Fragment analysis in SRC 2018 run

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for BM@N collaboration

SPbU

9th Collaboration meeting

13-16 September 2022

LHEP JINR

Outline

1. Background (Results of the previous collaboration meeting)
2. Changes in reconstruction procedure
3. Comparison between the experimental data and simulation
4. Summary

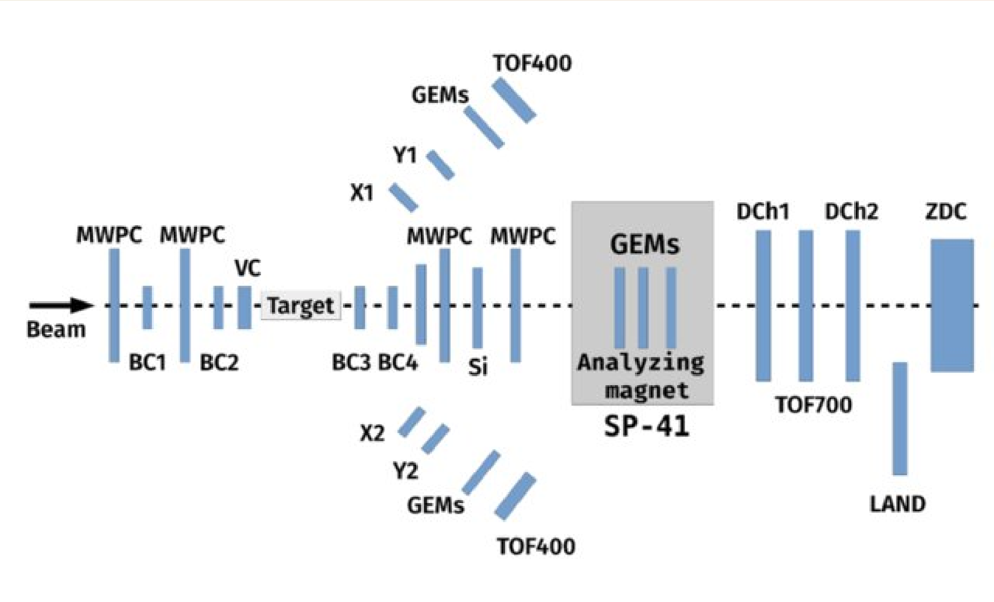


Fig. 1 SRC setup

Background information

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

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

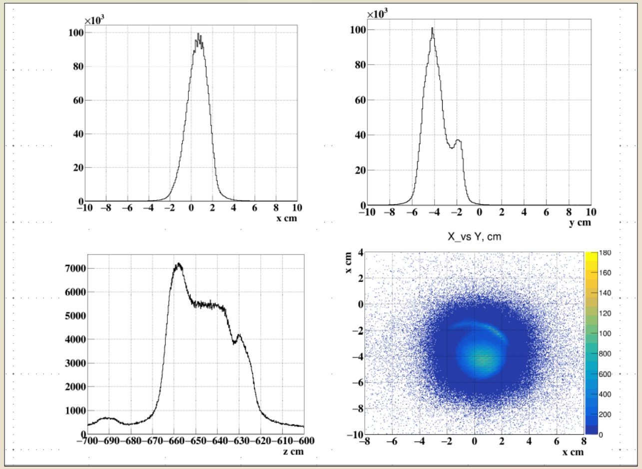


Fig. 2 Coordinates of vertex (exp)

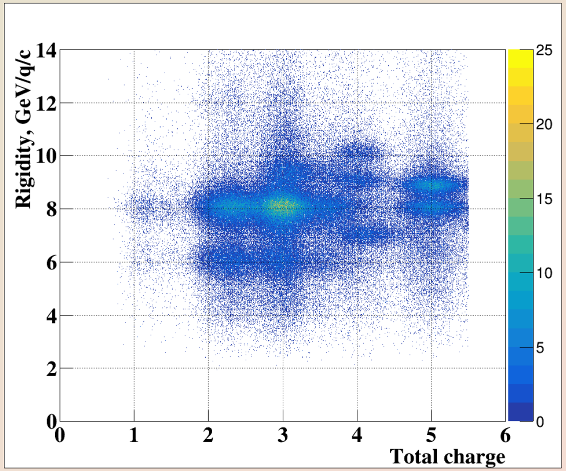


Fig. 3 fragments in the experiment

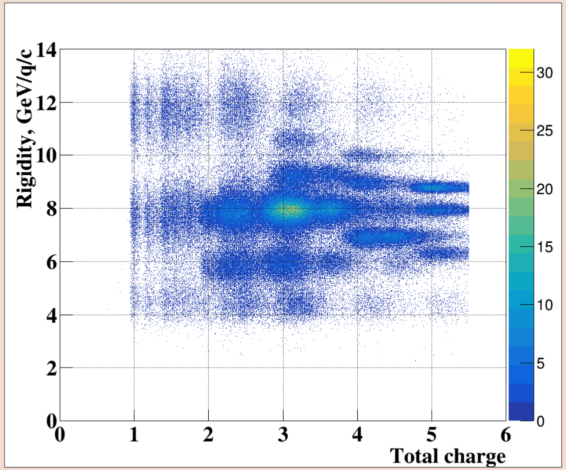


Fig. 4 fragments in the simulation

Changes in track reconstruction

Reason: significant difference in momentum distribution

Previous version

1. Based on GEM tracks
2. 4 and more hits in gem track

Current version

1. Based on DCh tracks
2. Tracks were propagated to GEMS and updated according to GEM hits
3. Matching with the best Upstream track
4. Refitting

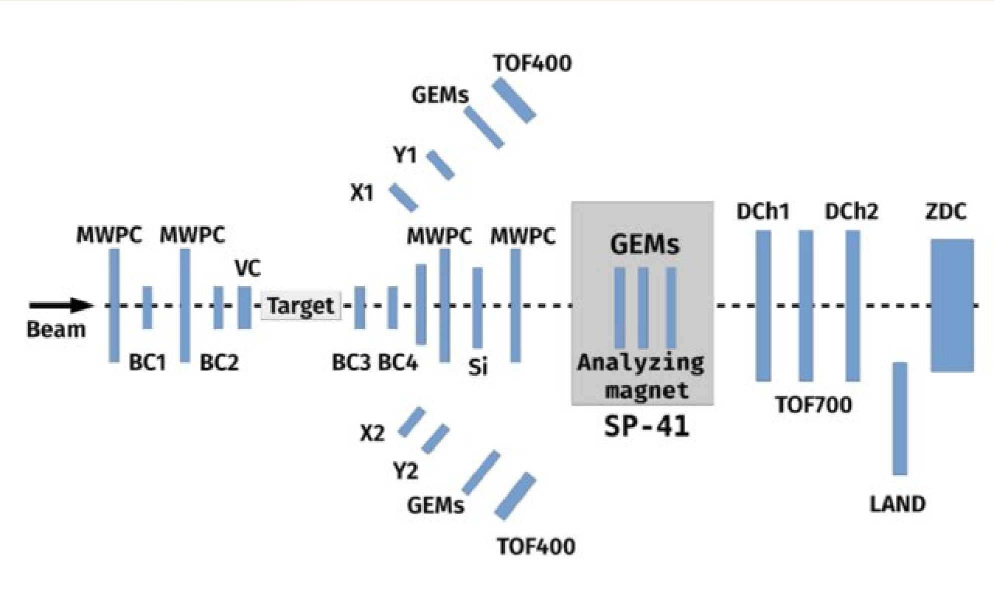
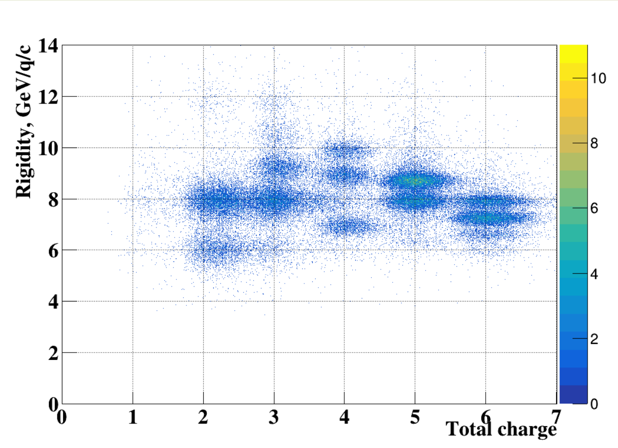
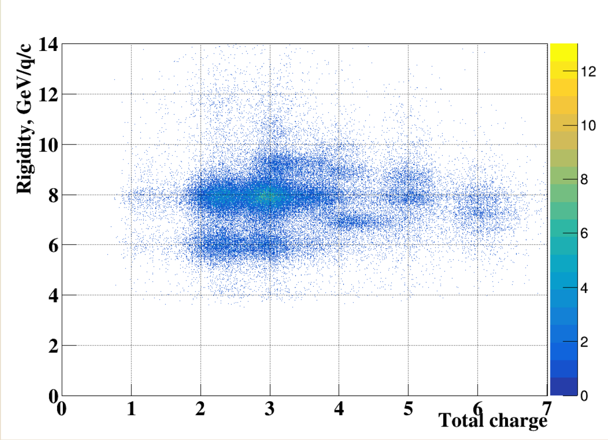


Fig 5. SRC setup

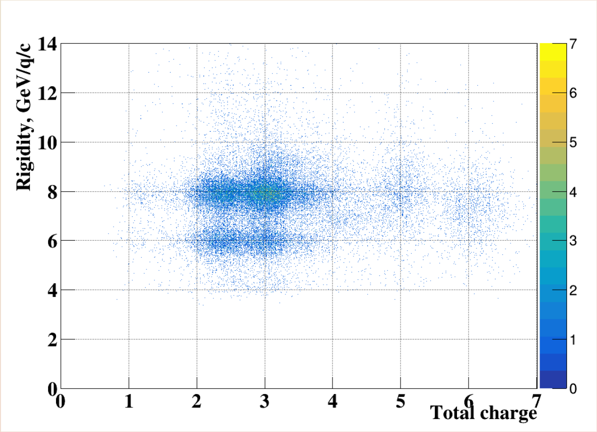
Fragments



a)



b)



d)

Fig 6. Charge vs Rigidity distributions for 1-(a) 2-(b) and 3-(c) tracks in events.

Cuts:

1. The tracks have at least 1 GEM-hit

2. The tracks have Upstream part

3. The vertex is inside the target

4. Cuts for incoming charge

DCh-tracks

experiment

simulation

1. The vertex is inside the target
2. Cuts for incoming charge

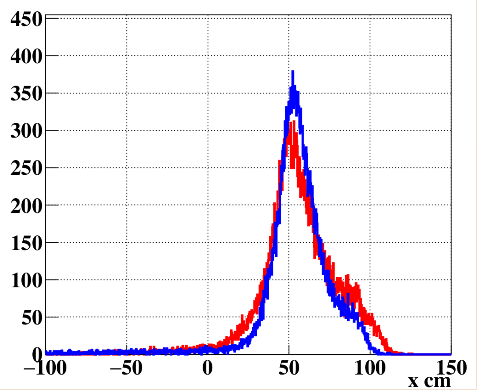
Distributions for DCh-tracks haven't significant difference

Fig 7. a) x coordinates for DCh tracks,

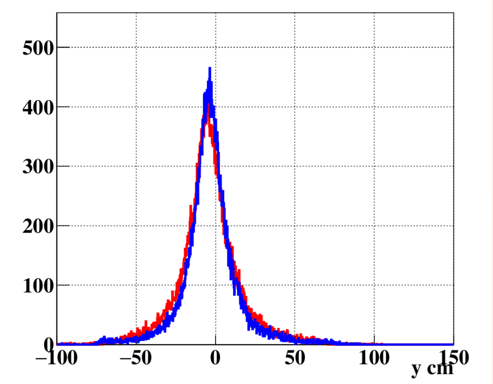
b) y coordinates for DCh tracks

c) angle Tx,

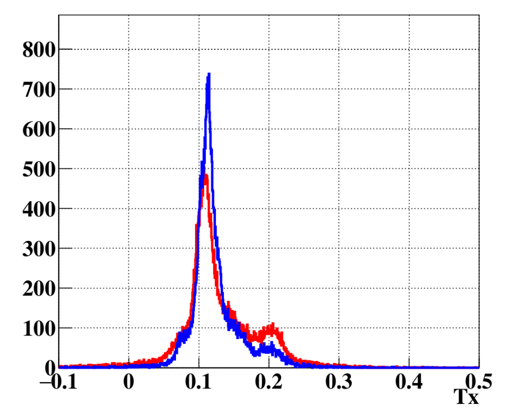
d) angle Ty



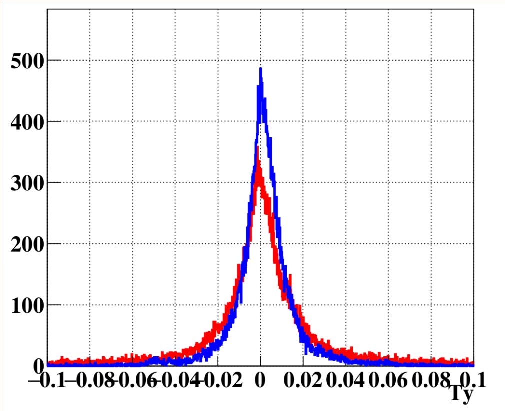
a)



b)



c)



d)

DCh-tracks

experiment　　　　simulation

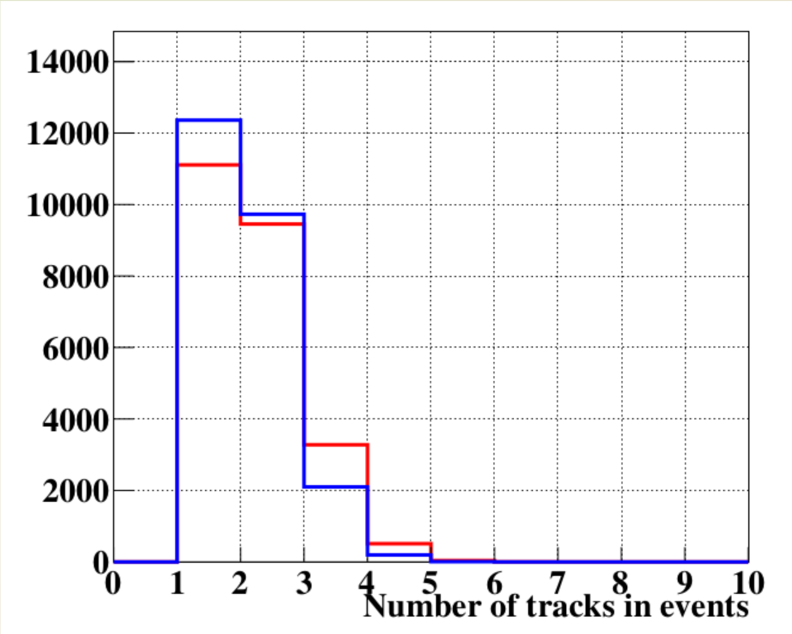


Fig 8. Number of DCh-tracks in Events

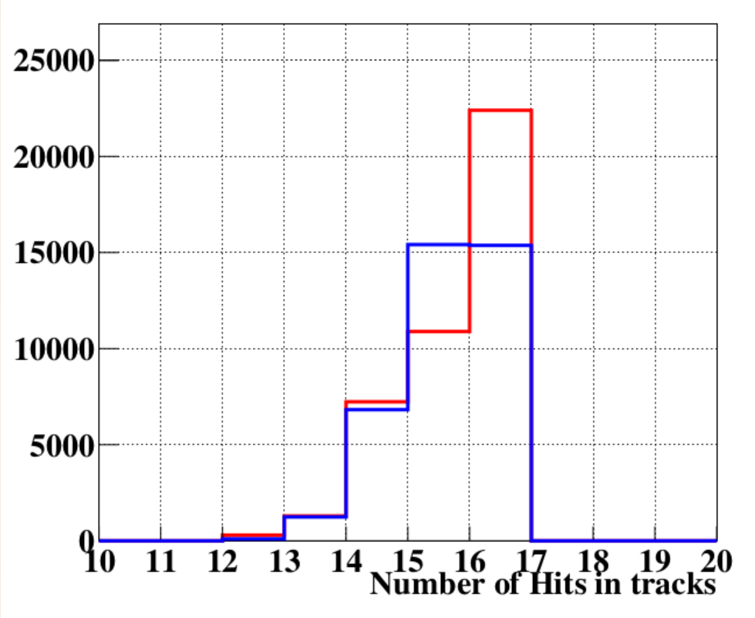


Fig 9. Number of DCh-hits in the tracks

Residuals in GEM Stations

experiment — simulation

1. Tracks propagate to each GEM station

2. The best hits were selected for matching

3. One hit can belong to the several tracks

4. Residuals were fitted by “gaus” + “pol2”

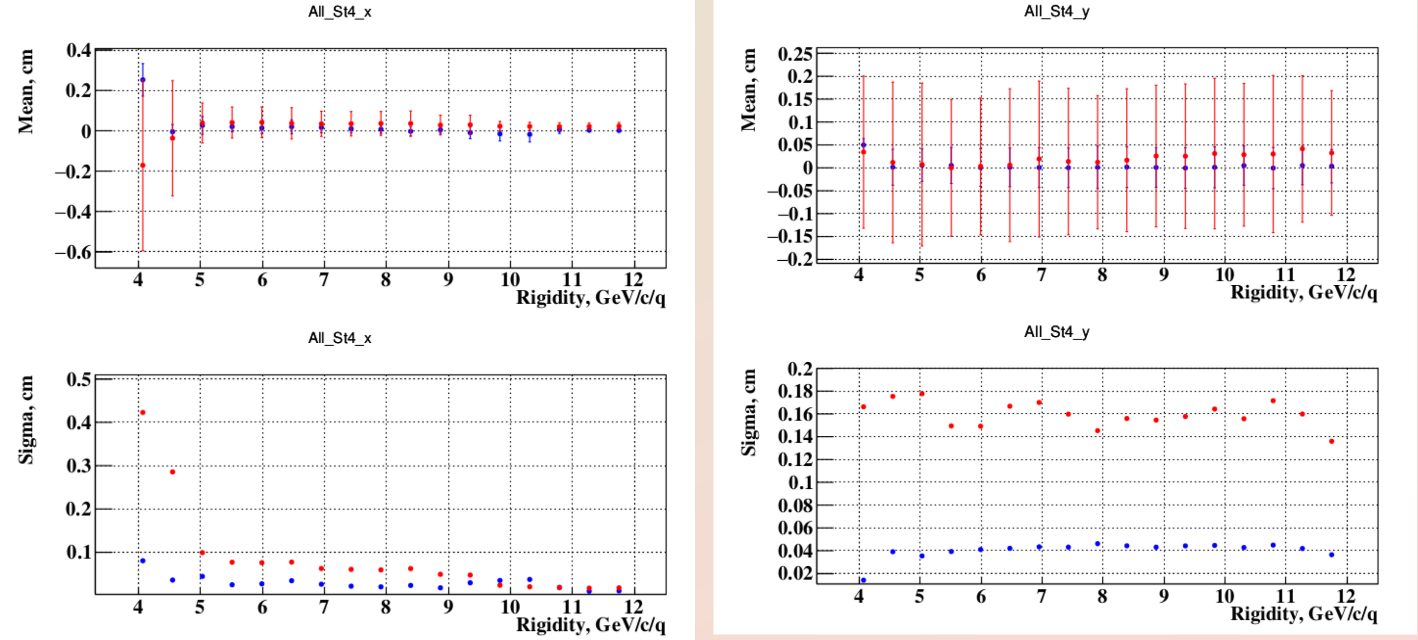
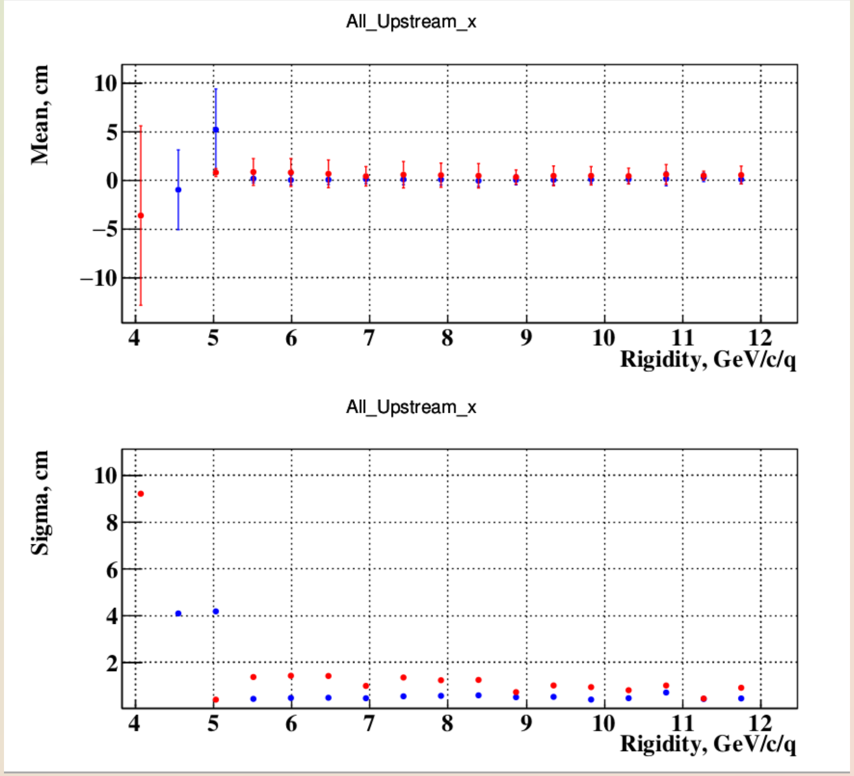


Fig. 10 a) x- and b) y- residuals(top) and variance (bottom)

Upstream Residuals

experiment | simulation



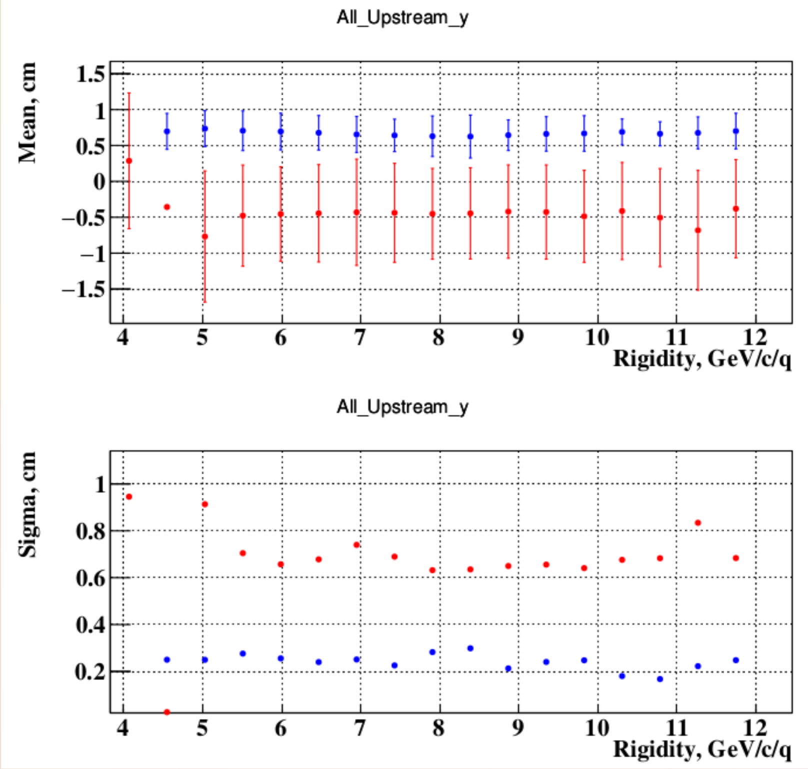


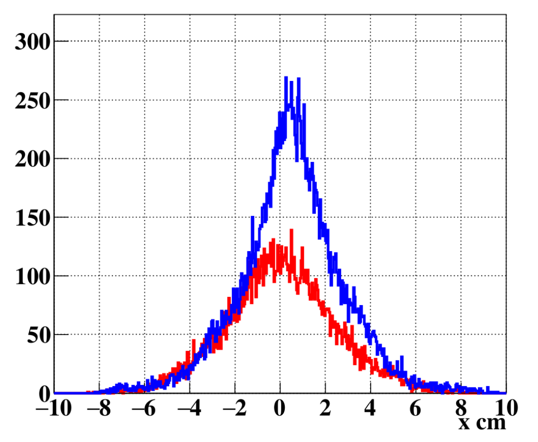
Fig. 11 a) x- and b) y- residuals(top) and variance (bottom)

Upstream tracks

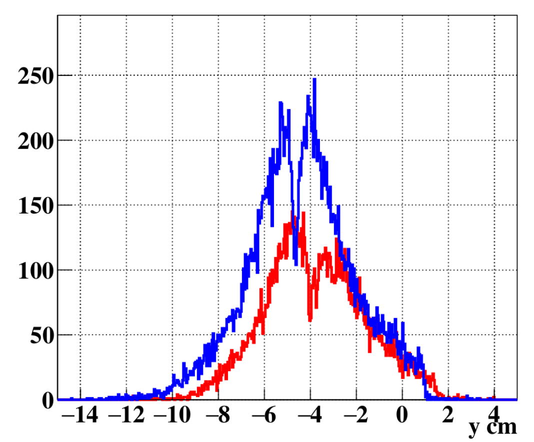
experiment

simulation

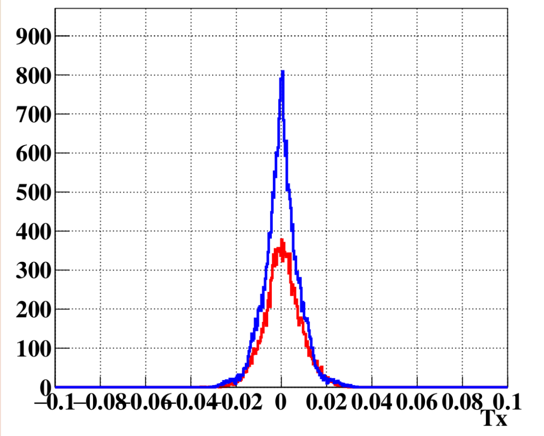
1. The vertex is in target position
2. Cuts for incoming charge



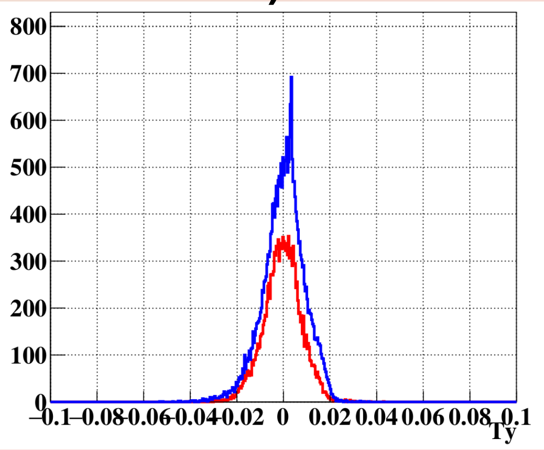
a)



b)



c)



d)

Fig. 12 a) x coordinates for Upstream Tracks,

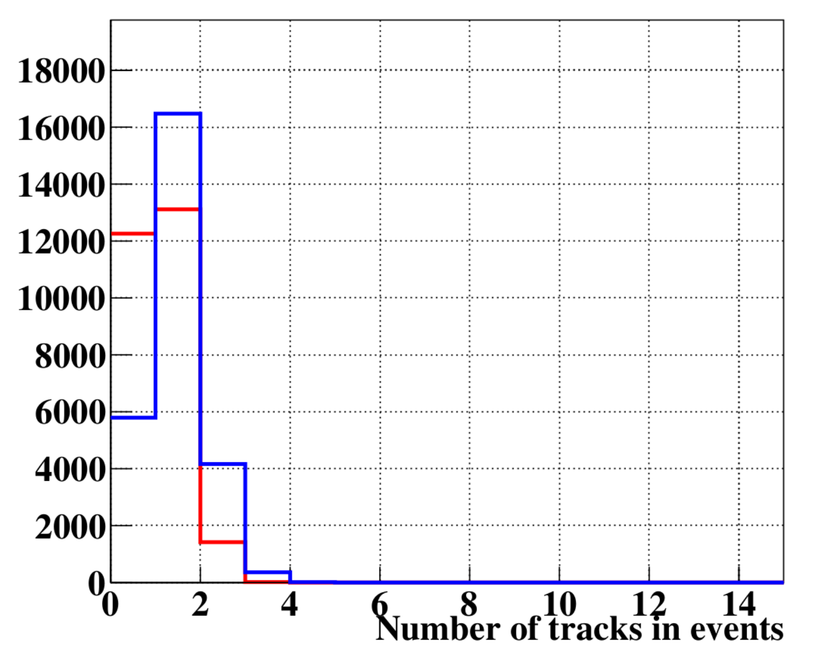
b) y coordinates for Upstream tracks

c) angle Tx,

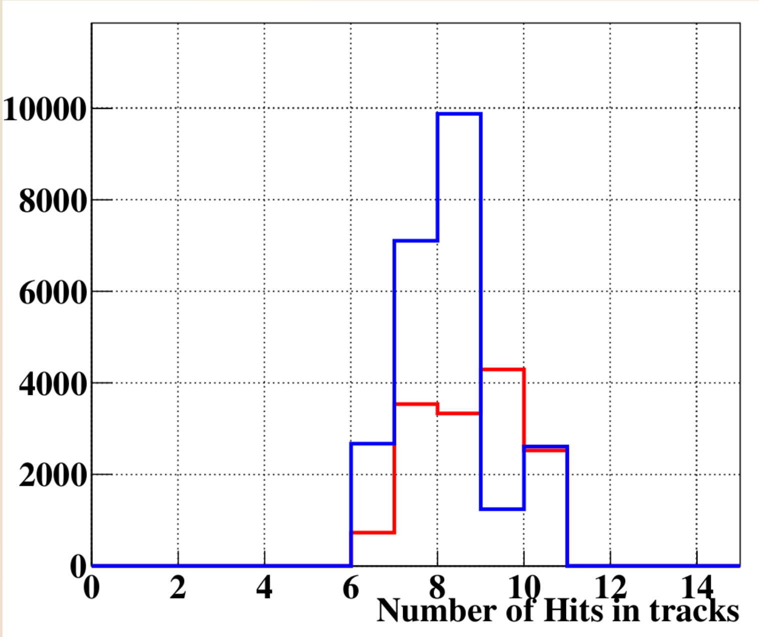
d) angle Ty

Upstream tracks

experiment simulation



a)



b)

Fig. 13 a) Number of upstream tracks in the events
b) Number of hits in upstream tracks

Matching Efficiency

$$Efficiency = \frac{Number\ Matched}{Number\ inAccepatance}$$

Calculation Procedure for station “i”:

1. DCh tracks propagated through the GEM stations (station “i” was excluded)

2. Track parameters were updated according hits (tracks) from the stations.

3. Back to DCh propagation

4. If the tracks matched with the hit from station “i”, matched number was incremented.

Matching	Exp %	Sim %
Upstream	48,91	48.56
Station 5	93,10	92.72
Station 6	89,31	91.37
Station 7	90,47	89.99
Station 8	90,99	91.05
Station 9	90,92	90.44
Station 10	90,83	90.00

Table 1. Matching Efficiency of Global Tracks

Global track distributions

experiment

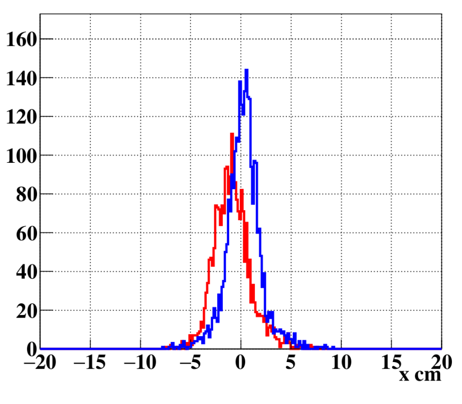
simulation

1. The tracks have more than 1 GEM-hit
2. The tracks have Upstream part
3. The vertex is inside the target
4. Cuts for incoming charge

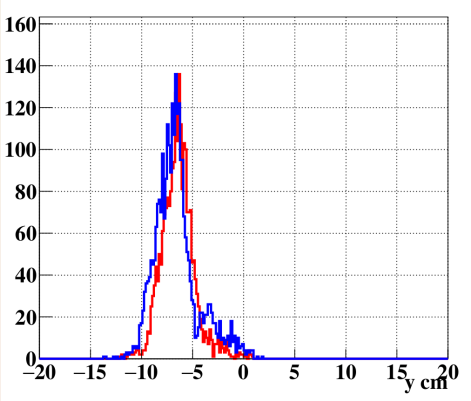
Fig. 14 a) x coordinates for Global Tracks,

b) y coordinates for Global tracks

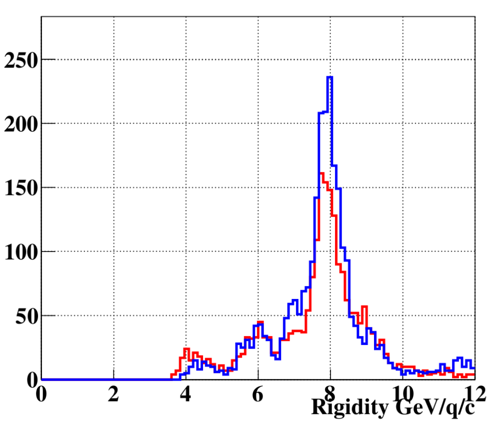
c) Rigidity



a)



b)



c)

Cross-section evaluation and reconstruction efficiency

$$1.\ \sigma_{B11} = \frac{N_{B_{11}}}{\varepsilon_{rec}\,\varepsilon_{trigg}\,L}$$

$$2.\ \varepsilon_{reco} = \frac{N_{B11}}{N_{gen}} = 0.00144$$

1. N_{B11} — number of events with Boron 11 in the experiment
2. ε_{reco} — efficiency of reconstruction (from MC), where N_{B11} – number of the successfully reconstructed B_{11}, N_{gen}- total number of generated MC events
3. $\varepsilon_{triggers}$ — efficiency of triggers
4. L - luminosity

Trigger efficiency

$$1.\ Eff_{X_i} = \frac{NEvents_{X_i, Y_i, GEM_i, TOF\,400_i}}{NEvents_{Y_i, GEM_i, TOF\,400_i}}$$

$$2.\ Eff_{Y_i} = \frac{NEvents_{X_i, Y_i, GEM_i, TOF\,400_i}}{NEvents_{X_i, GEM_i, TOF\,400_i}}$$

$$3.\ Eff_{X_i, Y_i} = \frac{NEvents_{X_i, Y_i, GEM_i, TOF\,400_i}}{NEvents_{GEM_i, TOF\,400_i}}$$

Efficiency of Triggers		
Trigger	Simulation	Experiment
X1	96,00	98,00
X2	98,30	96,30
Y1	95,90	96,70
Y2	97,40	96,00
X1&&Y1	91,50	93,80
X2&&Y2	95,00	90,50

Table 2. Trigger efficiency

Flux

For the 7th SRC run it has been decided to take a ratio

$$\frac{DAQ_{Busy} - N_{Pedestals}}{DAQ_{Trigger} - N_{Pedestals}}$$

from the trigger group DB text log as the ratio of accepted events

$$Flux = \sum_{spills} [\underbrace{(BT \wedge \overline{Busy})}_{MSC\,16¿} \frac{DAQ_{Busy} - N_{Pedestals}}{DAQ_{Trigger} - N_{Pedestals}}]$$

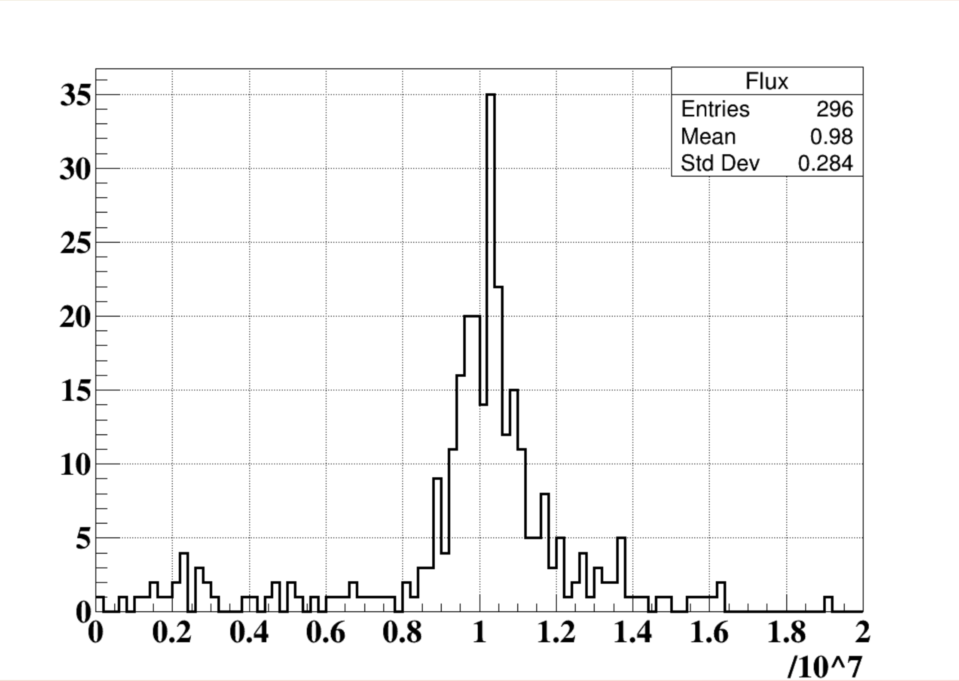


Fig 15. Total Flux

Total Luminosity (Preliminary)

$$L = \frac{Flux * N_A * \rho l}{A}$$

Where,

N_A - Avogadro constant,

ρ – density (0.708 g/cm^3),

l – target length (30 cm),

A = atomic number

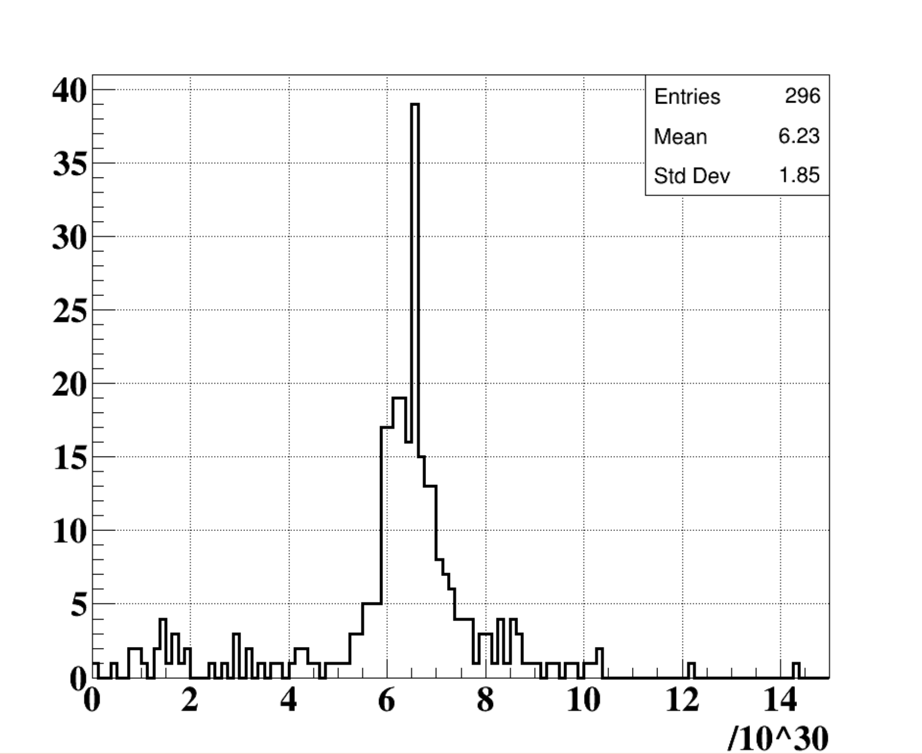


Fig 16. Total Luminosity

Summary

1. The new version of track reconstruction have been created, that decreased the difference for rigidity distribution between experimental data and simulation. The efficiency of matching and residuals were evaluated, as well as the main physical parameters of the track. Most of the parameters are close enough between the experimental and simulation data.

2.Trigger and reconstruction efficiencies and luminosity were estimated for the following account in boron 11 yield estimations.

3. The chain of fragment yields estimation is presented, the steps could be modified in future.

Plans:

1. Fix offset for upstream tracks and transverse momentum
2. Evaluate Yields and cross-section of Boron 11 (and other fragments)

Thank you for your attention

Backup

Rigidity (old reconstruction procedure)

simulation

experiment

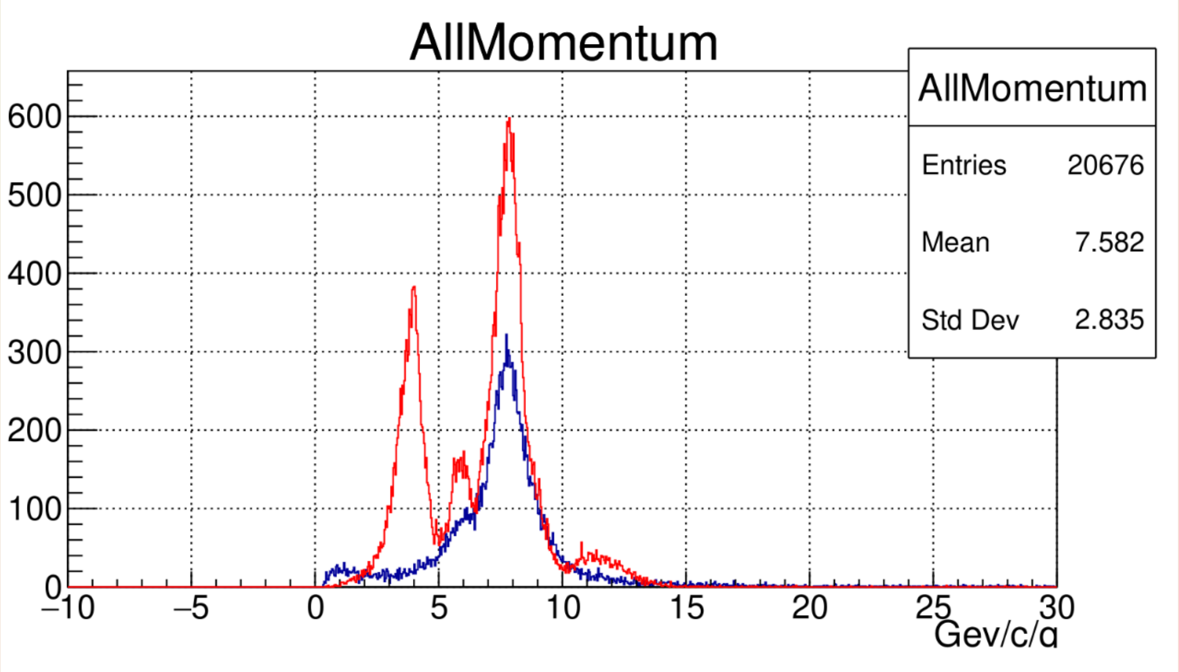
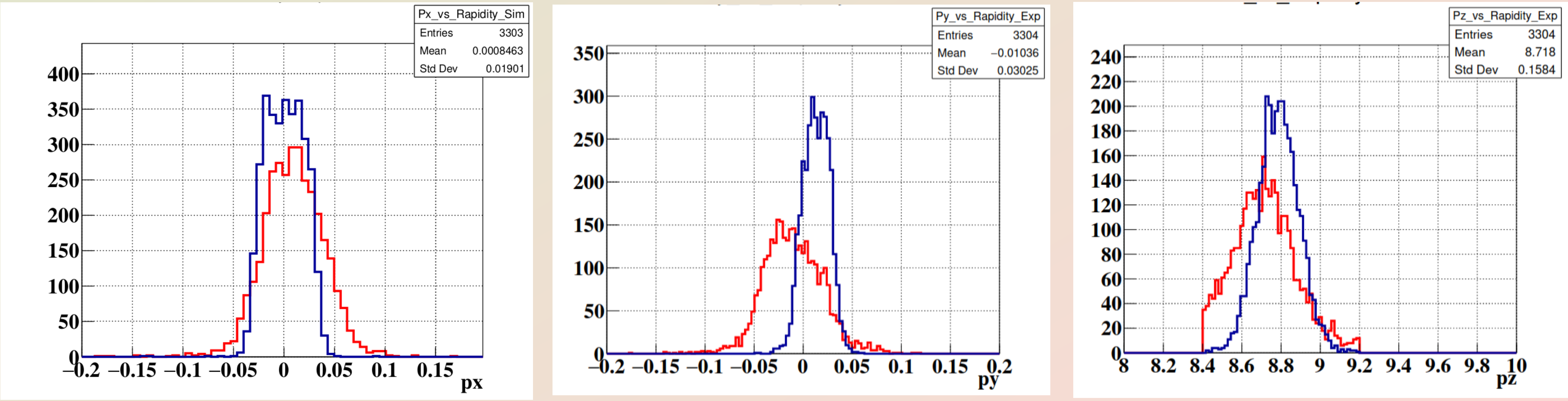


Fig 17. Rigidity (the old reconstruction procedure)

Momentum distributions for Boron 11

1. Boron 11 was selected
2. The vertex is inside the target
3. The tracks have upstream part

experiment
simulation



a) b) c)

Fig. 18 a)Px – projection b) Py – projection, c) Pz- projection

Cross Section Preliminary Results

$$\sigma_{B11} = \frac{N_{B_{11}}}{\varepsilon_{rec}\,\varepsilon_{trigg}\,L}$$

N_{B11} — number of events with Boron 11 in the experiment

2. ε_{reco} — efficiency of reconstruction (from MC)

3. $\varepsilon_{triggers}$ — efficiency of triggers

4. L - Luminosity

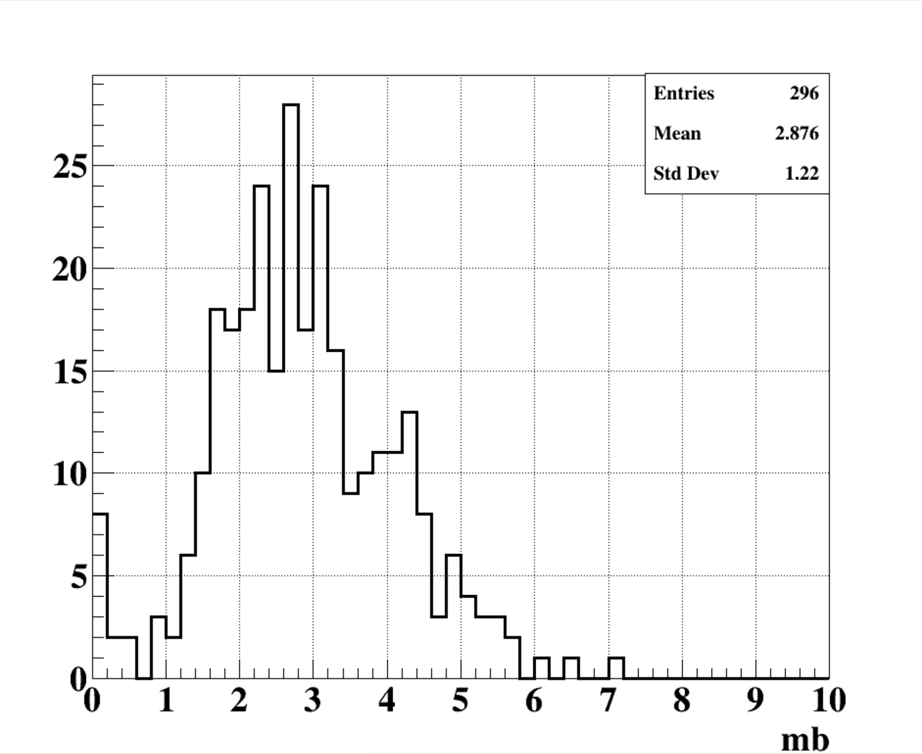


Fig 19. Total Luminosity

Yield Preliminary Results

Yield: $Y = \frac{\sigma_{B_{11}}}{\sigma_{inelastic}}$

$$\sigma_{inelastic} = \pi R_0^2 \left(A_P^{1/3} + A_T^{1/3} \right)^2$$

Where *R₀ = 1.2 fm*

$$\Delta\ \sigma_{inelastic} = \pi R_0^2 \left(A_P^{1/3} + A_T^{1/3} - b \right)^2$$

Where R_0 = 1.41 fm, b = 1.21

$$\boxed{\sigma_{inelastic} = 569{,}9 \pm 366{,}5\, mb}$$

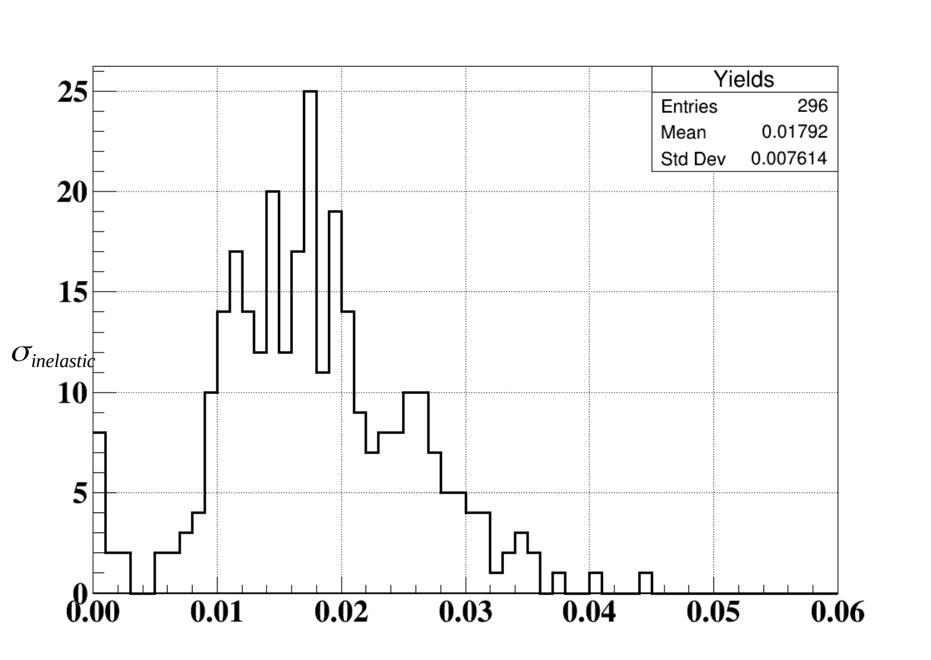


Fig. 20 Yields of Boron11