On light fragments in SRC data

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Goals of the current analysis

1. Analysis of yields of different fragments in C+p reaction
2. Comparison with the different physical models
3. Comparison with results of other experiments

Outline

1. Background (Results of the previous collaboration meeting)
2. Pt – balance
3. Empty target accounting
4. Comparison with MC simulation
5. Summary

Background information

Experiment
1. Interactions 12C with Liquid Hydrogen target
2. Vertex
3. The fragments are distinguished

Simulation:
1. QGSM generator
2. The target was smeared along z - 30 cm

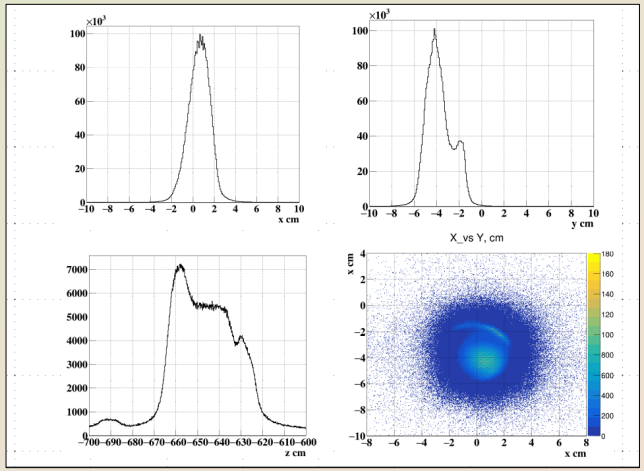


Fig. 1 Coordinates of vertex

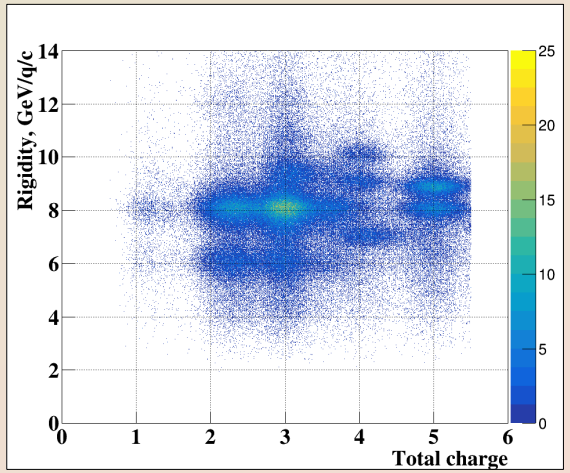


Fig. 2 The fragments in the experiment

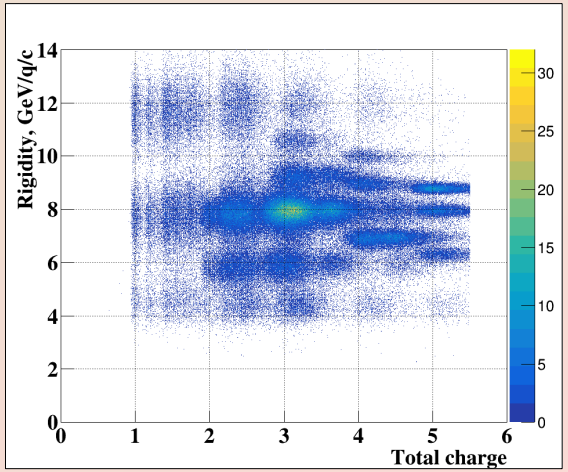
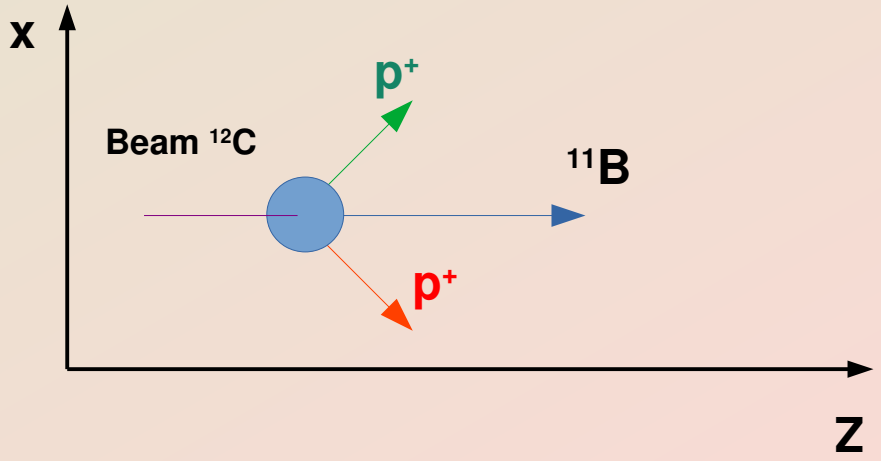


Fig. 3 The fragments in the simulation

Pt balance

1. LH target
2. Vertex in the physical volume
3. Incoming carbon
4. Number of fragments = 1
5. Select outgoing Boron 11

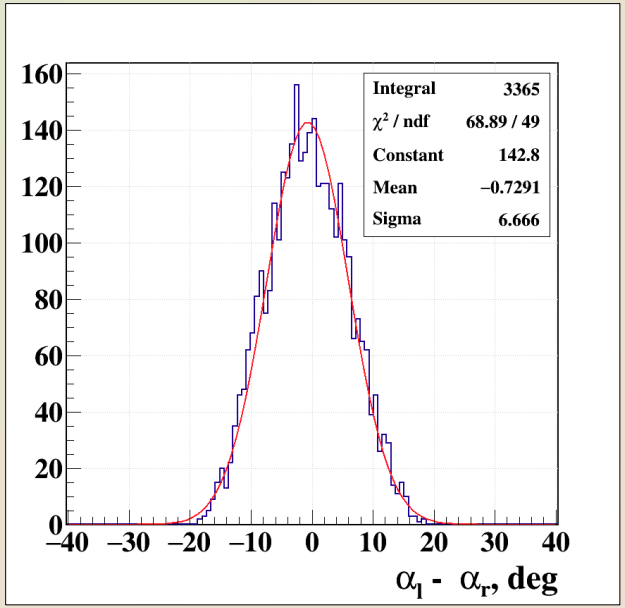


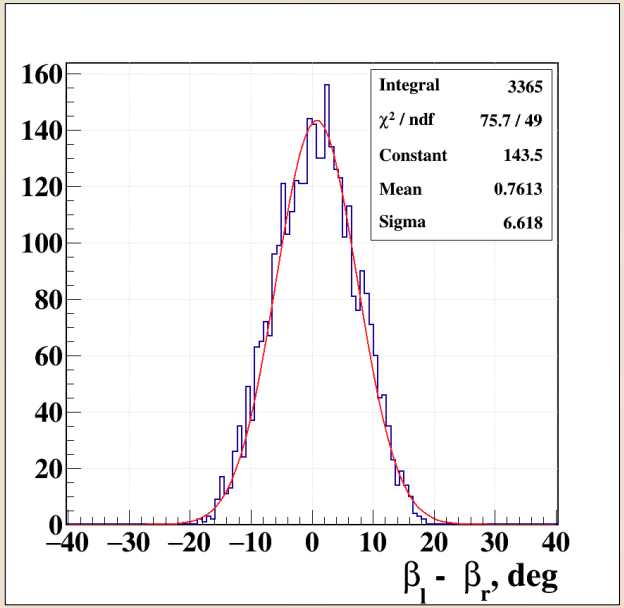
α - between the normal and x axis
β - between the normal and y axis
γ - between the normal and z axis

p+ and 11B – the first plane with normal n_1
p+ and 11B – the second plane with normal n_2

Pt balance

1. Mean value hasn't the offset → p_t balance





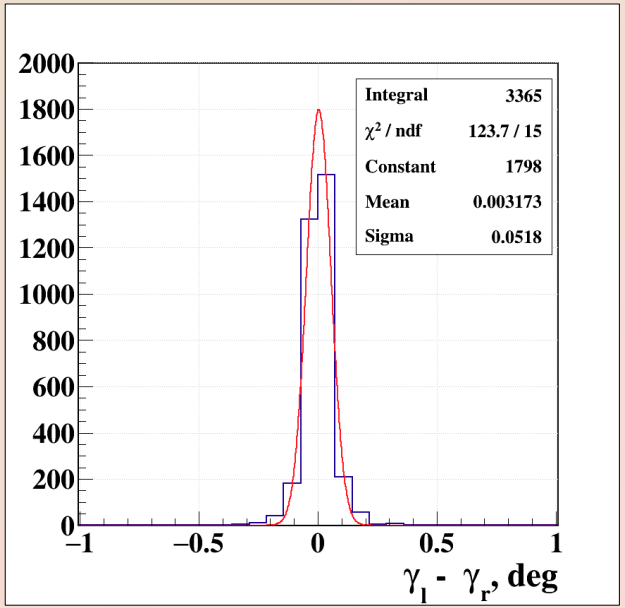


Fig. 4 Difference between angles of the normals to the reaction planes

Pt balance

Considered:

1. One global track

2. The events with one track in the left or right arm were selected.

3. P_x^{left} – momentum of fragments with the track in the left arm (x>0),

P_x^{right} – momentum of fragments with the track in the right arm (x<0)

Study P_x^{left}/P_x^{right}.

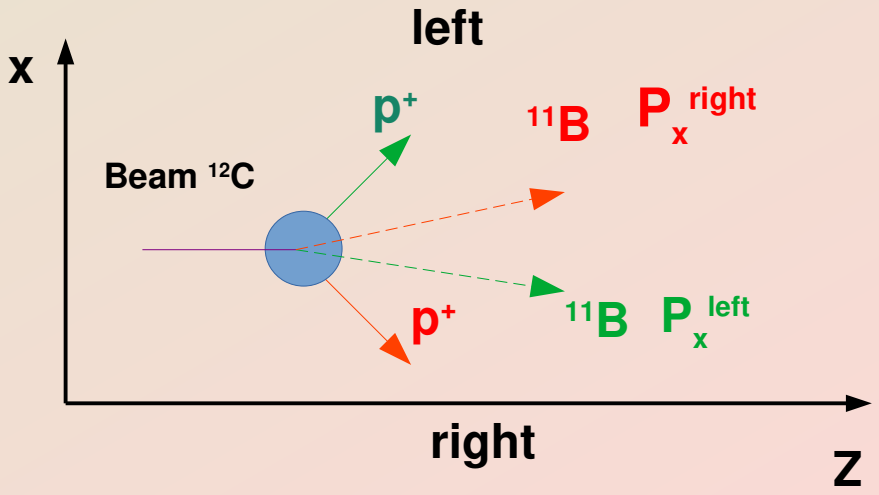


Fig. 5 P_t - balance

Pt balance in simulation

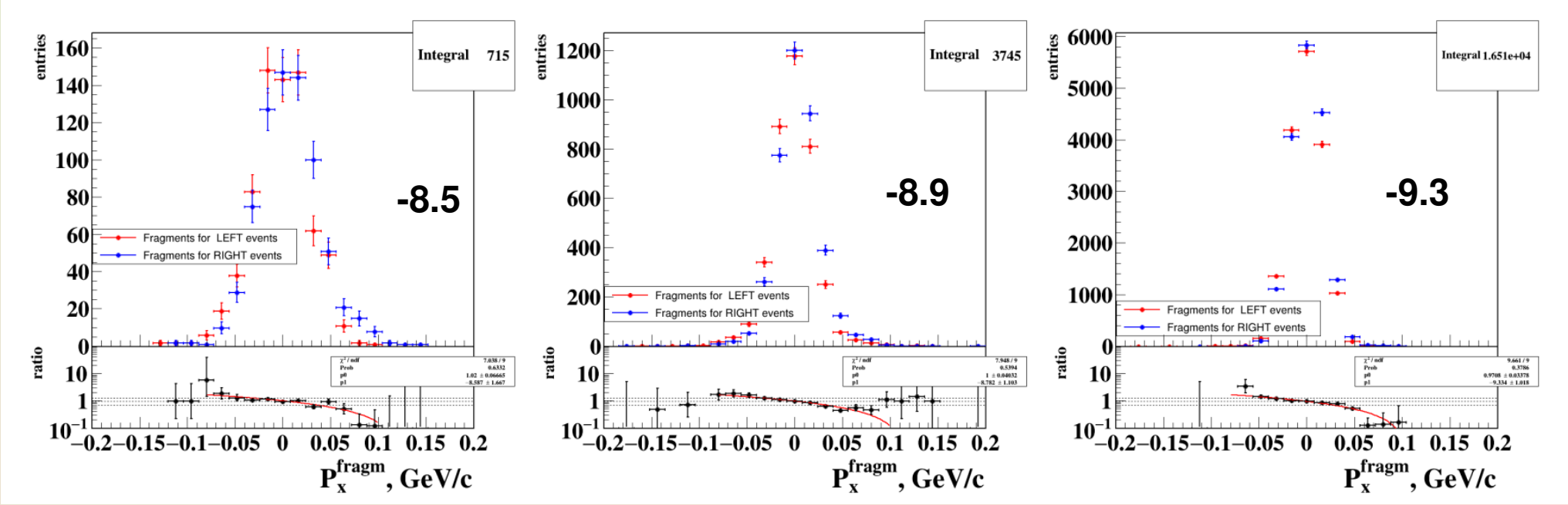


Fig. 6 – Px for boron isotopes and their relations with a proton in the arm

Pt balance in simulation

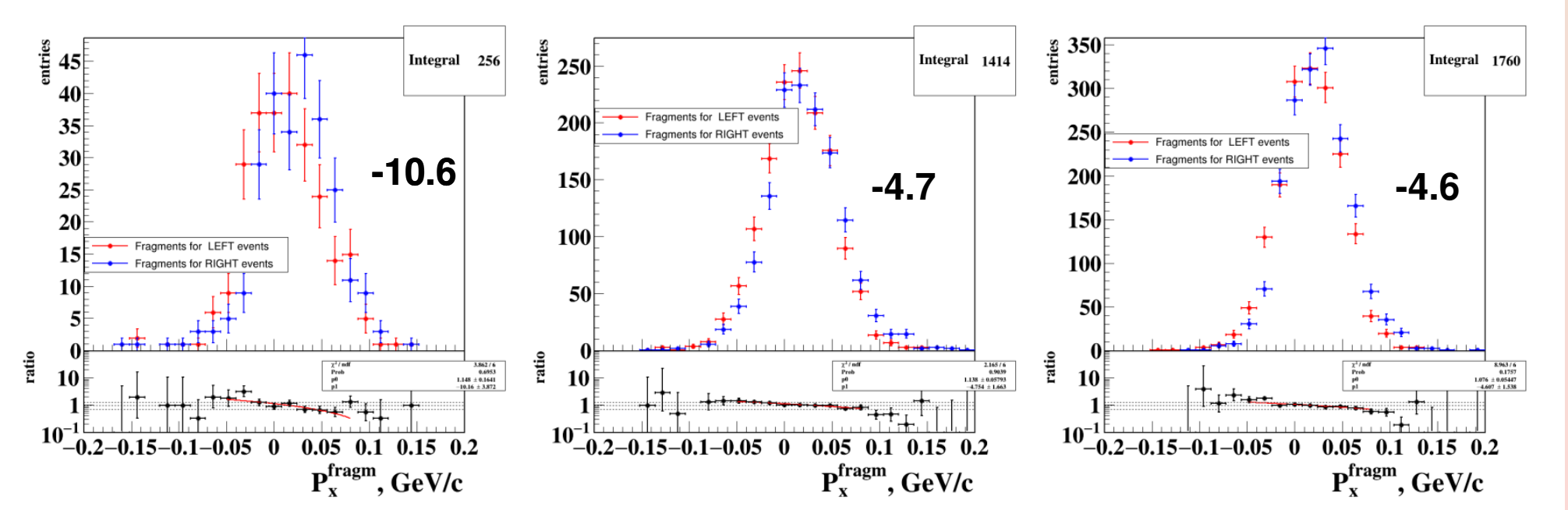


Fig. 7 – Px for boron isotopes and their relations with a pion in the arm

Pt balance

The visible slope is not so essential to define protons or pions

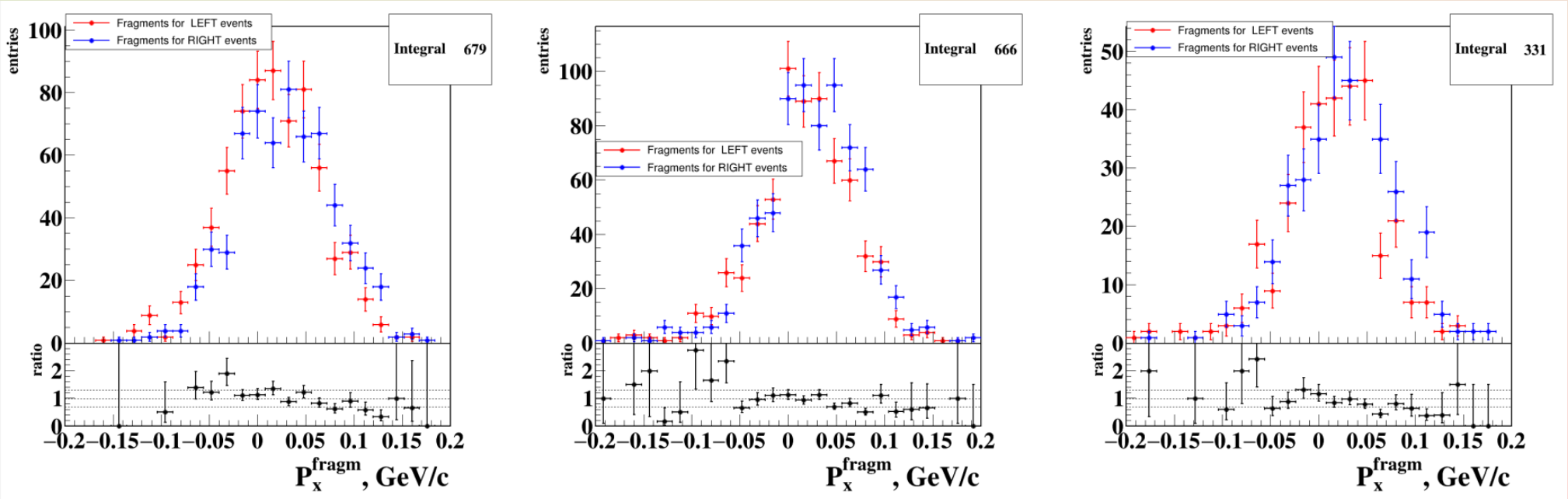


Fig. 8 Px for boron isotopes and their relations in the experiment

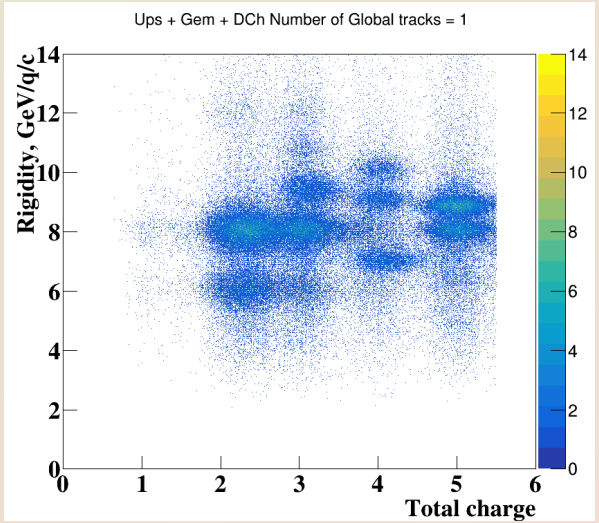
Fragment spots

Analysis of spots distributions:

1. Different number of tracks in the events
2. Low momentum (<1.5 GeV/c/q) in the events
3. Negative particles in the events

Results:

1. Dependence on number of global tracks in the events
2. See no significant difference in events with additional low momentum positive or negative particles



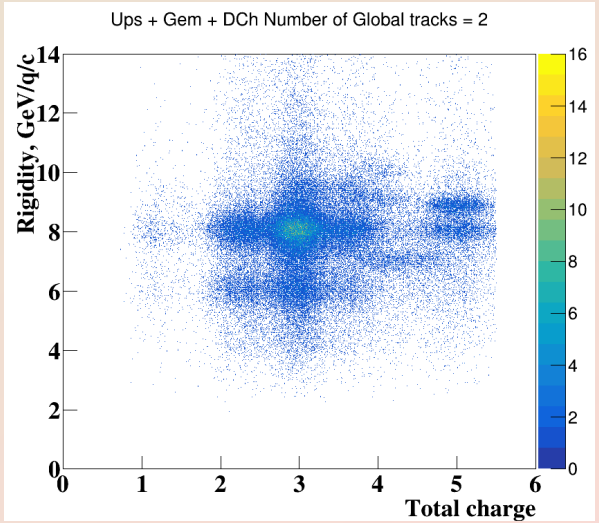


Fig. 9 The influence of different cuts in events on fragment spots (1 global tracks in the left figure and 2 tracks in the right)

Accounting of empty target

1. To take into account the events with the empty target the data should be normalized to the number of spills:

$$H_{Data} \Rightarrow H_{Data} - H_{EMPTY} * K$$

where H_{data} – number of events (with cuts), H_{empty} - number of events with empty target, K - coefficient

$$K = \frac{S_{DATA}}{S_{EMPTY}} \qquad K = 1.78 \pm 0.07$$

$S_{Data} = 1918 \pm 44$ **Number of spills with events (with cuts)**

$S_{EMPTY} = 1080 \pm 33$ **Number of spills with an empty target**

Comparison with MC Data

Cuts in the experiment:

1. Vertex in the physical volume

2. Incoming carbon

3. Outgoing charge <5.5

4 Number of global tracks >=1

BLACK LINE is for Experiment

Cuts in the simulation:

1. Outgoing charge <5.5

2 Number of global tracks >=1

RED LINE is for MC data

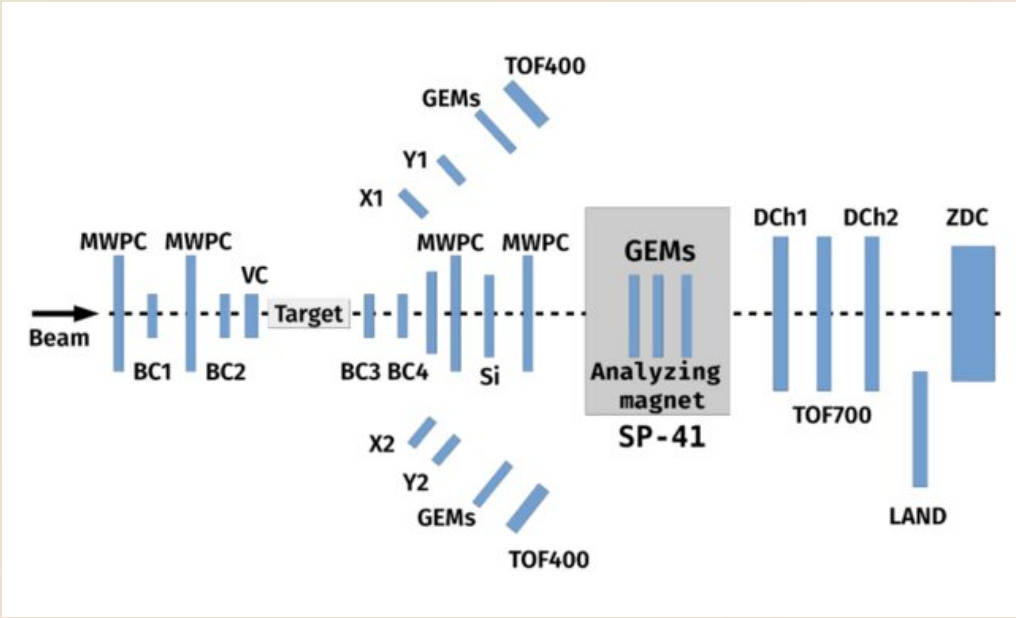


Fig. 10 Scheme of the experimental facility

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Search for η-mesic nuclei in the SRC/BM@N experiment at the Nuclotron

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Effects in MC

1. Lorentz shift were added.

2. Implementing map of “dead” strips in simulation.

3. Also, we removed some hits in the reconstruction.

Experiment **Simulation**

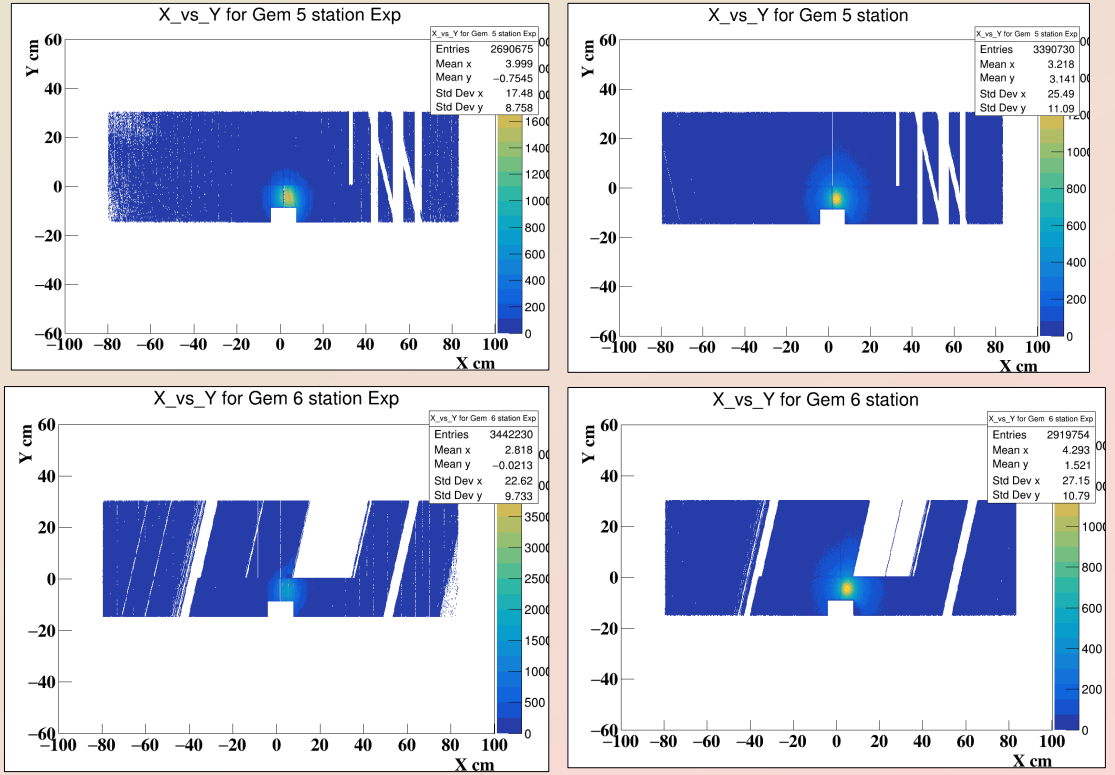


Fig. 11 “Dead” zones for the experiment and simulation

GEM efficiency

$$eff_i = \frac{N_i}{N^i_{all}} \qquad (1)$$

Efficiency calculation:

1. For each track in event:

a) 5 or 6 hits in track: N^i_{all} increases by 1, If station "i" has the hit, we increase N_i by 1.

b) 4 hits in track: N^i_{all} will increases by 1 if in the station "i" hit is absent.

2) Station 6 and station 7 have the low efficiency

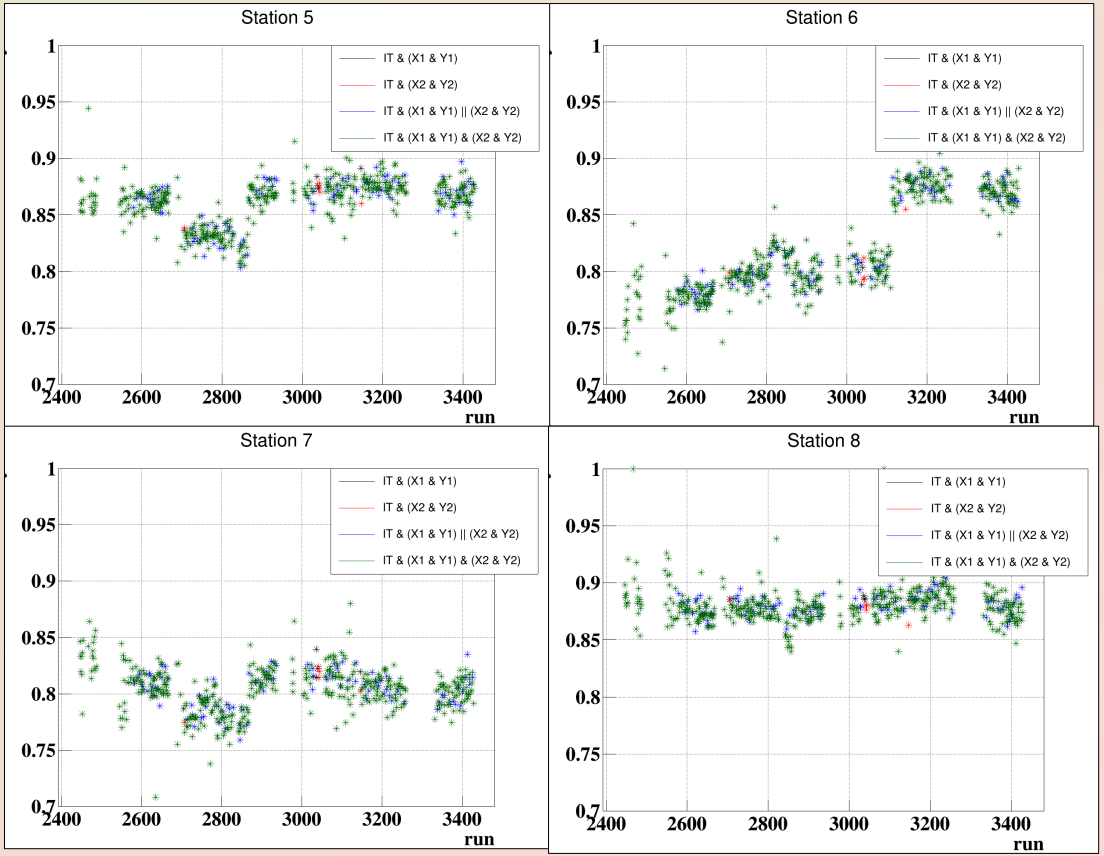
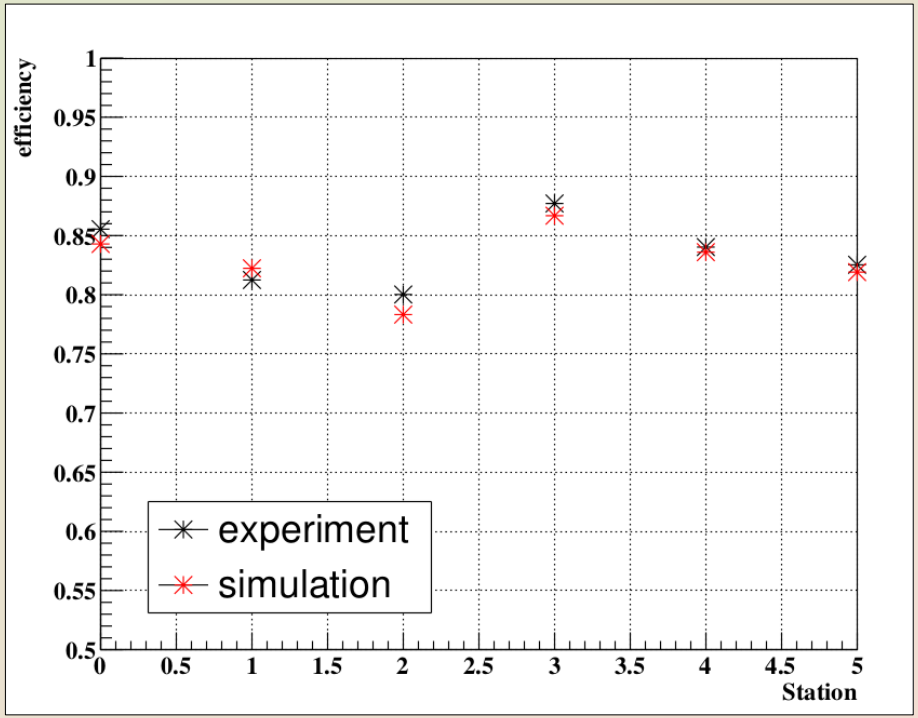
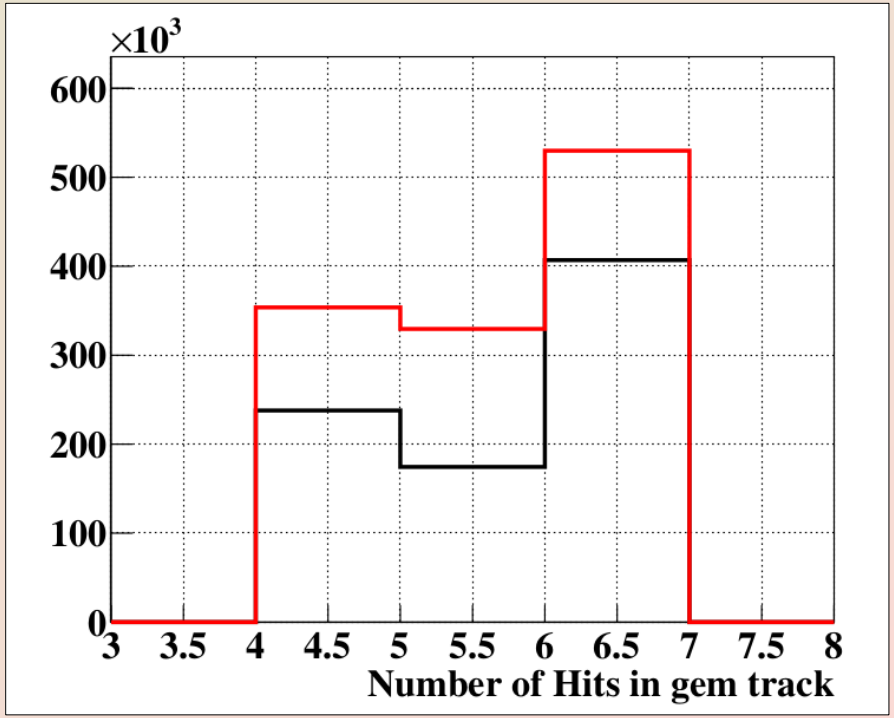


Fig.12 Efficiency for stations for different runs

Comparison with MC Data

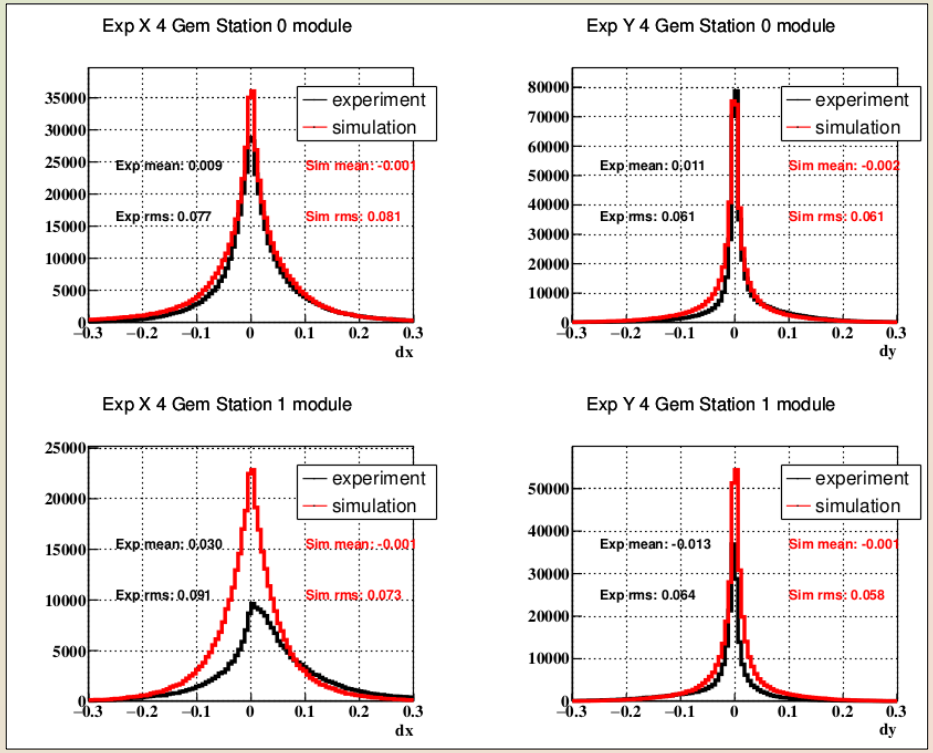




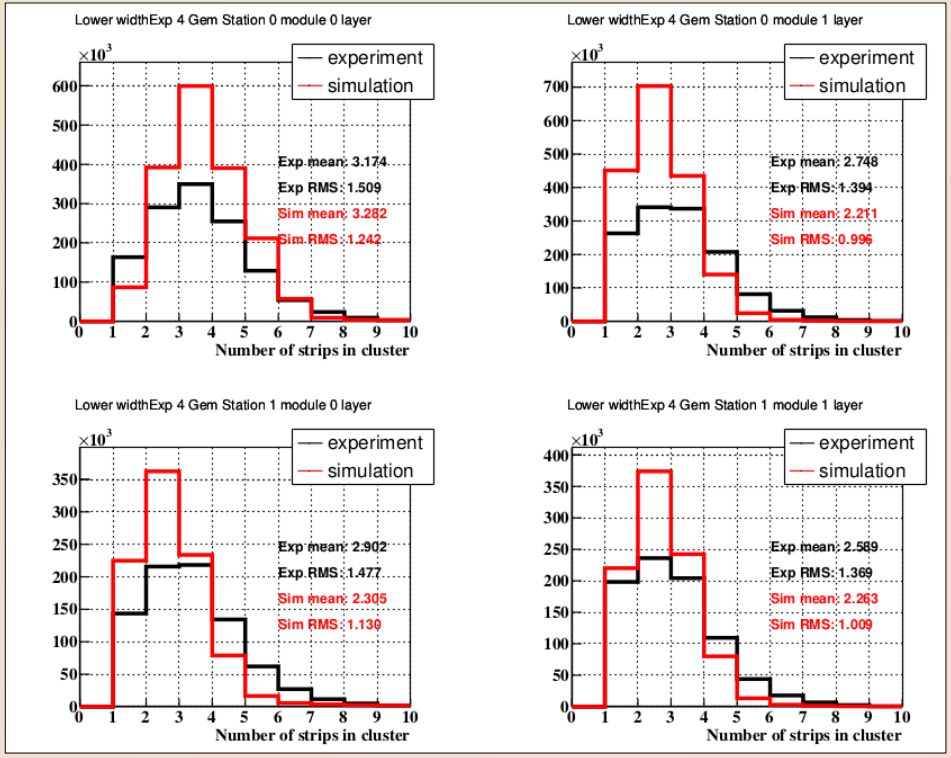
a) *b)*

Fig.13 Red line is simulation, black line is experiment
a) "Efficiency of hit producing", b) Number of Hits in gem Tracks

Comparison with MC Data



a)

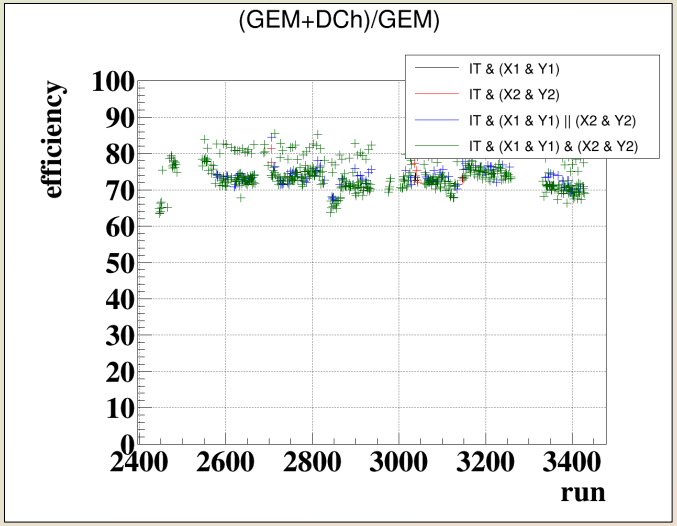


b)

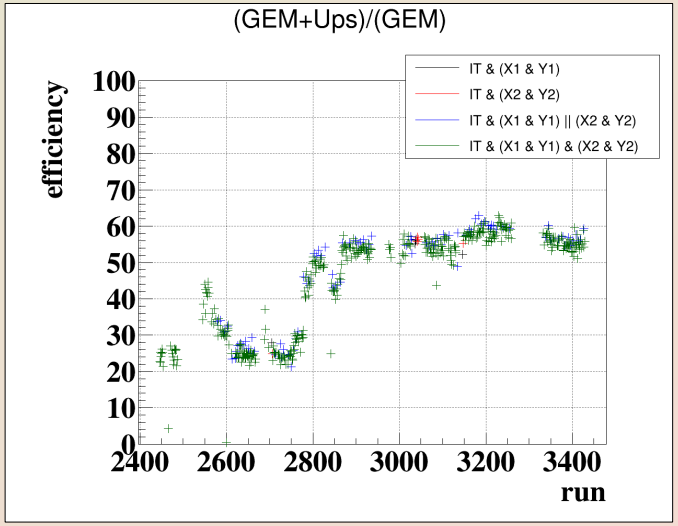
Fig. 14 a) “Residuals” b) Cluster widths

Matching efficiency

1. How many tracks from the upstream part and DCh were matched with GEM tracks



a)



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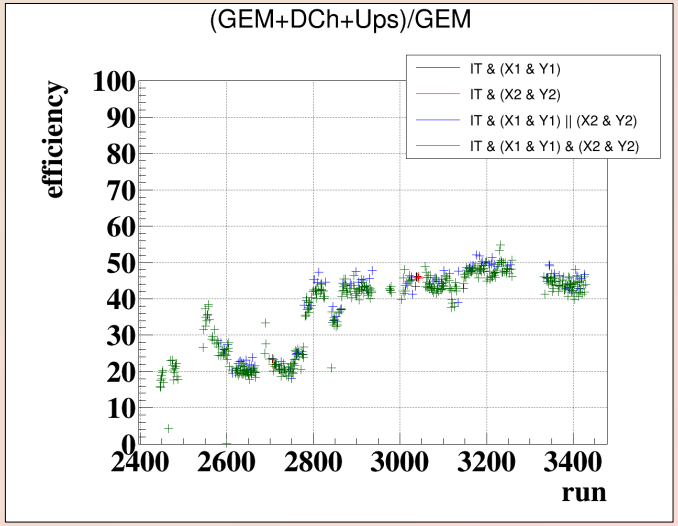


c)

Fig. 15 Tracks matching efficiency for different runs for a) GEM+DCh, b) GEM+Ups c) GEM+DCh+Ups

Matching efficiency

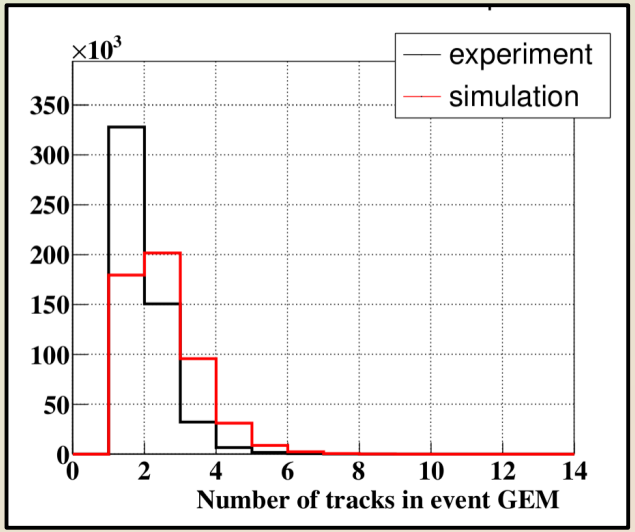
1. The efficiency for MC data are in good agreement with the experiment

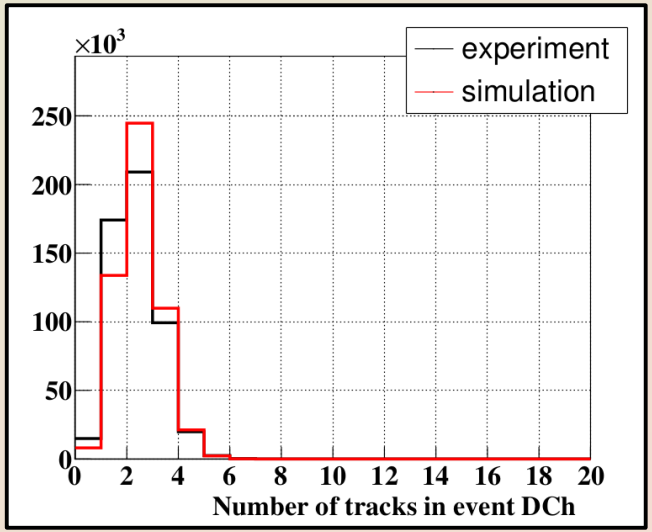
2. In some experimental runs (<2800) matching efficiency for upstream tracks is lower than for the others. Analysis of residuals of matching and e-log analysis didn't solve problems

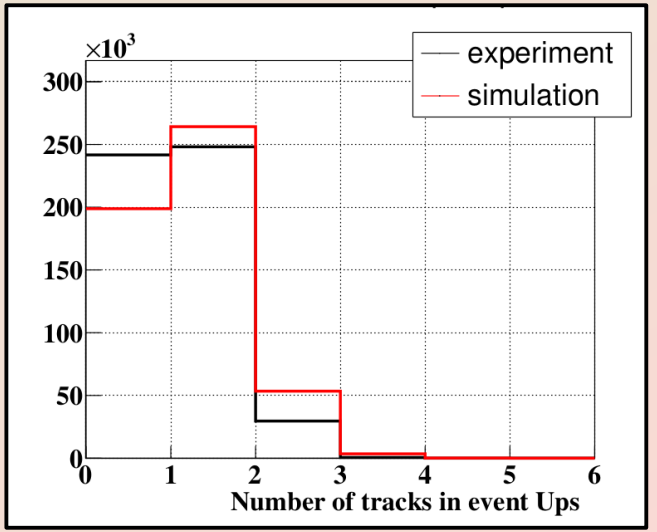
	Experiment	Simulation
(GEM+DCh)/GEM %	72.52	75.29
(GEM+Ups)/GEM %	41.93	37.52
(GEM+Ups+DCh)/(GEM) %	34.33	33.08
(GEM+Ups+DCh)/(GEM+DCh) %	47.34	43.94
(GEM+Ups+DCh)/(GEM+Ups) %	79.58	79.94

Table 1. Comparison mean efficiency of matching for experiment and simulation

Comparison with MC Data



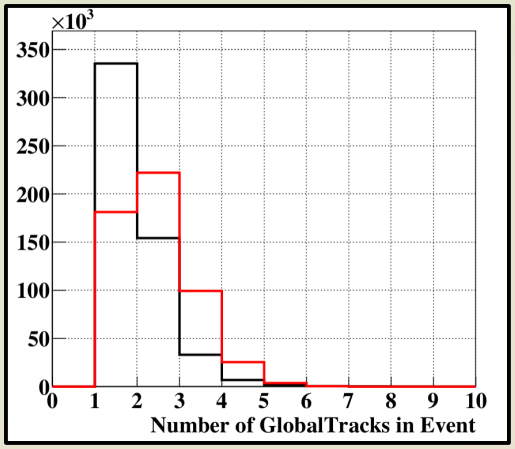




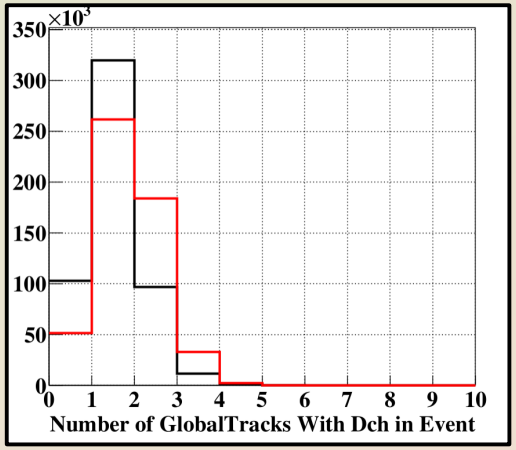
a) ***b)*** ***c)***

Fig.16 Number of tracks in events a) GEM , b) DCh, c) Upstream

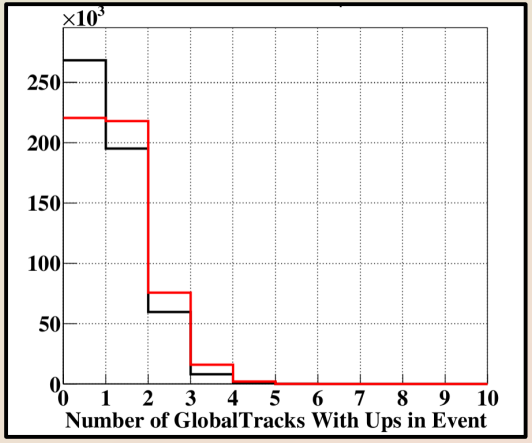
Comparison with MC Data



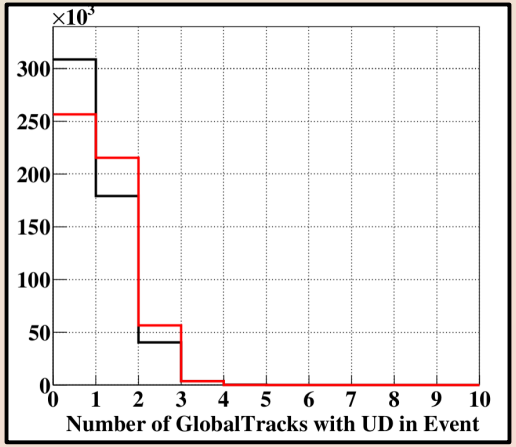
a)



b)



c)



d)

Fig. 17 Number of global tracks in the events:

a) All global tracks

b) GEM with Dch

c) GEM with Upstream

d) GEM with Upstream + DCh

1. There isn't full agreement. The difference could be explained by number of GEM tracks. The additional studies of events with the multiple tracks.

Summary

1.No visible changes in the P_t balance for the left and right arms in the experiment.

2. Events with empty target were taken into account. The coefficient for spill normalization were calculated.

3. Response of the GEM detectors in MC was adopted to the experimental data. However, number of GEM tracks in events requires the corrections.

4. The matching efficiency of different detector subsystems was estimated in the experiment and MC. The mean values are close enough.

Plans

1. The goal of the analysis is to evaluate yields of fragments in C+p reactions
2. Analysis of correlated fragments for two and more tracks.