Outer Tracker of the BM@N Experiment

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AYSS Prize Competition

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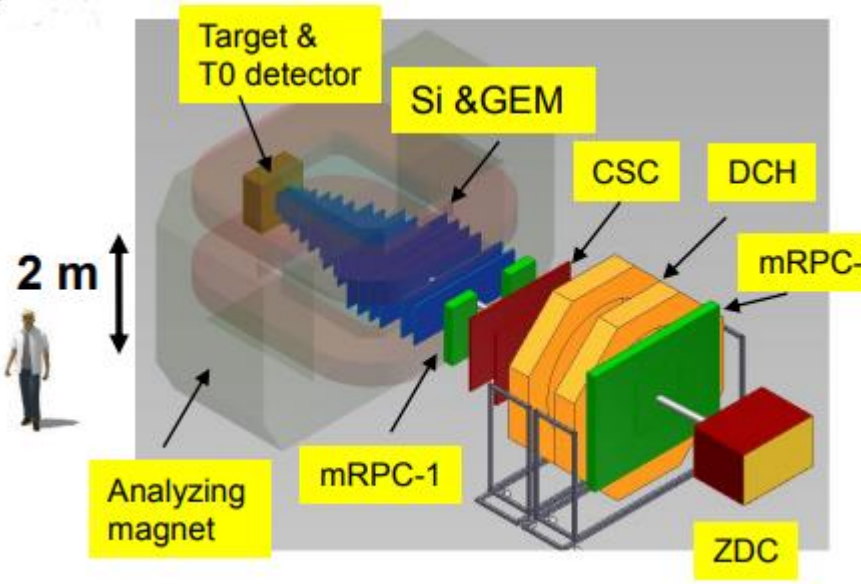
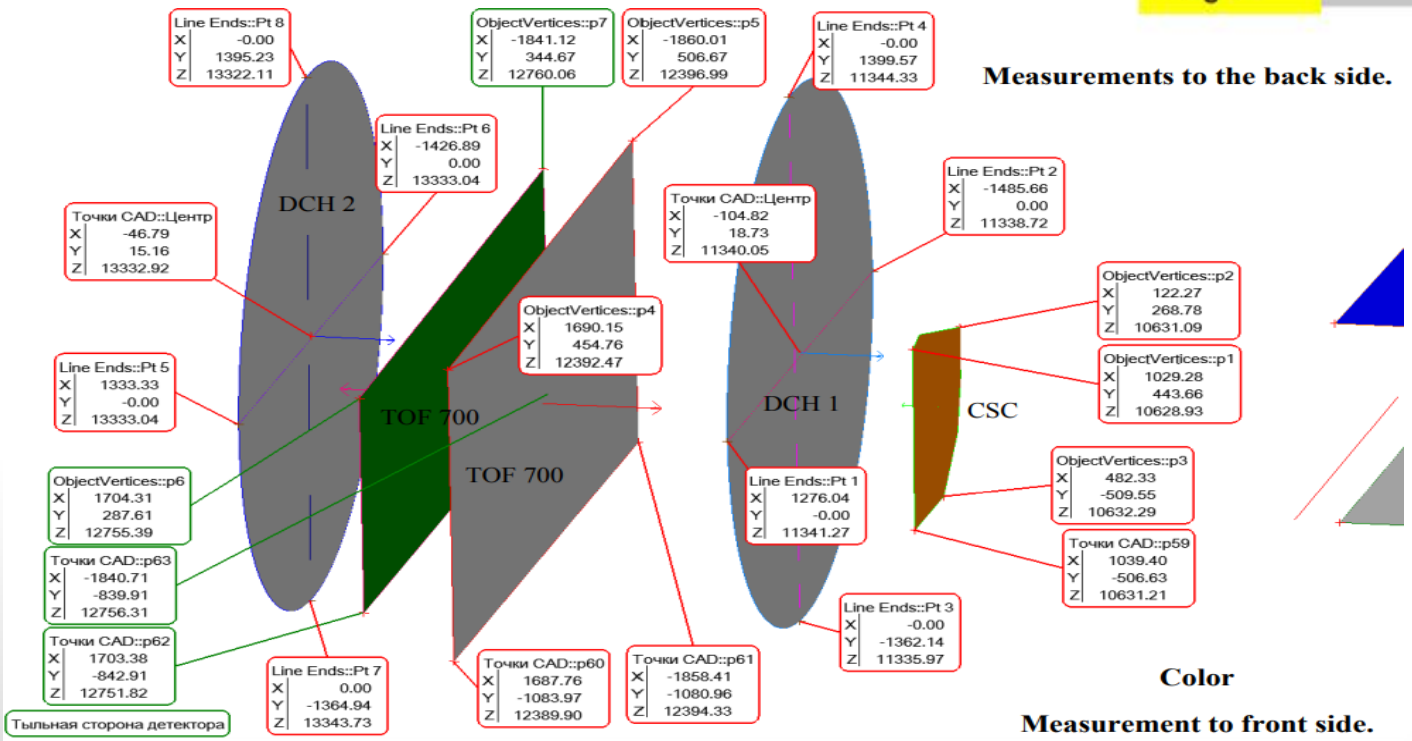
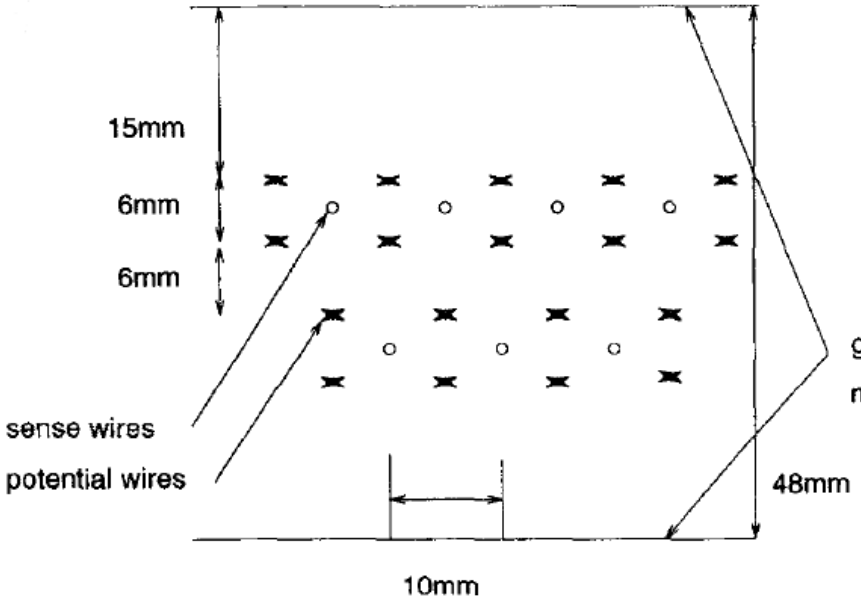
BM@N - 2018 experimental setup

- Central tracker (GEM) - AA interactions reconstruction;
- **Outer tracker** (DCH, CSC) - link central tracks to ToF;
- ToF - hadrons and light nucleus identification;
- ZDC calorimeter - centrality of AA collisions measurement;
- Detectors to form T0, L1 centrality trigger and beam monitors;
- Electromagnetic calorimeter - γ,e+e- detection;
- MWPC – alignment and incoming beam trajectory positioning.





Drift Chamber detector (DCH)

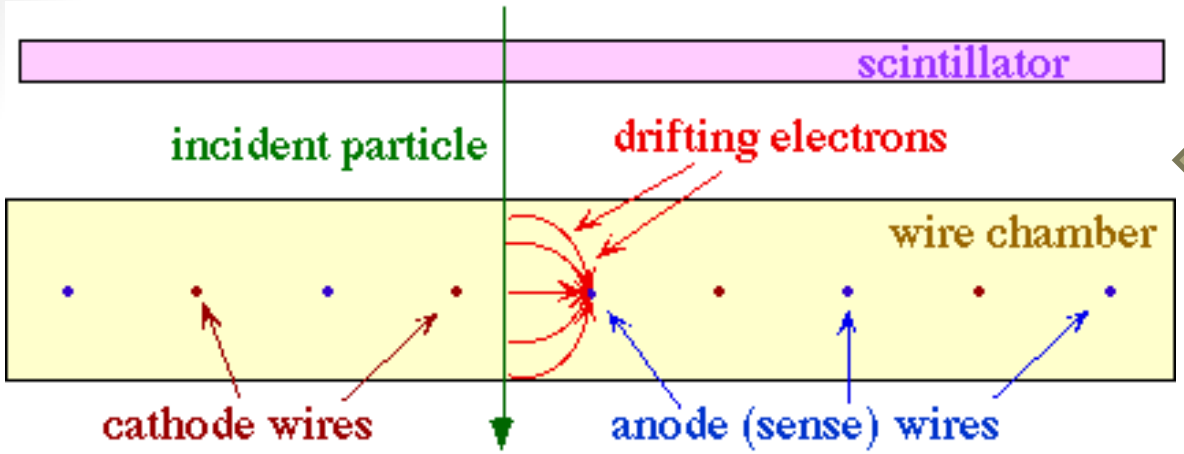


4 double coordinate planes: wire angles 0,90,±45°, wire pitch 10 mm, Yout ± 1.35 m, Xout ± 1.35 m, Rmin = 10 cm, 2048 wires per chamber

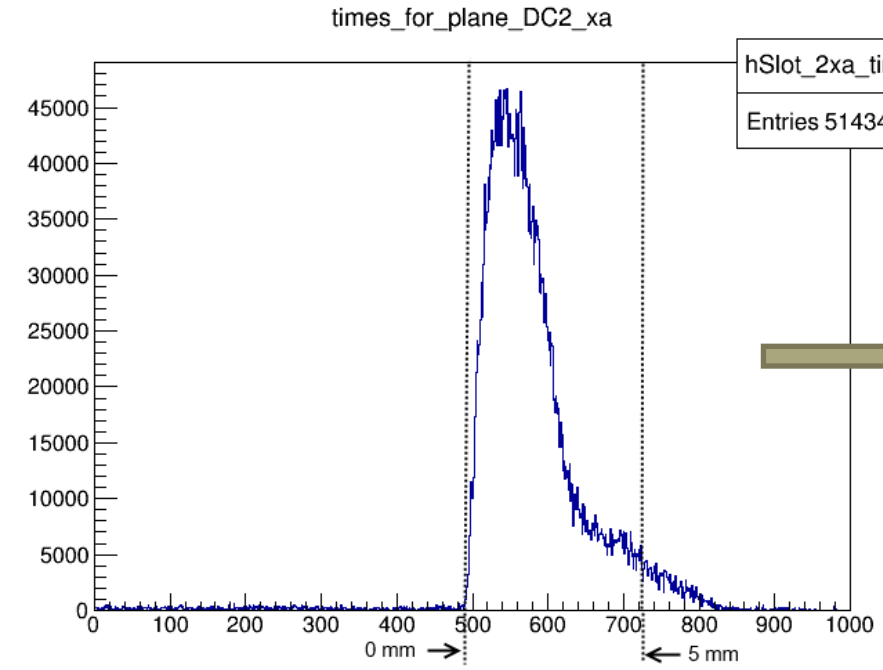
← one DC-plane schematic representation

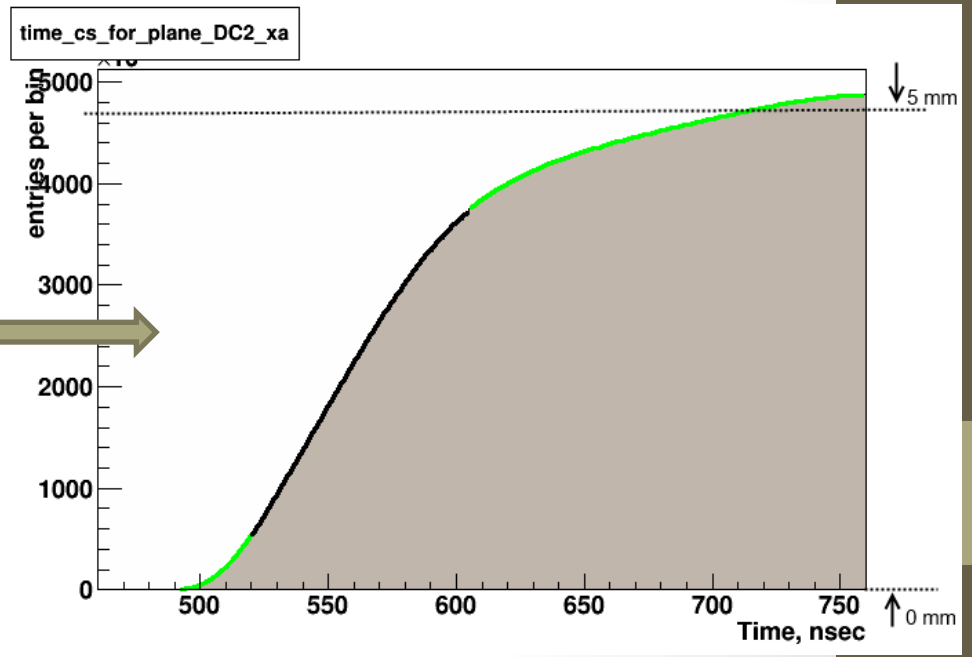
Team: A.Morozov, D.Nikitin, R.Kattabekov, V.Spaskov

DCH coordinate reconstruction

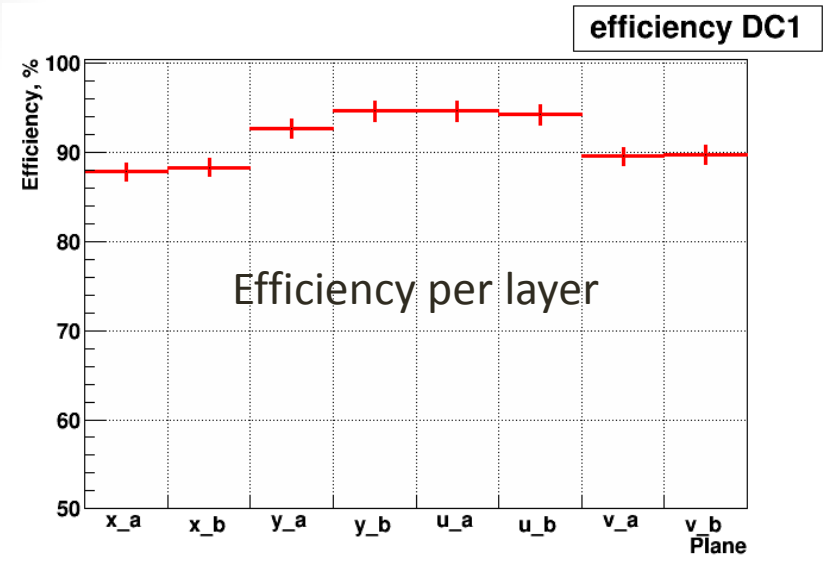


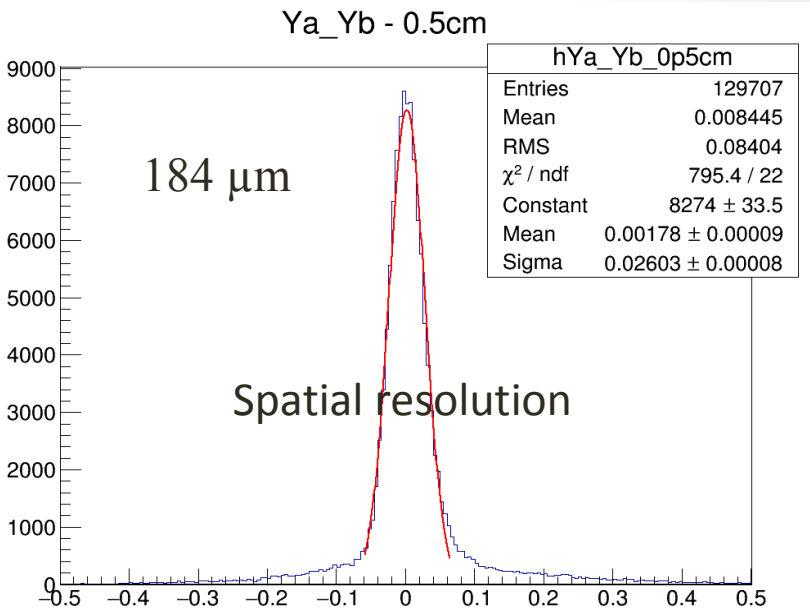
Principle of working of a Drift Camber detector

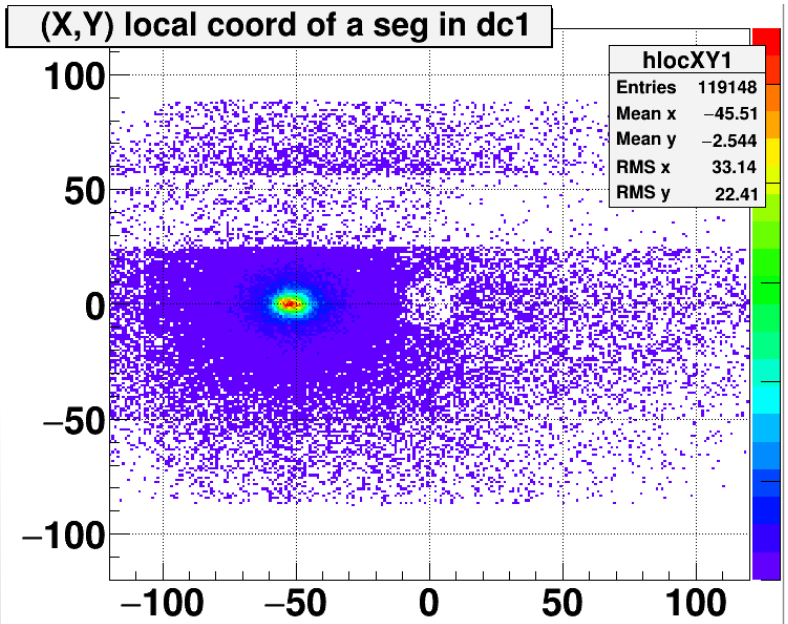


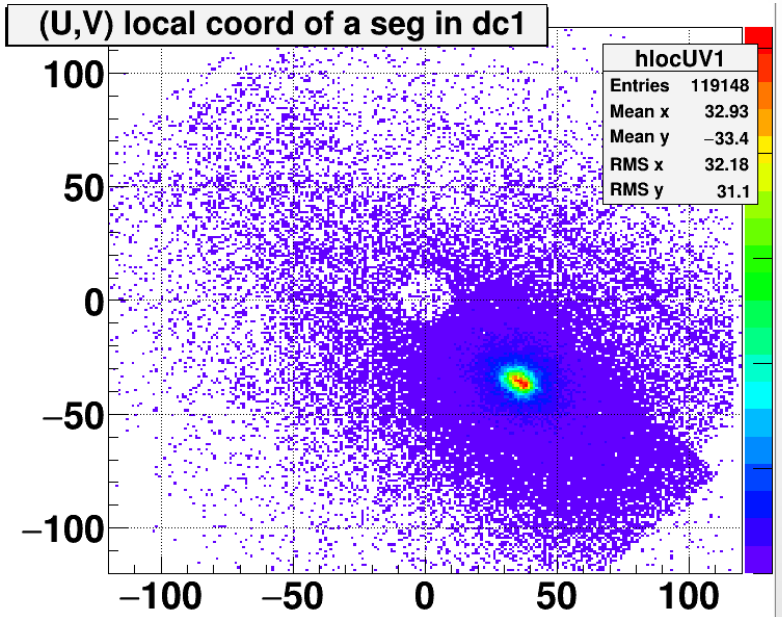


DCH Performance

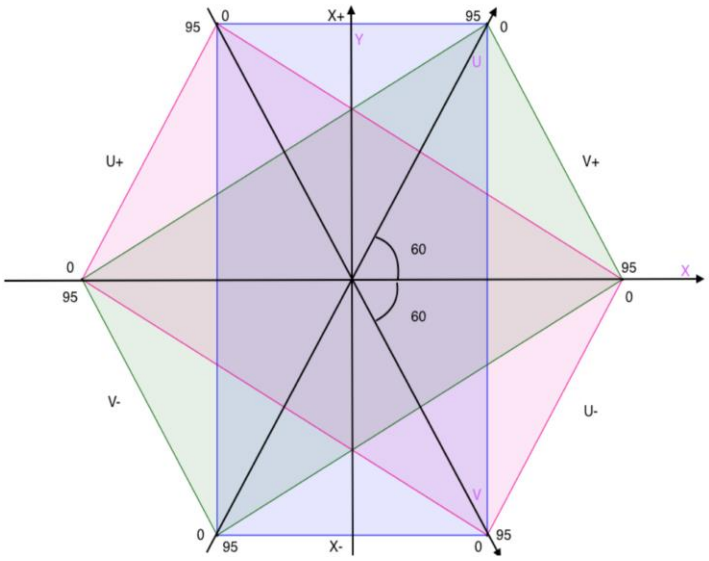


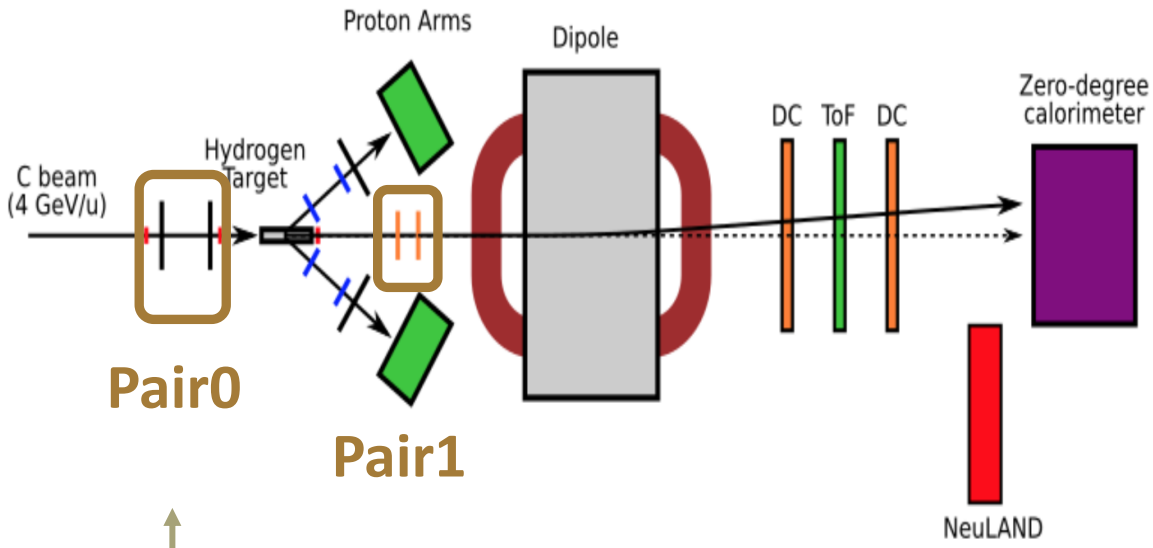






MWPCs structure and location





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

96 wires in each plane

Two pairs of MWPCs in the SRC at BM@N experiment: Pair0 and Pair1

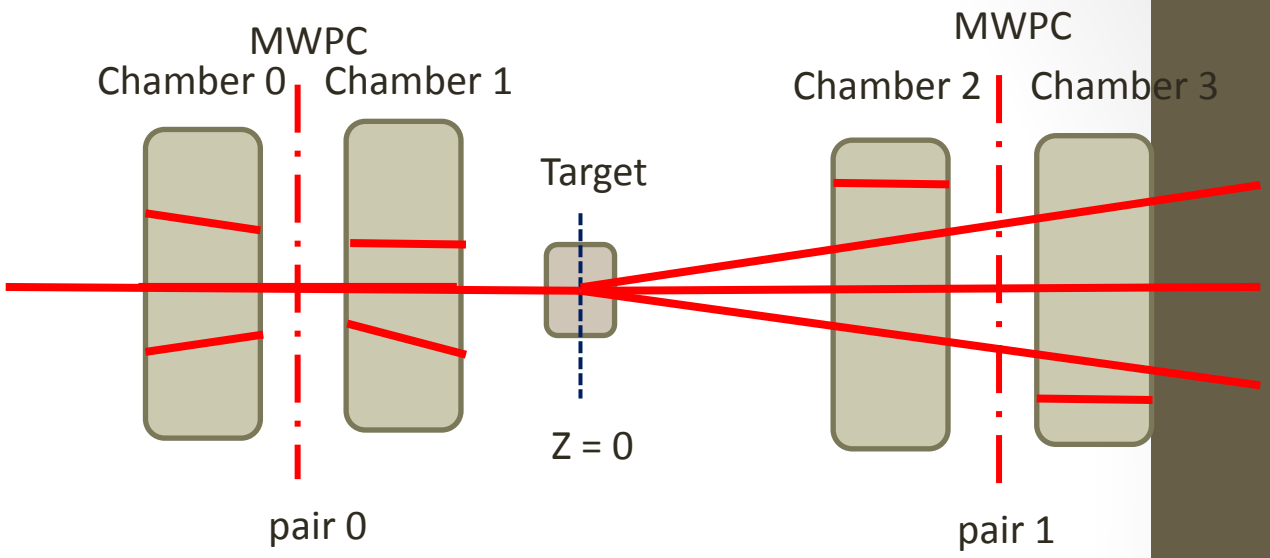
Alignment was done with **4 chambers** (**SRC at BM@N**)
Pair0 was removed for the **BM@N** run

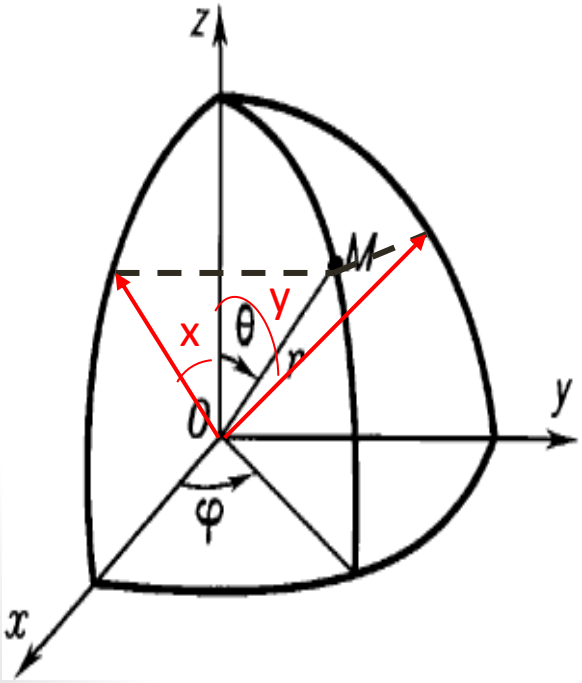
MWPC Reconstructed Track parameters: slopeX, slopeY, posX, posY

Straight line fit equations:

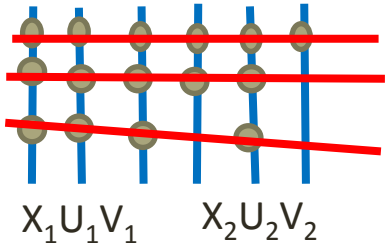
ZX: X = slopeX *Z + posX

ZY: Y = slopeY *Z + posY





1. Recognize segments with groups of 6/6, 5/6, 4/6 - fired wires per segme



6/6 points per segment

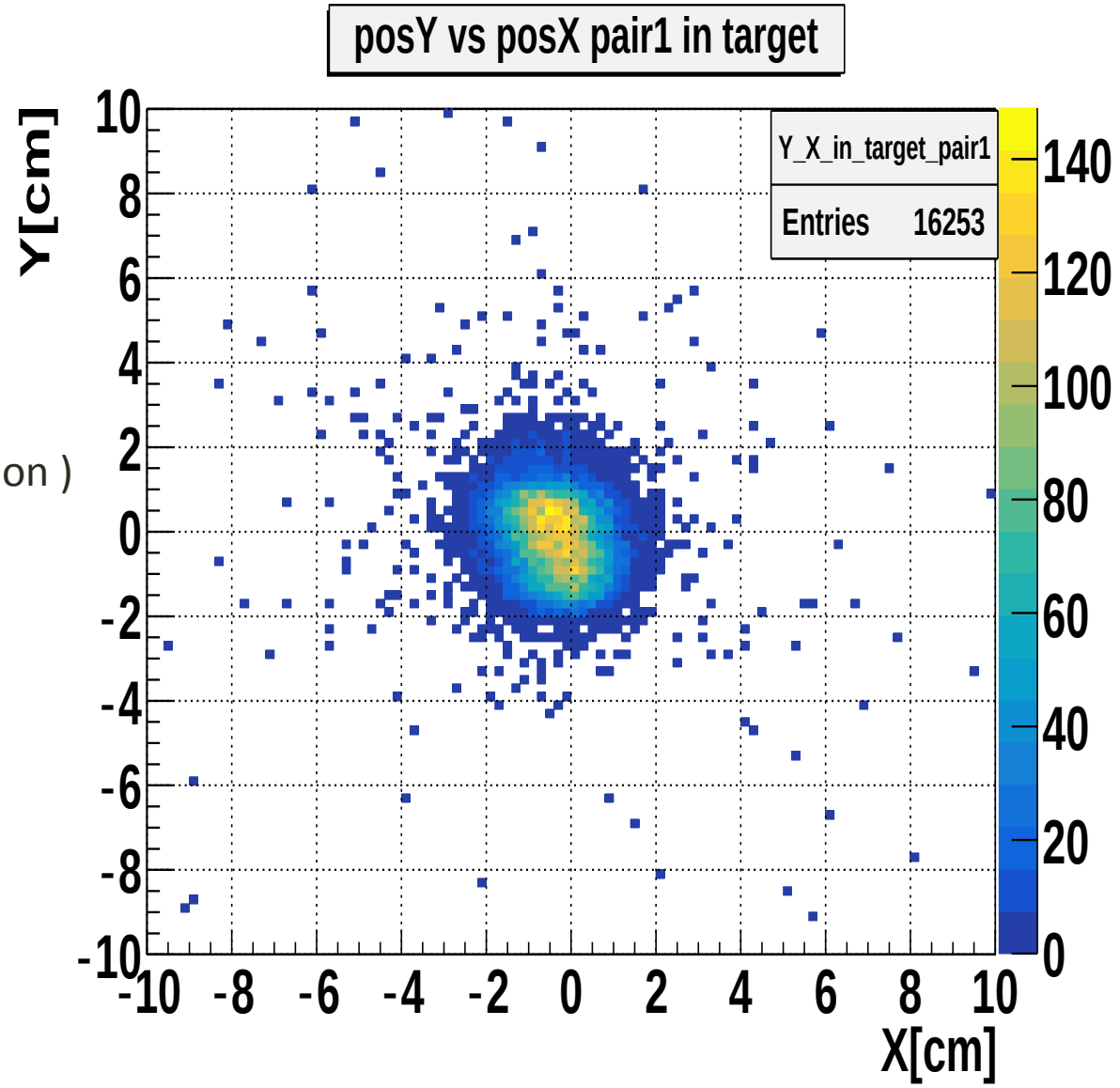
5/6

4/6

Using two space points: (X_1, U_1, V_1) and (X_2, U_2, V_2)

2. Reconstruct & fit track-segments in each chamber ($slopeX_i$, $slopeY_i$, $posX_i$, $posY_i$ in the Z_i- chamber center)
3. Reconstruct track in each pair of chambers ($slopeX_{0,1}$, $slopeY_{0,1}$, $pos_{x\,0,1}$, $pos_{y0,1}$ in the $Z_{0,1}$- pair center)
4. Extrapolate tracks to the target center for each pair

MWPC Track Parameters for Pair 1 in the target center



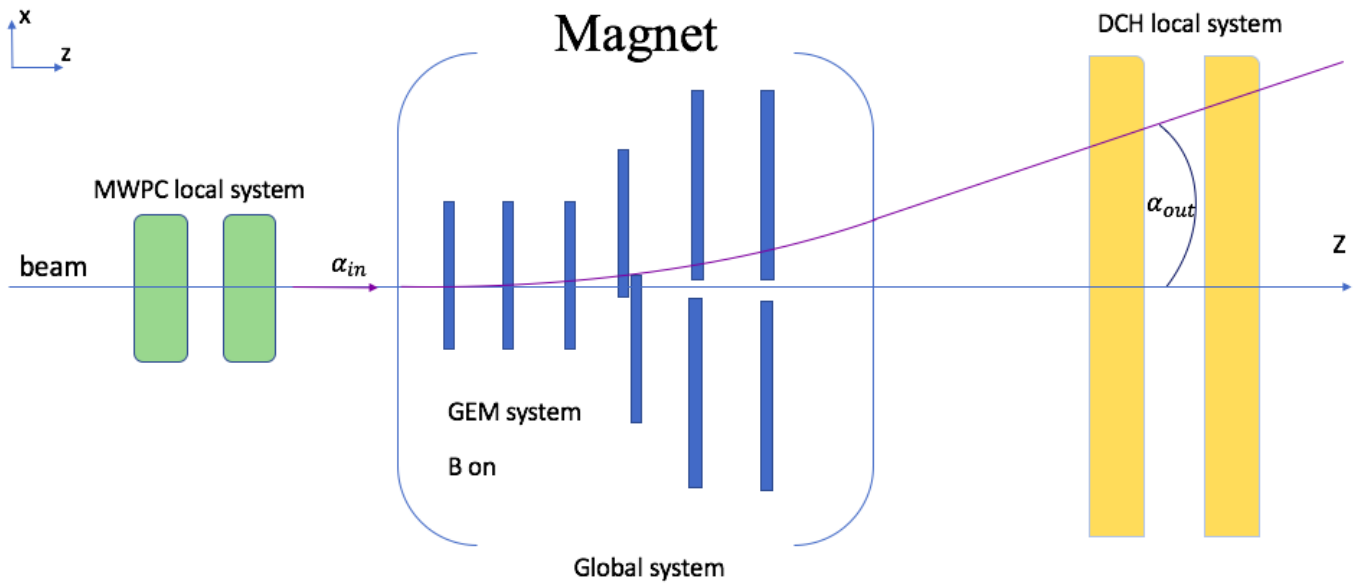
Run 2706
(Beam: C, B on)

6/6 points per segment

Beam momentum estimation procedure

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

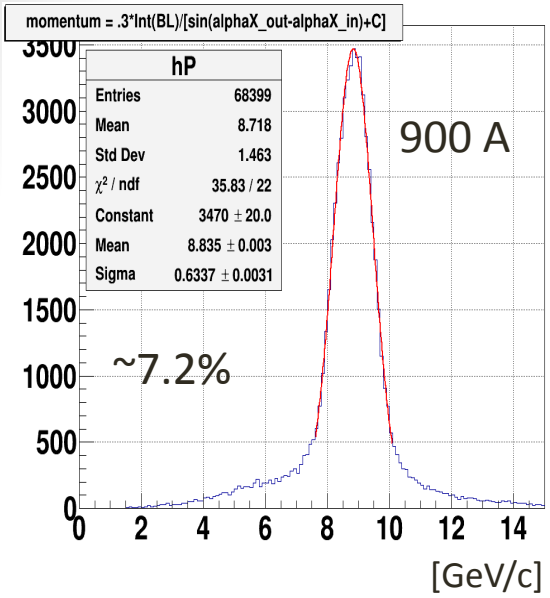
α_{in} - angle of beam before magnet (MWPC);
α_{out} - angles of beam after magnet (DCH);
$\int Bdl$ - magnet field integral [T*m].

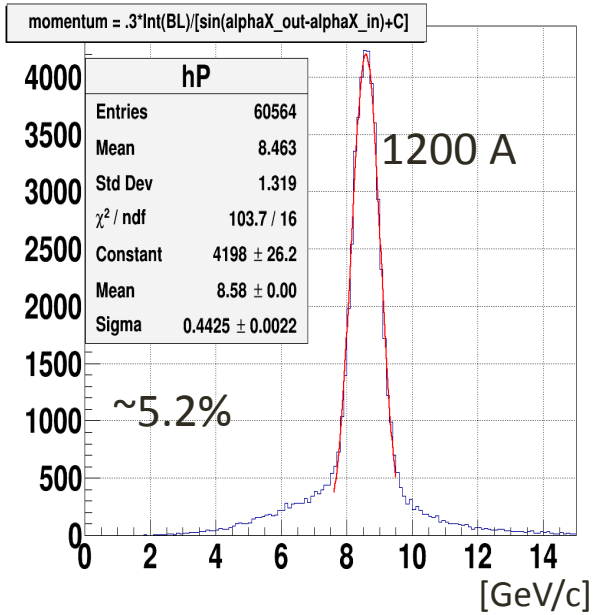


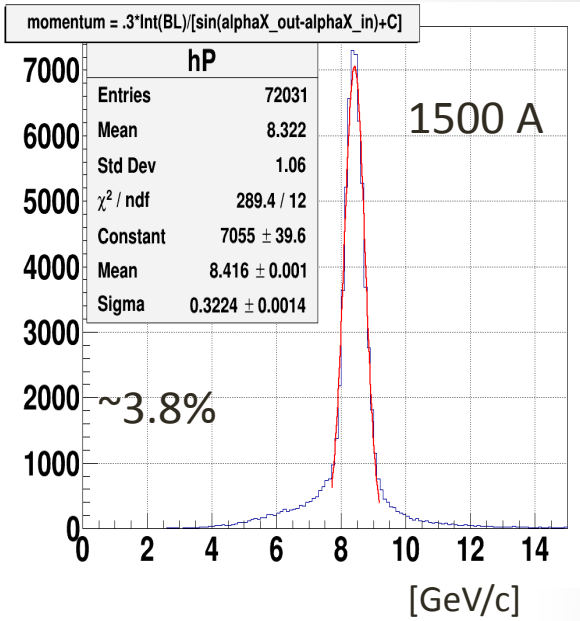
$$P_{beam} = \frac{A}{Z} * \sqrt{\left(E/n + M_p\right)^2 - M_p{}^2}$$

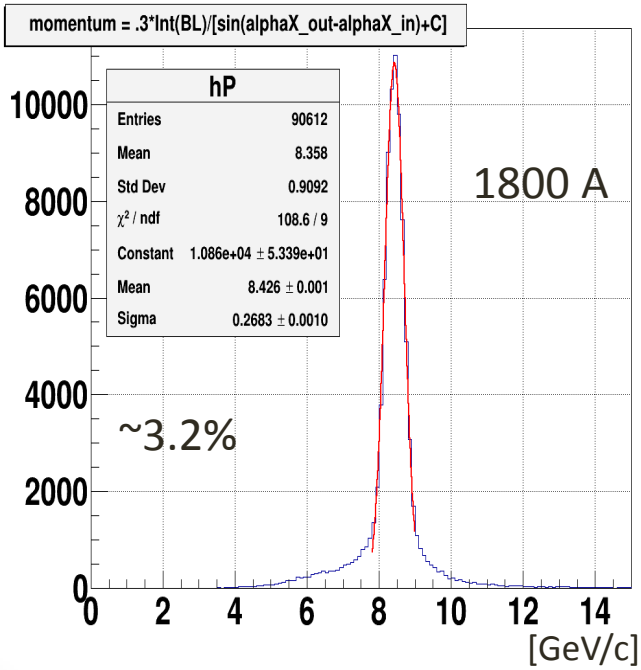
A - mass number;
Z - number of protons;
E/n - beam energy per nucleon;
M_p - proton mass.

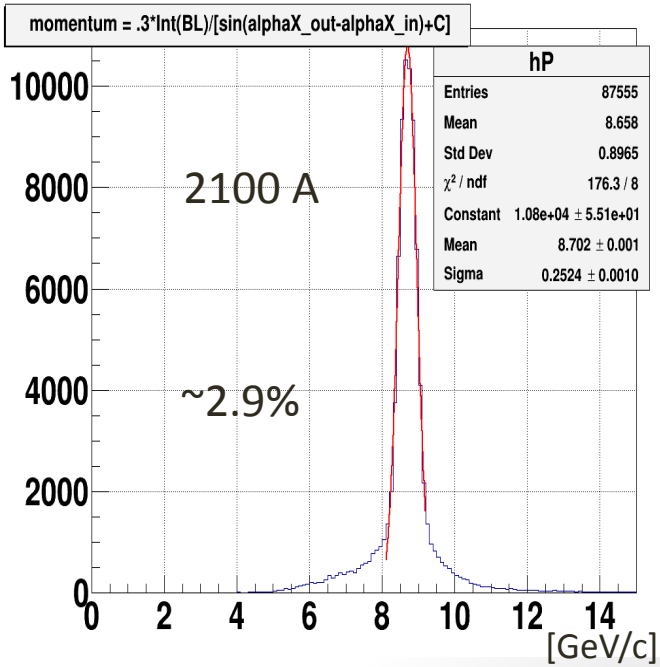
Momentum estimation for particular magnetic field values





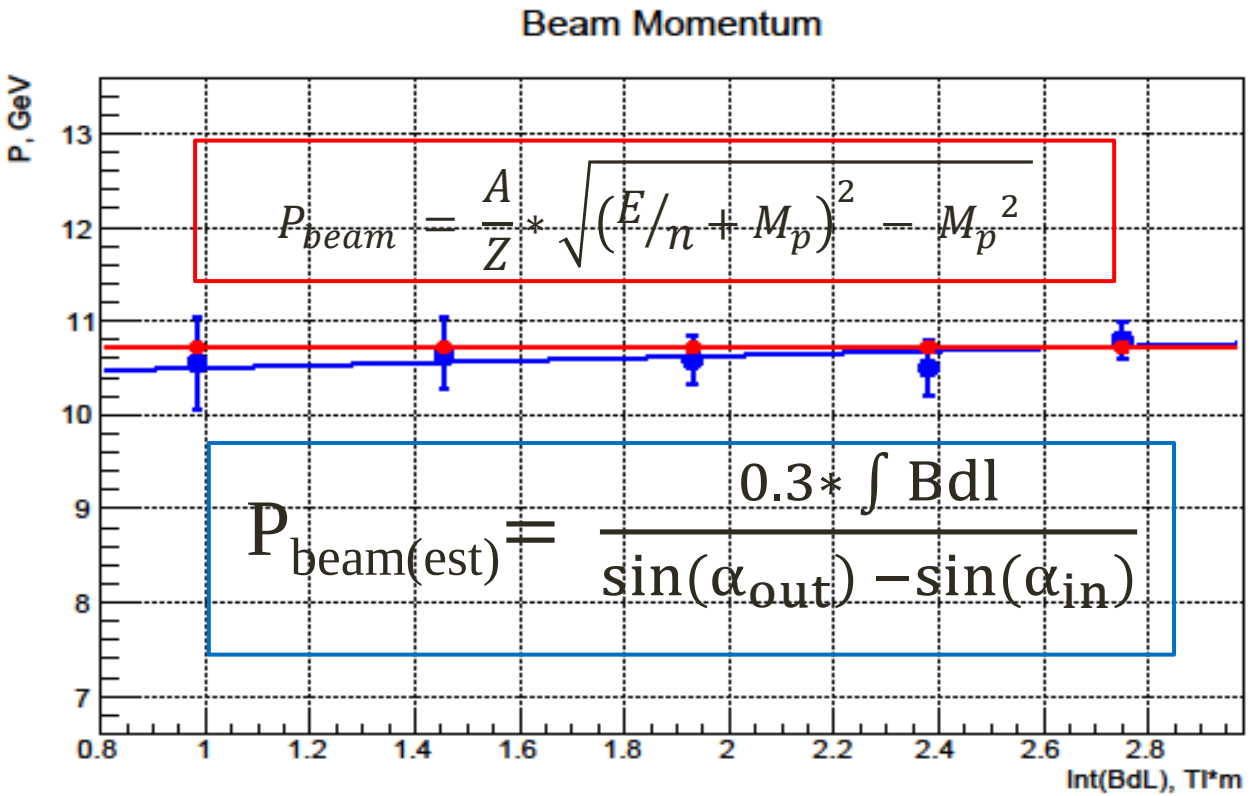






Momentum vs. Int(BdL)

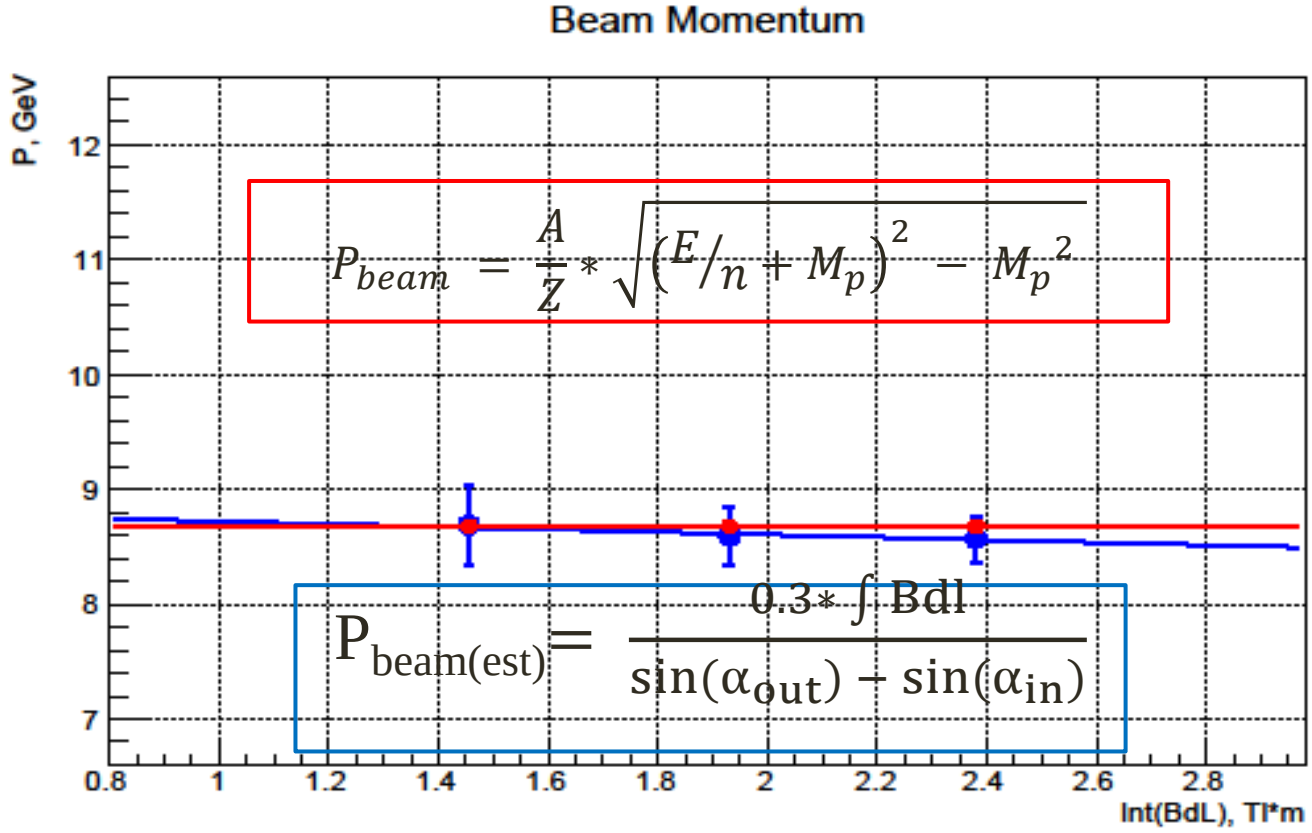
C beam energy 4.5 GeV/nucleon;
Momentum 10.7 GeV/c;



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

Momentum vs. Int(BdL)

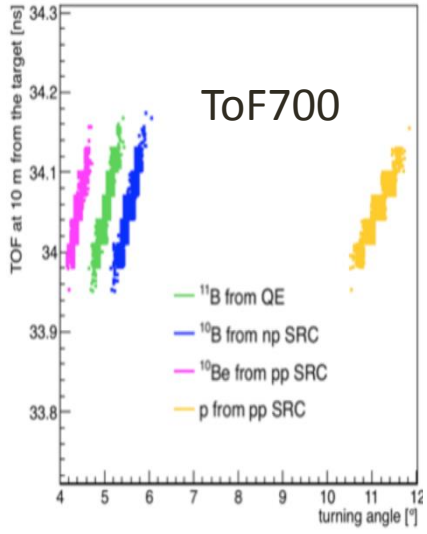
C beam energy 3.5 GeV/nucleon;
Momentum 8.7 GeV/c;

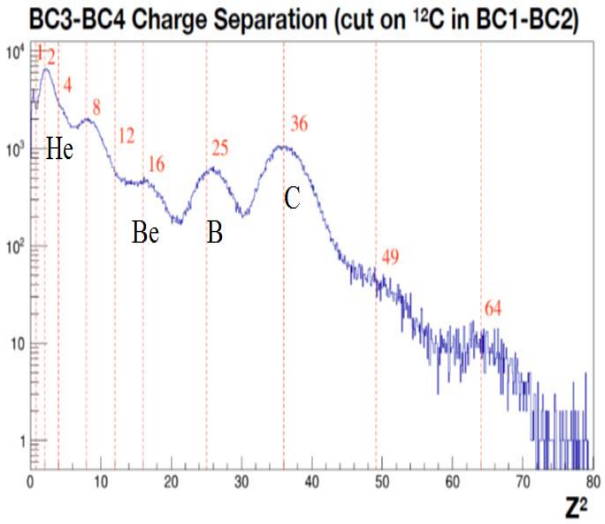


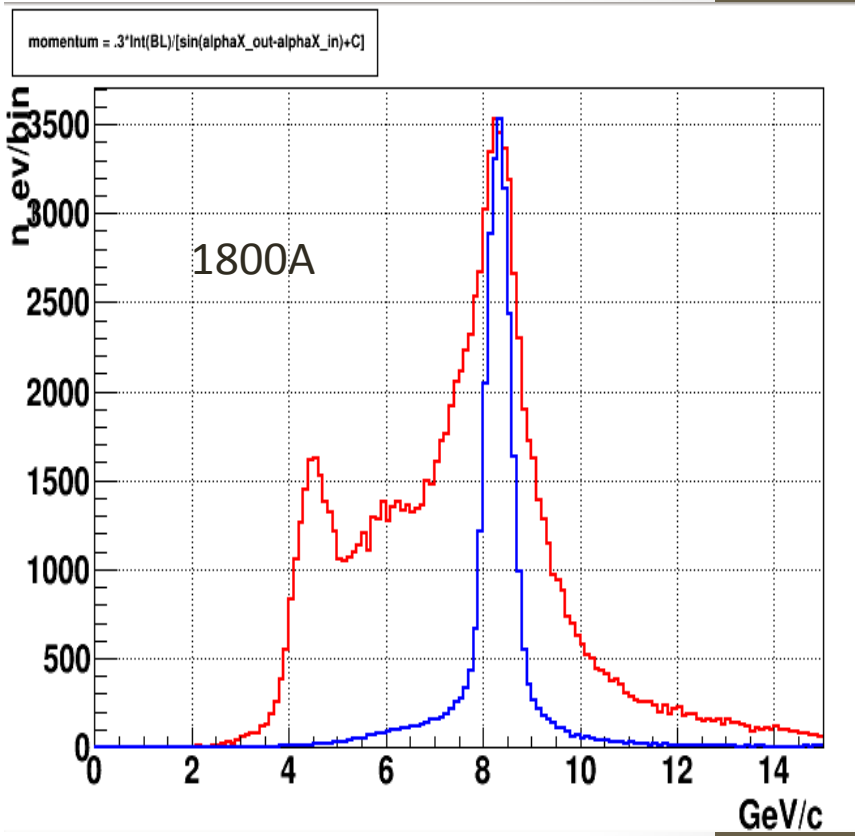
RED – Nuclotron beam momentum;
BLUE – estimated beam momentum.

RUN7 SRC B_{10}, B_{11} isotopes separation using momentum/angle difference (plans)

Runs for B(10,11) separation					
Runs	Beam	target	SP-41, A	SP-57, A	events
3400-3429	C	H2	1800	0	50K per file





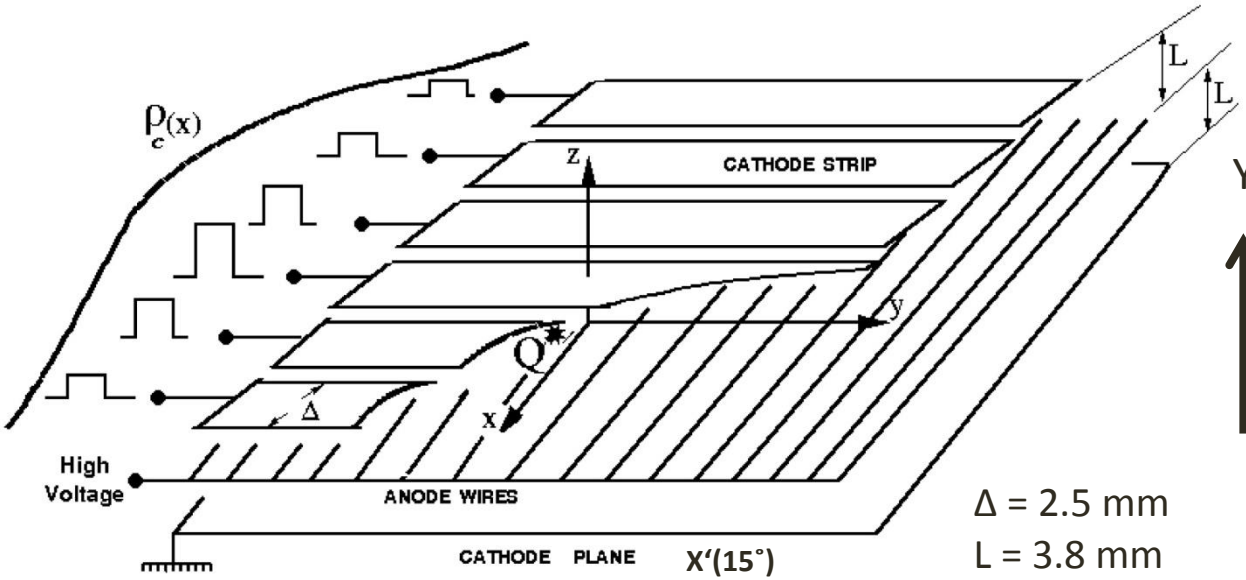


RED – H_2 target

BLUE – empty target

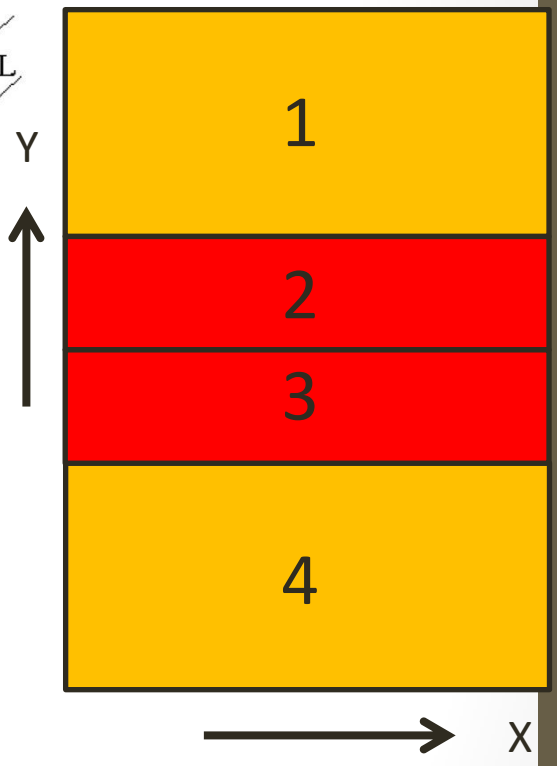
Cathode Strip Chambers (CSC)

The principle of working of cathode strip chambers



Δ = 2.5 mm
L = 3.8 mm

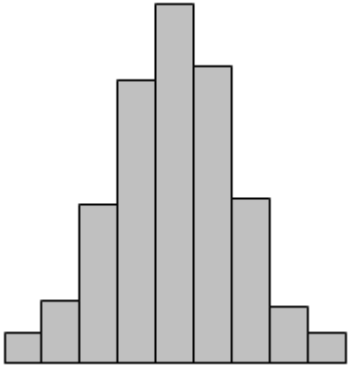
Zones



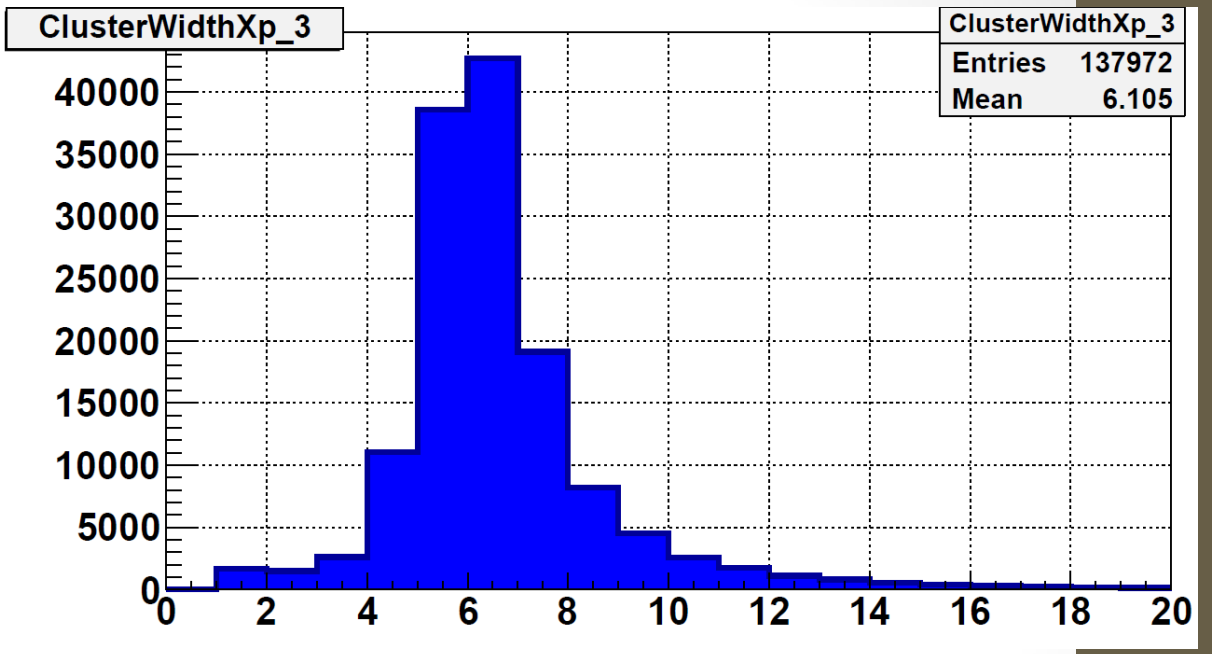
Reconstructed Hit - 2D coordinate of the passing particle on a zone.

Technical developers:
A. Vishnevsky, Yu. Kiryushin;
Team:
A. Makankin, S. Vasiliev, E. Kulish, A. Maksimchuk.

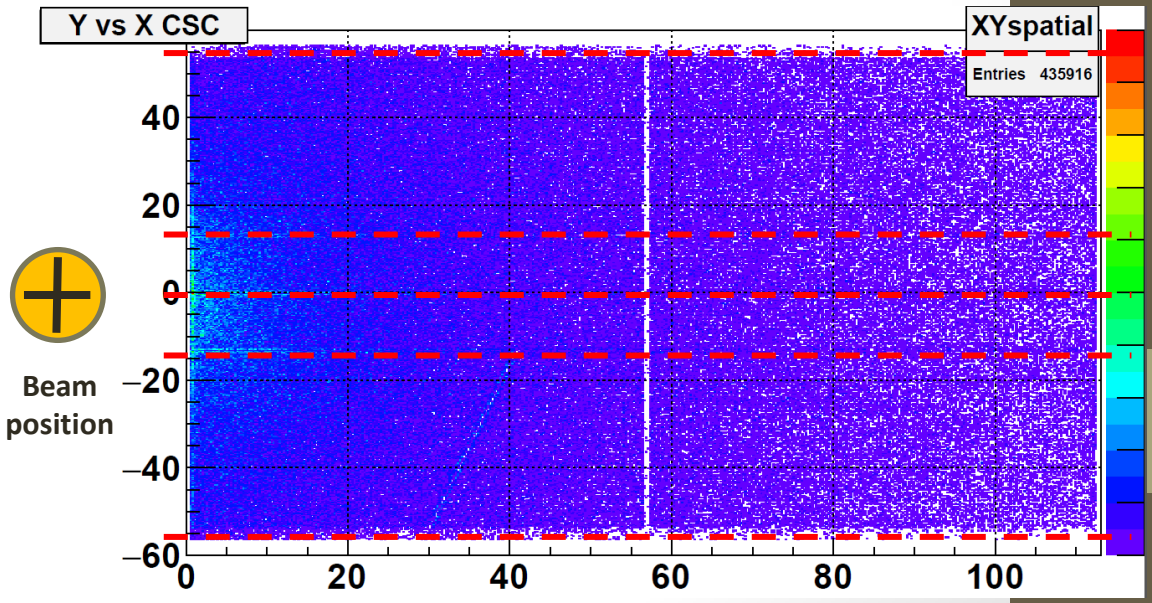
Cathode Strip Chambers



Typical cluster charge distribution on strips

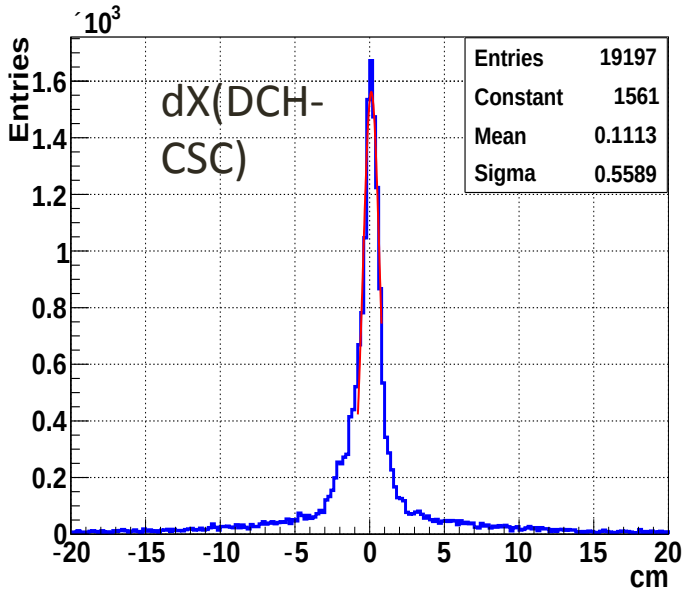


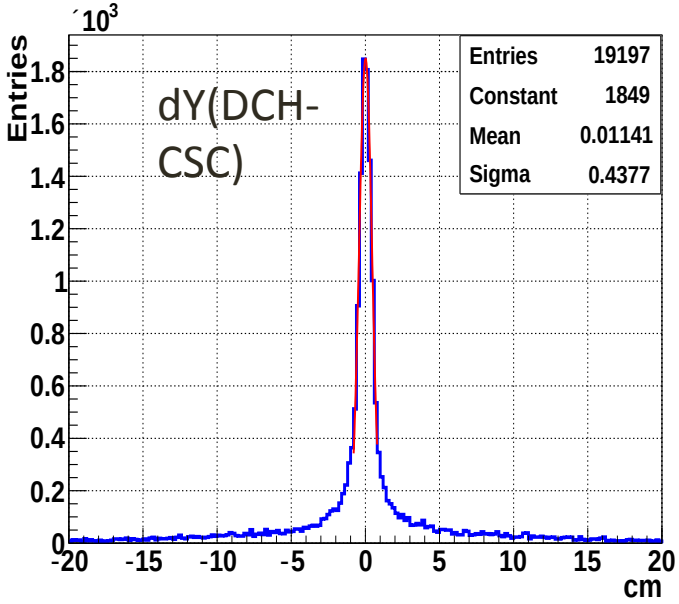
Coordinate calculated by CoG at the moment.
To be fitted by Gatti function in the future.

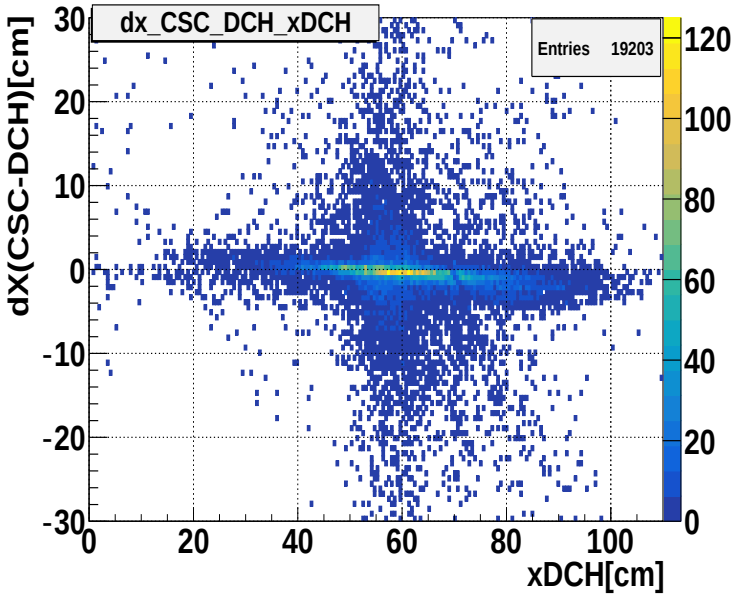


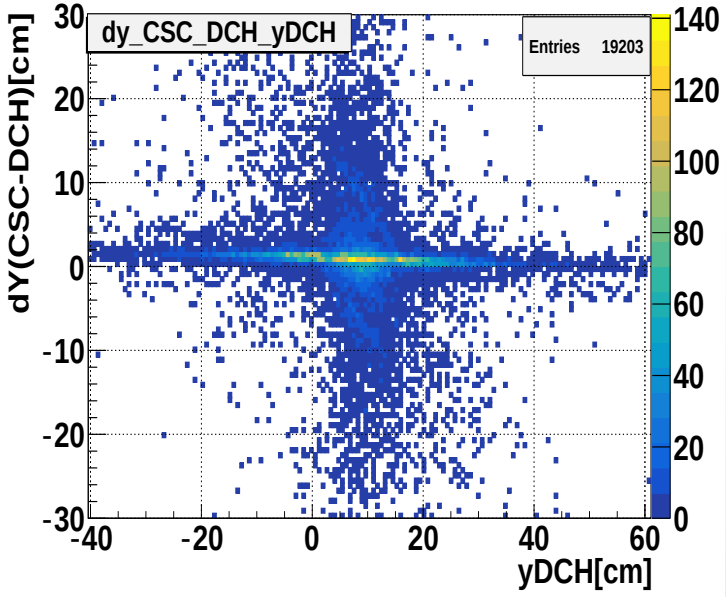
CSC matching to DCH

Run 2706 (Beam: C, B on)





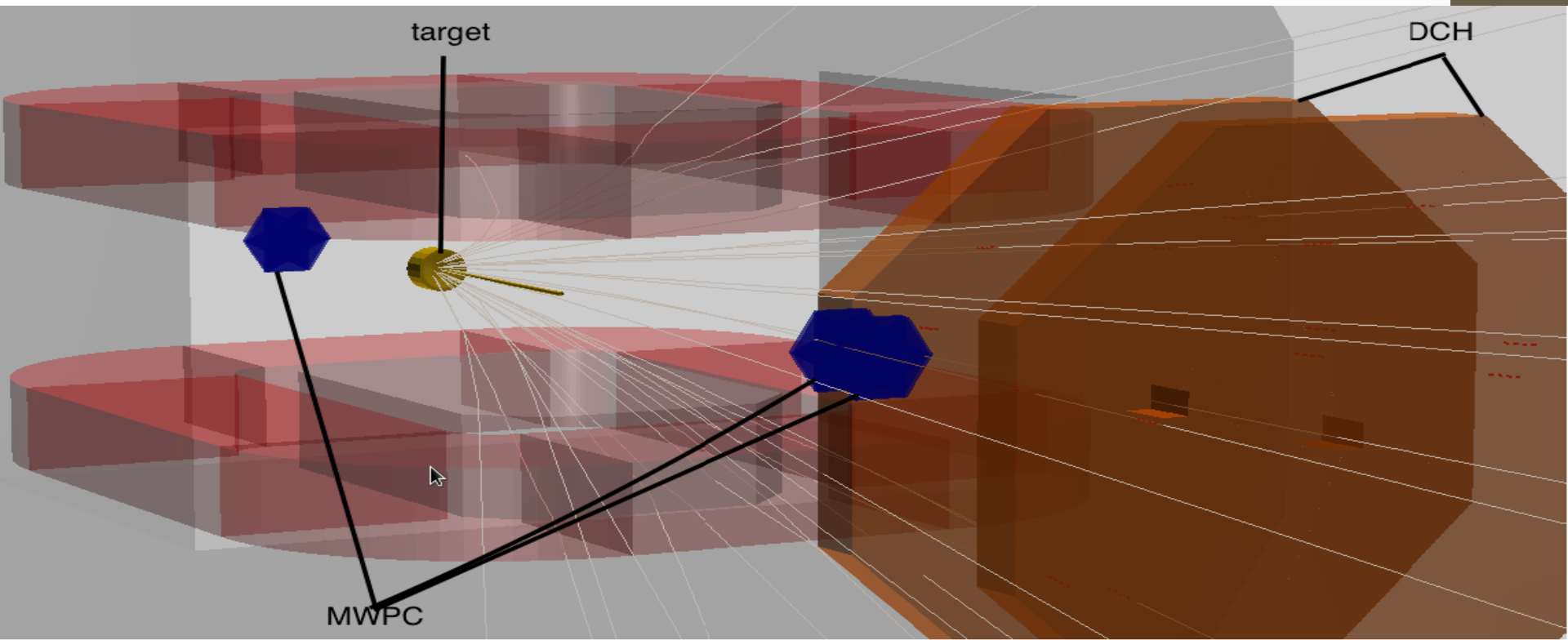




Summary

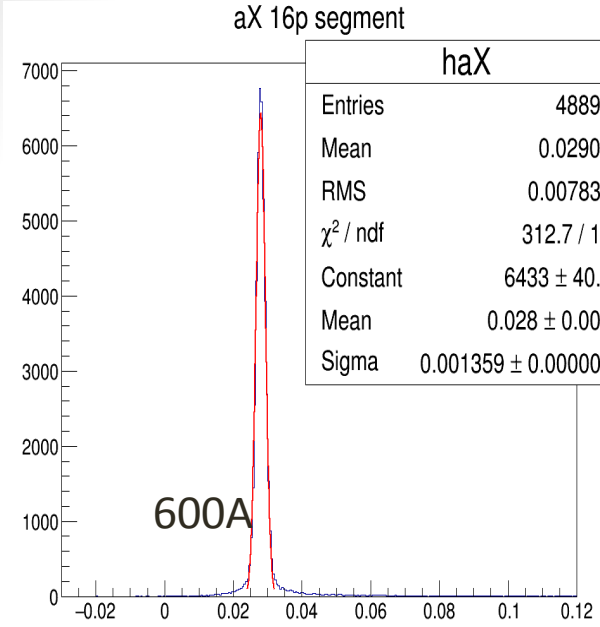
- The software for the MWPC and DCH detector systems was developed and implemented into the official experiment software and the software for CSC is under development;
- The spatial resolution for different layers of the DC chambers varies within 150-200 μm;
- The MWPC and DCH systems give us the possibility 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.

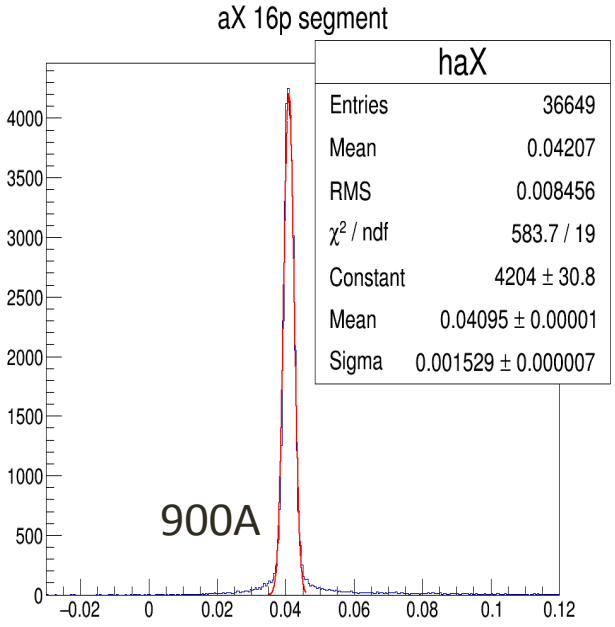
Thank you for your attention!

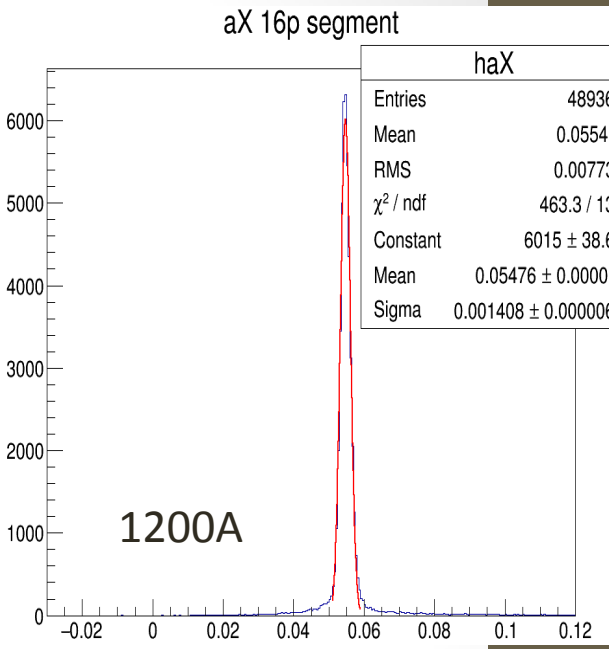


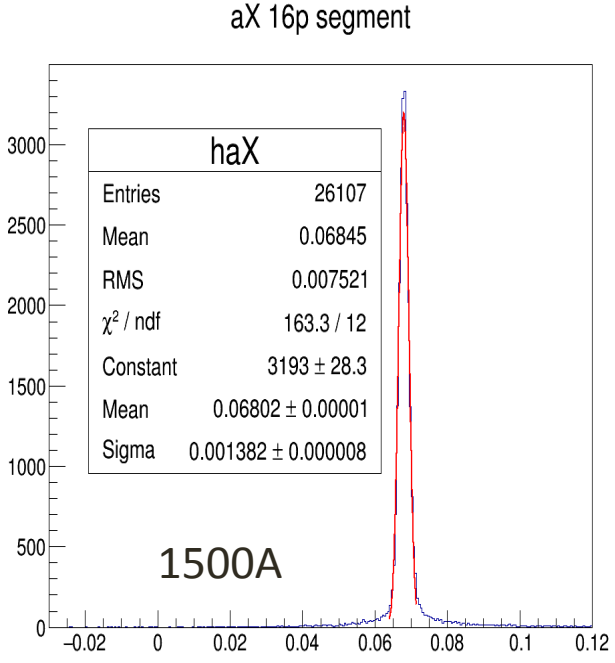
Backup slides

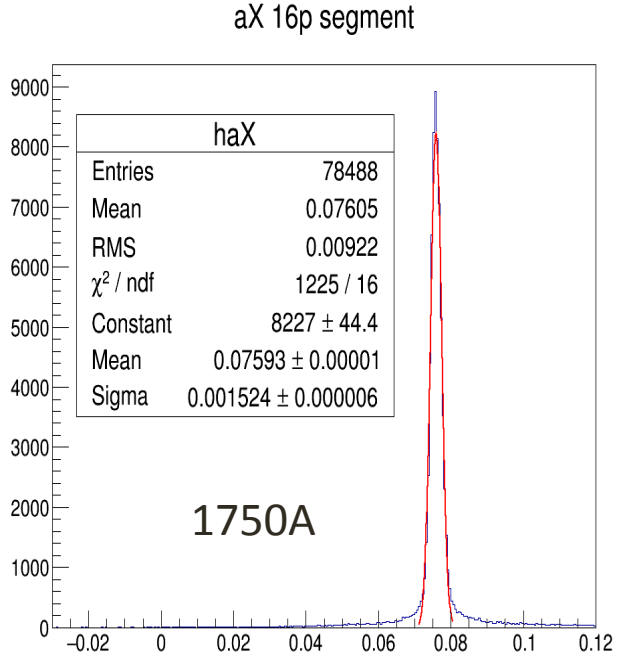
ax slope for beam – C 4.5 GeV/nucl











Monitoring detector info (from Makankin)