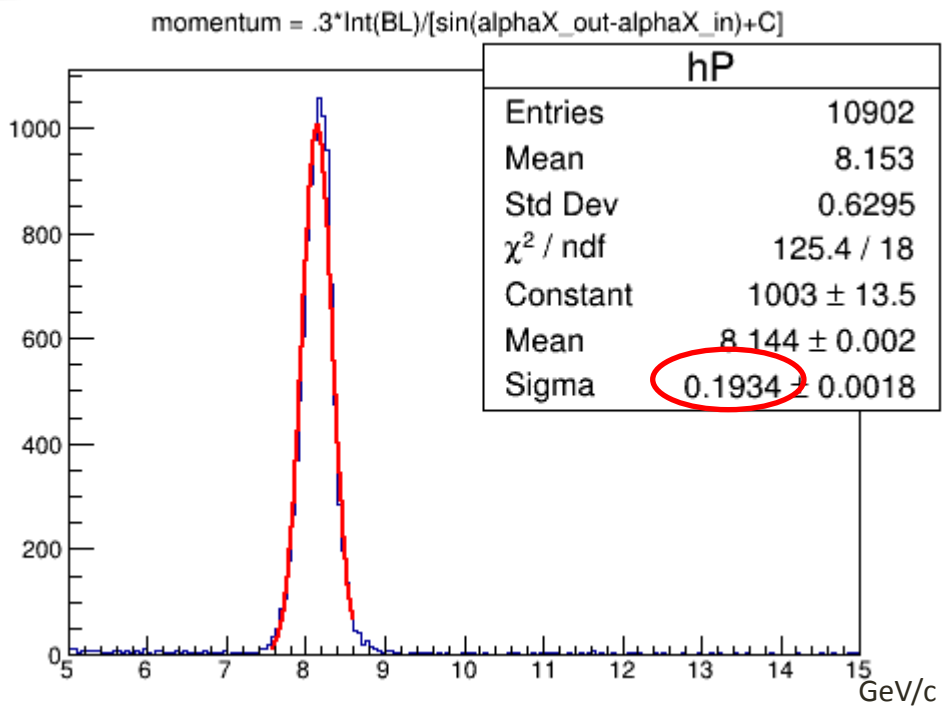
100K events

Smearing for MC coordinates is adequate to SRC data

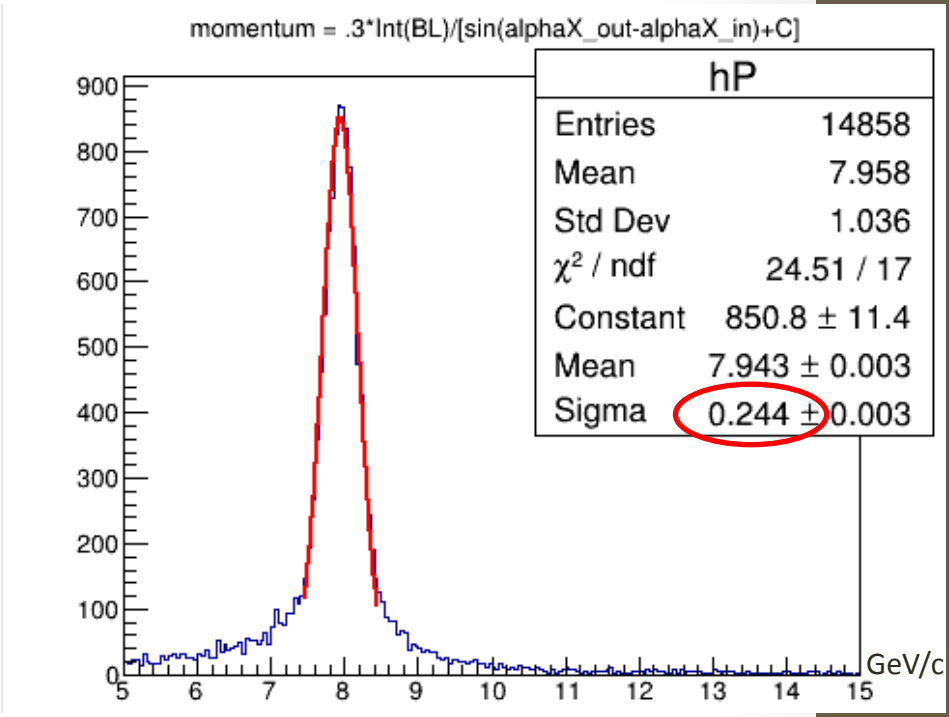
C Beam momentum resolution

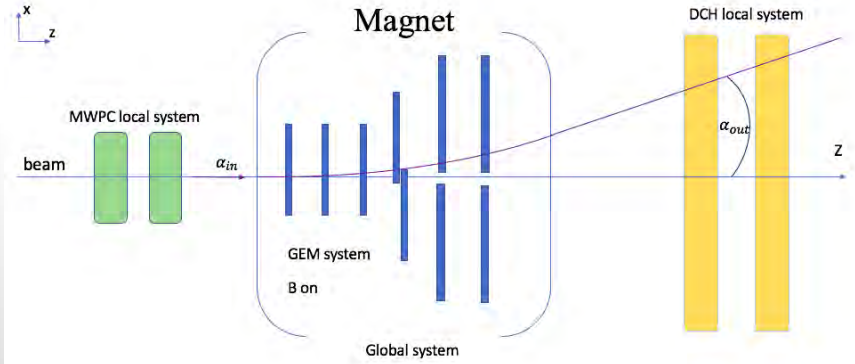
C Beam, empty target, B = 1200A

MC DCH global tracks



RUN7 data DCH global tracks





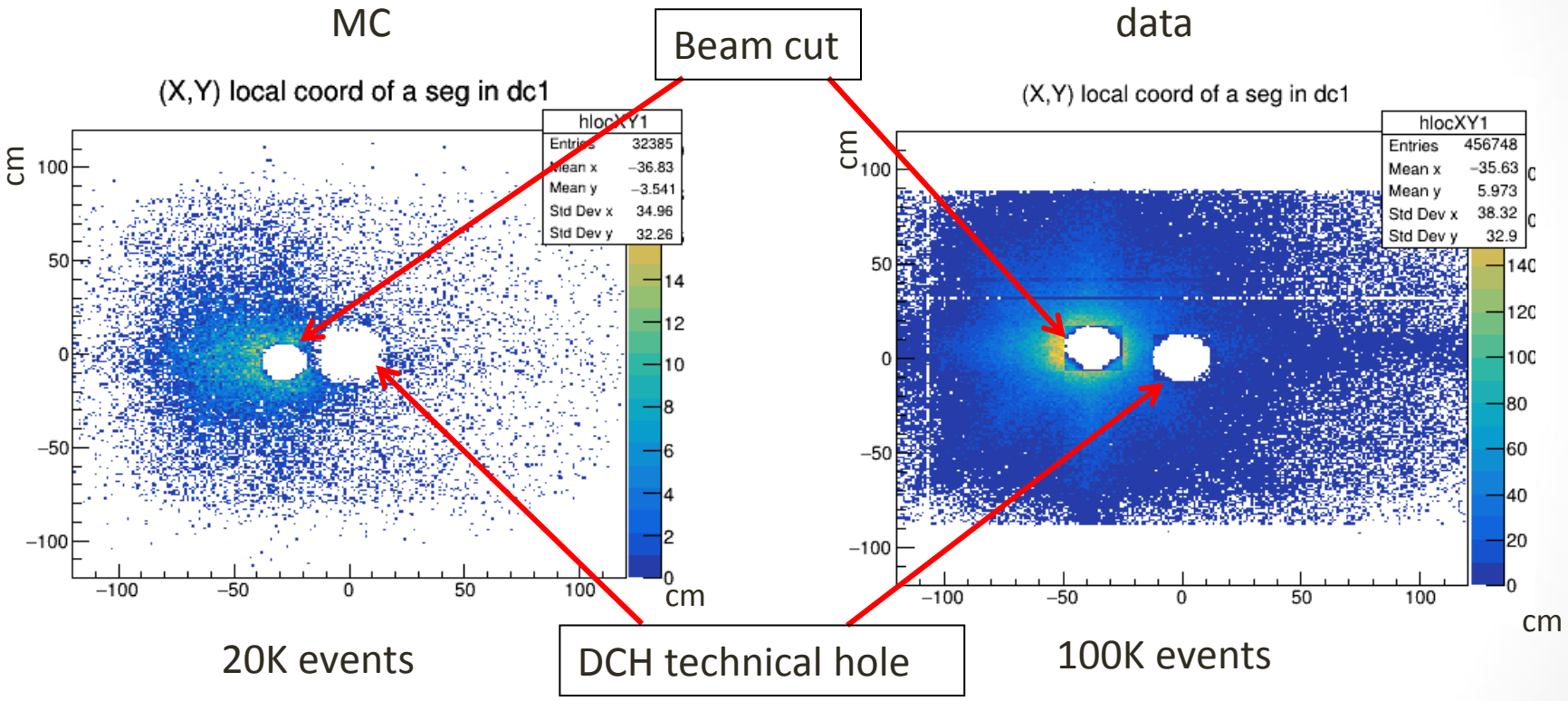
$$P_{beam(est)} = \frac{0.3 * \int Bdl}{\sin(\alpha_{out} - \alpha_{in})}$$

α_{in} - angle of beam before magnet (MWPC);
α_{out} - angles of beam after magnet (DCH);
$\int Bdl$ - magnet field integral [T*m].

Ar beam e.m. contaminated MC data vs. Ar data

Ar beam, empty target, B = 1250A

DCH1 reconstructed segments local coordinates



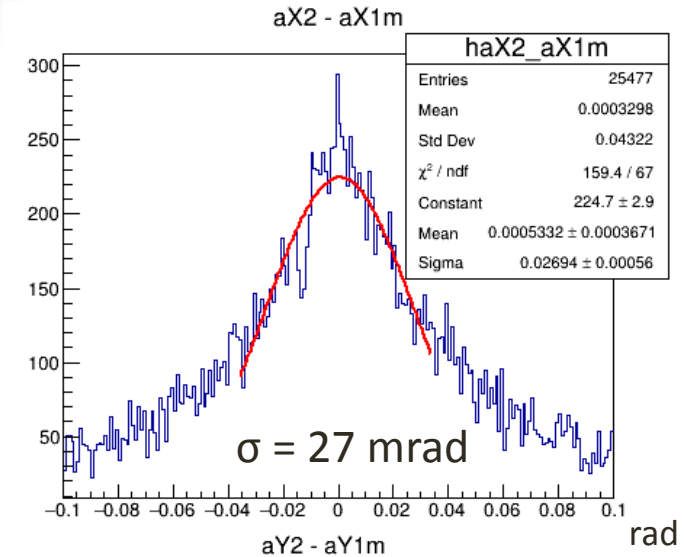
Remark. Cut on beam region applied in order for reconstruction to work properly

Difference in slopes for DC1 & DC2

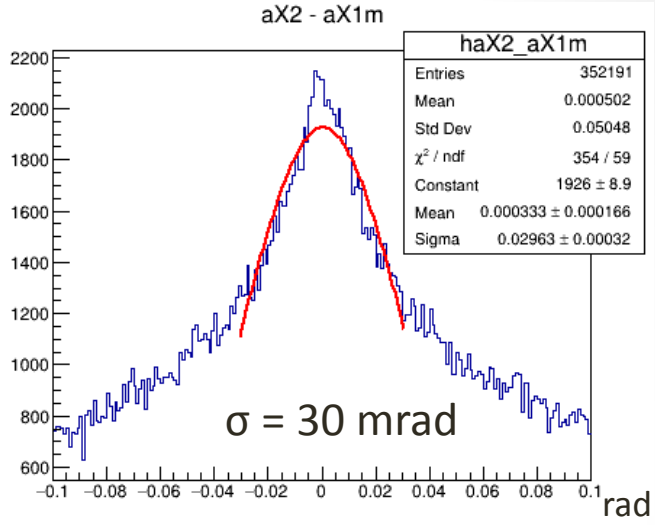
MC

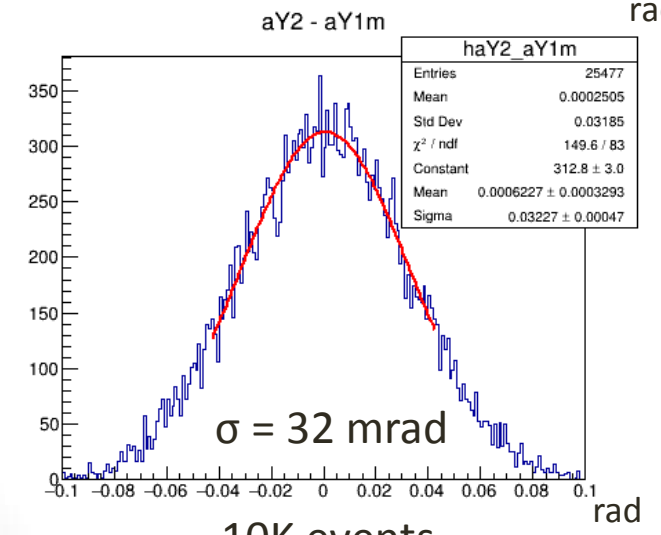
Ar Beam, empty target, B = 1250A

data

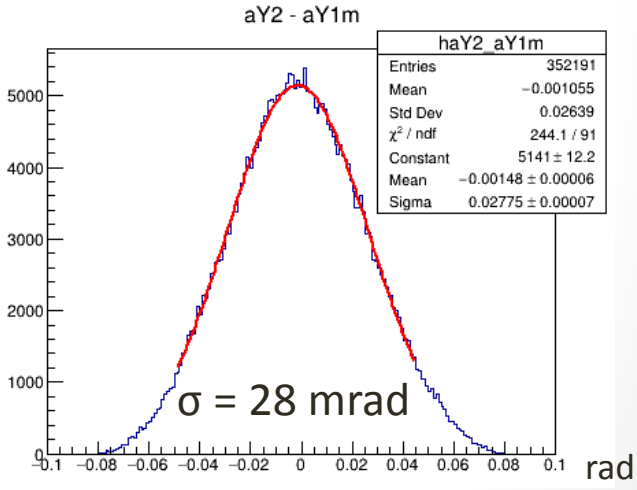


X slope





Y slope



10K events

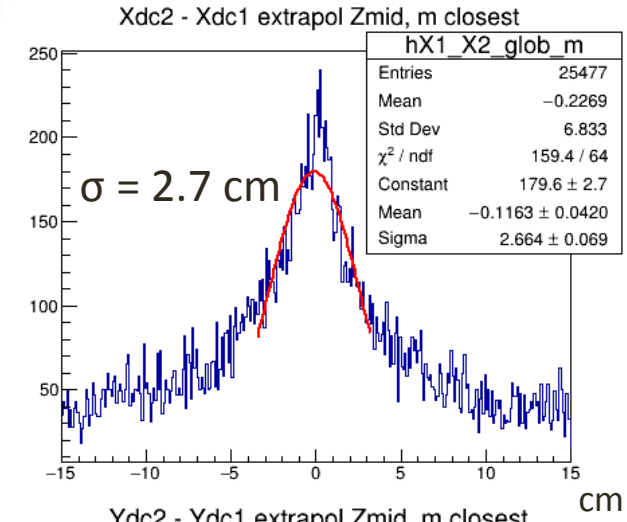
100K events

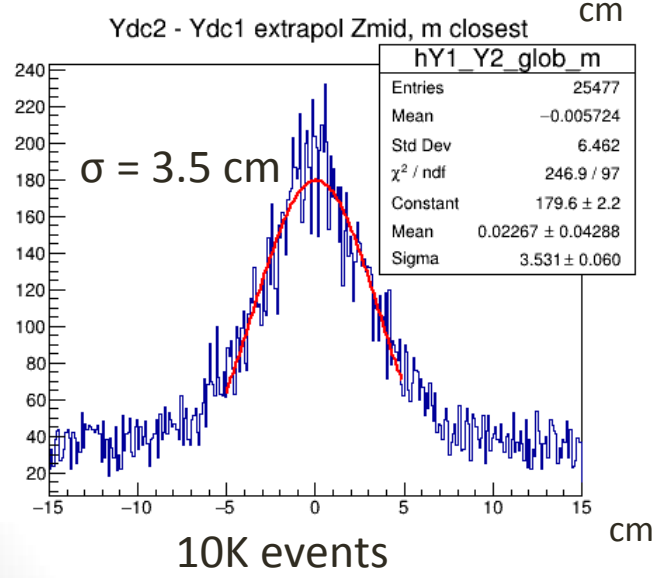
MC slope difference distributions are adequate to Ar data

Difference in coordinates for matching DC1 with DC2

Ar Beam, empty target, B = 1250A

MC reco



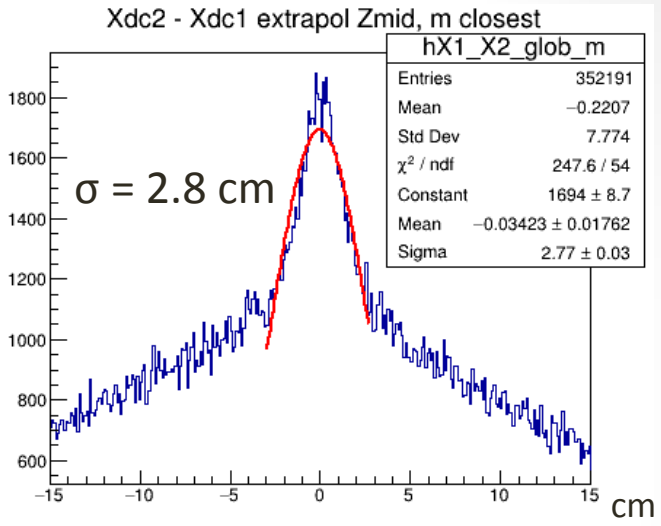


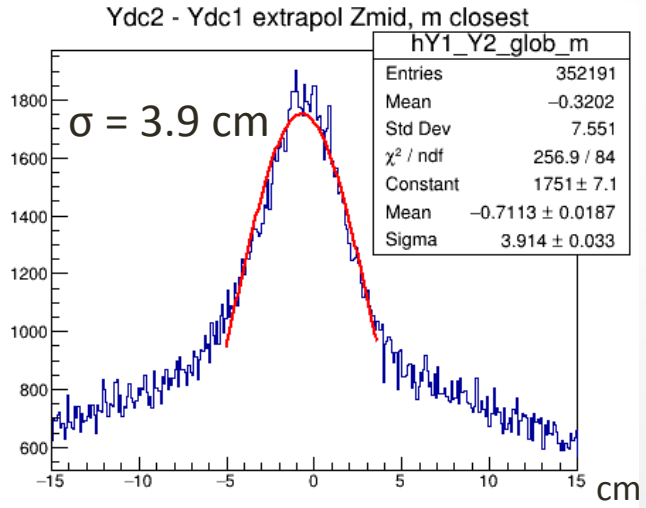
10K events

X

Y

data reco





100K events

Smearing for MC coordinates is adequate to Ar data

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Part2

Gem + DCH + tof700 matching with MC data

Criteria and Notations

"Good" GEM tracks – those which pass cut selection.
Yuri Petuhkov data cut

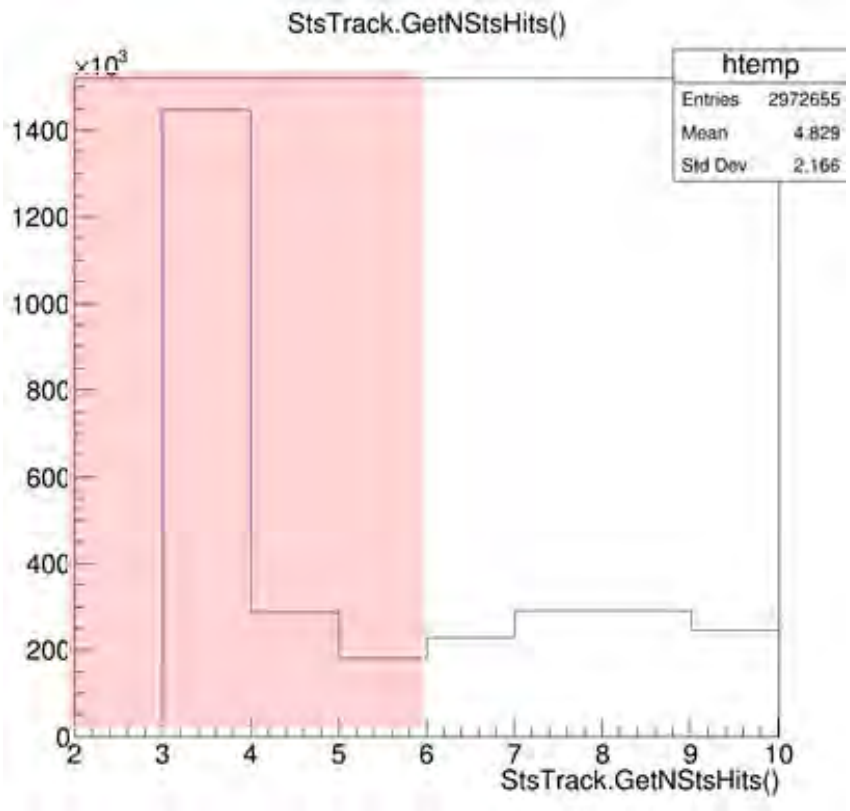
```
if (nSiGemHits < 6  ||
gemX < -140 || gemX > 240 ||
gemY < -40 || gemY > 200 ||
gemTx < -0.5 || gemTx > 1.0 ||
gemTy < -0.1 || gemTy > 0.5 ||
Xpv  < -3.5  || Xpv  > 4.0 ||
Ypv  < -1.0  || Ypv > 6.0 ||
Qp == 0.0  ||  1.0/TMath::Abs(Qp) > 15.0 || 1.0/TMath::Abs(Qp) < 0.15 ||
gemZ < 500)  continue;
```

Matching criteria:
"Good" GEM+DCH tracks – those which pass cut selection.
Abs(Dx)<4 σ and Abs(Dy)<4 σ

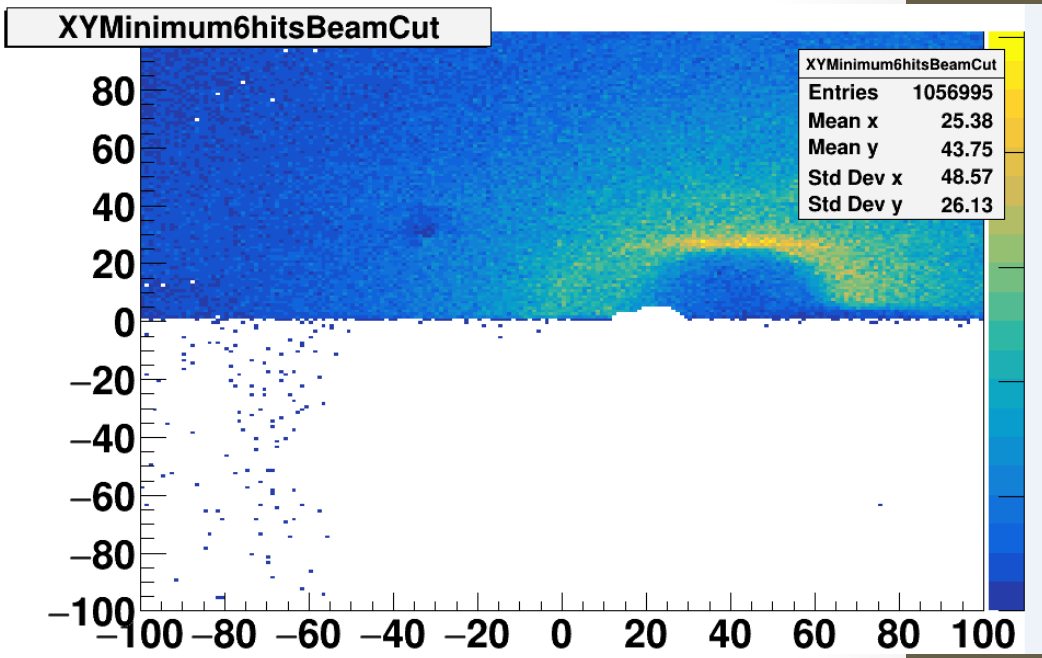
"Good" GEM+DCH tracks+TOF700 hits matching criteria:
track and hit pairs are sorted in a multimap by minimum distance, unique pairs are selected **MAX distance (R) cut ~7 cm**

“Good” Gem Tracks

L1 tracking used for DCM-SMM Simulated Ar+target, B= 1250 A



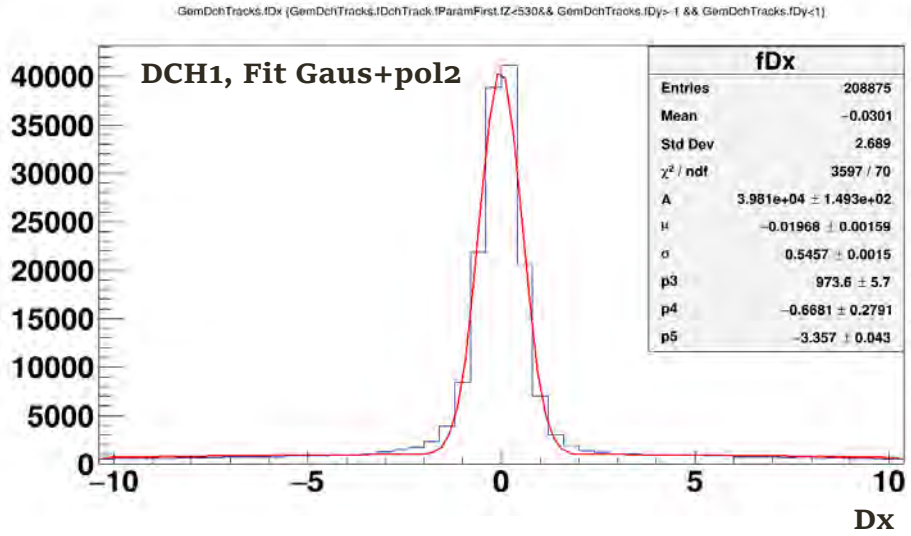
Minimum 6 SIGEM hits

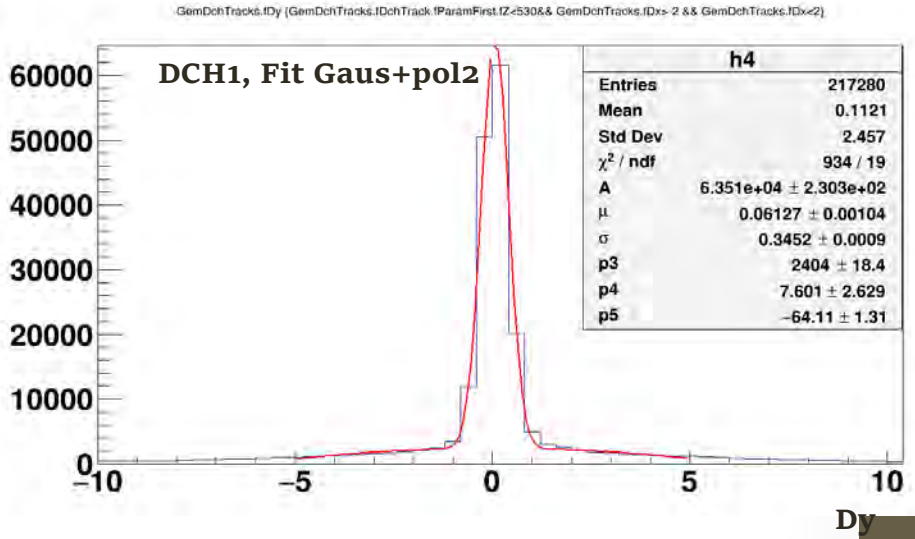


GEM to DCH extrapolation

“Good” GEM tracks are 1/3 of all GEM tracks associated with MC Id

GEM-DCH1 Matching Criteria





Function: Gaus + pol2

Dx-peak is situated in interval of ±2cm

Dy-peak is between ±1cm

Dx σ ~ 0.54

Dy σ ~ 0.34

Matching criteria: **Abs(Dx)<4 σ and Abs(Dy)<4 σ**

GEM-DCH Matching Efficiencies

$N_{gem\ trs}$= **2 886 024** all gem tracks associated with MC track

$N_{good\ gem\ trs}$ = **1 030 346** gem tracks with minimum 6 si-gem hits and associated with MC track

$N_{w.\ dch\ tr}$ = **148 831** dch tracks that are associated with a MC track and correspond to a good gem track

$N_{\ matched\ trs}$ = **124 511** dch tracks that pass matching criteria with good gem

$N_{\ true\ matched\ trs}$= **123 523** matched dch tracks that coincide by associated MC track.

$$Eff_{MC\_Id\_matching} = \frac{N_{truematchedtrs}}{N_{matchedtrs}} = \frac{123\,523}{124\,511} = 99.2\,\%$$

$$Eff_{matching} = \frac{N_{truematchedtrs}}{N_{w.dchtr}} = \frac{124\,511}{148\,831} = 82.99\,\%$$

GEM-DCH-TOF700 Matching Efficiencies

$N_{\text{good gem dch trs}}$ = **124 511** good gem tracks that pass the matching criteria with dch

$N_{\text{w. tof hit}}$ = **107 766** tof hits that have MC Id corresponding to good gem dch track

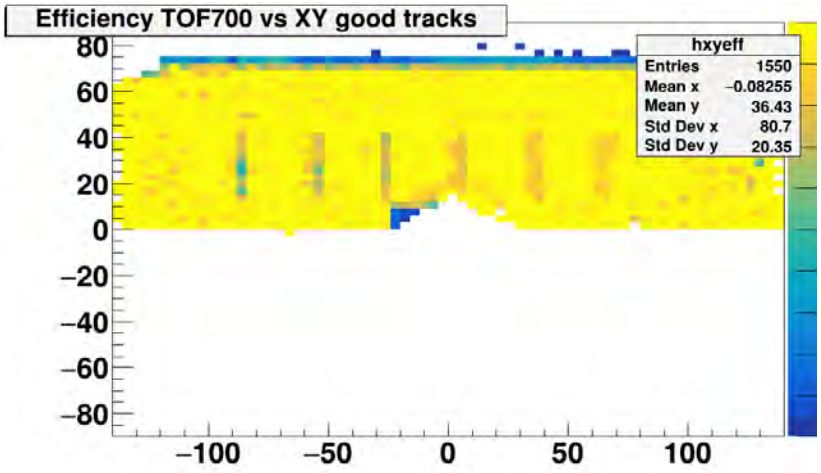
$N_{\text{matched trs}}$ = **95 838,** tof hits that pass the matching criteria with good gem dch track

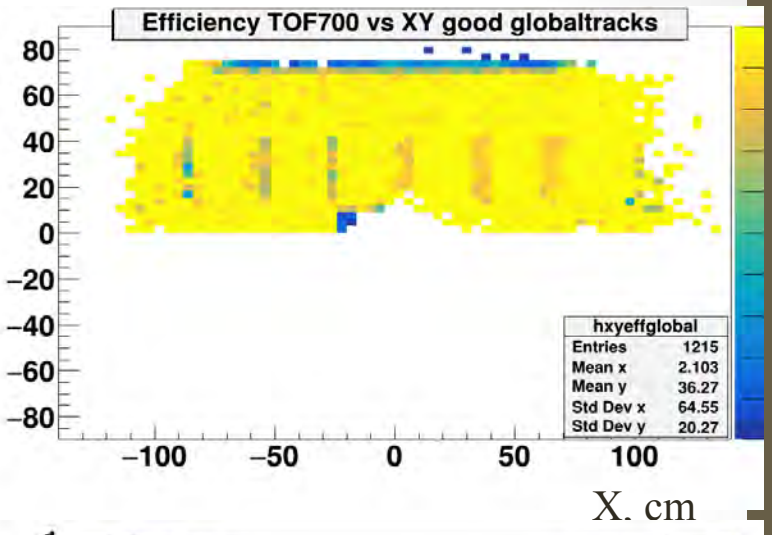
$N_{\text{true matched trs}}$ = **91 218** tof hits that pass the matching criteria and coincide by MC Id with good gem track

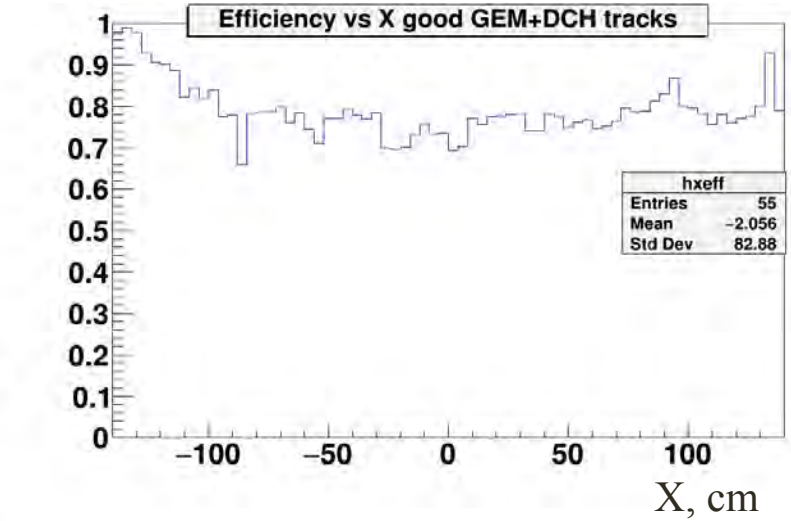
$$Eff_{MC\_Id\_matching} = \frac{N_{truematchedtrs}}{N_{matchedtrs}} = \frac{91\ 218}{95\ 838} = 95.17\,\%$$

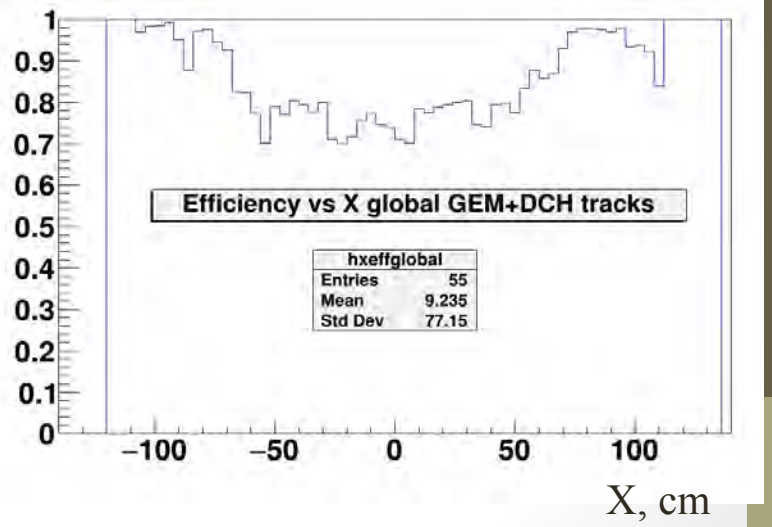
$$Eff_{matching} = \frac{N_{truematchedtrs}}{N_{w.tofhit}} = \frac{91\ 218}{107\ 766} = 84.64\,\%$$

TOF700 Efficiency vs XY









Efficiency is good enough. Small edge effect.

Conclusions

1) DCH MC vs. data:

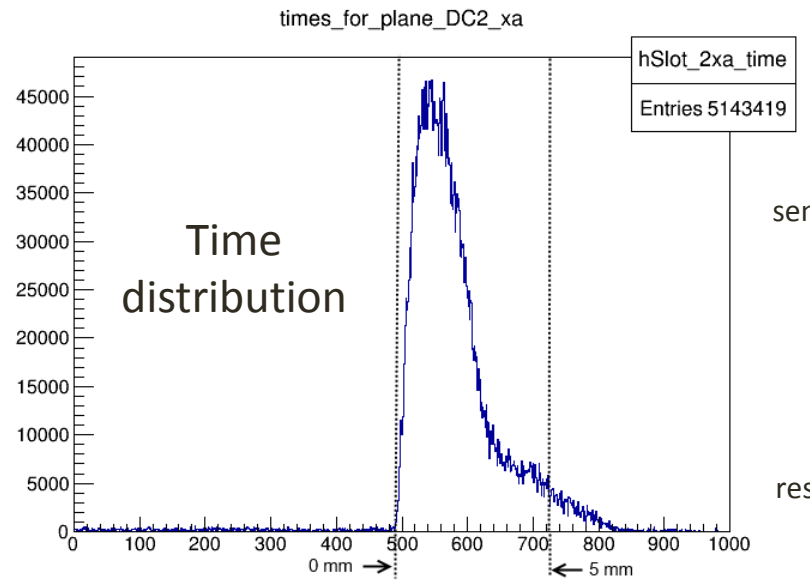
- MC with adequate DCH hit smearing was done
- Residuals and segment parameters are in agreement between MC and data
- The differences for matching between two DCH chambers in slopes and coordinates are quite similar for MC and data

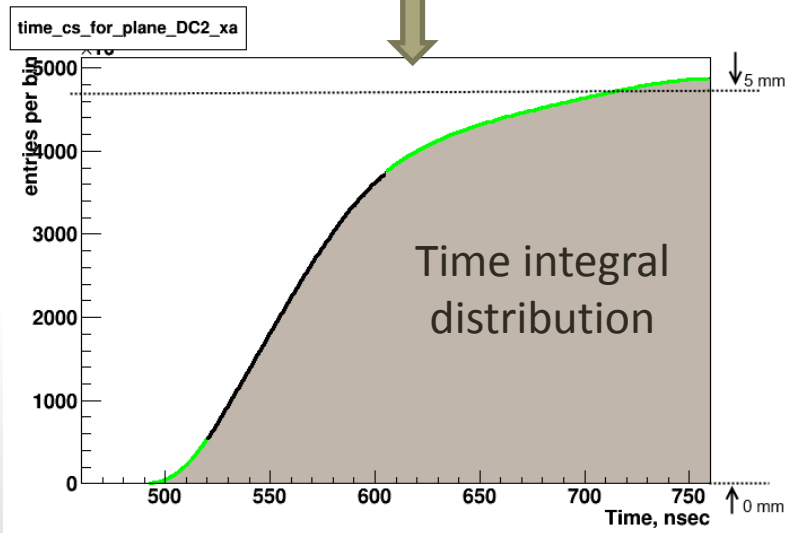
2) GEM-DCH-TOF700 matching for MC Ar+targets:

- GEM-DCH matching efficiency is 83% (tracking needs to be improved)
- MC Id matching efficiency is high - 99.2%
- GEM-DCH-TOF700 efficiency matching efficiency is high enough - 84.6%, while MC Id matching efficiency is 95.2%

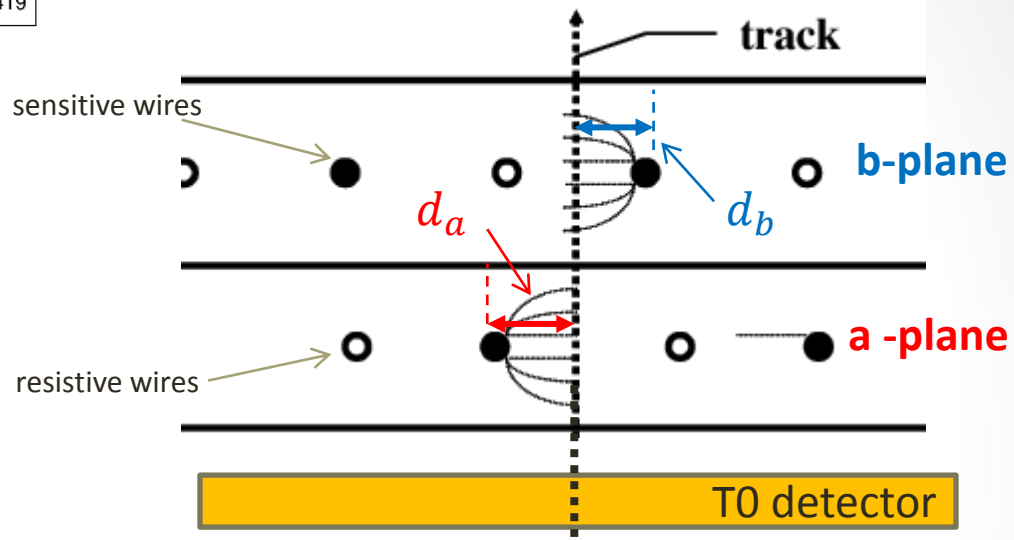
backup

Drift Chambers coordinate reconstruction on a layer





$$d_a + d_b - 5mm \rightarrow 0$$



- 4 double coordinate planes: 2x; 2y, 2u, 2v;
- wire angles 0°,90°,±45°;
- wire pitch 10 mm;
- Yout ± 1.35 m, Xout ± 1.35 m;
- R_hole = 10 cm;
- 2048 wires per chamber.

Drift Chambers Reconstruction & Performance

Hit reconstruction on a particular layer

↓

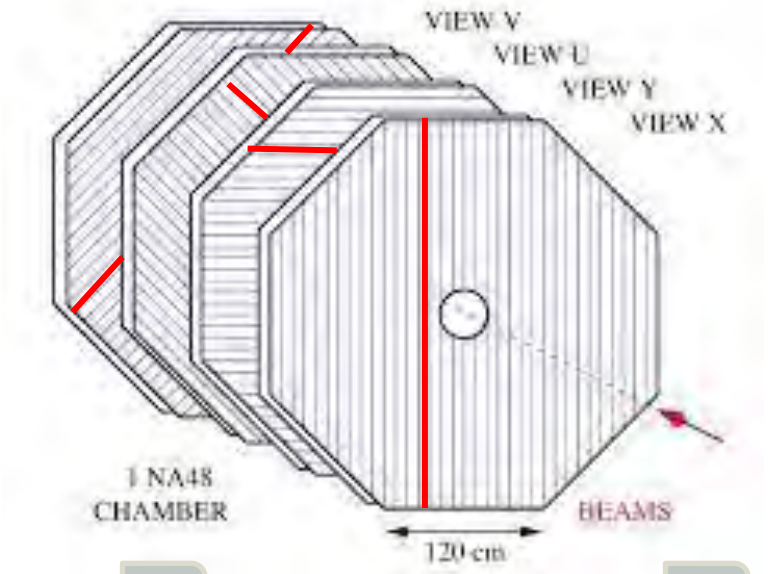
Pair hit assembly

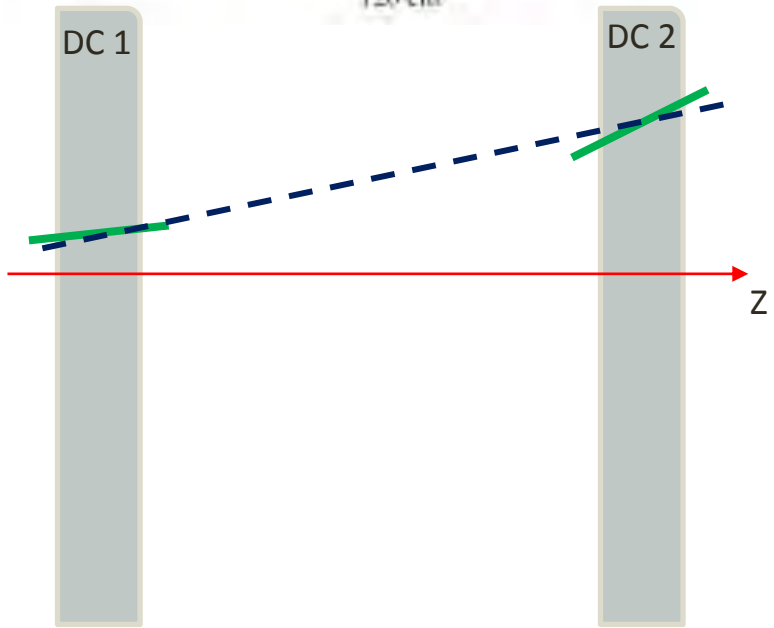
↓

Segment reconstruction

↓

Global track reconstruction



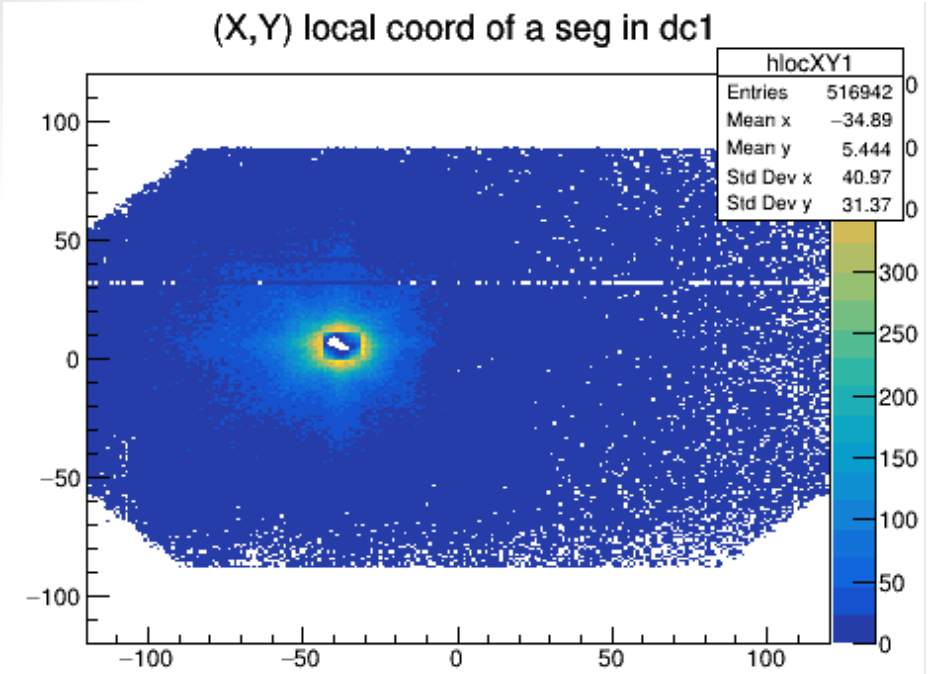


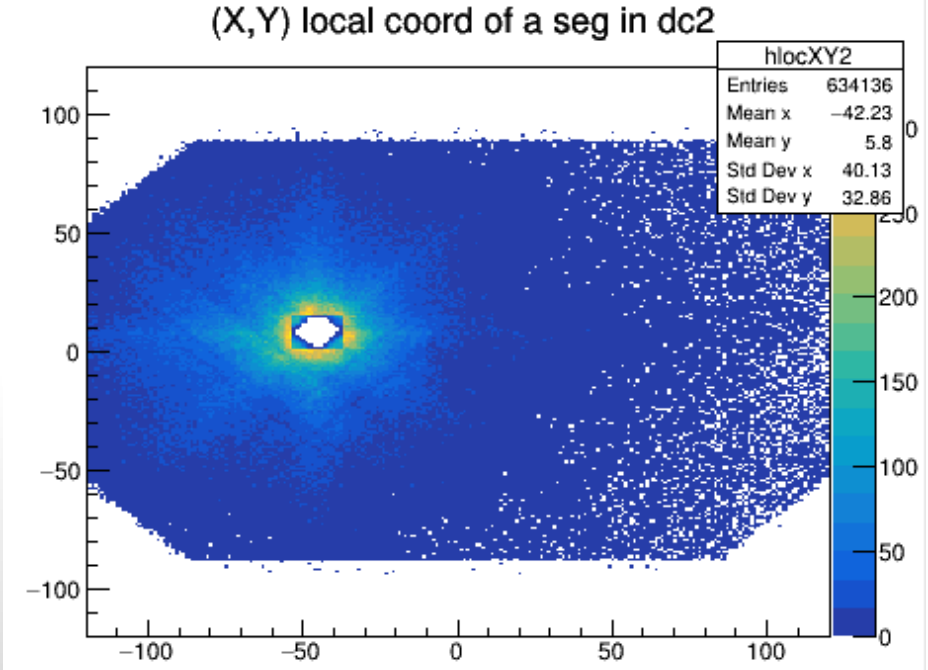
$$X = \frac{V-U}{\sqrt{2}};$$

$$Y = \frac{V+U}{\sqrt{2}};$$

- 4 double coordinate planes;
- wire angles 0°,90°,±45°;
- wire pitch 10 mm;
- Yout ± 1.35 m, Xout ± 1.35 m;
- R_hole = 10 cm;
- 2048 wires per chamber.

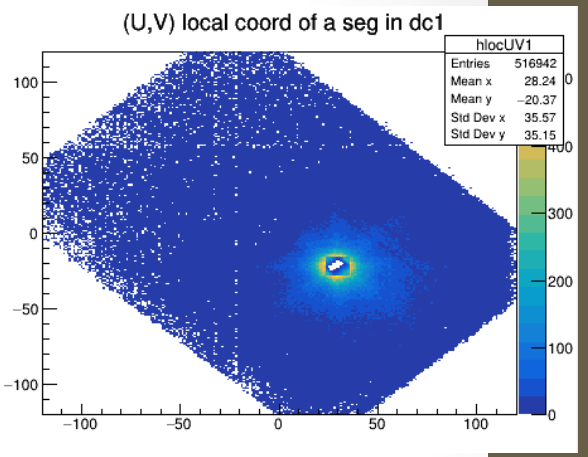
Beam cut





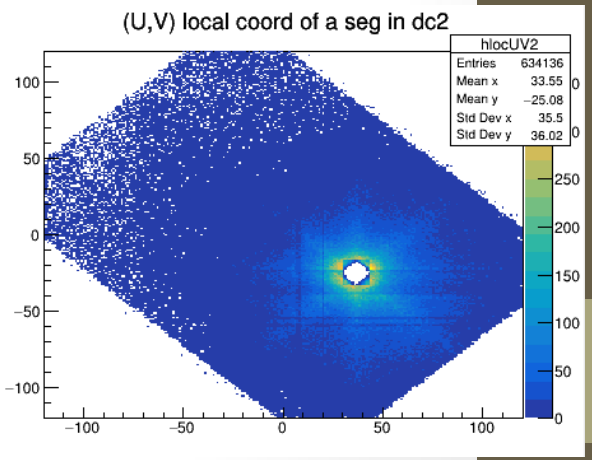
Run 4706, B = 1250A, empty target

DCH1



~10cm X 10cm cuts

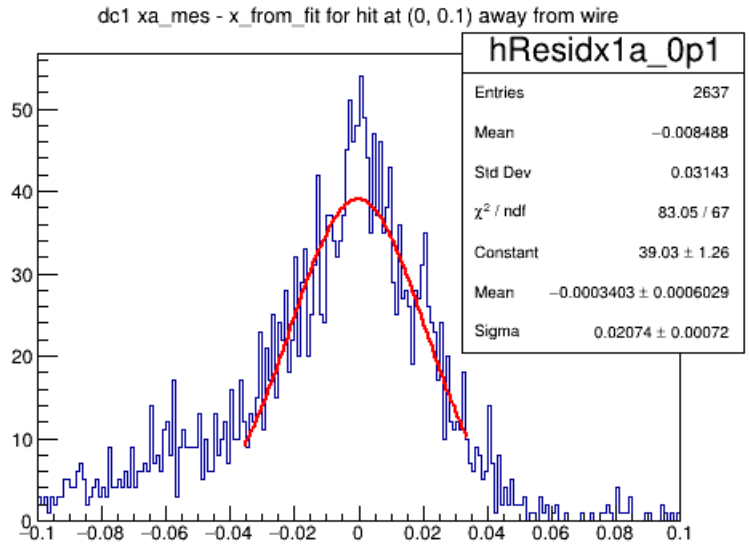
DCH2

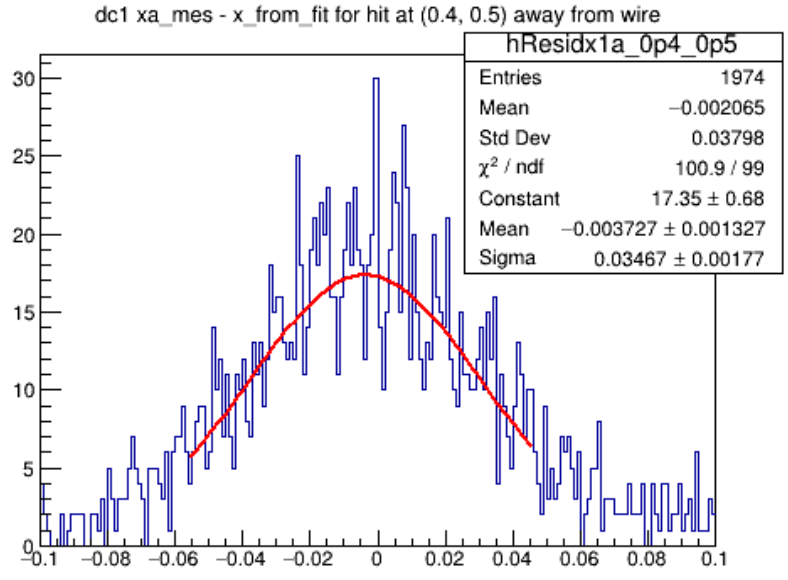


All in cm !!!

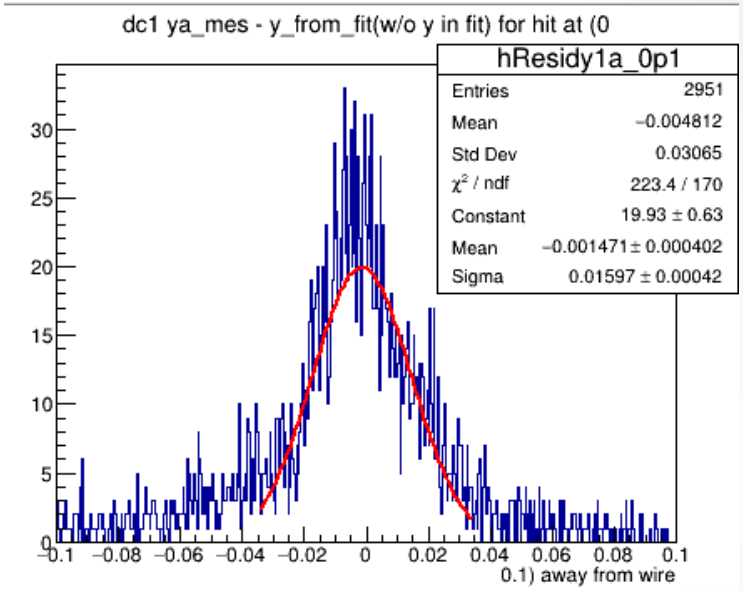
Residuals at edges

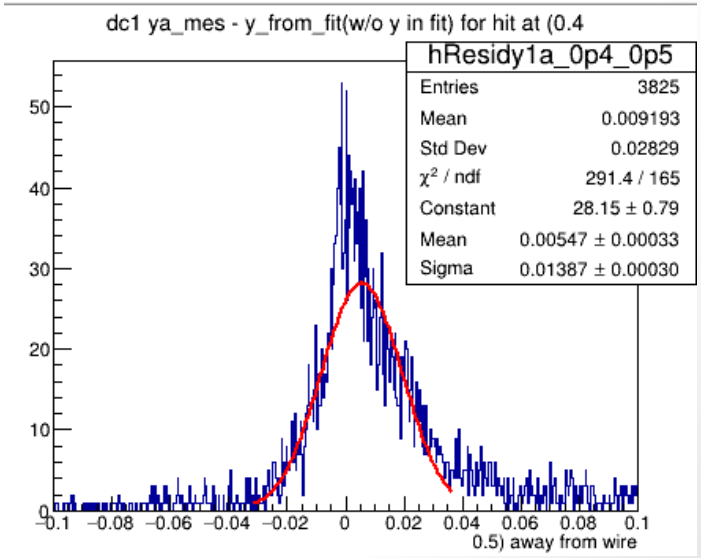
MC reco segs





Data reco segs



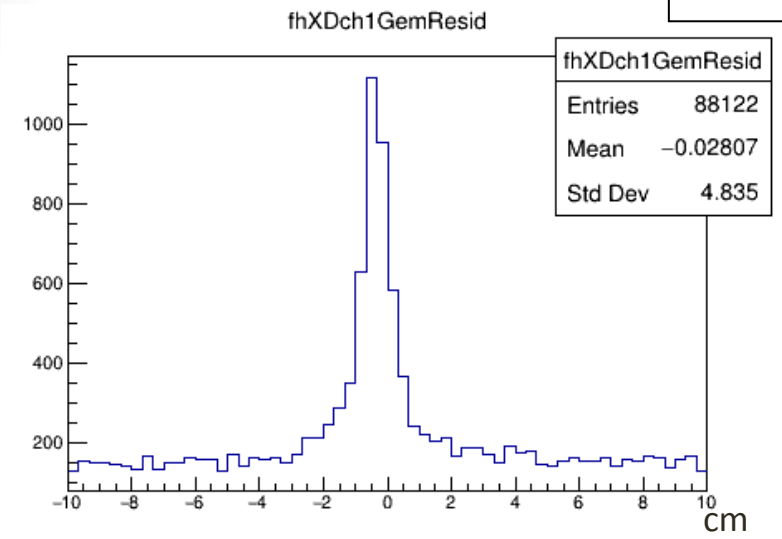


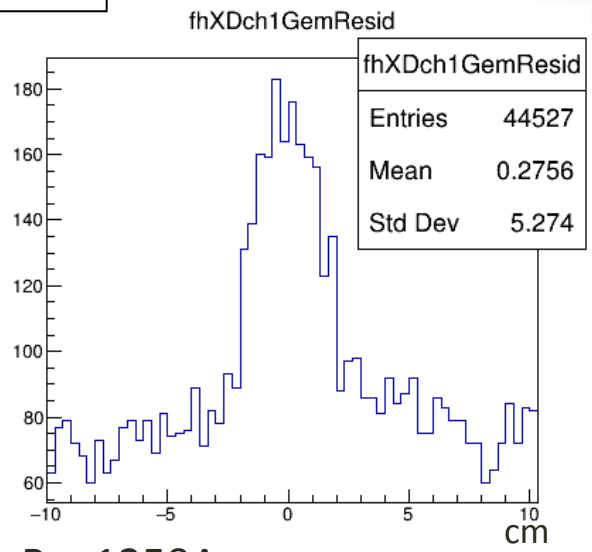
DCH – GEM matching

MC tracks

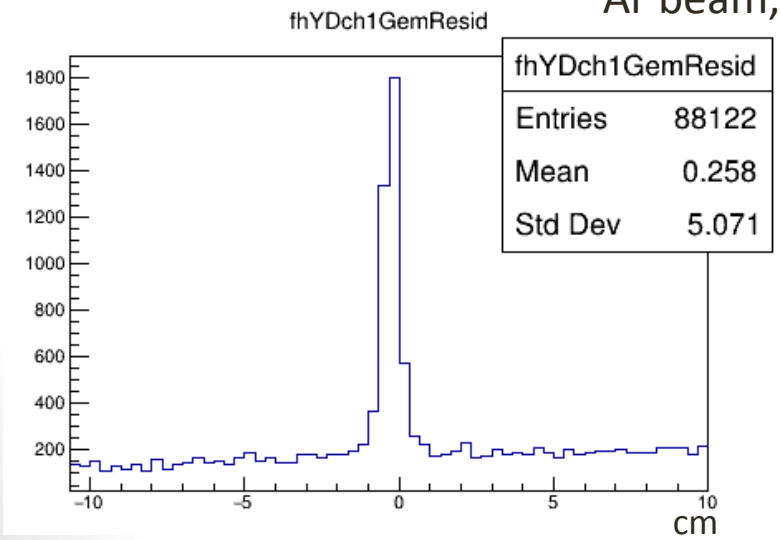
GEM(>= 5 hits) + DCH

data tracks

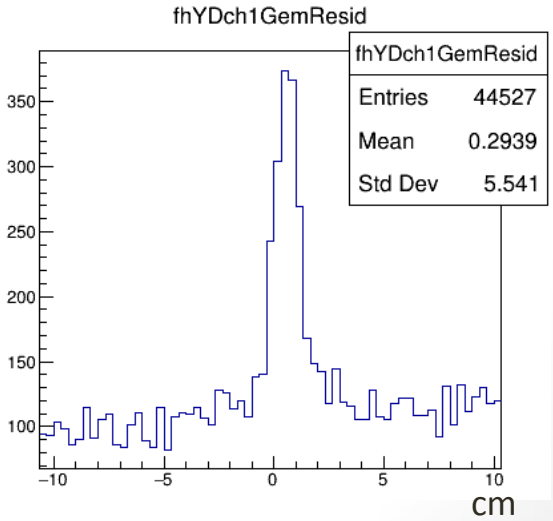




Ar beam, empty target, B = 1250A



10K events



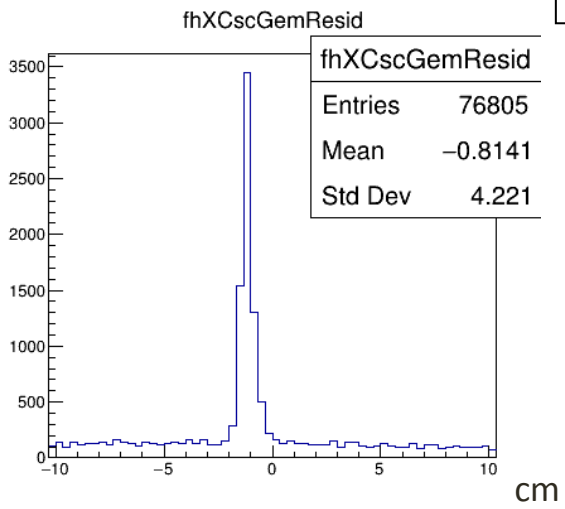
100K events

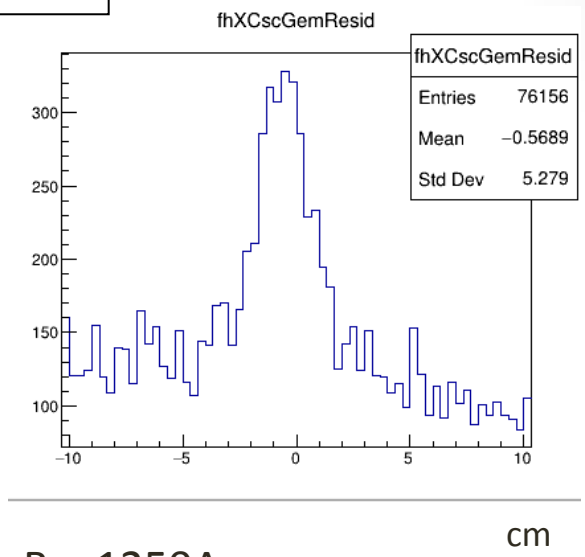
CSC – GEM matching

MC tracks

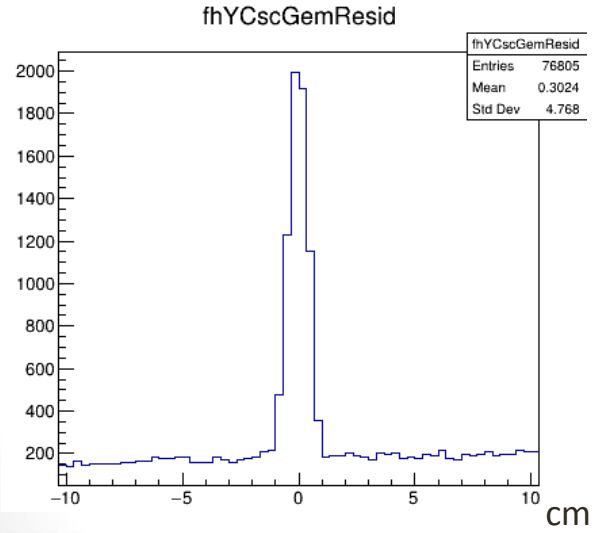
GEM(>= 5 hits) + CSC

data tracks

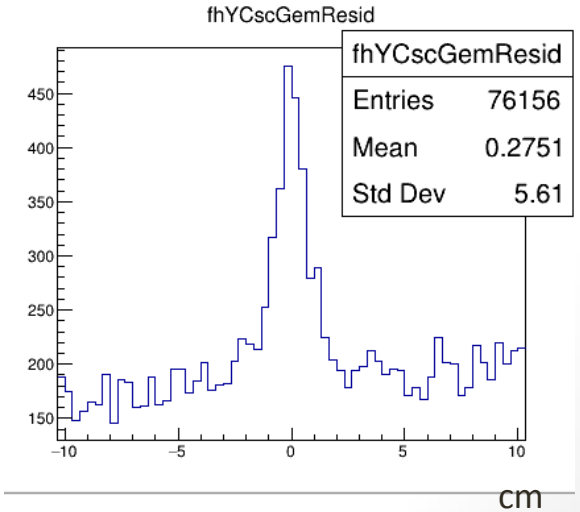




Ar beam, empty target, B = 1250A



10K events

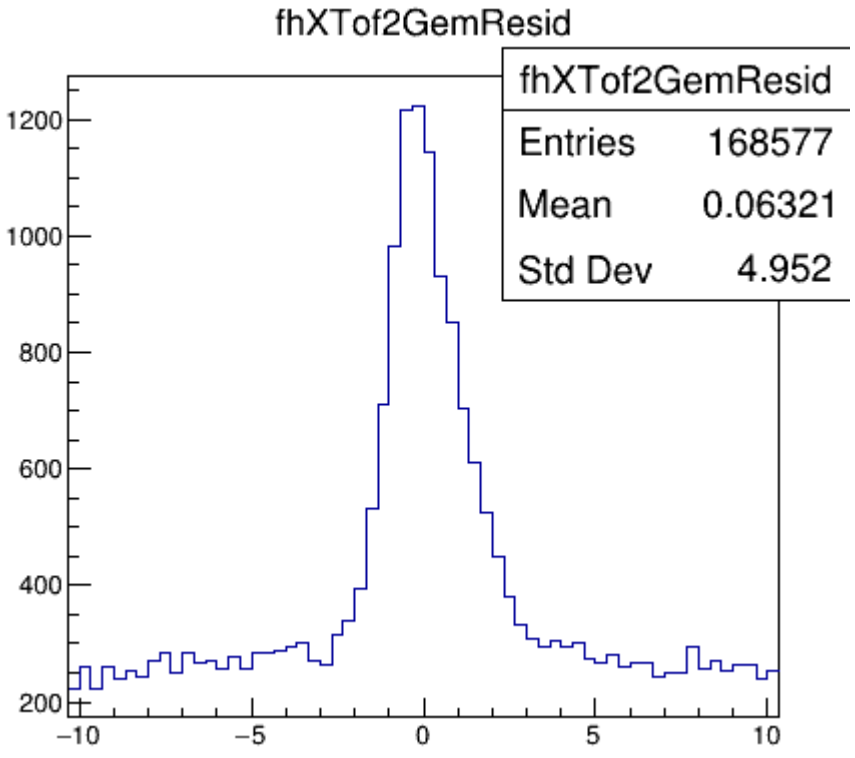


100K events

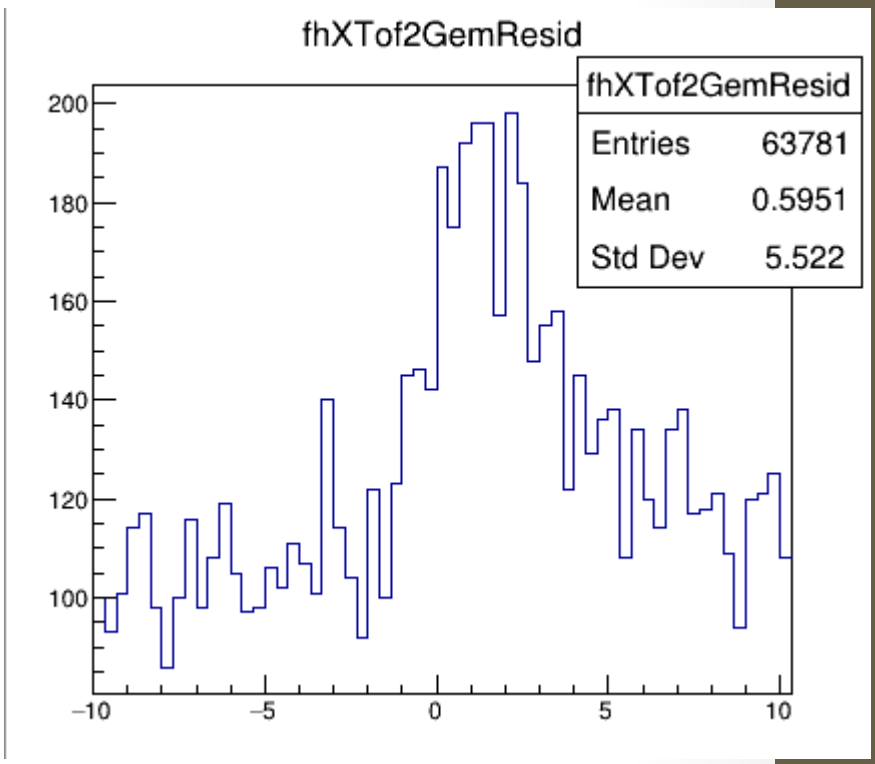
TOF700 – GEM matching

GEM(>= 5 hits) + CSC

MC tracks



data tracks



Ar beam, empty target, B = 1250A

Notations

$N_{\text{gem trs}}$ GEM tracks (reconstructed MC gem tracks)

$N_{\text{good gem trs}}$ ”Good” GEM tracks (those which pass cut selection)

$N_{\text{dch trs}}$ **DHC** tracks (reconstructed MC DCH1 tracks)

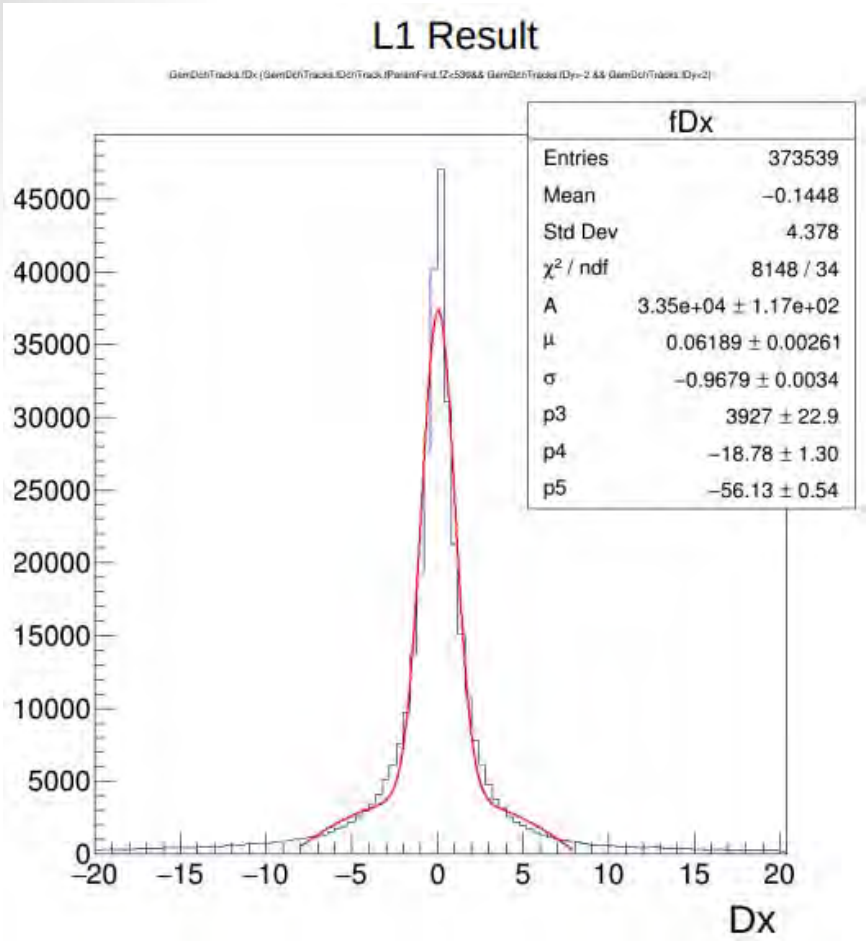
$N_{\text{w. all dch tr}}$ GEM tracks with a least 1 **DCH1** track

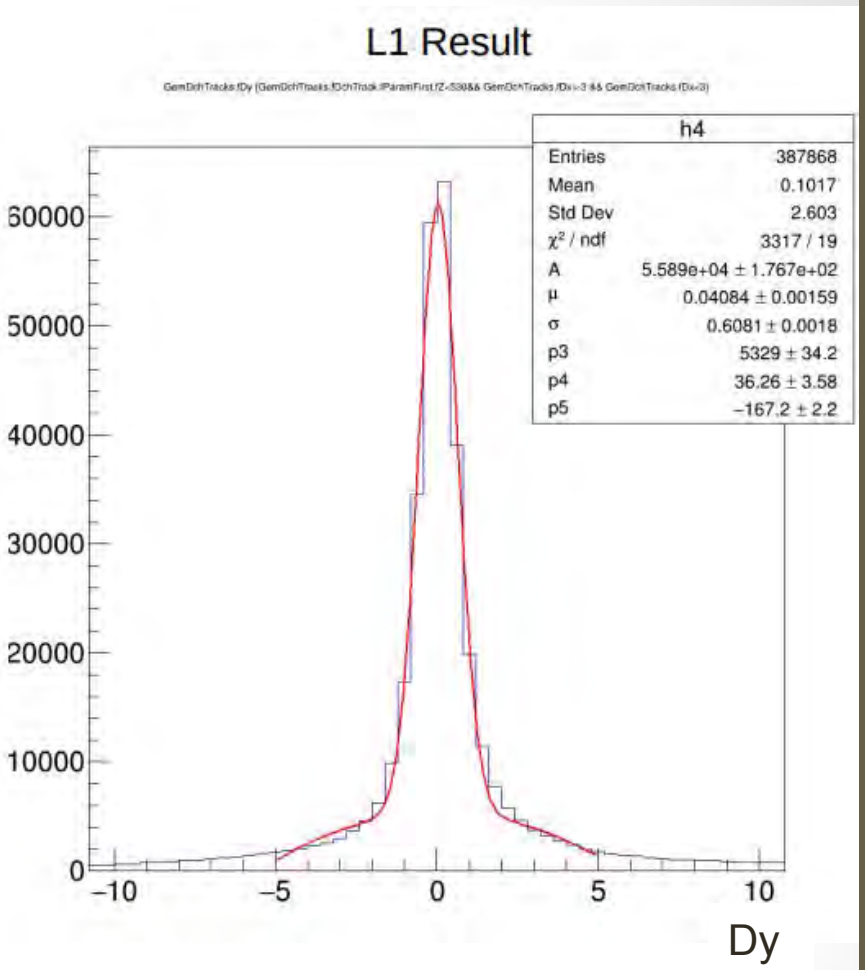
$N_{\text{w. dch tr}}$ ”Good” GEM tracks with a least 1 **DCH1** track

$N_{\text{matched trs}}$ GEM tracks extrap. to **DCH1** and **matched** to **DCH1** tracks

$N_{\text{true matched trs}}$ GEM tracks mathched to **DCH1** tracks and

29





GEM-DCH matching on Run7 Ar data