Simulation in Drift Chambers of the BM@N Experiment

D. Baranov, V. Palichik, M. Patsyuk, N. Voytishin
JINR

AYSS-2020
November 12, 2020

Drift Chambers Reconstruction Chain

Hit reconstruction on a particular layer

↓

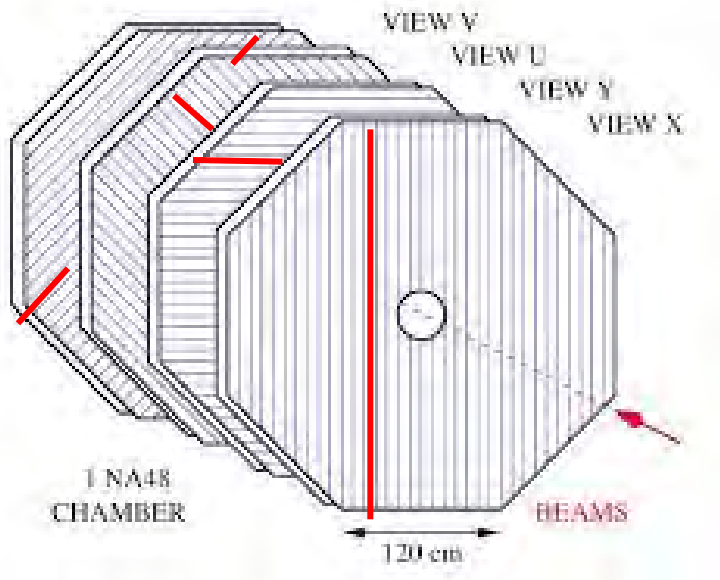
Pair hit assembly

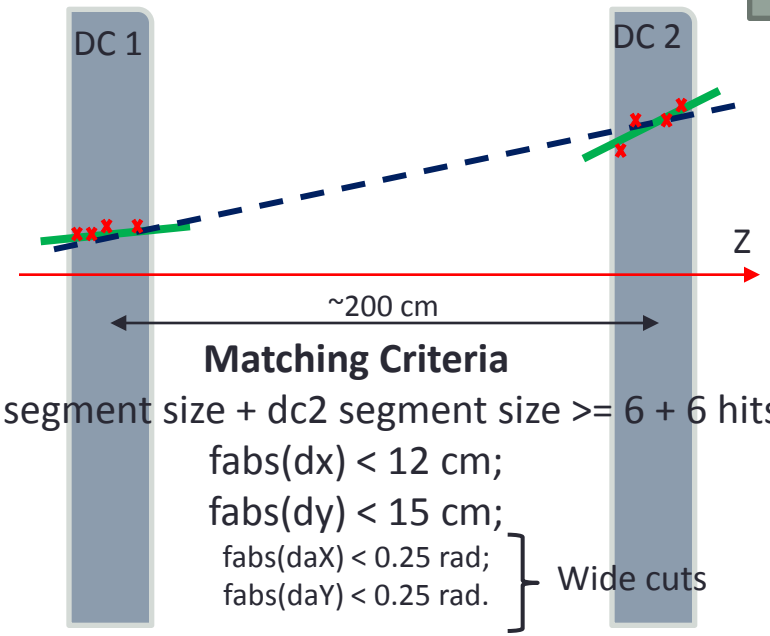
↓

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

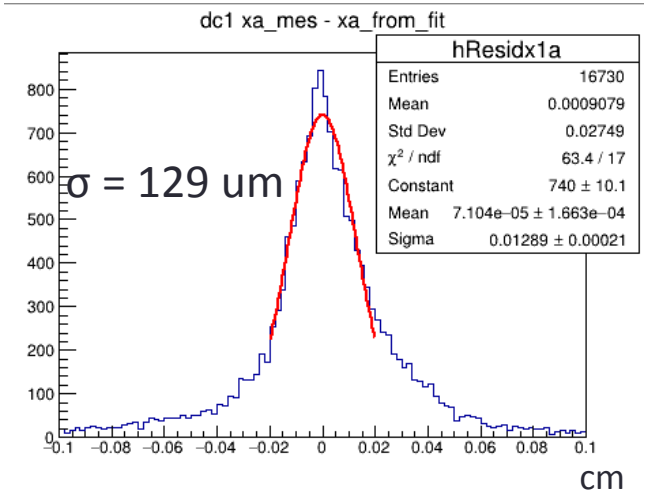
DCH
Hits on layer;
Segments;
global tracks

output

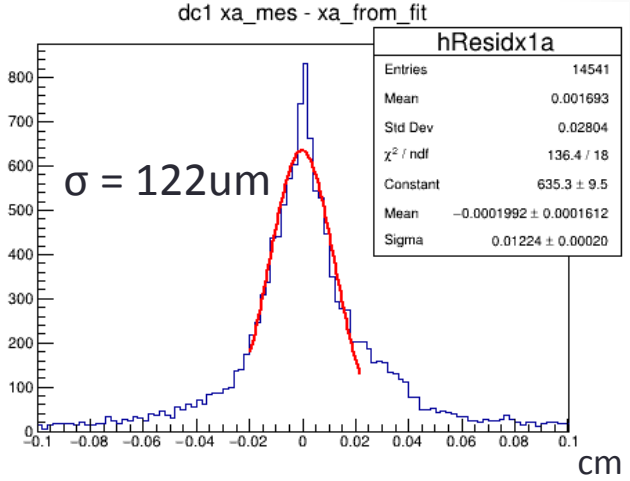
Some selected residuals [Measurement – segmentFit]

C beam, empty target, B = 1200A

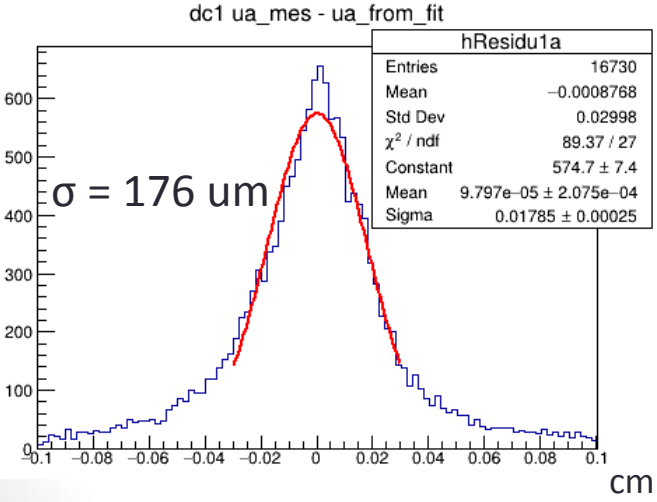
MC segments



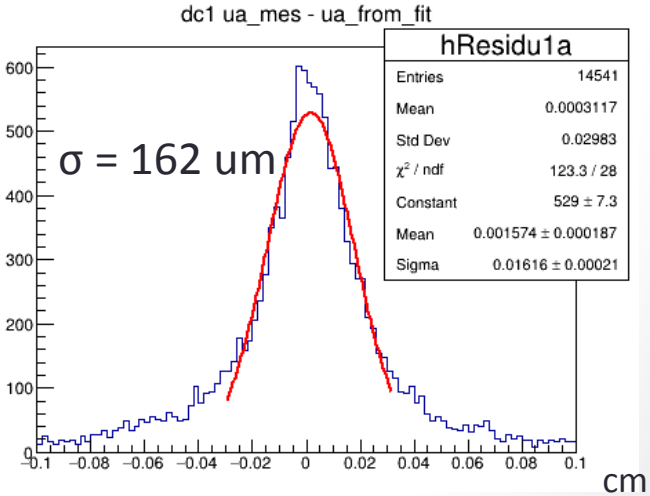
Data segments



X - coordinate



U - coordinate

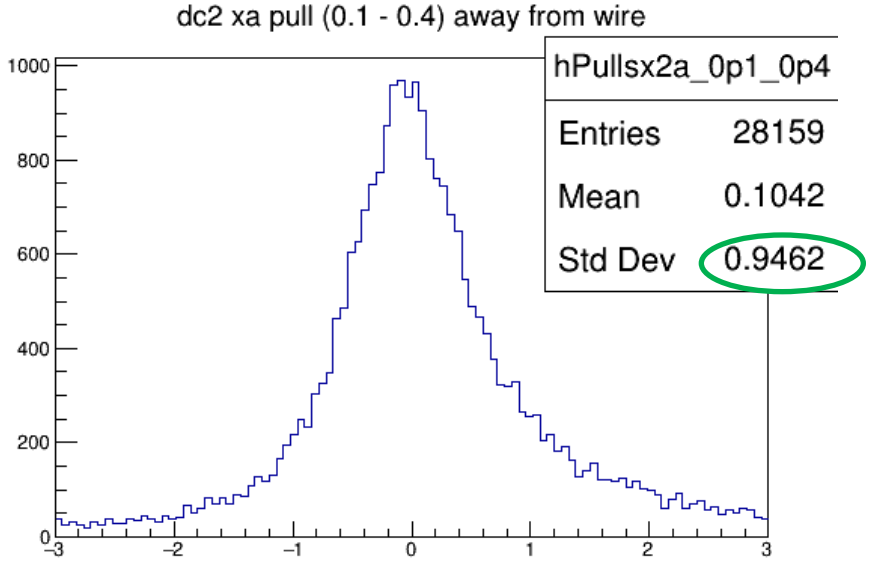


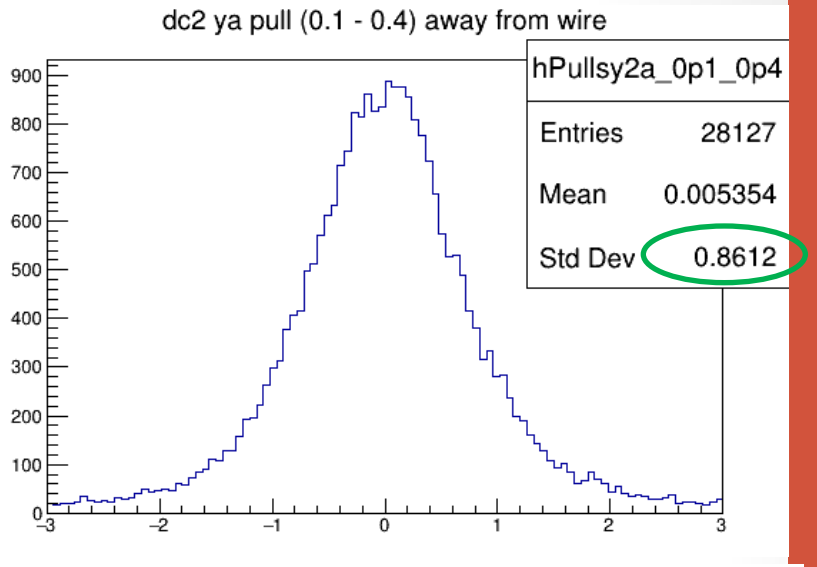
MC and data residuals are in agreement for all coordinates

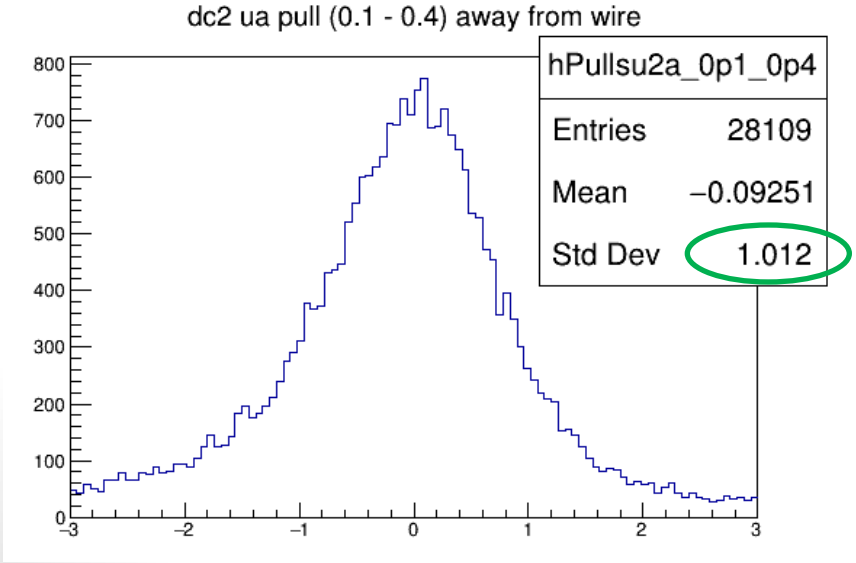
Pulls

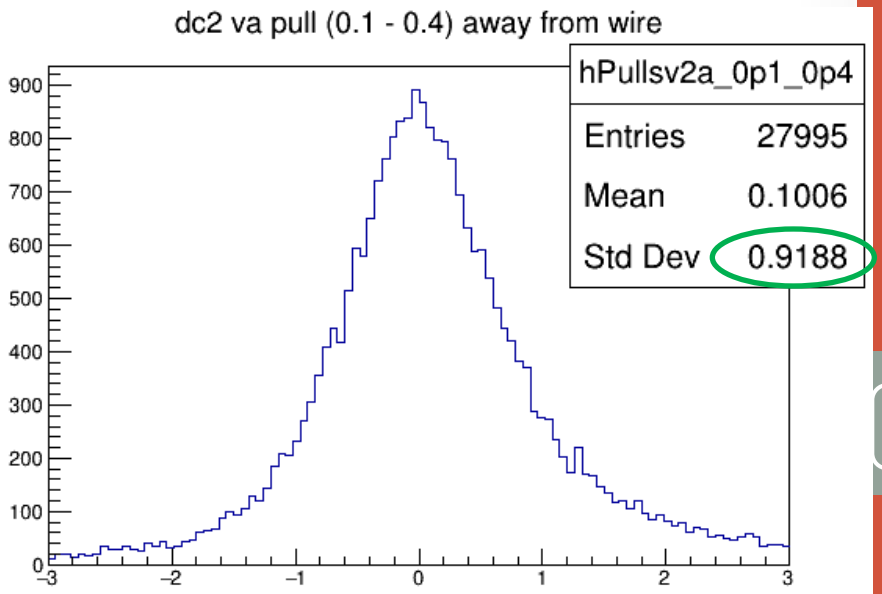
$$\frac{(X_{fit} - X_{measured})}{\sigma}$$

If σ for measurement is chosen correctly the pull's RMS ≈ 1





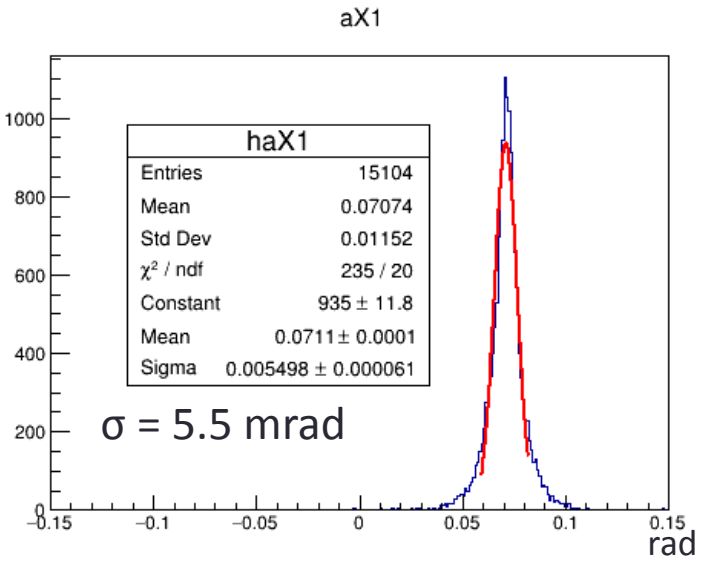




Angle values and resolution

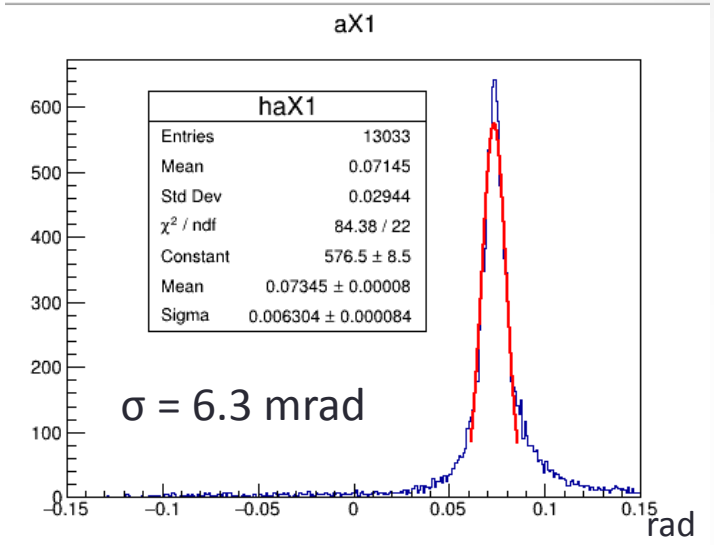
C beam, empty target, B = 1200A

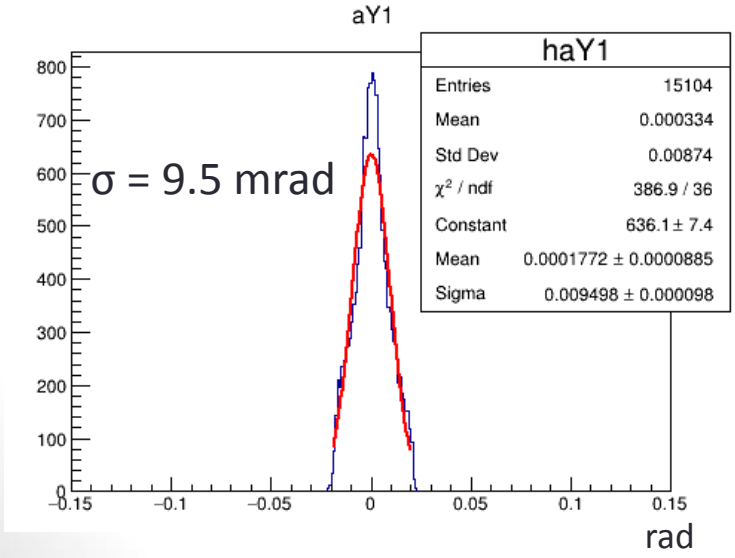
MC segments



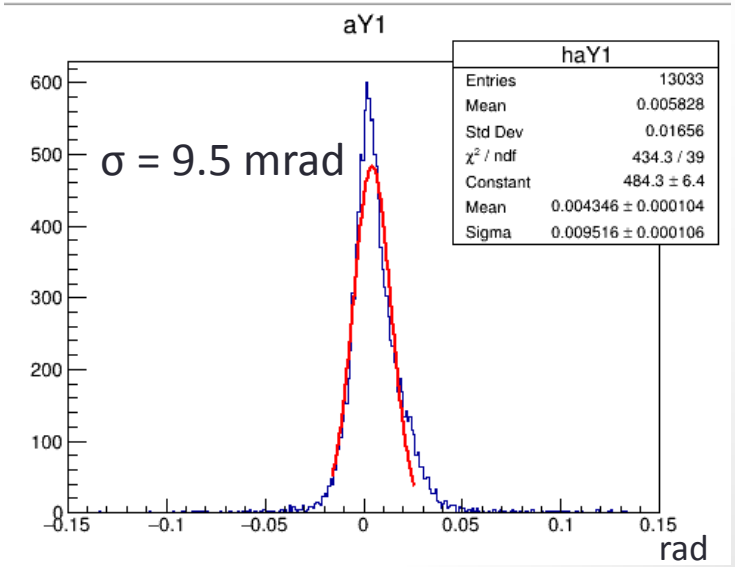
X slope

Data segments





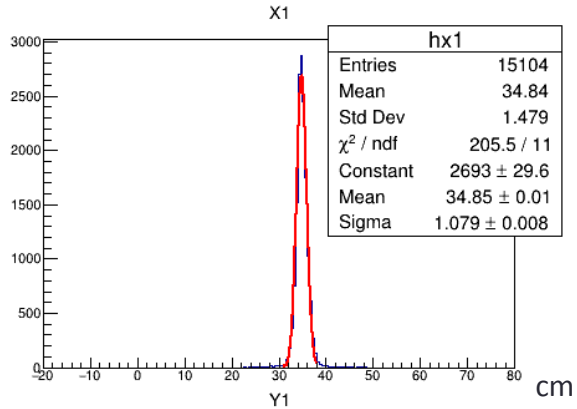
Y slope



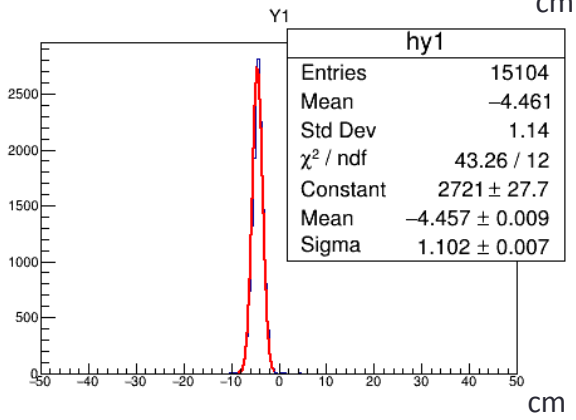
Coordinates values and beam width

C beam, empty target, B = 1200A

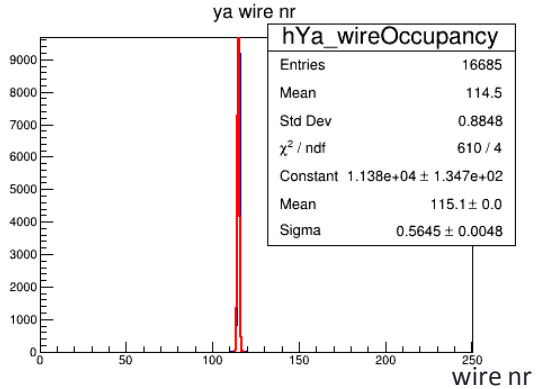
MC segments



X segment coordinate



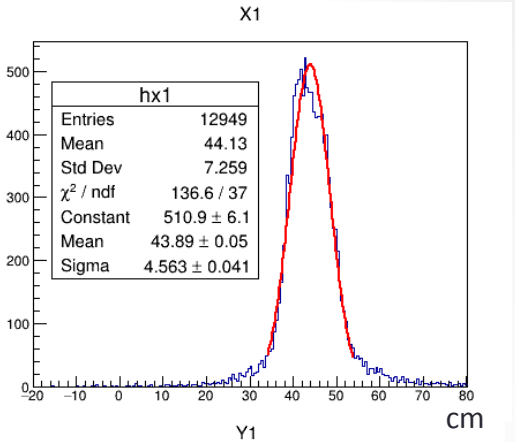
Y segment coordinate

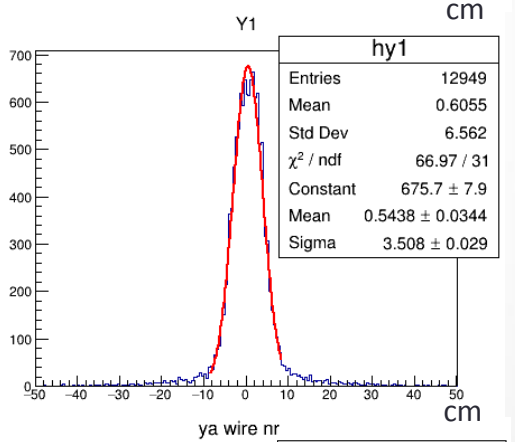


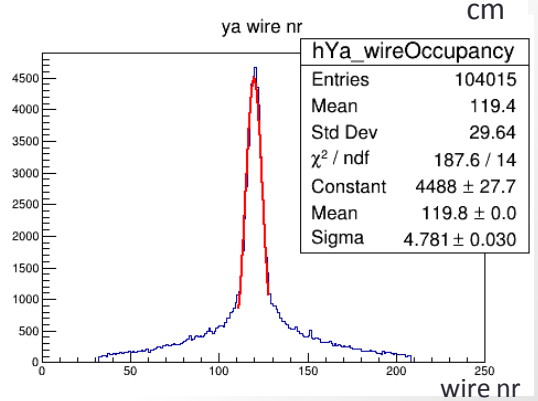
Wire occupancy

The difference is due to the width of the beam

Data segments



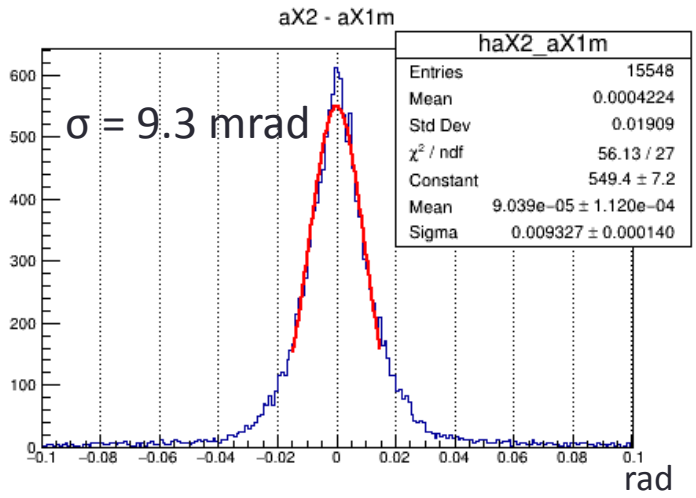




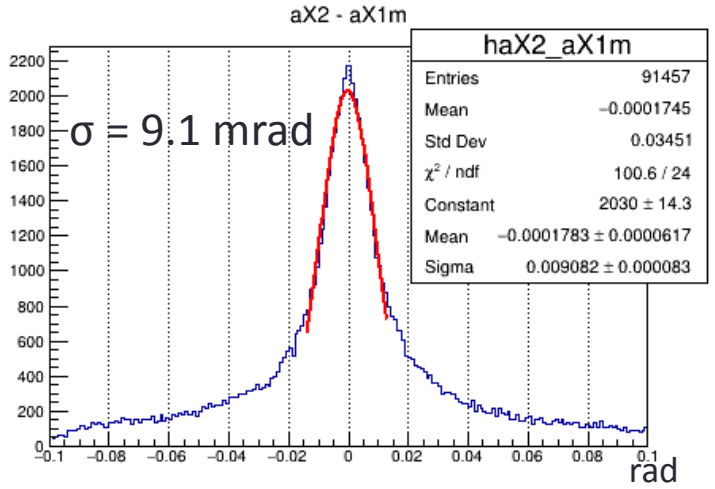
Difference in slopes between DC1 & DC2

C beam, empty target, B = 1200A

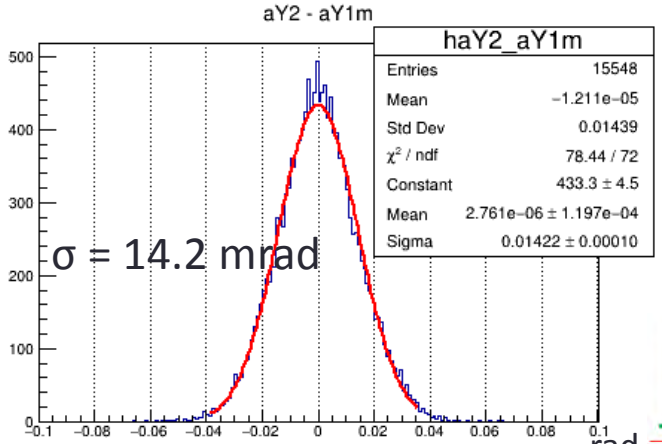
MC reco



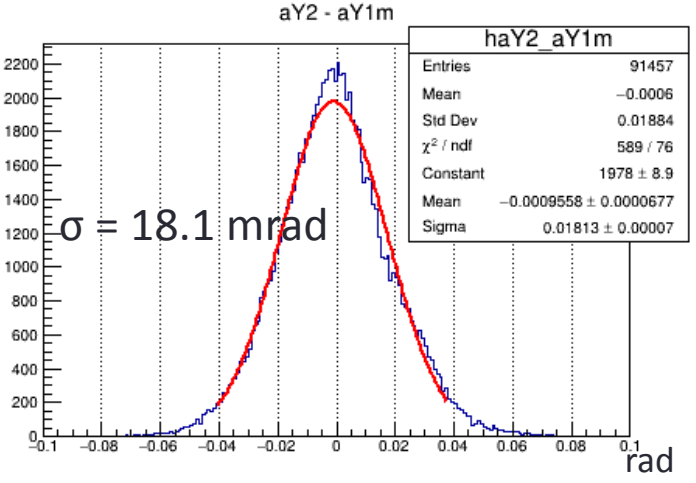
data reco

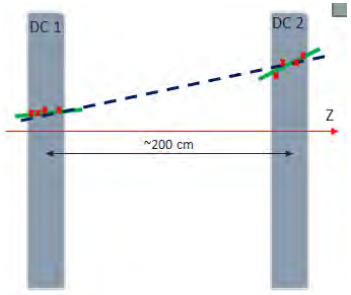


X slope



Y slope



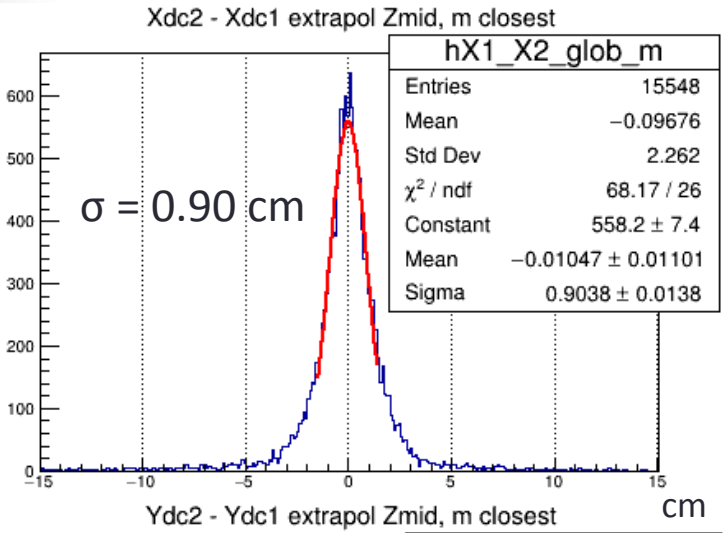


MC slope difference distributions are adequate to SRC data

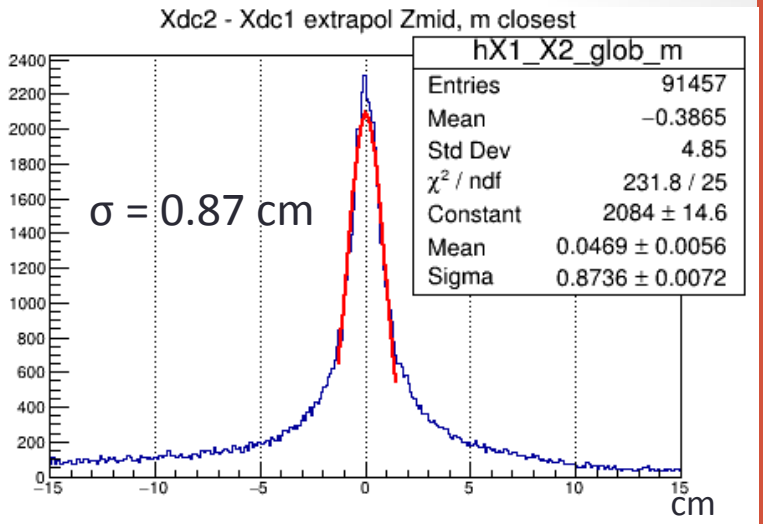
Difference in coordinates for matching DC1 with DC2

C beam, empty target, B = 1200A

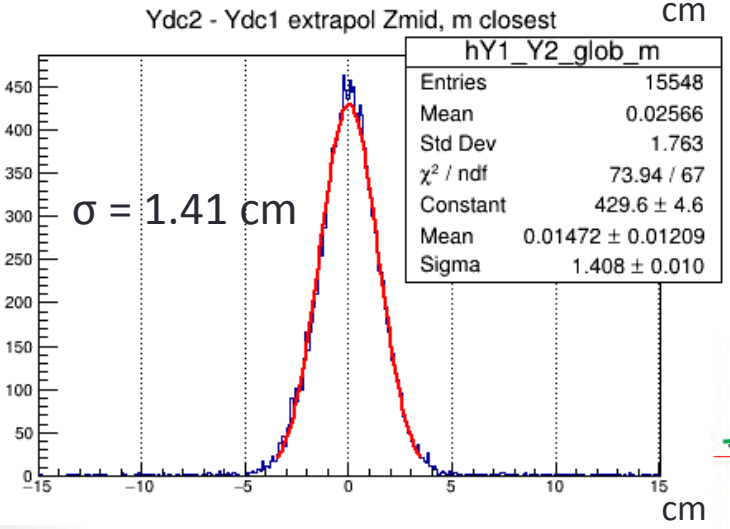
MC reco



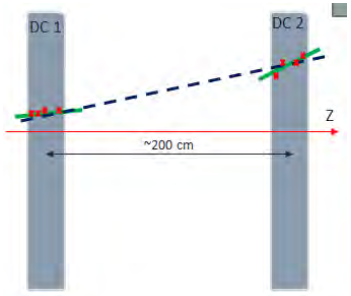
data reco

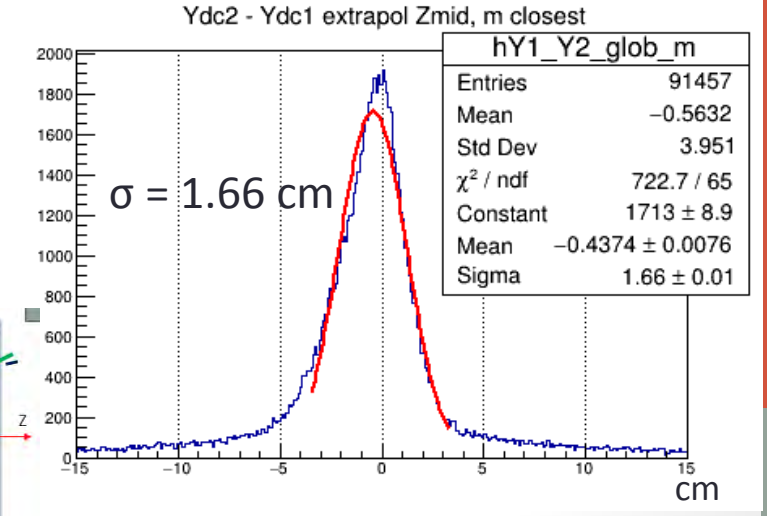


X



Y



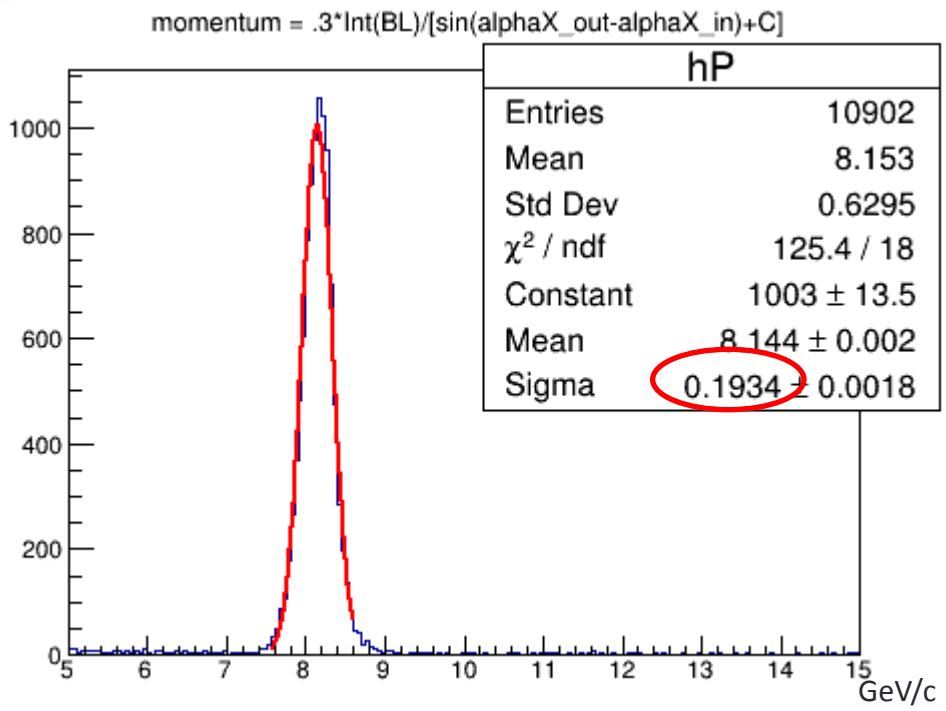


Smearing for MC coordinates is adequate to SRC data

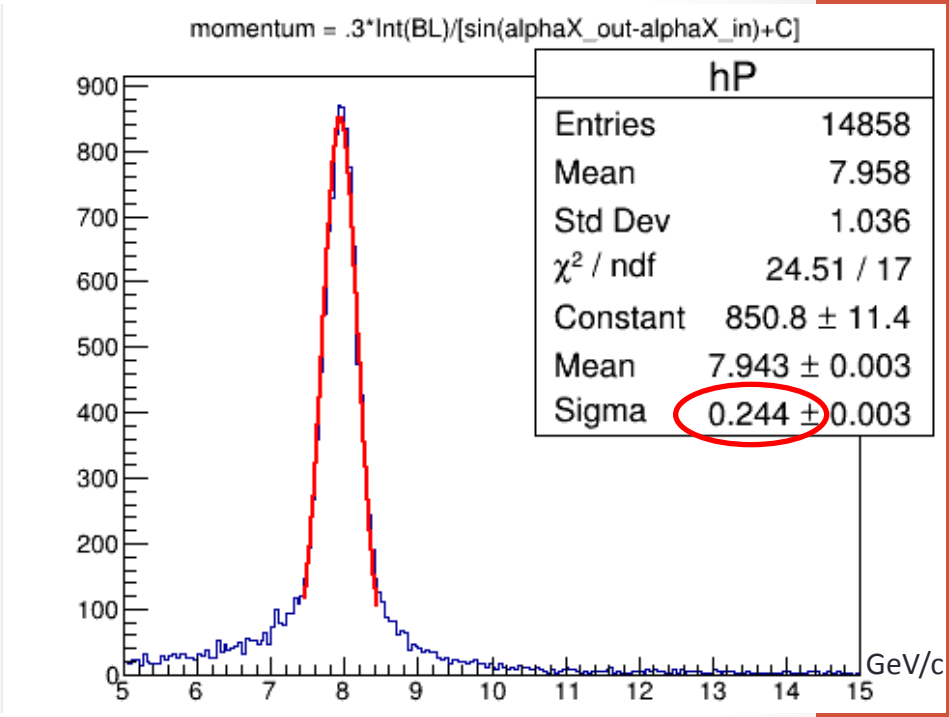
C Beam momentum resolution

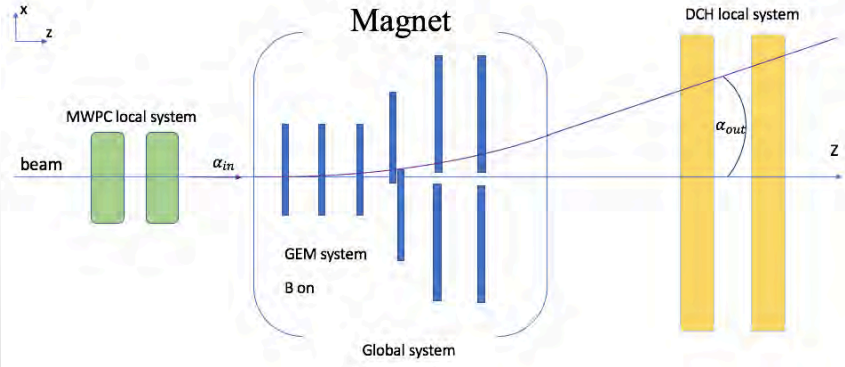
C Beam, empty target, B = 1200A

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].

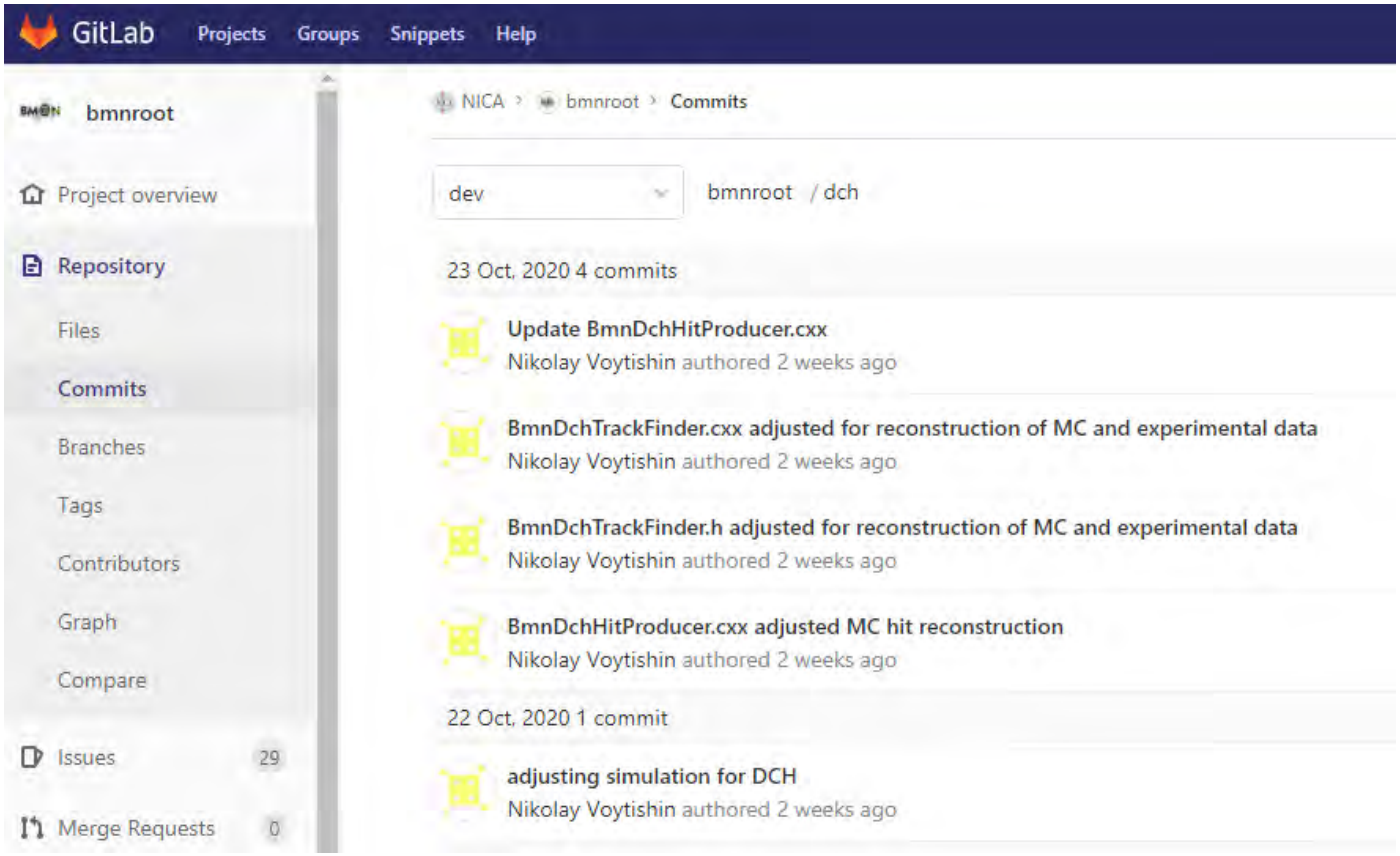
Reconstruction Efficiency vs. MC hit probability

The probability that there is a detector response on layer corresponding to a particular MC point can be adjusted.

	dc1, %	dc2, %	dcGlobal, %
100% hit on layer probability	100	100	100
90% hit on layer probability	86.32	86.37	69.18

$$Efficiency = \frac{number\ of\ reconstructed\ tracks}{number\ of\ MC\ tracks} * 100\%$$

Implementation into bmnroot

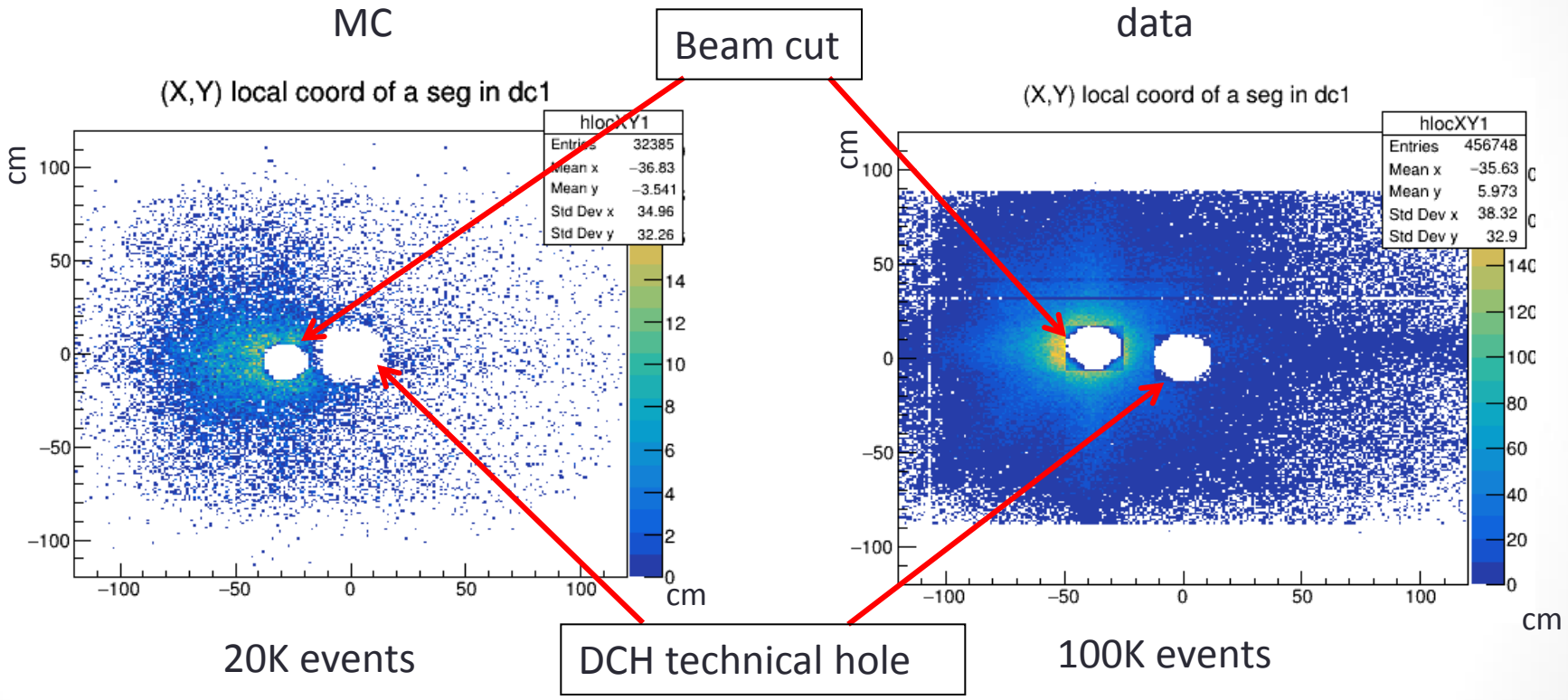


Unified DCH tracking for SRC/BM@N/MC/EXP was implemented into bmnroot.

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

Ar beam, empty target, B = 1250A

DCH1 reconstructed segments local coordinates



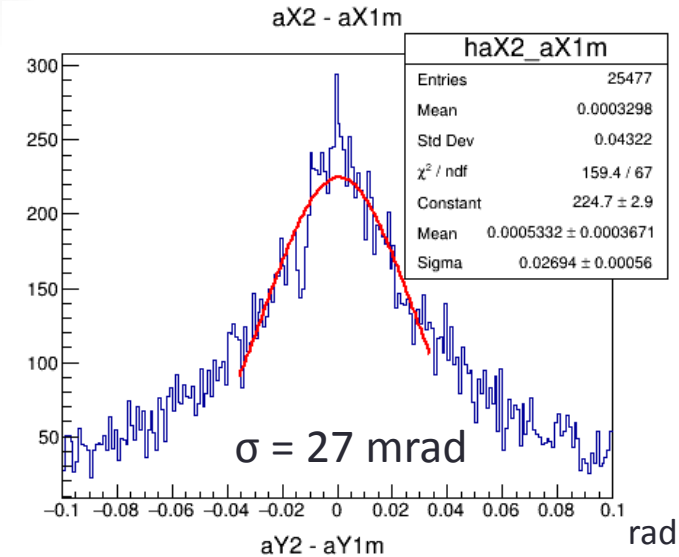
Remark. Cut on beam region applied in order for reconstruction to work properly

Difference in slopes for DC1 & DC2

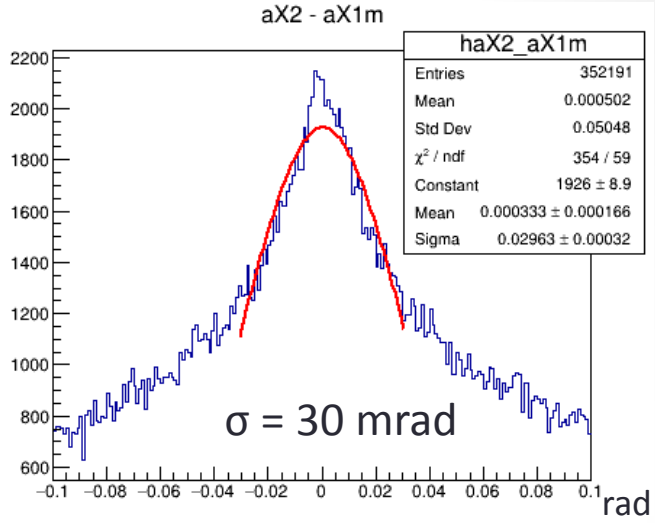
MC

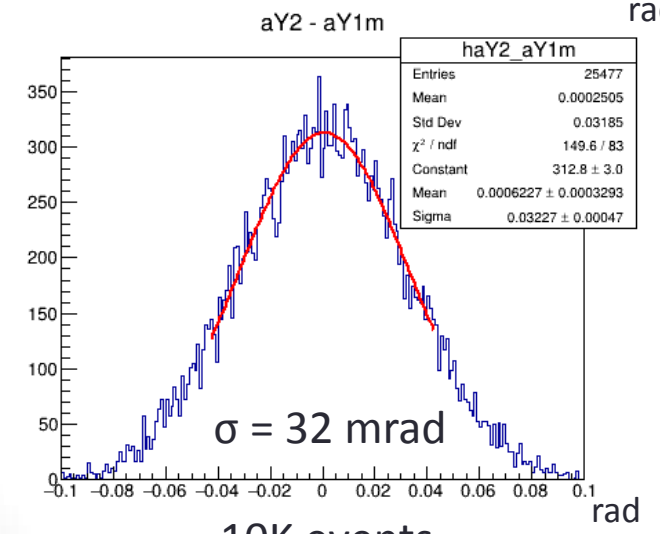
Ar Beam, empty target, B = 1250A

data

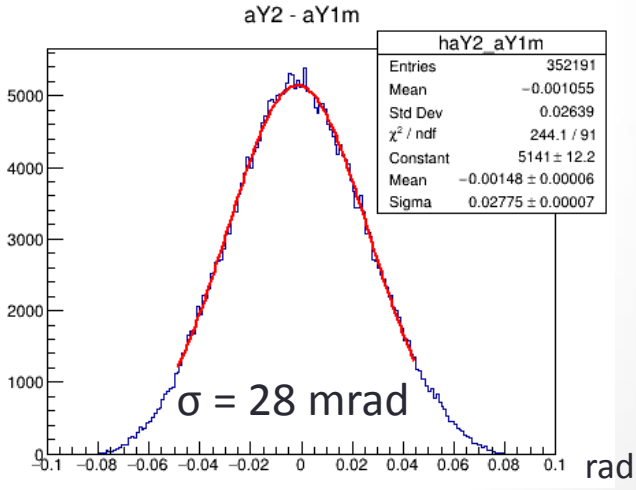


X slope





Y slope



10K events

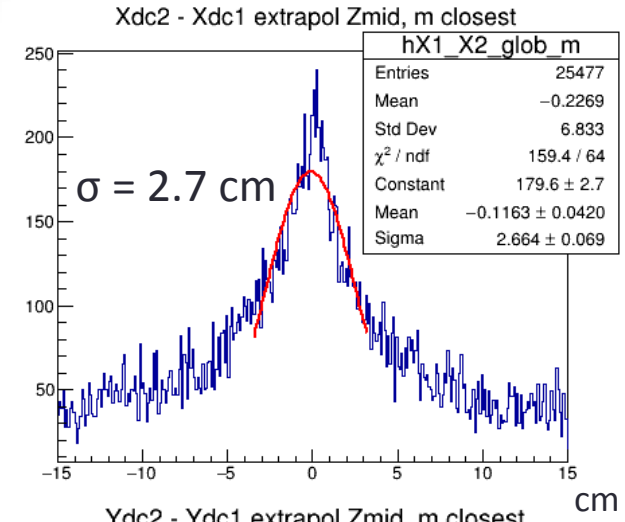
100K events

MC slope difference distributions are adequate to Ar data

Difference in coordinates for matching DC1 with DC2

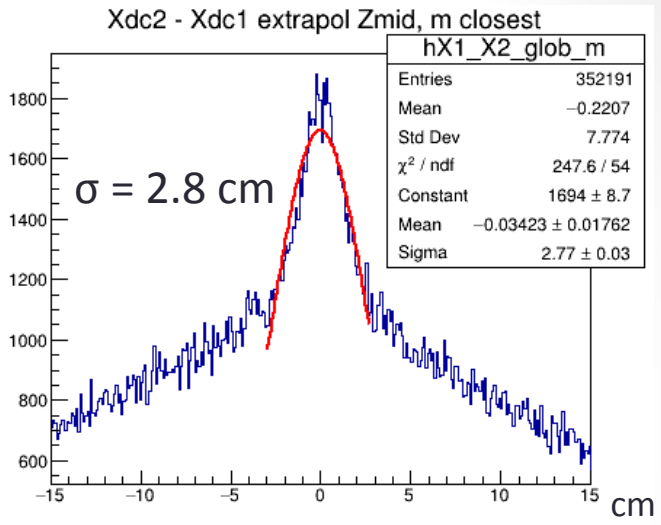
Ar Beam, empty target, B = 1250A

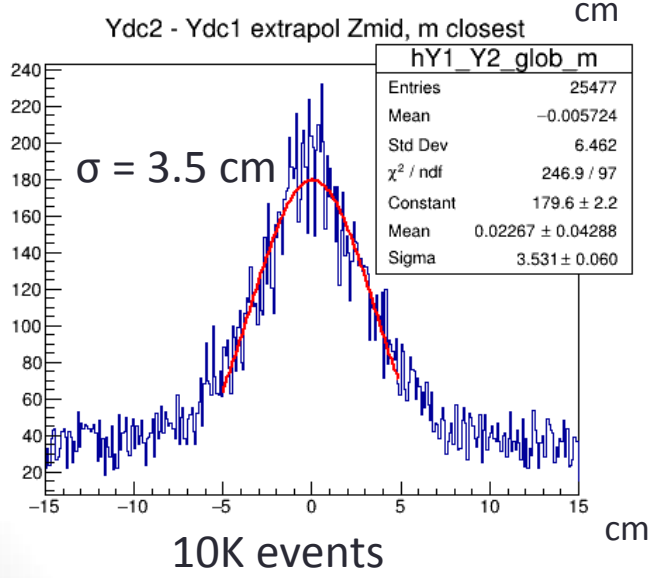
MC reco



X

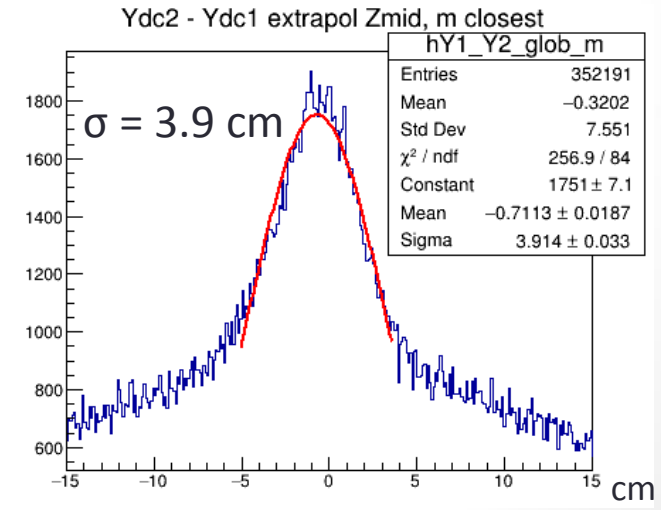
data reco





10K events

Y

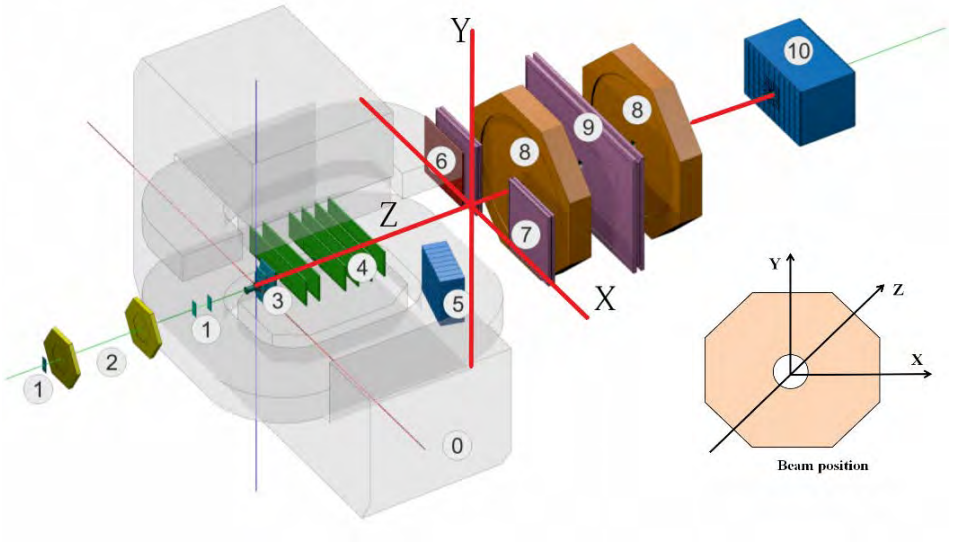


100K events

Smearing for MC coordinates is adequate to Ar data

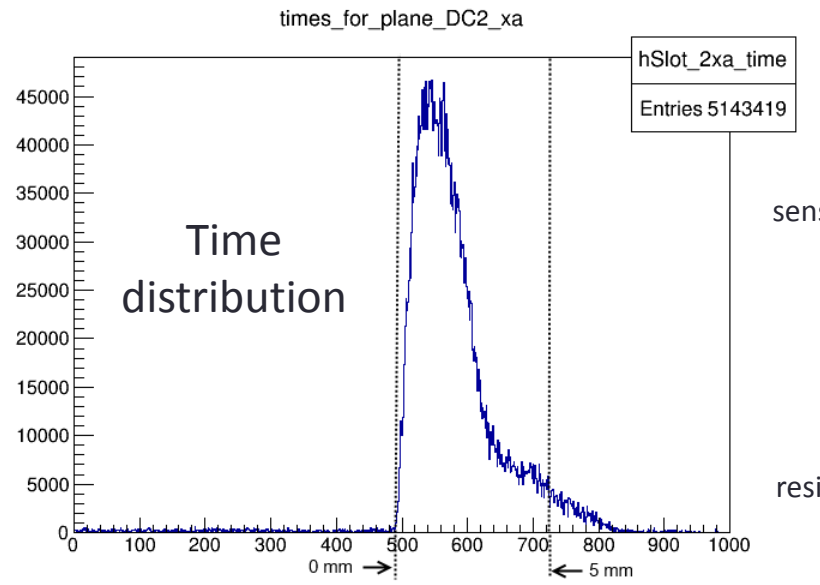
Conclusions

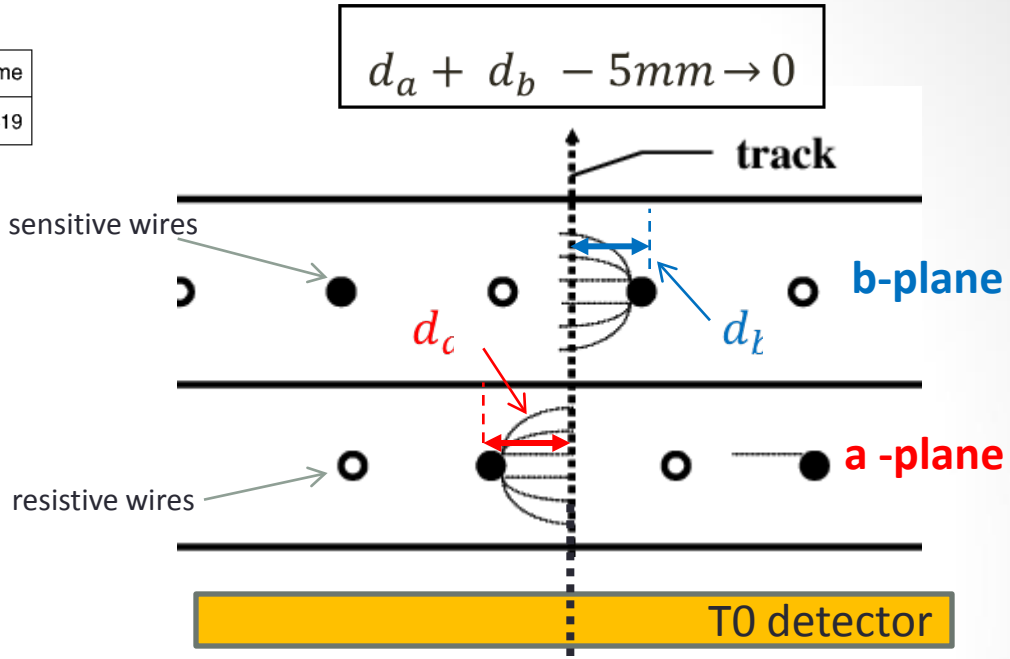
- Realistic response of DCH added in simulation procedure
- Residuals and segment parameters are in agreement between MC and data
- The differences for matching between two DCH chambers in slopes and coordinates are quite similar for MC and data
- Tracking unified for SRC/BM@N/MC/EXP
- The full reconstruction chain for Dift Chambers is available in *bmnroot* package.

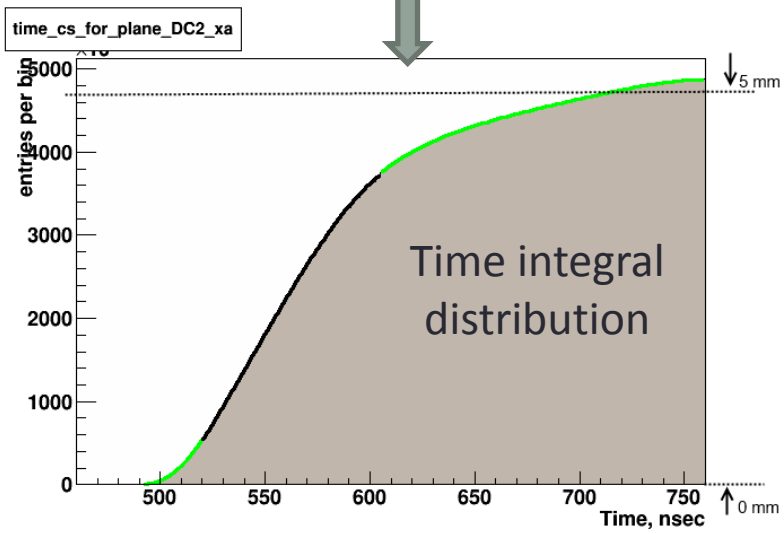


backup

Drift Chambers coordinate reconstruction on a layer







- 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

↓

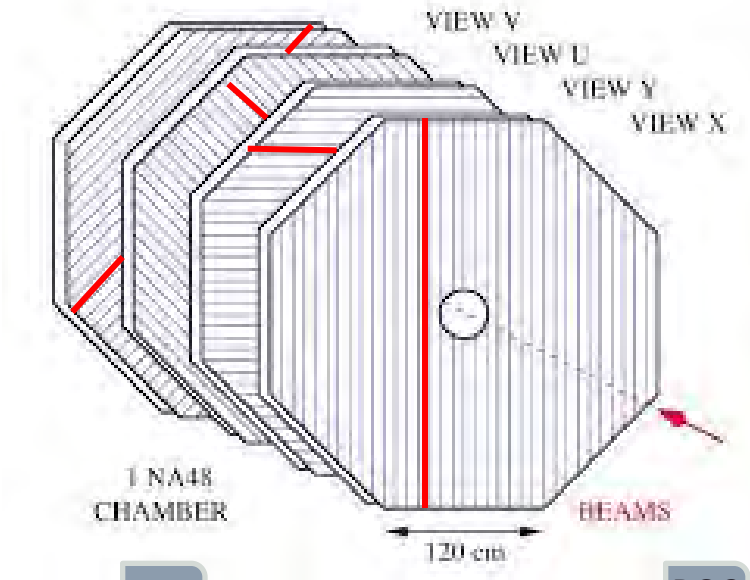
Pair hit assembly

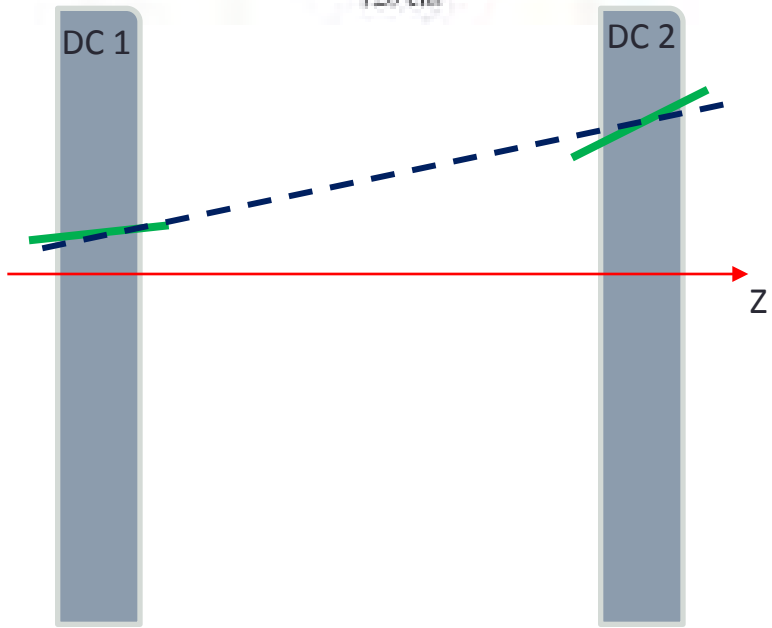
↓

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.