Outer Tracker of the BM@N Experiment

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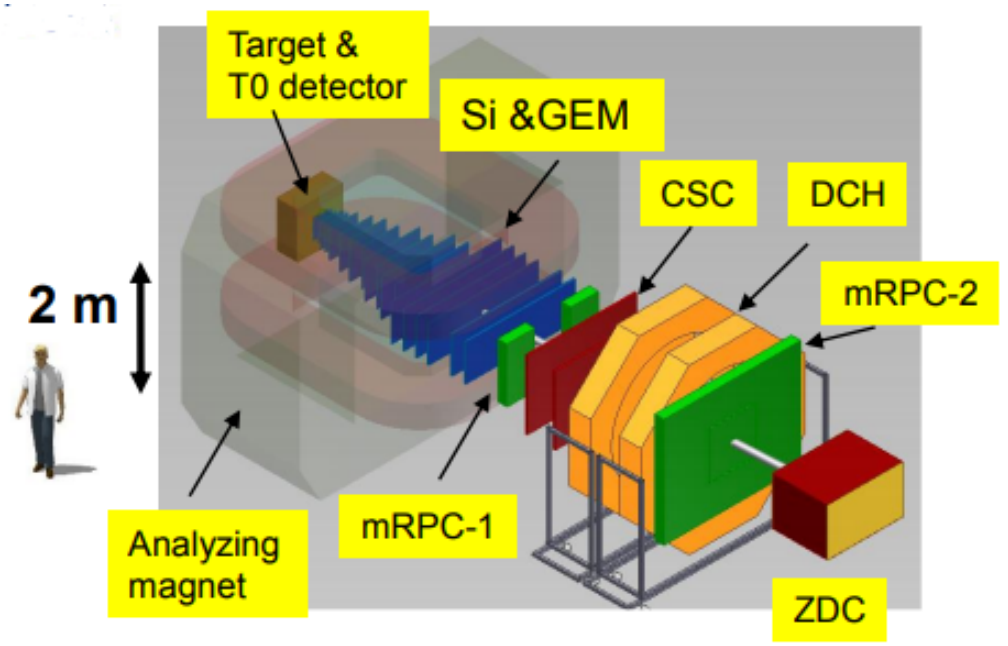
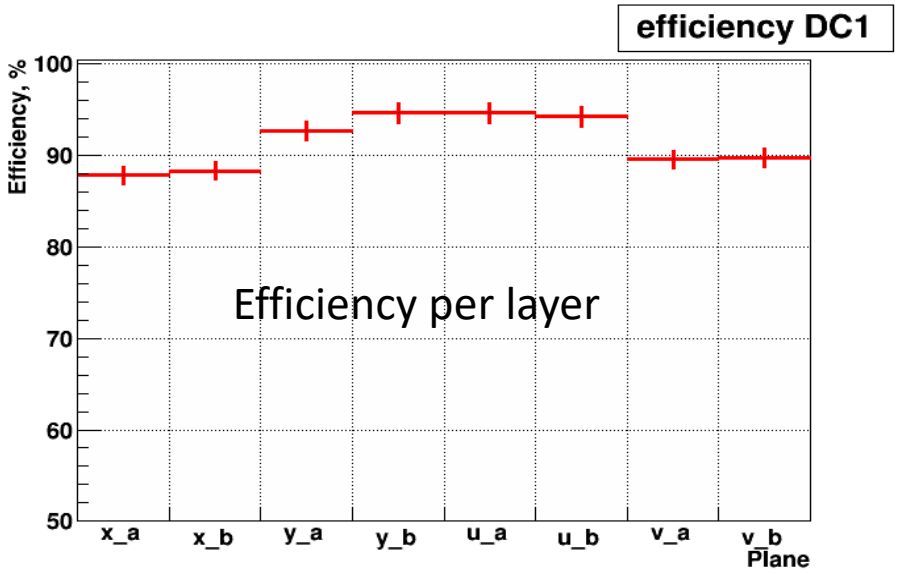
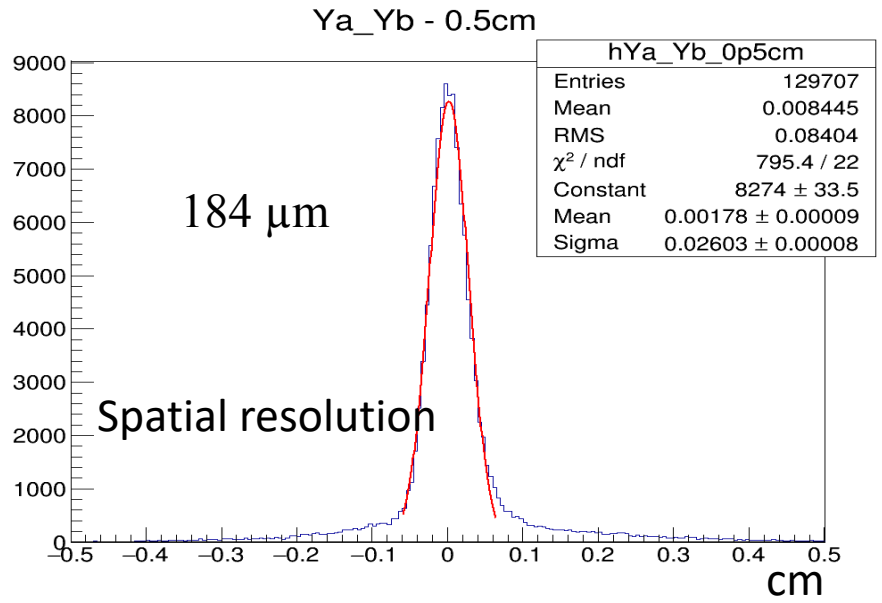
BM@N - experimental setup Run7 (March-April 2018)

- Beam counters: T0 and beam monitors
- **MWPC** – alignment and incoming beam trajectory positioning
- Central tracker (GEM) - AA interactions reconstruction
- **Outer tracker** (DCH, CSC) - link central tracks to ToF
- ToF - hadrons and light nuclei identification
- ZDC calorimeter - centrality of AA collisions measurement
- Electromagnetic calorimeter - γ,e+e- detection



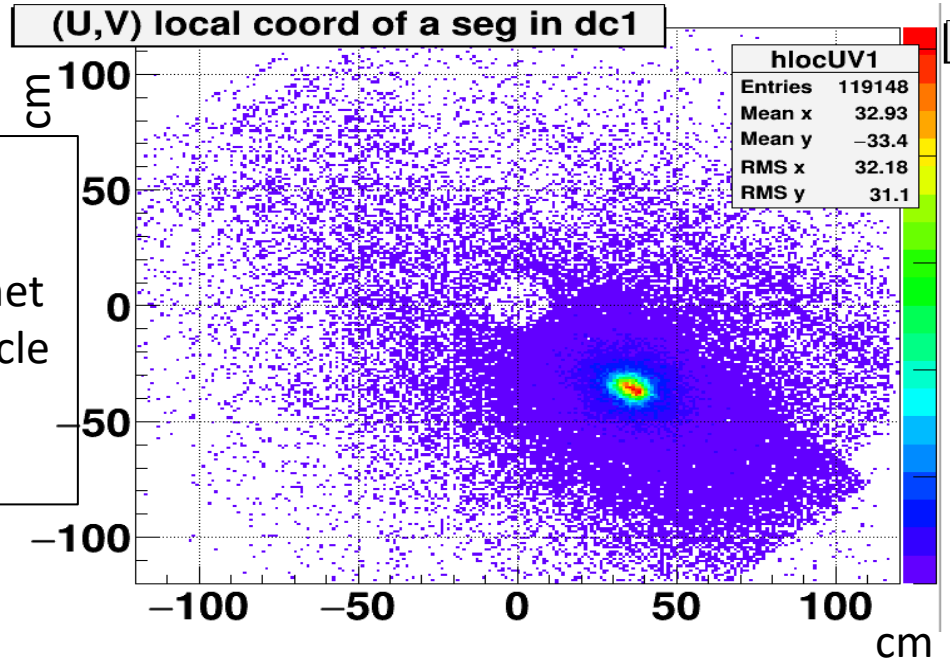
DCH Performance



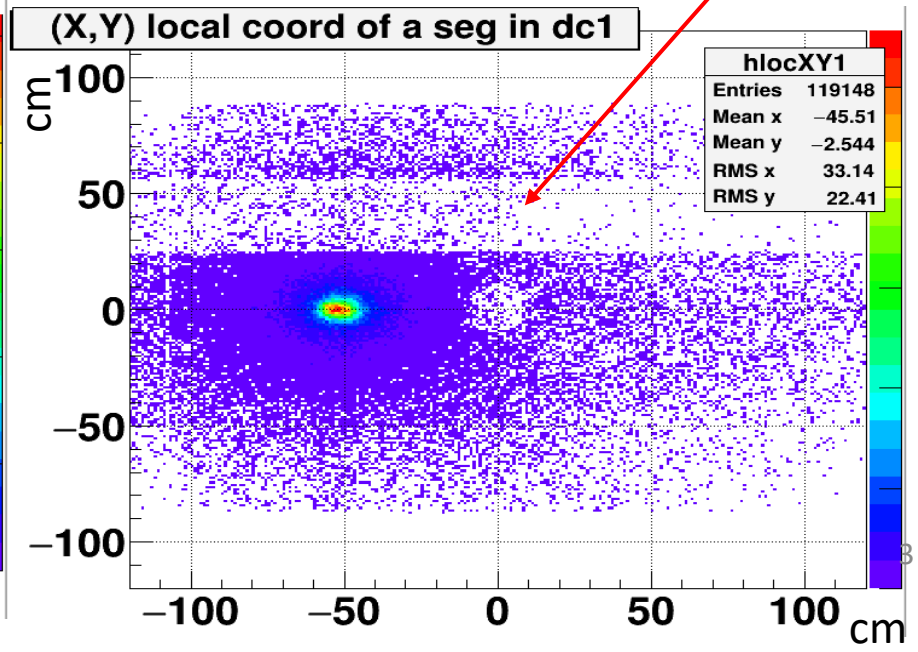


4 double coordinate planes:
wire angles 0,90,±45°,
wire pitch 10 mm,
Yout ± 1.35 m,
Xout ± 1.35 m,
Rmin = 10 cm,
2048 wires per chamber

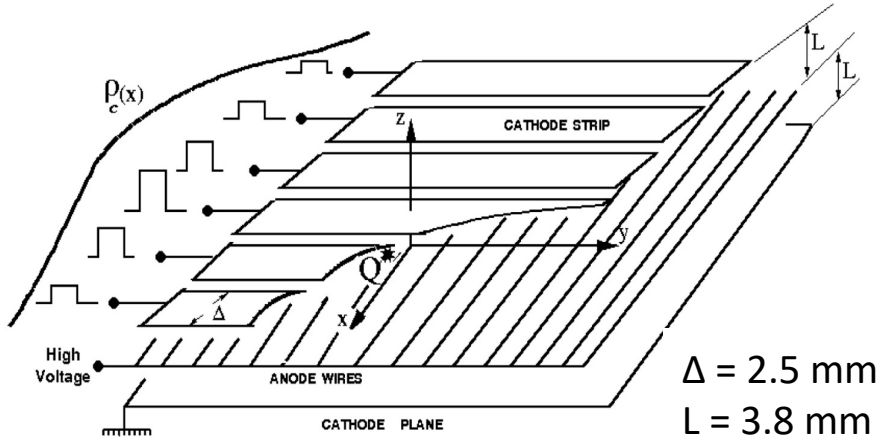
Role of DCH:
- Calculation of track coordinate after magnet
- Link ToF-DCH for particle identification
- B off global alignment



Not working amplifier (run7)

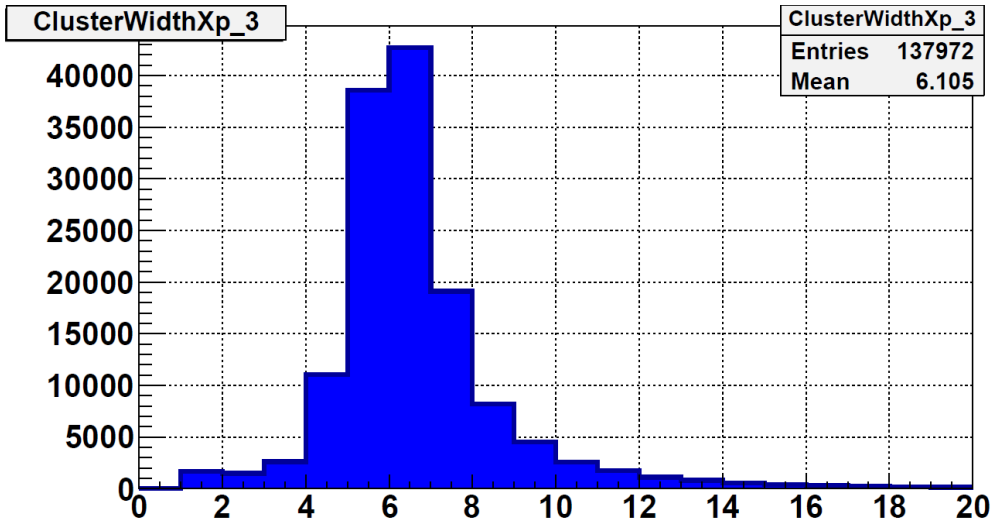


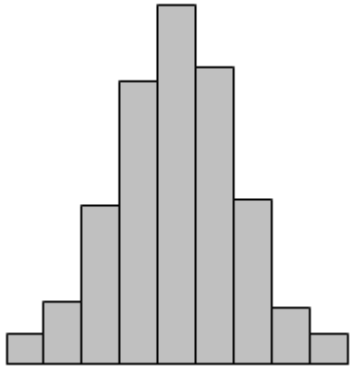
Cathode Strip Chambers



Δ = 2.5 mm
L = 3.8 mm

Number of strips per cluster

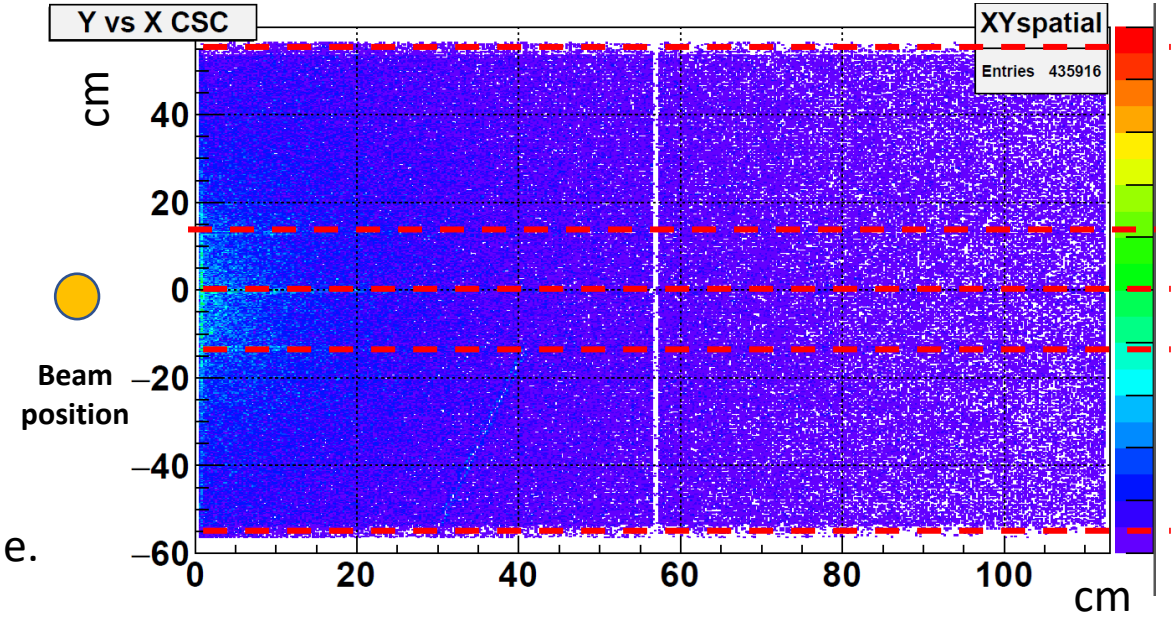




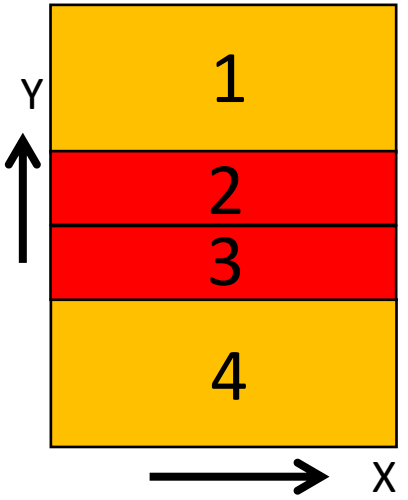
Typical cluster charge distribution on strips

Coordinate calculated by CoG at the moment.
To be fitted by Gatti function in the future.

- CSC is resistant to high loads
- Does not depend on starting time

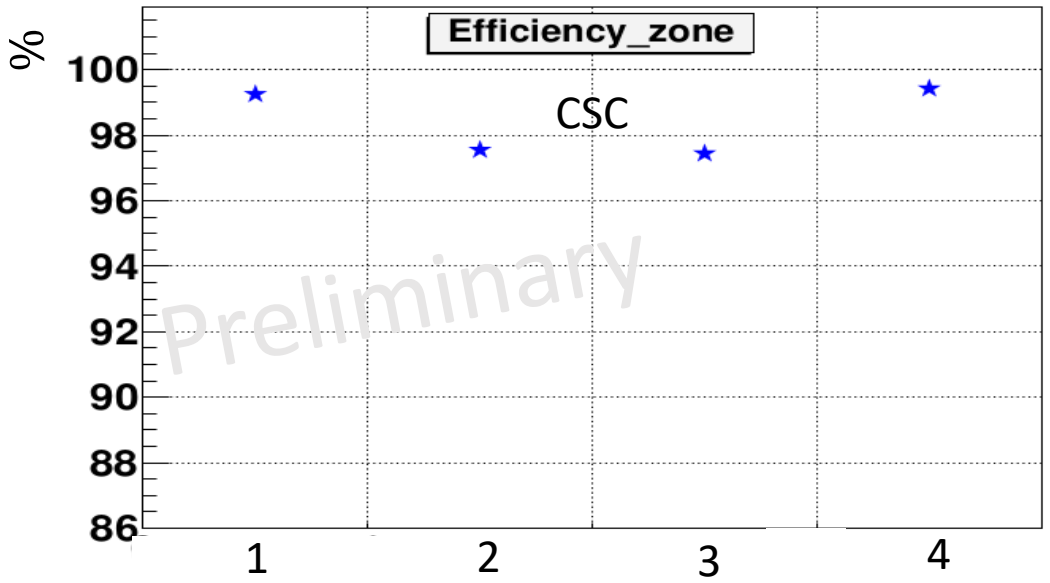


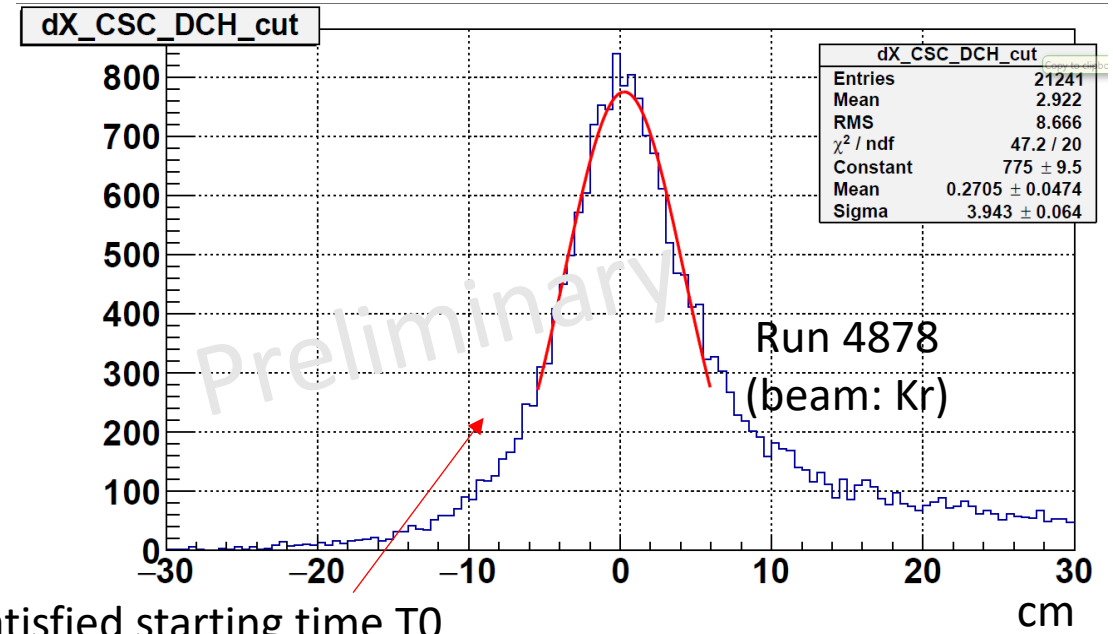
Zones



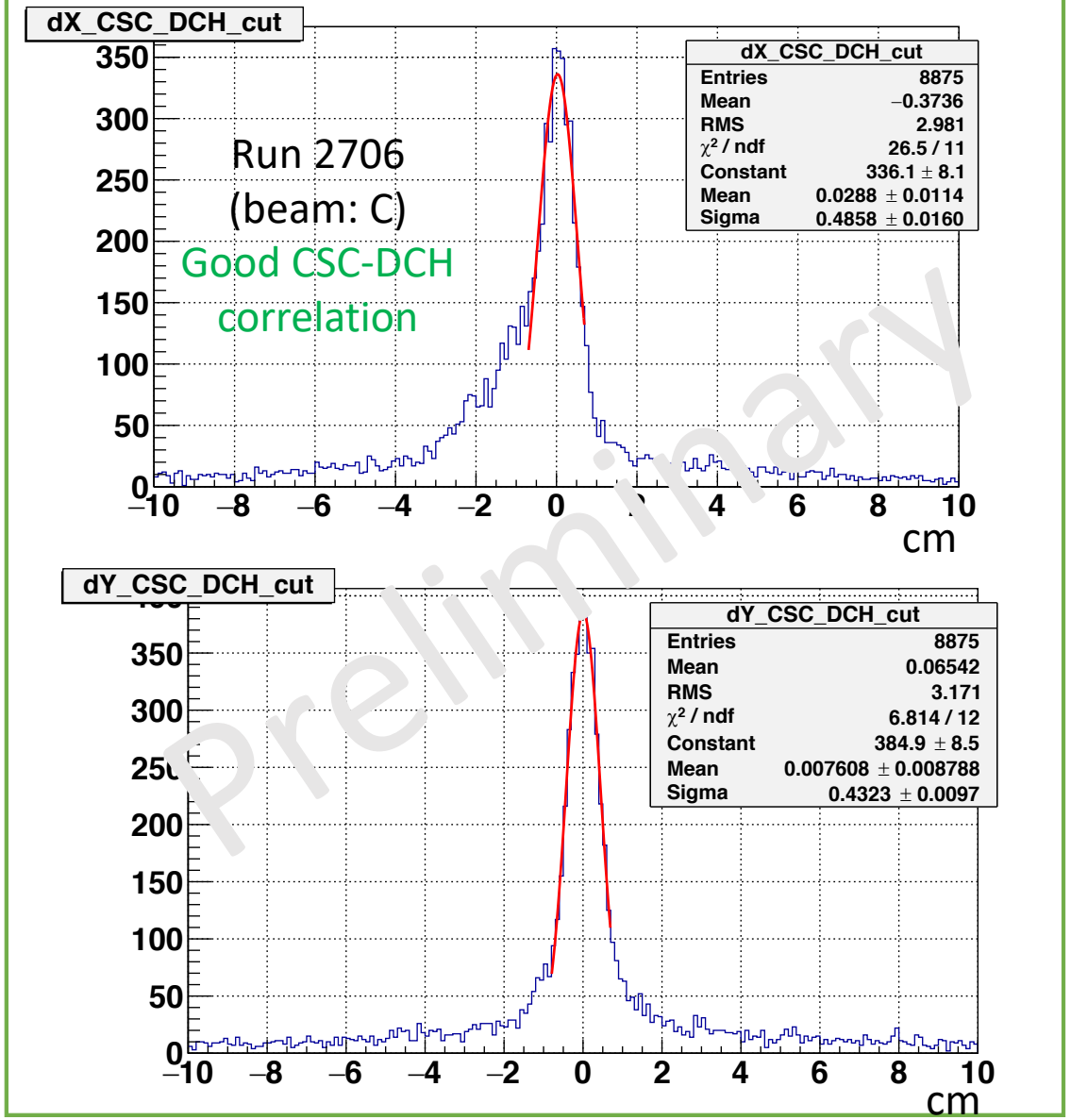
Reconstructed Hit
- 2D coordinate
of the passing particle on a zone.

CSC performance and matching to DCH





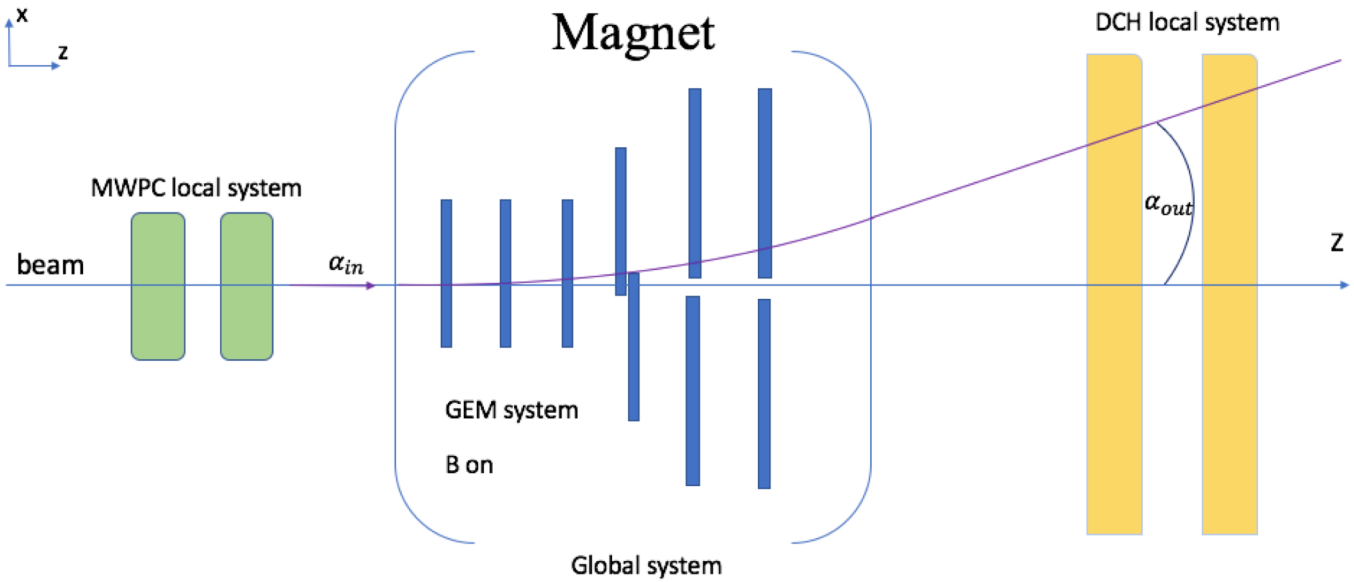
Unsatisfied starting time T0



Beam momentum estimation procedure

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

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



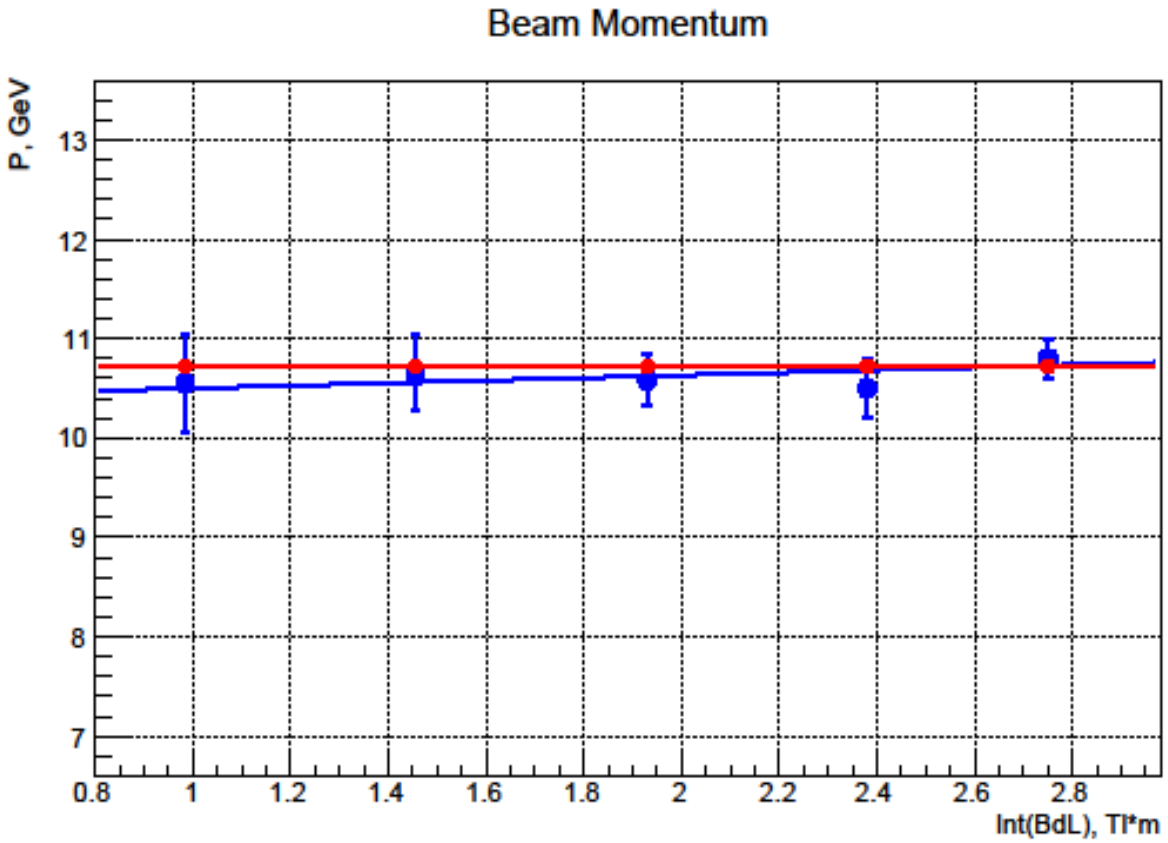
$$P_{beam} = \frac{A}{Z} * \sqrt{\left(E/n + M_p\right)^2 - M_p{}^2}$$

A - mass number;
Z - number of protons;
E/n - beam energy per nucleon;
M_p - proton mass.

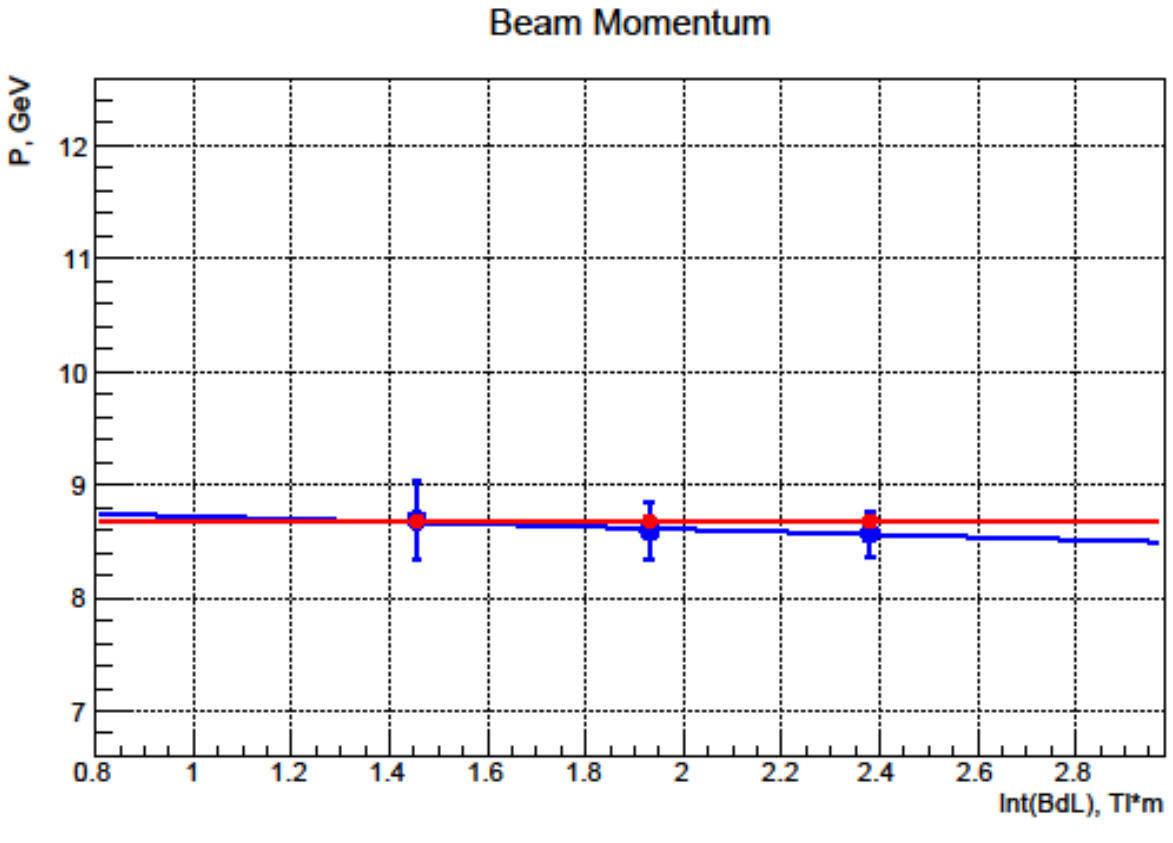
Momentum vs. Int(BdL)

Data Run6

C beam energy 4.5 GeV/nucleon;
Momentum 10.7 GeV/c;



C beam energy 3.5 GeV/nucleon;
Momentum 8.7 GeV/c;



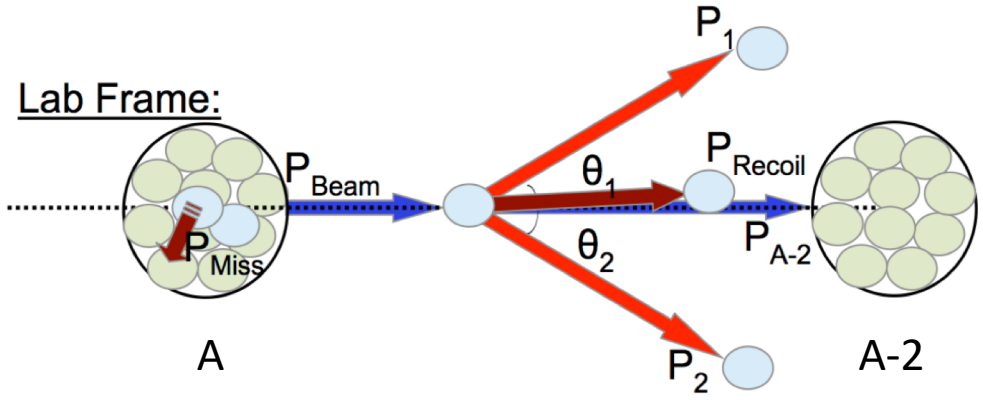
RED – Nuclotron beam momentum;
BLUE – Estimated beam momentum.

2 nucleon Short Range Correlations

- Occasionally 2 nucleons are at close proximity in the nucleus
- This pair is characterized by high momentum of each nucleon and low center of mass momentum
- Properties of SRC pairs were studied in the last BM@N run

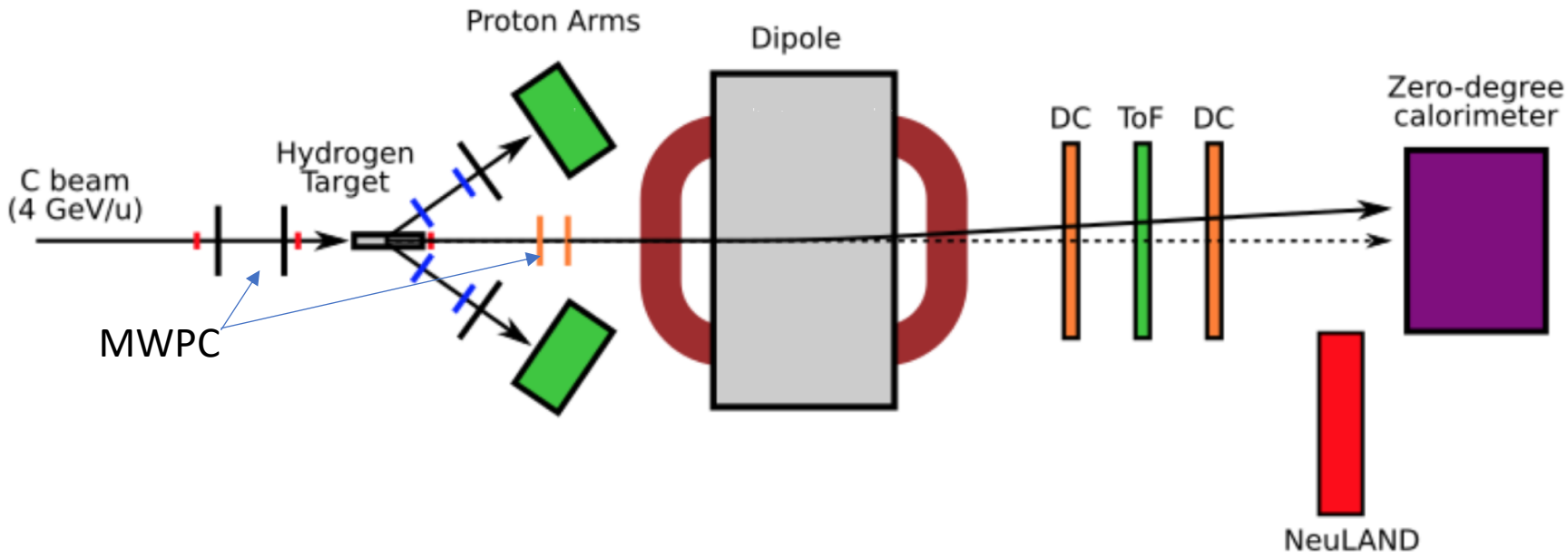
SRC at BM@N

2 nucleons are knocked out from the nucleus



- Measure the residual nucleus (A-2)

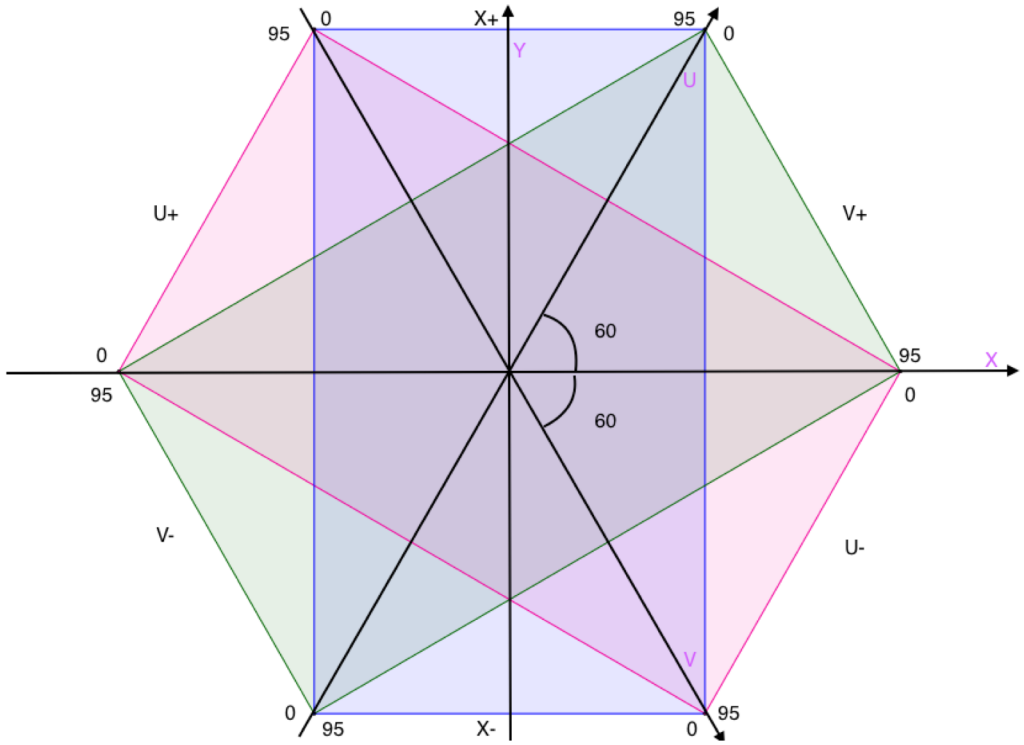
  for the first time: define A and Z
- BC3 for measure Z (Z^2)
- MWPC and DCH – turning angle
- TOF-700 information will help to identify A-2



Role of MWPC in SRC at BM@N

- Beam monitor
- N of tracks after target
- Initial direction for turning angle

Each chamber has 6 planes(X_1,V_1,U_1, X_2, V_2, U_2) with angle 60 degrees between them



$$U = \frac{x + \sqrt{3}y}{2},$$

$$V = \frac{x - \sqrt{3}y}{2},$$

which leads to X= U+V

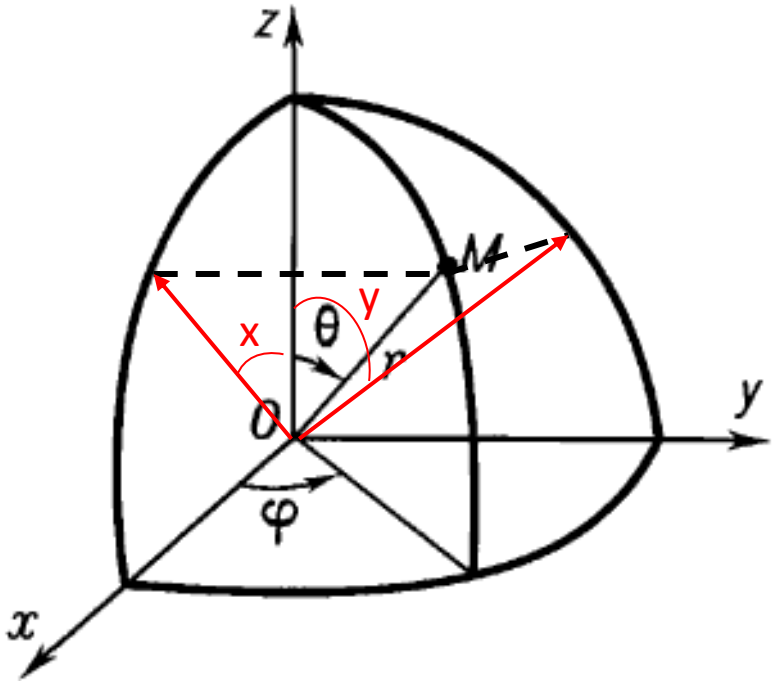
The intersection of these planes is a working area.

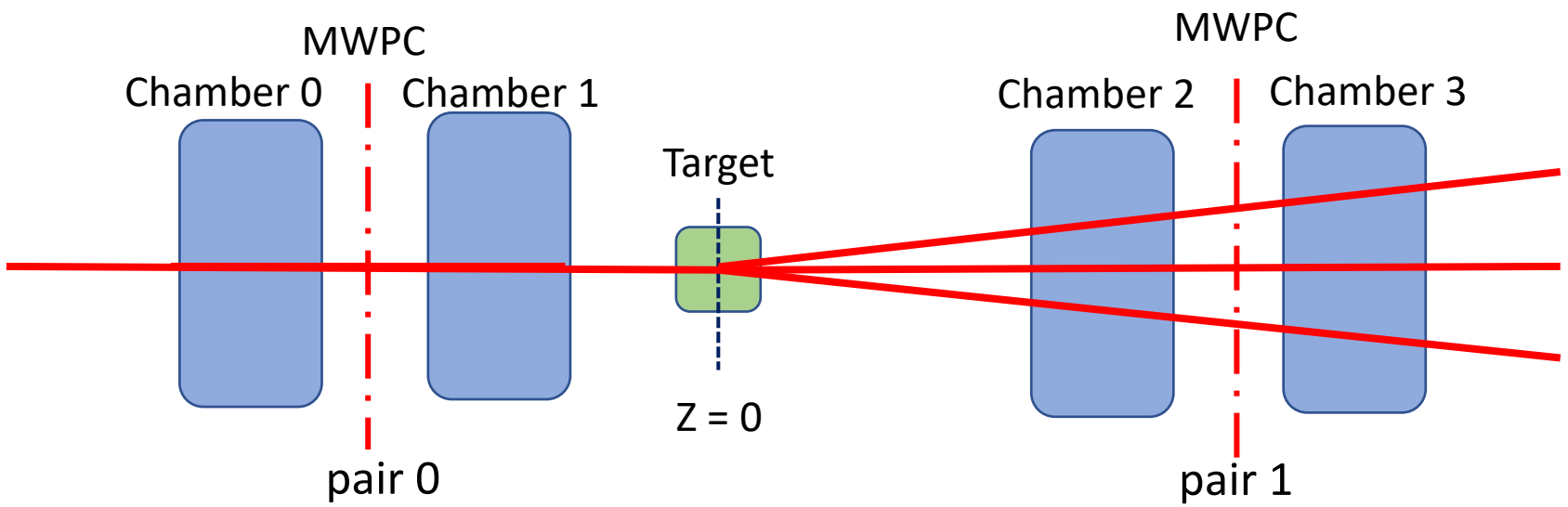
Reconstructed Track parameters: slopeX, slopeY, x, y

Straight line fit equations:

ZX: $X = slopeX * Z + k_x$

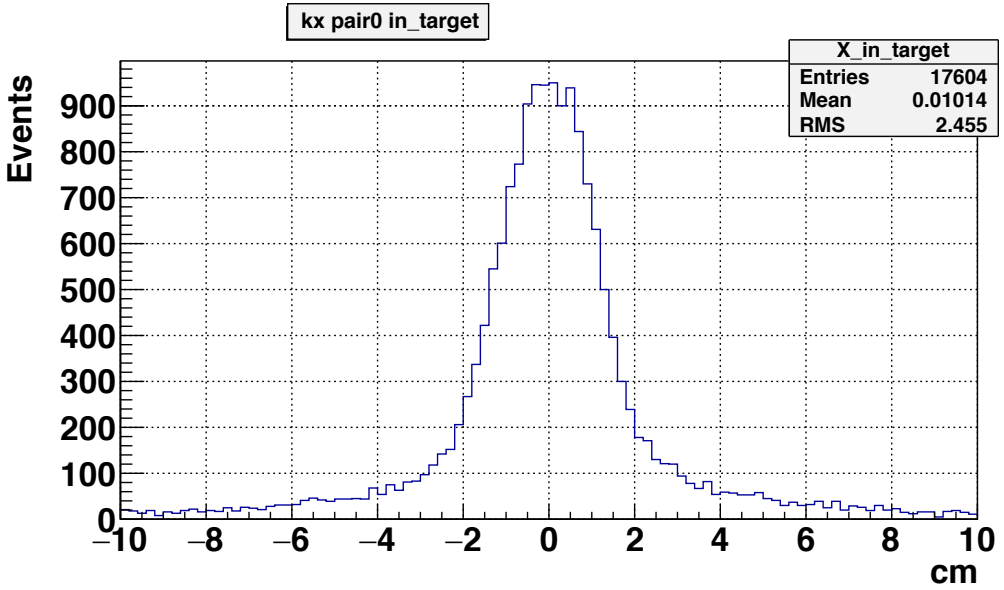
ZY: $Y = slopeY * Z + k_y$

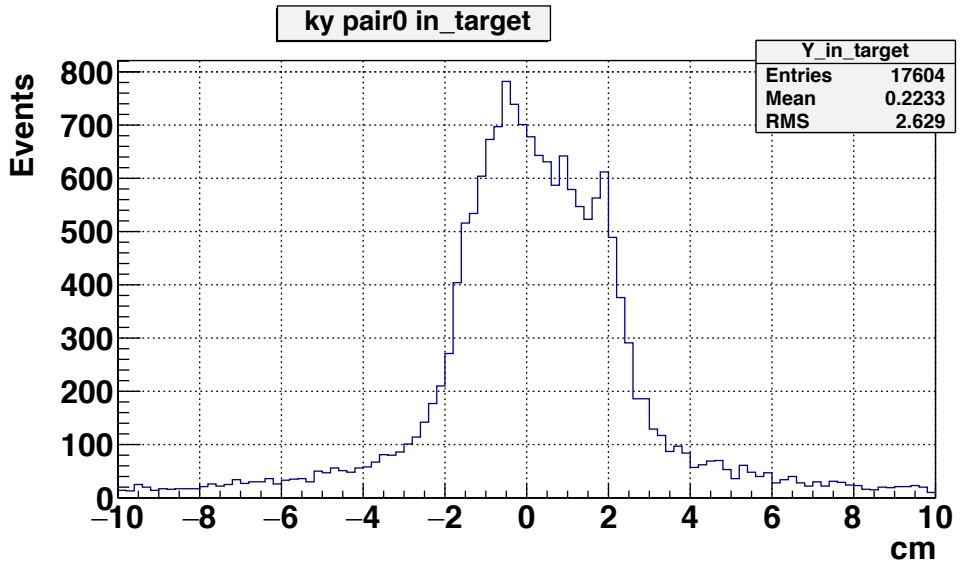


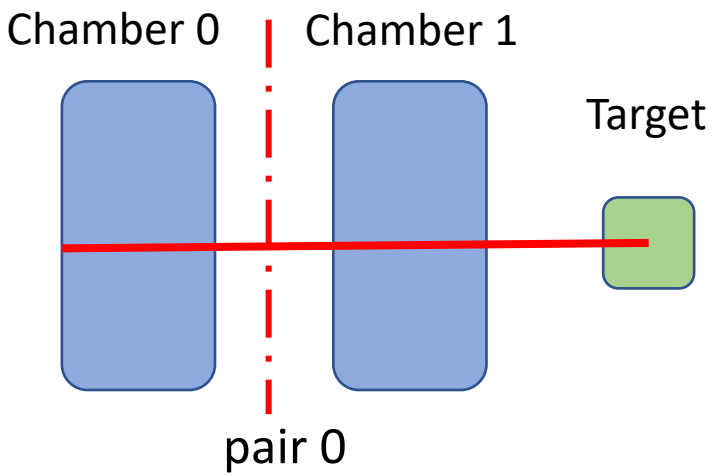


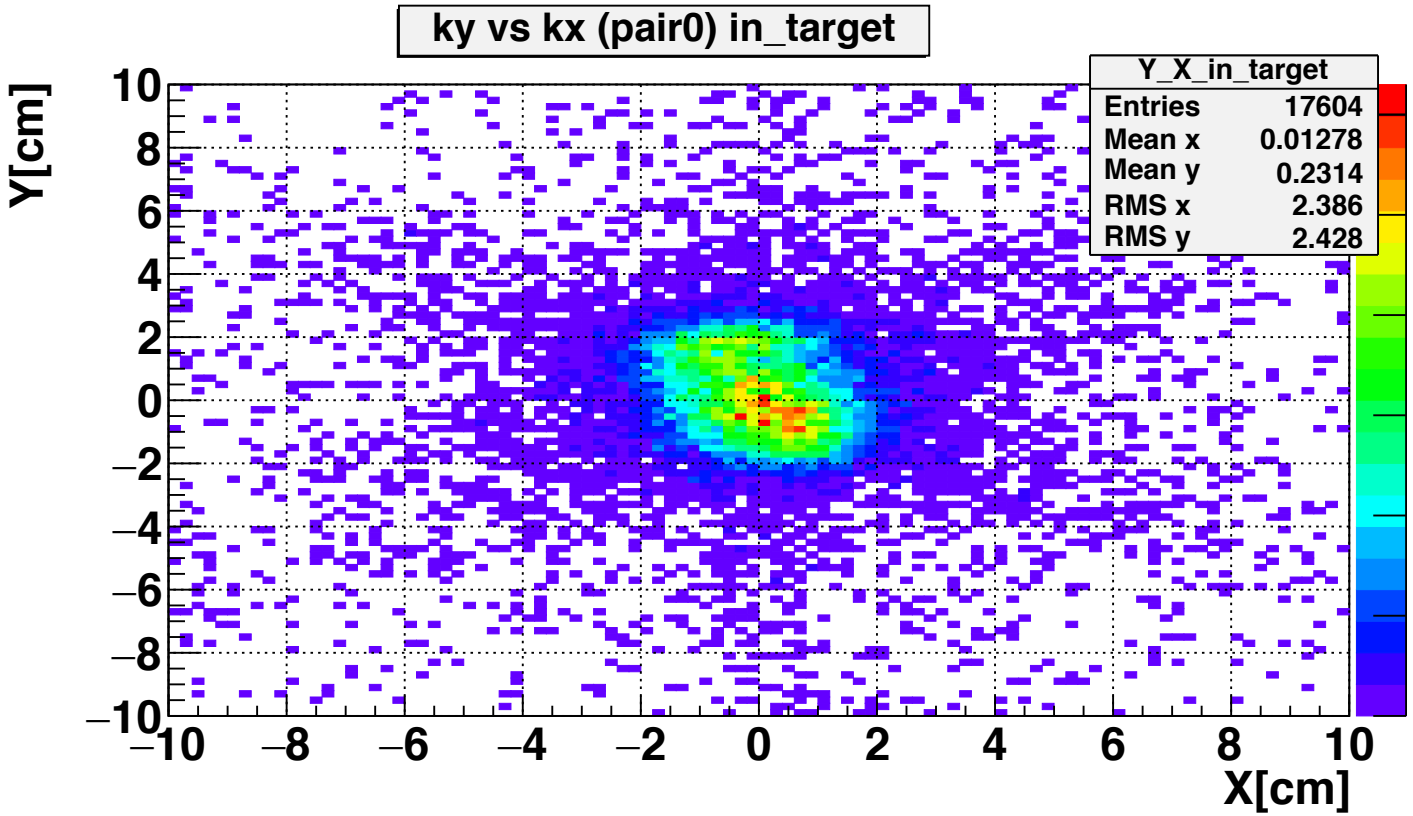
1. Recognize segments with groups of 6, 5, 4 - fired wires per segment
2. Reconstruct & fit track-segments in each chamber
   ($slopeX_i$, $slopeY_i$, kx_i, ky_i in the Z_i- chamber center)
3. Reconstruct track in each pair of chambers
   ($slopeX_{0,1}$, $slopeY_{0,1}$, $kx_{0,1}$, $ky_{0,1}$ in the $Z_{0,1}$- pair center)
4. Extrapolate tracks to the target center for each pair
5. Plot distributions

Track parameters for Pair 0 in the target center: run 2685 (Beam: C, empty target)

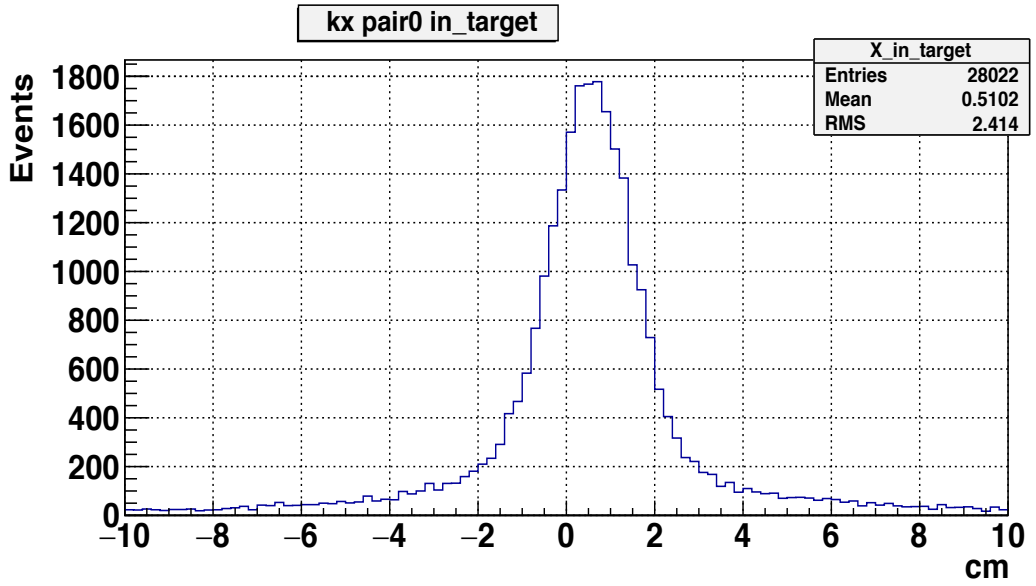


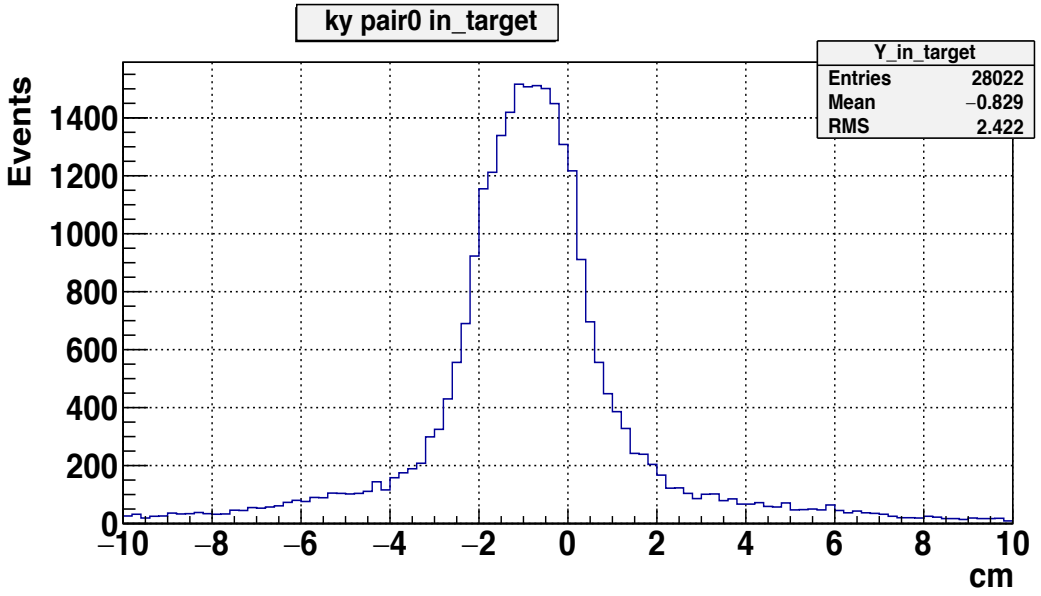


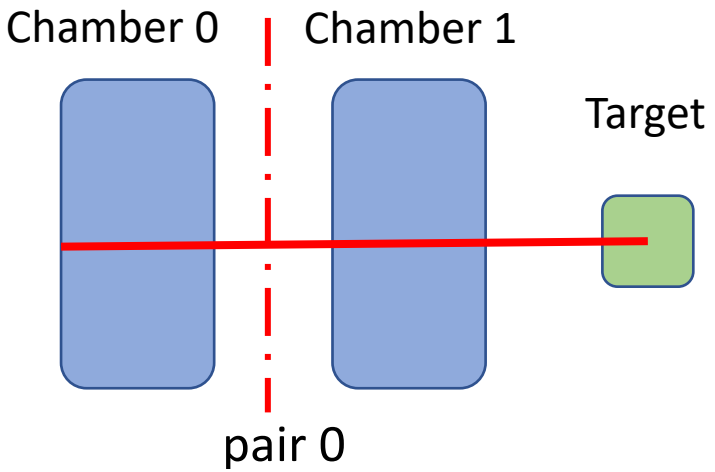


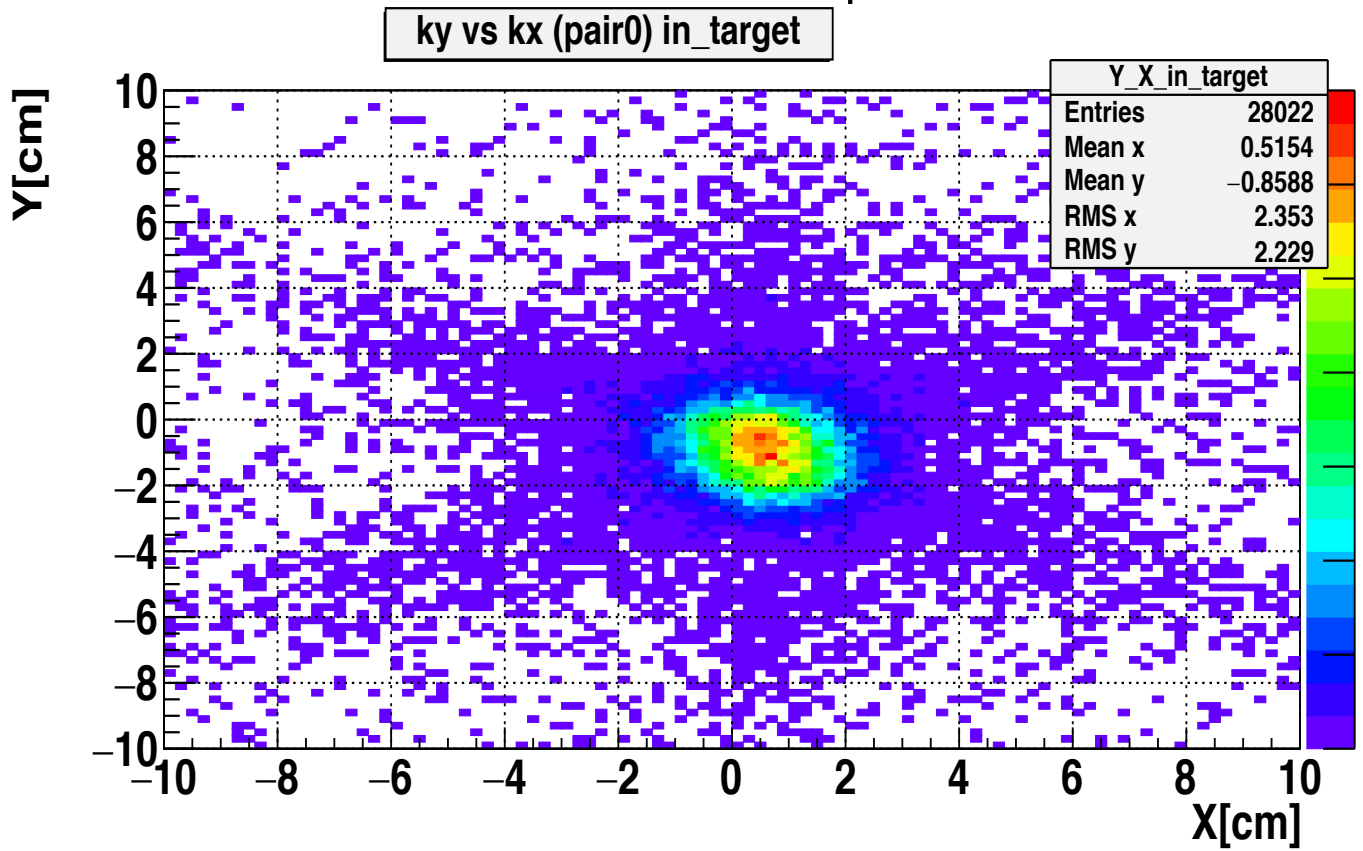


Track parameters for Pair 0 in the target center: run 2706 (Beam: C , target: H2)







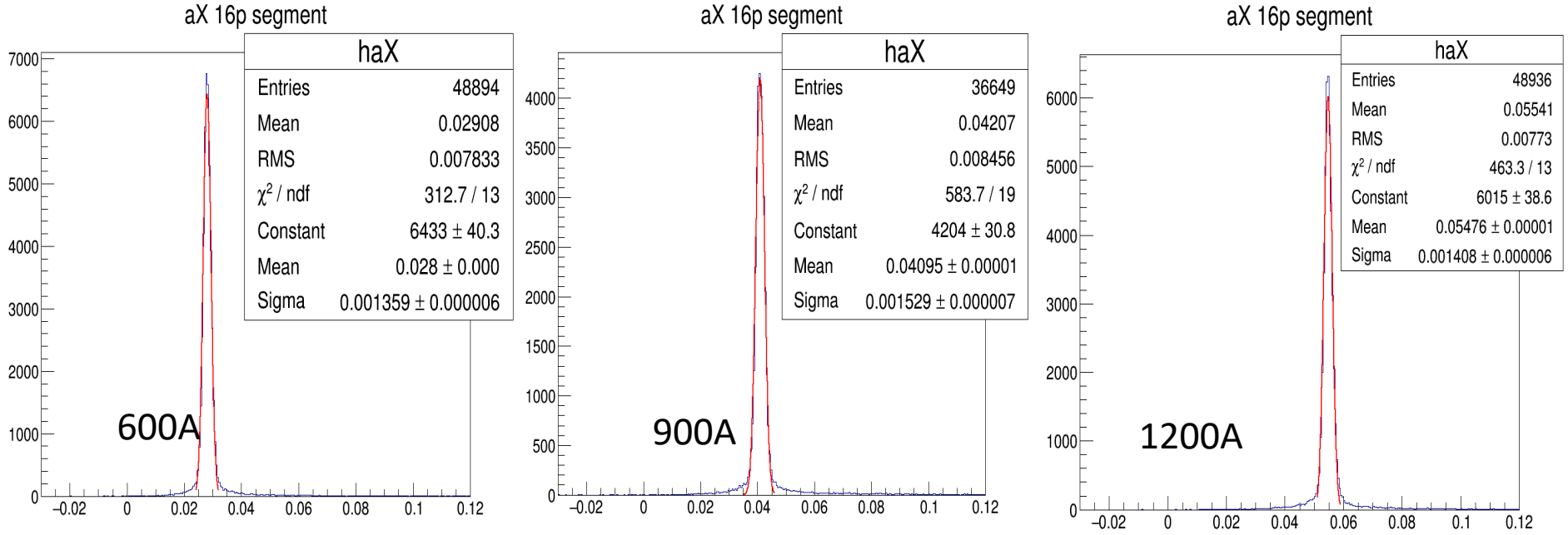


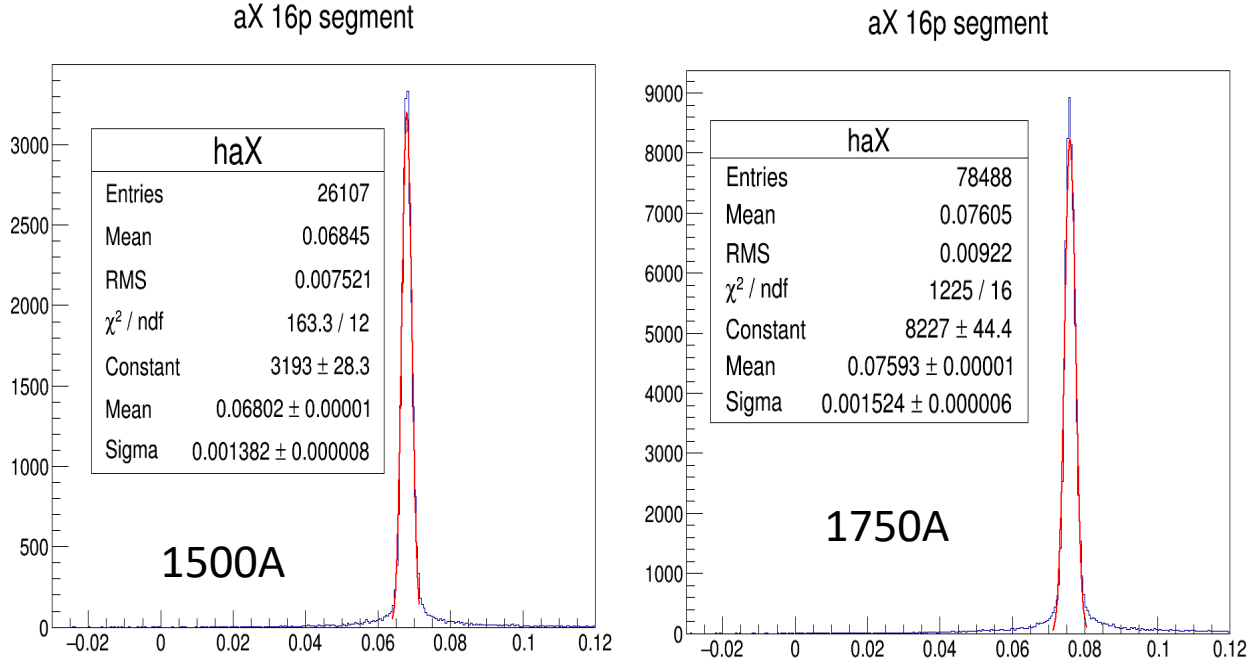
Summary

- The **software for the MWPC** and DCH detector systems was developed and implemented into the official experiment software and the software for CSC is under development
- The spatial resolution for different layers of the DC chambers varies within 150-200 μm
- The MWPC and DCH systems give us the possibility to estimate the beam momentum value with a high precision ~2% for the working values of the magnetic field integral
- The outer tracker detector systems (DCH & CSC) provide a high hit efficiency per layer
- The first look at CSC spatial hits matching with DCH global tracks shows a good CSC-DCH correlation
- **MWPC plays a key role in estimation of beam momentum and identification of A-2 for SRC program**

Thank you for your attention!

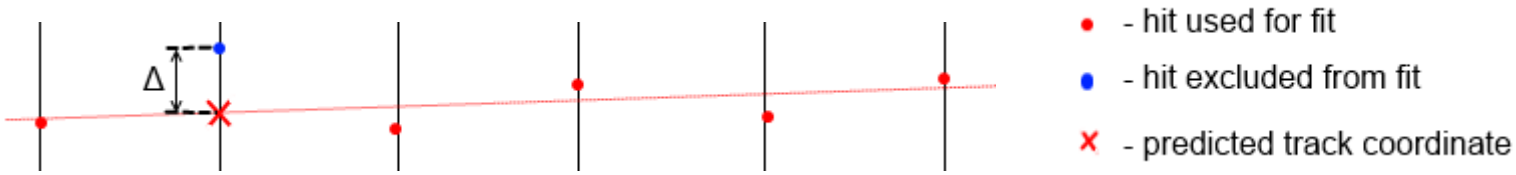
ax slope for beam – C 4.5 GeV/nucl





Spatial resolution calculation:

- Only 6 & 5-point segments are considered;
- For each layer with hit a straight line fit is applied excluding the current layer and the residual (Δ) between the measured strip coordinate and the predicted track coordinate from fit is used for resolution calculation.



Efficiency per layer (from segments):