Overview of the analysis session

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VBLHEP, JINR, Dubna, Russia

7-th BM@N Collaboration Meeting, JINR, Dubna, Russia
19-20 April 2021

Agenda

7th Collaboration Meeting of the BM@N Experiment at the NICA Facility

Monday 19 April 2021

Analysis meeting - Room 347, Building 215 (10:00-13:00)

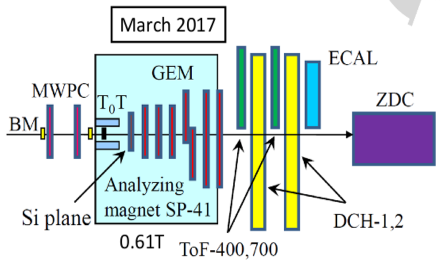
-Conveners: Alexander Zinchenko

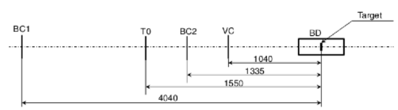
time	[id] title	presenter
10:00	[14] Status of C+A data analysis (Run 6)	STEPANENKO, Yury
10:20	[15] ZDC response study in CC@4AGeV (Run6)	ZHEREBTSOVA, Elizaveta
10:35	[16] Methods of centrality determination in AuAu@4.5 AGeV with FHCal and and fragments hodoscope	KARPUSHKIN, Nikolay
10:50	[17] Recent progress in #Lambda^{0}-reconstruction with argon data	BATYUK, Pavel
11:10	Coffee Break	
11:40	[18] The Status of Identification in Argon Run, TOF400	PLOTNIKOV, Vasily
12:00	[19] TOF particle indetification in Argon data run 7	KOVACHEV, Lalyo
12:20	[21] Analysis of fragment production in C + p reaction on the SRC data	DRIUK, Andrei
12:40	[20] Application of the Vector Finder toolkit for track reconstruction in BM@N	ZINCHENKO, Alexander

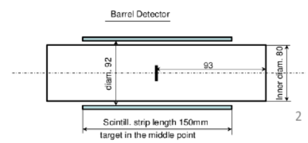
Status of the Λ hyperon analysis in the carbon beam – I Yury Stepanenko

BM@N configuration in Run6

- Central tracker
  - One plane of a forward Si detector
  - 6 GEM stations
    - 5 GEM detectors (66x41 cm2)
    - 2 GEM detectors (163x45 cm2)
- Triggers: BD, BC1, BC2, T0, VETO
- Beam Ekin=4.0 and 4.5 GeV
  - Intensity 10^5 per spill
  - Spill duration 2-2.5 sec.
- Physics: measure inelastic reactions C+A→X
  - Targets: C, Al, Cu, Pb







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Analysis current status

- **Main goal of current analysis** – cross-check with previous analysis (was performed by Gleb Pokatashkin)
- **From previous analysis status:**
  - Check residuals for MC & Data ✅
    - Make corrections for residuals in Data & MC ✅
    - Momentum smearing procedure for MC simulation ✅
  - Check GEM efficiencies for MC & Data ✅
    - Apply efficiencies for MC simulation (in progress) ⚠️
- **Analysis:** compare distributions MC/Data for pt/momentum/etc.
- **Measure cross-sections of the Λ^0's hyperon** May-June 2021

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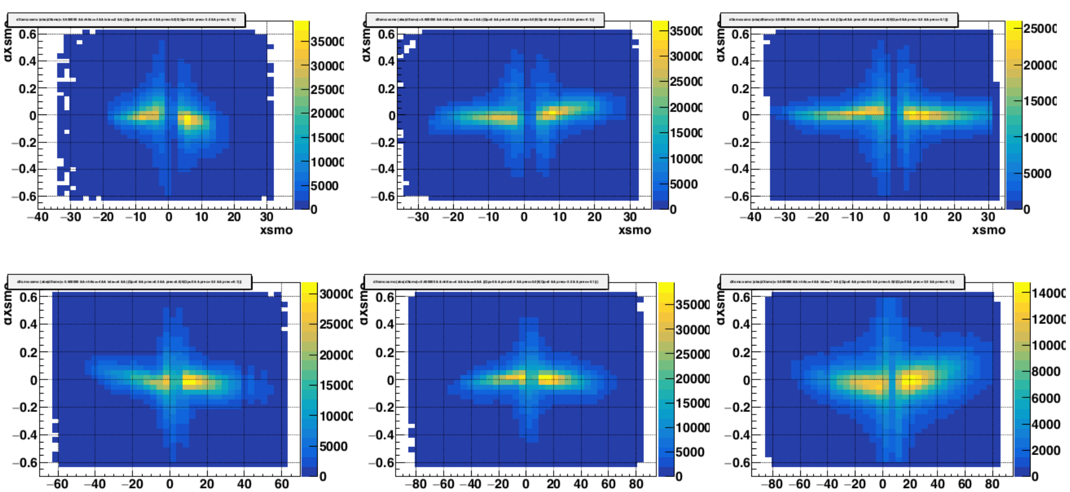
Check residuals Data DX vs.X (4.0GeV CCu)



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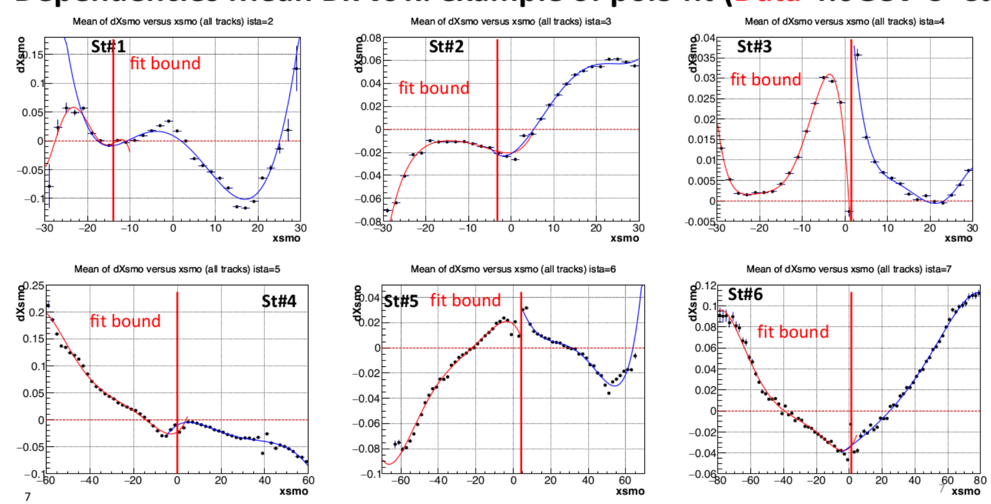
Dependencies Mean Dx vs x: example of pol5 fit (Data 4.0GeV C+Cu)



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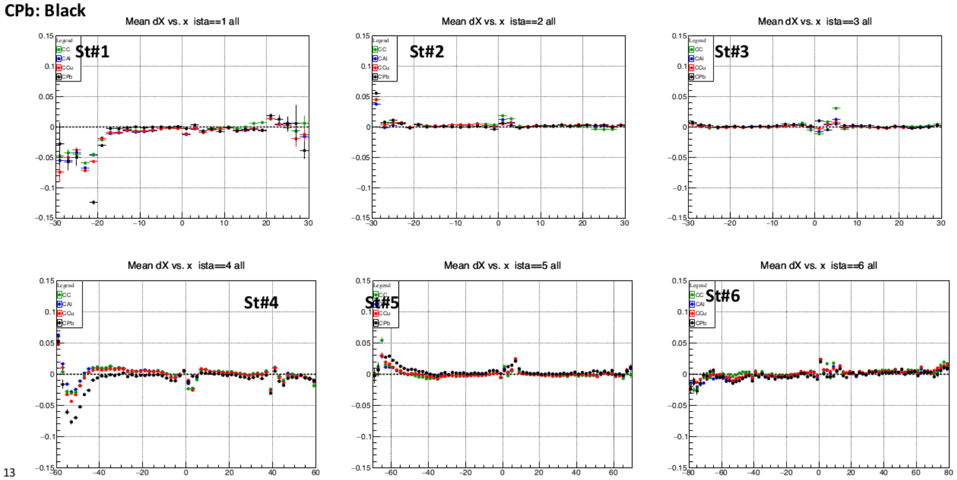
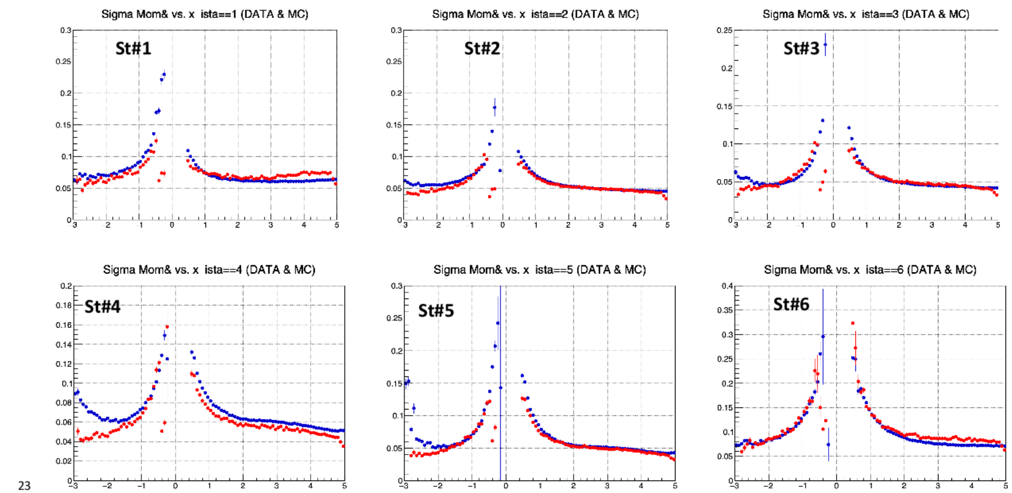
Status of the Λ hyperon analysis in the carbon beam – II   Yury Stepanenko

CC: Green
CAl: Blue
Ccu: Red
CPb: Black

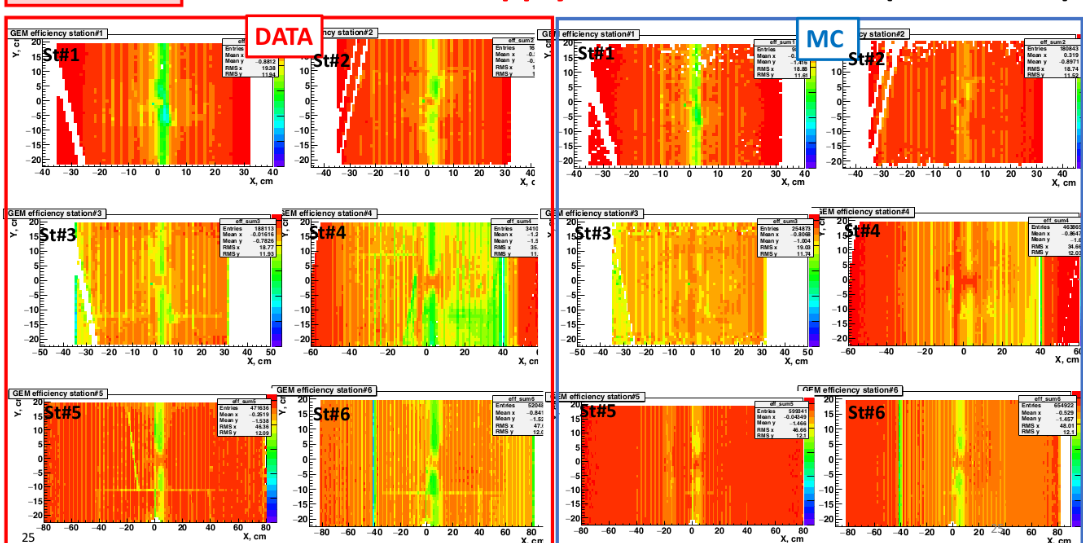
Mean Dx vs x (DATA all targets)



Sigma Dx vs Momentum after smearing (MC & Data 4.0GeV C+Cu)

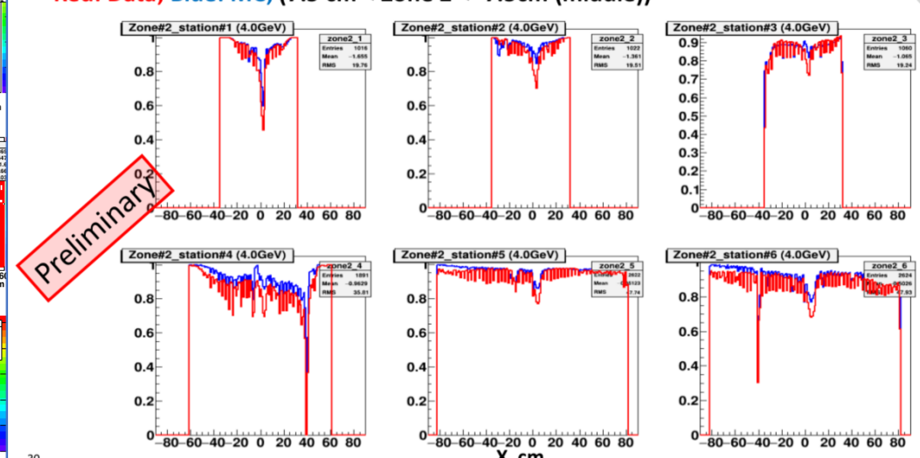


Preliminary GEM efficiencies: Apply efficiencies to MC (4.0GeV all)



GEM efficiencies: Apply efficiencies to MC (4.0GeV all, middle)

Red: Data; Blue: MC; (7.5 cm < Zone 2 < -7.5cm (middle))



Status of the Λ hyperon analysis in the carbon beam – III   Yury Stepanenko

Next steps…

- Applying more accurate fit procedure for residuals corrections
- Applying corrections/smearing for Data/MC for 4.5GeV
- Appling GEM efficiencies to MC simulation according energies/targets/periods
- Comparing distributions MC/Data for pt/momentum/mass/etc…
- Measuring cross-sections of the Λ^0's hyperon

Plan to finish Run6 analysis to the end of June 2021

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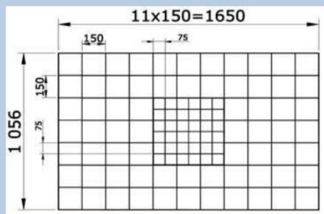
Study of the ZDC response in CC@4AGeV (Run 6) – I   Elizaveta Zherebtsova

ZDC calorimeter at the BM@N experiment

➔ In run 6 was collected data with carbon beam at 4AGeV .
➔ ZDC calorimeter measure spectator energy.



Central part with 36 modules 7.5 x 7.5cm²
Outer part with 68 modules 15 x 15cm²

➔ Some features of the ZDC experimental data for CC@4AGeV will be presented.

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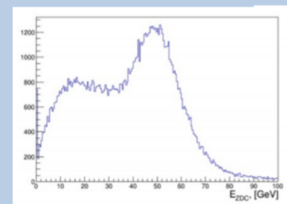
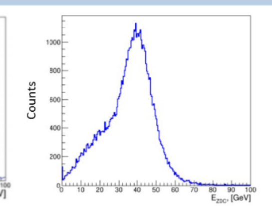
Features of the ZDC data for C+C reaction at 4.0 AGeV

Experimental data

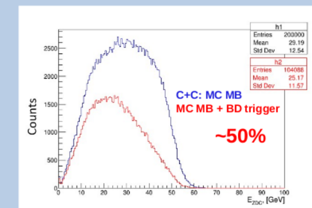
Carbon target



Empty target



Simulation



- **Significant fraction of events corresponds to carbon ions.**
- **How to reject these beam events?**

- **At given trigger there are only 50% of the most central events**

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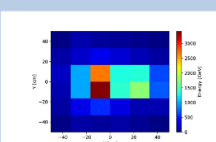
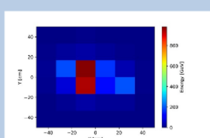
Application of ML approach to select the events in reaction CC@4.0 AGeV



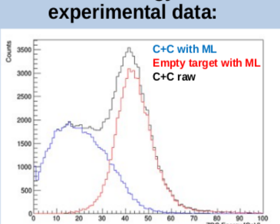
E_{dep} **distribution in ZDC modules with target**

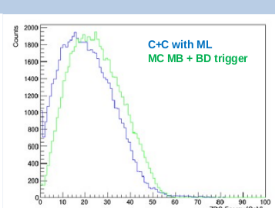


E_{dep} **distribution in ZDC modules without target**

➔ **Train ML to recognize empty target events and then apply to experimental data.**

ZDC energy in experimental data:





Experimental data:
ML approach is able to recognize and reject beam carbon events in ZDC energy spectra.

Simulation:
The energy distribution of events measured in ZDC is shifted relative the data obtained MC MinBias. →
The calibration should be checked.

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One-nucleon cluster calibration method for the ZDC calorimeter

➔ Calibration of ZDC modules was based on using cosmic muons

➔ To obtain a more uniform response of the calorimeter, a method was proposed for the reconstruction of single-nucleon clusters

➔ Single-nucleon clusters events: one spectator nucleon arrives at a given calorimeter module, with an energy equal to the beam energy

$E_{cluster} = E_{central\ module\ N} + E_{N\ cluster\ modules}$
$E_{cluster} = E_{beam}$

Cluster types:

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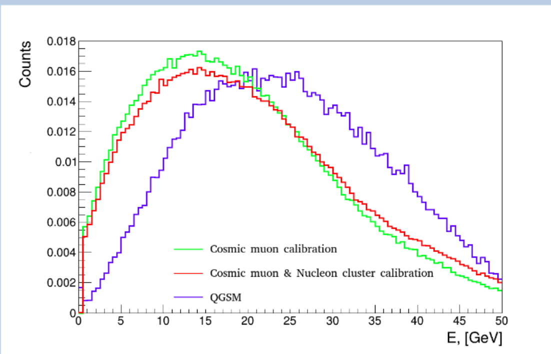
Study of the ZDC response in CC@4AGeV (Run 6) – II

Elizaveta Zherebtsova

Results of application single nucleon cluster calibration

Distribution of the total reconstructed energy in the calorimeter in modeling and in experimental data



Application of the one-nucleon cluster calibration shows a **slighly difference** in energy spectra from cosmic muon calibration → the calibration was done correctly.

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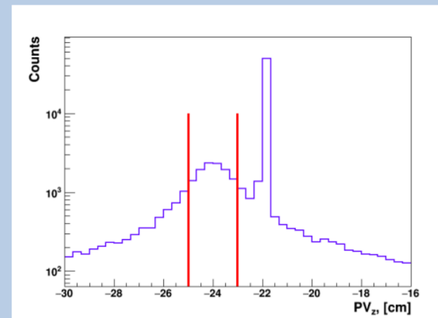
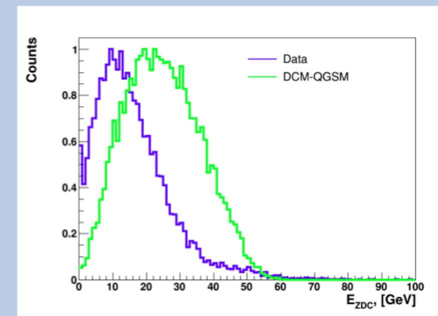
Selection of events for ZDC with primary vertex cut

Z coordinate of primary vertex (PVz):



Reconstructed energy in ZDC with cut on PVz: -25cm <PVz < -23cm



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Conclusion

- Rejection of carbon events was made by machine learning approach and cut on primary vertex.
- Cosmic muon calibration was checked with one-nucleon cluster calibration algorithm, calibration is correct.
- Cutting out beam events by different methods, the energy spectrum in the calorimeter does not match the simulation.

Future plans:

- Make the same procedures for Cu and Al target runs at 4 AGeV.

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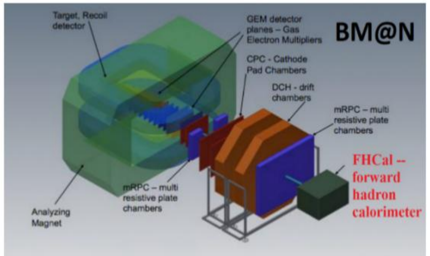
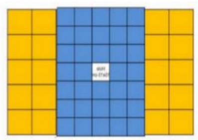
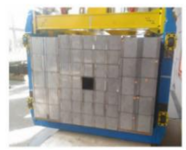
Centrality determination in AuAu@4.5 AGeV with FHCal and forward hodoscope – I
Nikolay Karpushkin

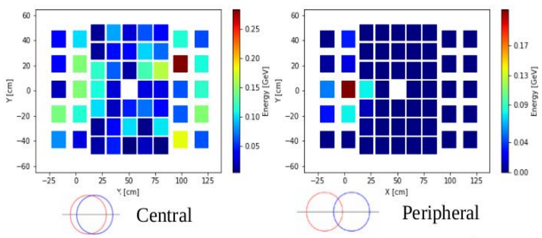


Determination of centrality using hadron calorimeters by ML methods

54 “pixels” to train ML algorithm

Calorimeter energy surface (single event)



Use of simulation files:

Input parameters – modules positions and energy depositions

Target variable – impact parameter

Expected result: online trigger for centrality estimation

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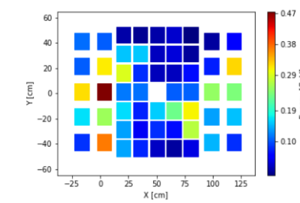
Supervised approach

Main goal:
Confirm approach capabilities.
Not to be used on real data.

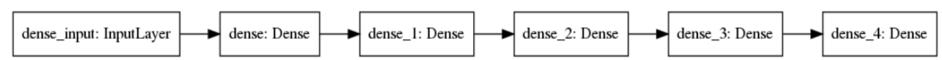
1. Train-test split
2. Train the model:

Inputs:

- 1D arrays of energy depositions in calorimeter modules (Energy surface)
- Centrality class index (impact parameter label)



Model architecture:



3. Test model accuracy

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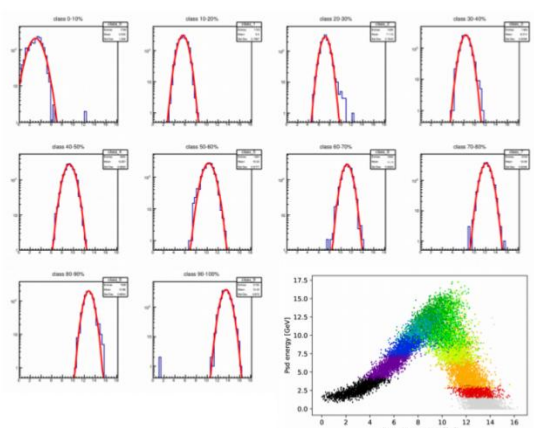
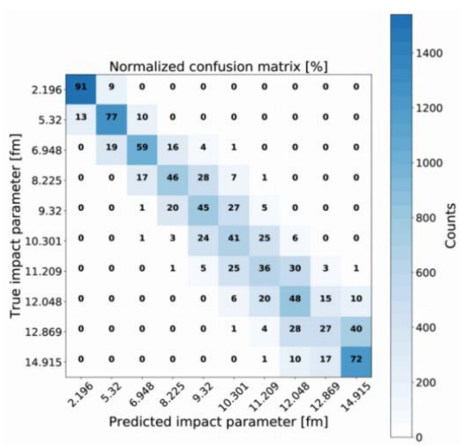
AuAu 4.5AGeV DCMQGSM Supervised





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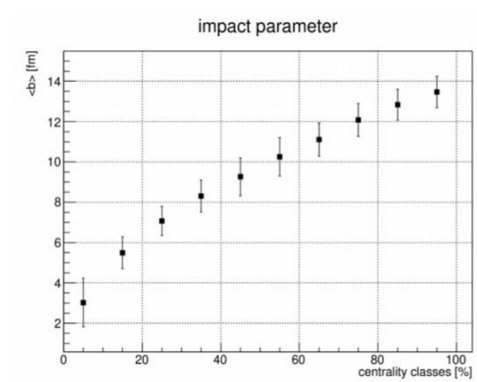
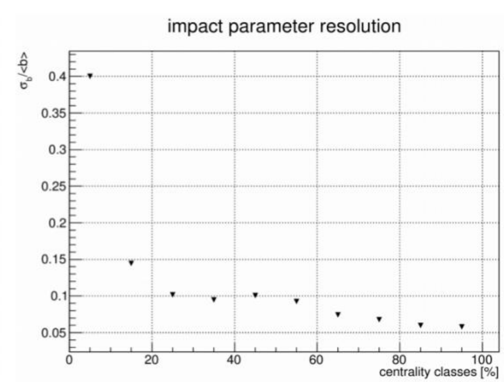
AuAu 4.5AGeV DCMQGSM Supervised





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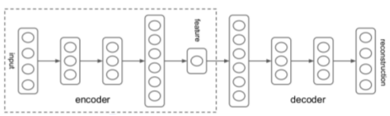
Centrality determination in AuAu@4.5 AGeV with FHCal and forward hodoscope – II
Nikolay Karpushkin

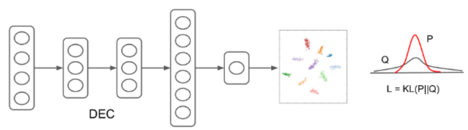
Unsupervised approach – Deep Embedded Clustering

1. Train autoencoder



2. Estimate cluster centroids: Encode data + TSNE + KMeans

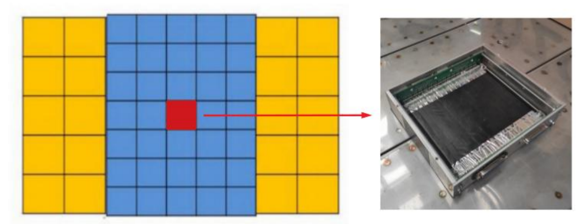
3. Deep Embedded Clustering (link):



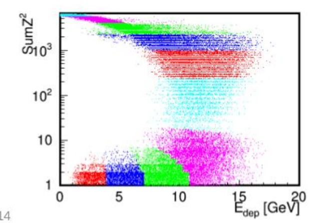
a) Soft clustering of encoded data by Student's t-distribution

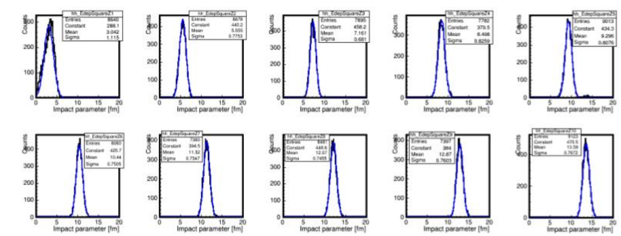
b) Iteratively strengthen predictions by approximating the obtained distribution **Q** to the auxiliary target distribution **P**

FHCal & forward hodoscope

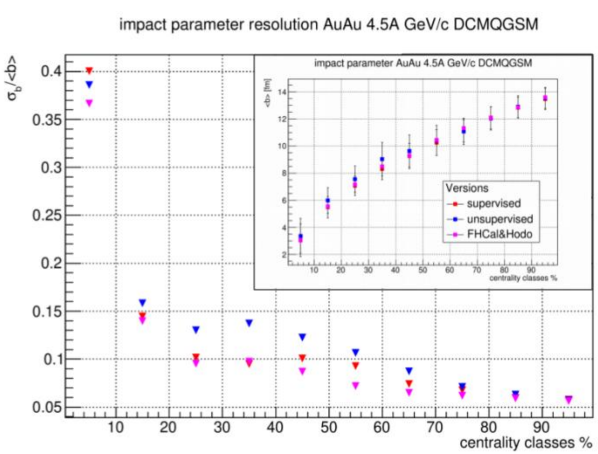


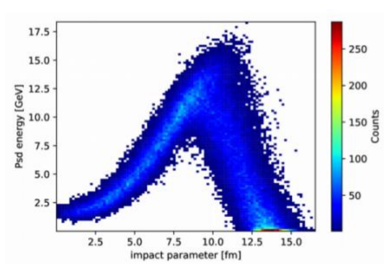
- Additional detector placed in the FHCal beamhole
- Measure charge of fragments at very forward rapidity region
- Online trigger for minbias/ centrality selection available





Resolution: supervised, unsupervised, FHCal&Hodo





Conclusions

- Supervised&Unsupervised ML approaches are developped for centrality classes determination with forward hadron calorimeters with beam holes.
- Forward hodoscope is designed and manufactured to measure charge of fragments at very forward rapidity. A method for determining centrality using a front hodoscope and a calorimeter is presented.
- The results of applying the approaches to BM@N simulation data were shown. The centrality resolution and impact parameters determined by three methods are in a good agreement with each other.

Outlook

- Further improvement of methods will be carried out. Git repository: link

Recent progress in Λ-reconstruction with argon data - I   Pavel Batyuk

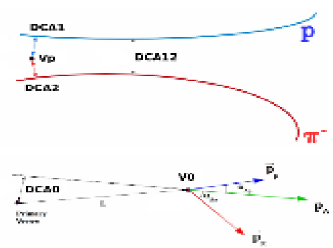
Algorithm of cut optimization

Used cut values ("source")

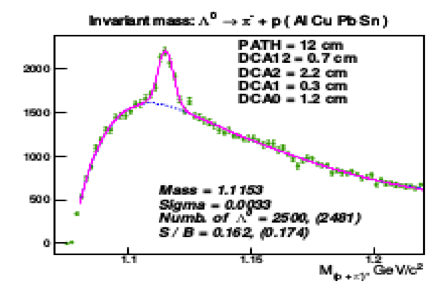
Cut	Used values	nValues
DCA0 [cm] (<)	0.5, 0.75, 1.0, 1.2, 1.4, 1.6	6
DCA1 [cm] (>)	0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5	9
DCA2 [cm] (>)	0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5	9
DCA12 [cm] (<)	0.5, 0.75, 1.0, 1.2, 1.4, 1.6	6
PATH [cm] (>)	6, 8, 10, 12, 14, 16	6
nPos (>)	2	1
nNeg (>)	2	1
Size of cut grid		17496

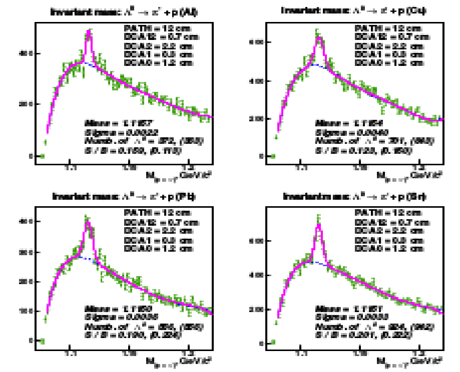
Main idea

- To search for a wide cut set ("source") for each target aimed at giving max. signal value (with arbitrary background)
- Once the set is defined, to do a 1D optimization over each geom. cut ("improved") to suppress the background with the minimal signal suppression.



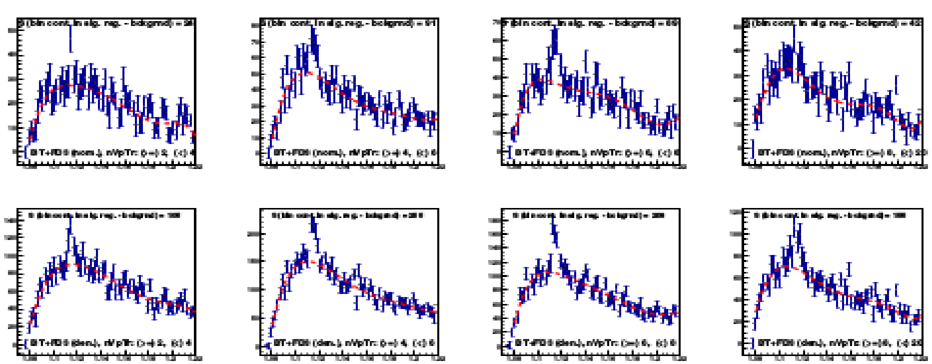
Result of optimization





Performed optimization allowed one to get the same set of cuts (shown in figs.) for all targets and to see the signal for all targets as well as for each target

Trigger efficiency (how to calculate?)

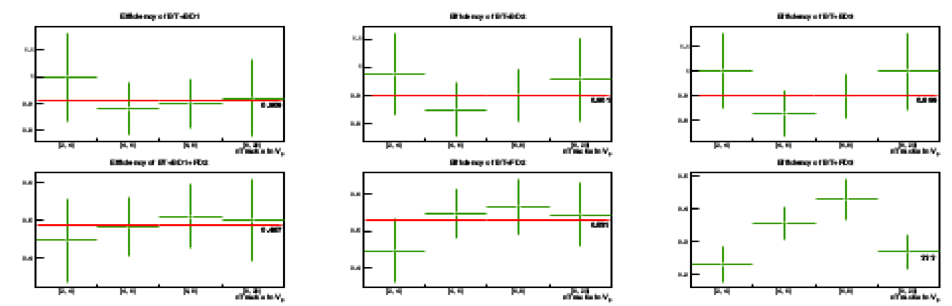


- Done for all trigger conditions available
- A set of centrality bins is taken into account (number of tracks participated in V_p)
- Background is fitted with Chebyshev's orthogonal polynoms of 4-th order giving access to the fit covariance matrix (to be used for error estimations)
- Sig. is calculated via the back. subtraction in the signal region to avoid possible bias (not by fit!)

$$\varepsilon_{TRIGGER} = \frac{N_{\Lambda^0} \text{ taken from nom.}}{N_{\Lambda^0} \text{ taken from den.}}$$

- Nom. and den. contain data sets without trigger condition which efficiency is estimated
- In nom. is applied a cut for number of counts of trigger which efficiency is estimated (BD > 2, FD > 3 ...)

Trigger efficiency (estimated by Λ^0 reconstruction)



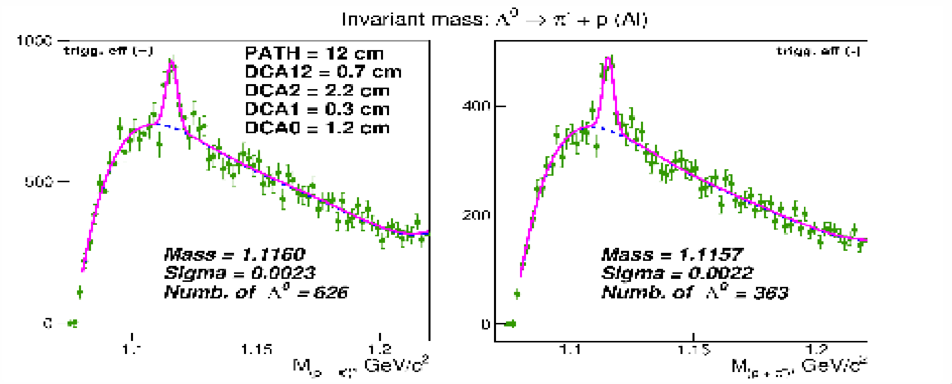
$\varepsilon_{BT+BD1} = \frac{((BT+FD2)+(BT+FD3))|_{BD>1}}{(BT+FD2)+(BT+FD3)}$ $\varepsilon_{BT+BD2} = \frac{((BT+FD2)+(BT+FD3))|_{BD>2}}{(BT+FD2)+(BT+FD3)}$ $\varepsilon_{BT+BD3} = \frac{((BT+FD2)+(BT+FD3))|_{BD>3}}{(BT+FD2)+(BT+FD3)}$

$\varepsilon_{BT+BD1+FD2} = \varepsilon_{BT+BD1} \cdot \varepsilon_{BT+FD2}$ $\varepsilon_{BT+FD2} = \frac{((BT+BD2)+(BT+BD3))|_{FD>2}}{(BT+BD2)+(BT+BD3)}$ $\varepsilon_{BT+FD3} = \frac{((BT+BD2)+(BT+BD3))|_{FD>3}}{(BT+BD2)+(BT+BD3)}$

BT + BD(N) means beam trigger included and number of counts in barrel detector greater than N
BT + FD(N) means beam trigger included and number of counts in forward silicon detector greater than N
BT + BD(M) + FD(N) means beam trigger included and number of counts in barrel detector greater than M and in forward silicon detector greater than N

Recent progress in Λ-reconstruction with argon data - II Pavel Batyuk

Taking into account obtained trigger efficiencies ...

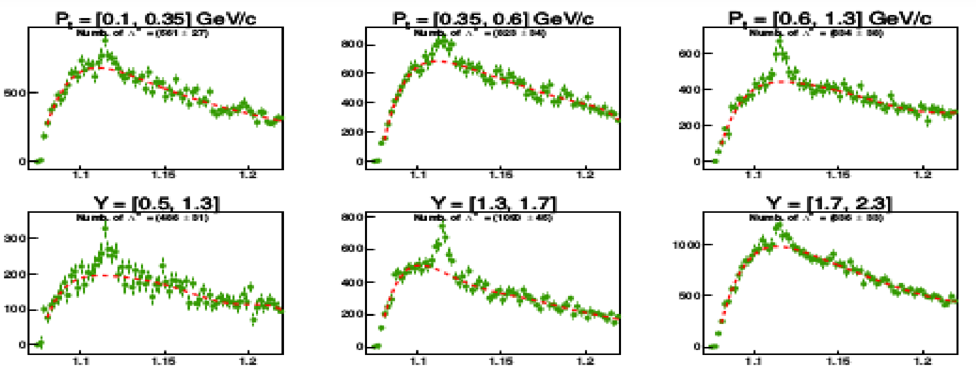


Target:	Al	Cu	Sn	Pb
N_{Λ^0} with (without)	626 (363)	1171 (643)	1912 (942)	1250 (556)
Inc. factor:	1.72	1.82	2.03	2.25

Looking at reconstructed Λ^0 in terms of PtY

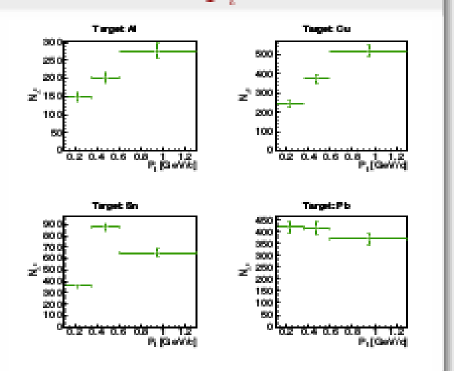
- Done for all targets
- Three chosen P_t bins: (0.1, 0.35), (0.35, 0.6) and (0.6, 1.3) GeV/c
- Three chosen Y bins: (0.5, 1.3), (1.3, 1.7) and (1.7, 2.3)
- Lower value of first bin and upper value of last bin were chosen not to suppress signal significantly (done when analyzing all targets)
- For each chosen bin $(S \pm \Delta S)$ is estimated

Target: Sn

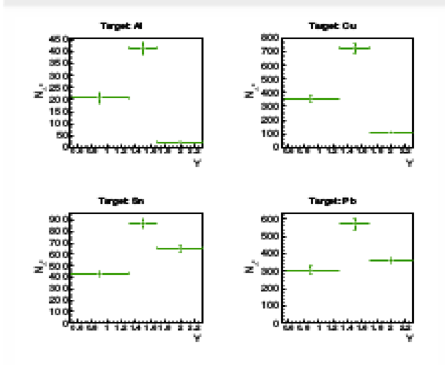


Looking at reconstructed Λ^0 in terms of PtY

P_t



Y



Target / P_t bins	Al	Cu	Sn	Pb
0.1 ... 0.35	148 ± 13	246 ± 17	361 ± 22	421 ± 26
0.35 ... 0.6	202 ± 16	376 ± 22	879 ± 40	415 ± 26
0.6 ... 1.3	275 ± 21	518 ± 30	651 ± 35	372 ± 26

Target / Y bins	Al	Cu	Sn	Pb
0.5 ... 1.3	207 ± 22	355 ± 28	433 ± 30	304 ± 24
1.3 ... 1.7	417 ± 28	730 ± 37	871 ± 41	574 ± 34
1.7 ... 2.3	23 ± 4	110 ± 10	653 ± 30	361 ± 23

Conclusion

- Performed optimization allowed one to "elaborate" the same set of cuts applied to all targets to see the signal from Λ^0
- Estimated trigger efficiency w.r.t. Λ^0 reconstruction showed that triggers containing FD condition have less efficiency if compared with those ones having BD condition
- Produced Λ^0 spectra for different bins in (Y, P_t)-space with estimation of number of Λ^0 for each bin chosen.

Thank you for your attention!

Coffee break – all participants

The status of identification in Argon run, TOF400 – I   Vasily Plotnikov

Content

- Wide CSC residuals for Data at p<1 GeV/c
- Dependence of CSC/TOF400 residuals on P
- Taking into account the dependence of CSC/TOF400 residuals on p
- New TOF400 efficiency results
- Detailed GEM geometry
- $<dx_{GEM}>(p)$ compensation for Data and MC and $\sigma_{GEM}(p)$ smearing for MC

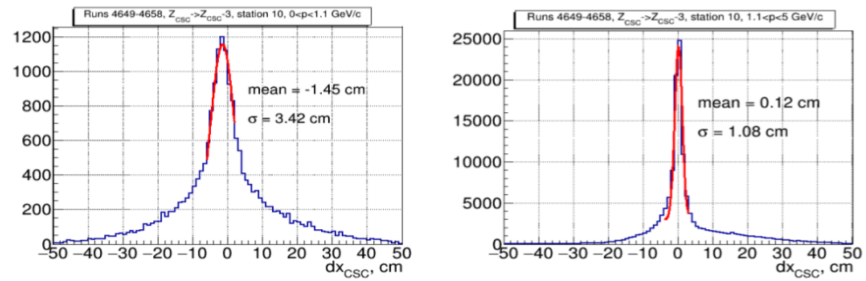
Vasilii Plotnikov, 19.04.2021   2

Content

- GEM efficiency
- CSC residuals in MC
- TODO

Vasilii Plotnikov, 19.04.2021

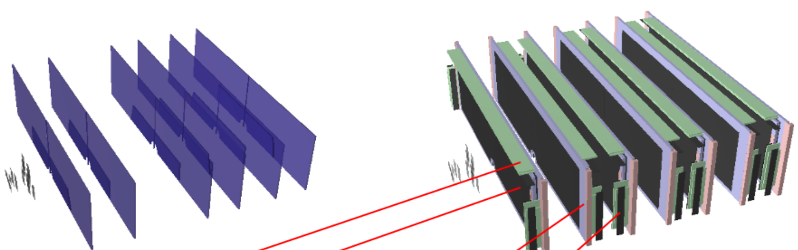
CSC residuals for Data



- The CSC residuals not Gaussian. The tails are very wide. Especially for 0<p<1.1 GeV/c
- $|mean_{0<p<1.1} - mean_{1.1<p<5}| \sim 1.5$ cm
- $\sigma_{0<p<1.1} \sim 3\sigma_{1.1<p<5}$
- The number of low momentum tracks (0<p<1.1 GeV/c) <10% of all tracks (0<p<5 GeV/c)

Vasilii Plotnikov, 19.04.2021   4

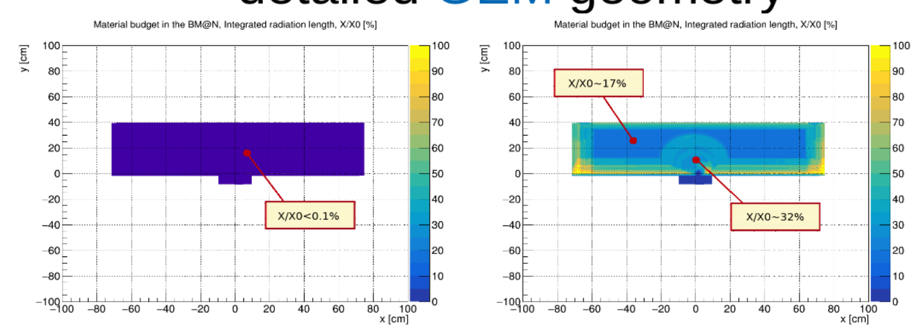
Detailed vs simple GEM geometry



- New layers (**black**), frames (indigo), electronics (green) were added for each GEM sensitive volume
- Broken station was added
- Detailed geometry from D. Baranov

Vasilii Plotnikov, 19.04.2021   10

Taking into account detailed GEM geometry



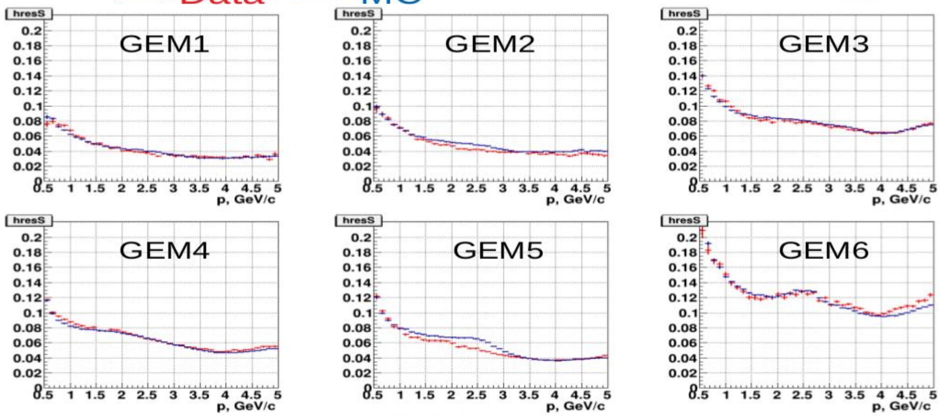
- Material budget is calculated using straight tracks from the target
- Material budget has been significantly increased in GEM detailed geometry
- Much of the material budget comes from frames around the beam hole

Vasilii Plotnikov, 19.04.2021   11

The status of identification in Argon run, TOF400 – II Vasily Plotnikov

GEM residuals compensation and smearing for Data and MC. $\sigma_{dx}(p)$

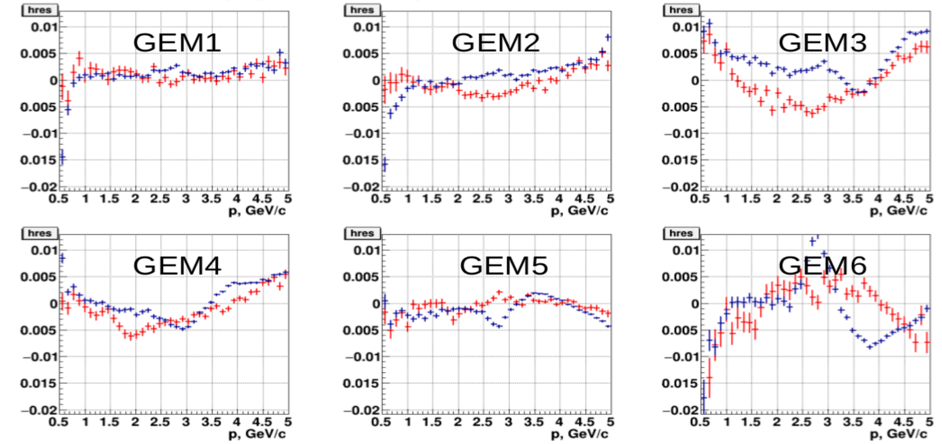
— Data — MC



Vasilii Plotnikov, 19.04.2021 12

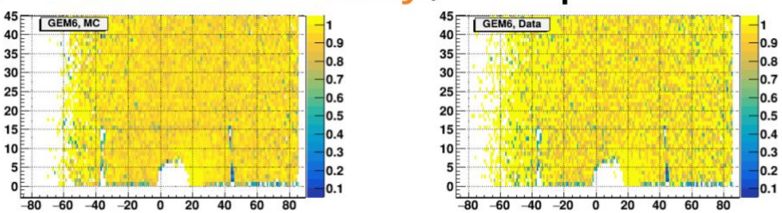
GEM residuals compensation and smearing for Data and MC. <dx>(p)

— Data — MC

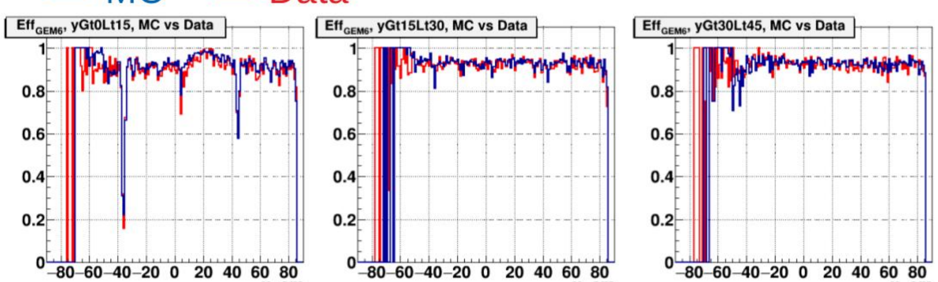


Vasilii Plotnikov, 19.04.2021 13

GEM6 efficiency, 0.5<p<2 GeV/c

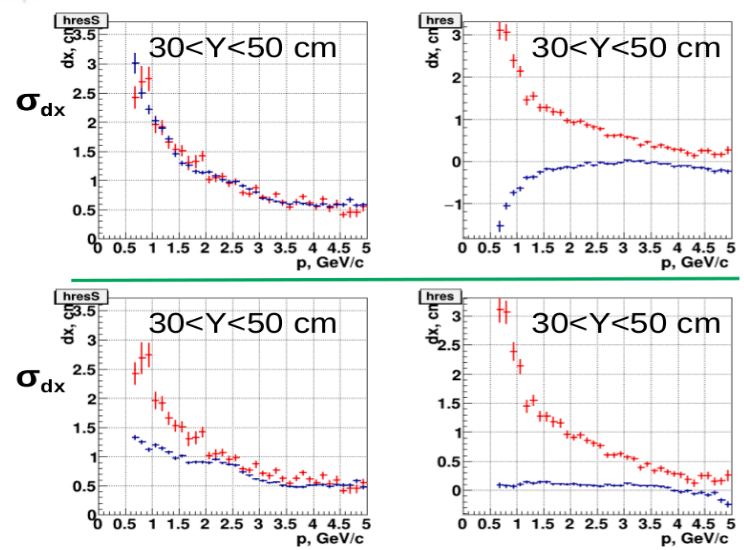


— MC — Data



Vasilii Plotnikov, 19.04.2021 16

CSC residuals in MC



— Data — MC

Detailed GEM geometry

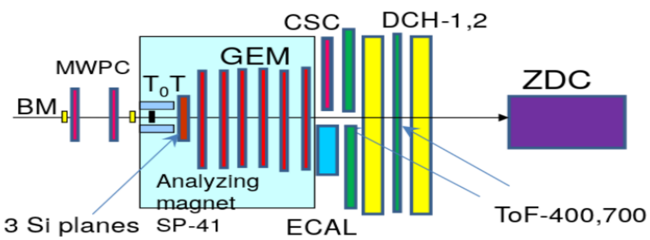
Simple GEM geometry

Vasilii Plotnikov, 19.04.2021 18

Current Progress in TOF700 Particle Identification in Argon data run 7 - I
Lalyo Kovachev

Argon data run 7

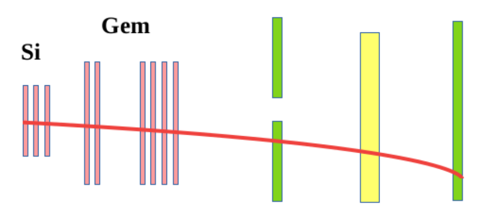
Ar beam 3.2 GeV/n
Targets Al,C,Sn,Cu,Pb



Schematic drawing of the location of the TOF700 on the BM@N setup

TOF700 Particle Identification chain

For **Data** and **MC** we use the **same** Identification chain



For **MC** we use **DCM QGSM** Generator

Si-GEM(data) tracks from **V. Plotnikov**

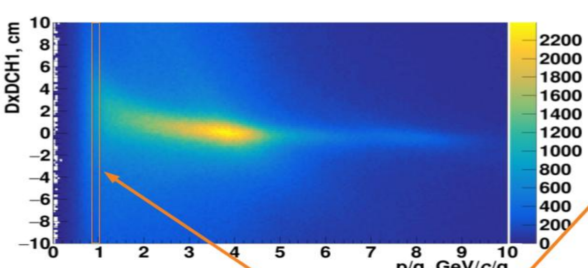
DCH tracks from **DCH group**

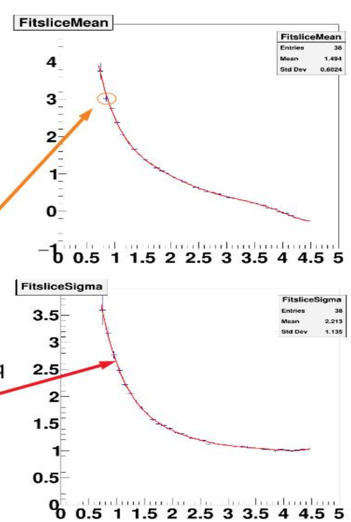
TOF700 hits from **Y. Petukhov**

Si-GEM tracks are extrapolated to the **DCH1** z-position and matched against the **DCH1** tracks

Successfully matched tracks are extrapolated to the **TOF400** and **TOF700** planes and matched against the **TOF400** and **TOF700** hits

DX Corrections





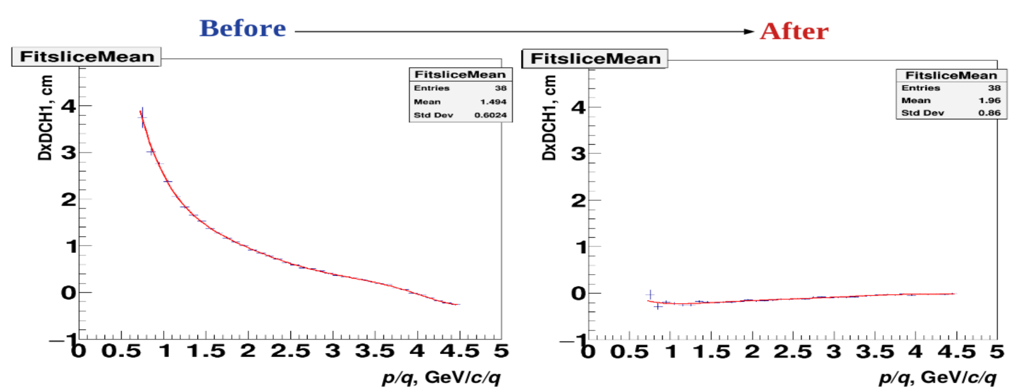
We used the FitSlices method for DxDCH1 vs p/q plot, producing projections of DxDCH1-axis each bin(slice) of p/q axis. Each slice is fitted with a Gauss+pol2

The resulting dependencies Gaus mean and sigma vs p/q are fitted with a polynomial function pol9

Based on these functions, in further analysis we performs corrections on X coordinate for GEM track extrapolated to the DCH1

5

DX Corrections DCH1

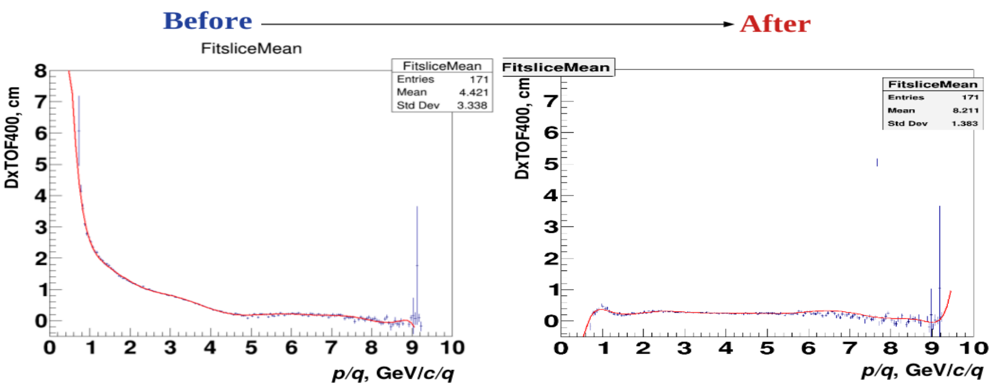


Good corrections results!
Negligible shifts of mean values of the order of a few millimeters.

6

Current Progress in TOF700 Particle Identification in Argon data run 7 - II
Lalyo Kovachev

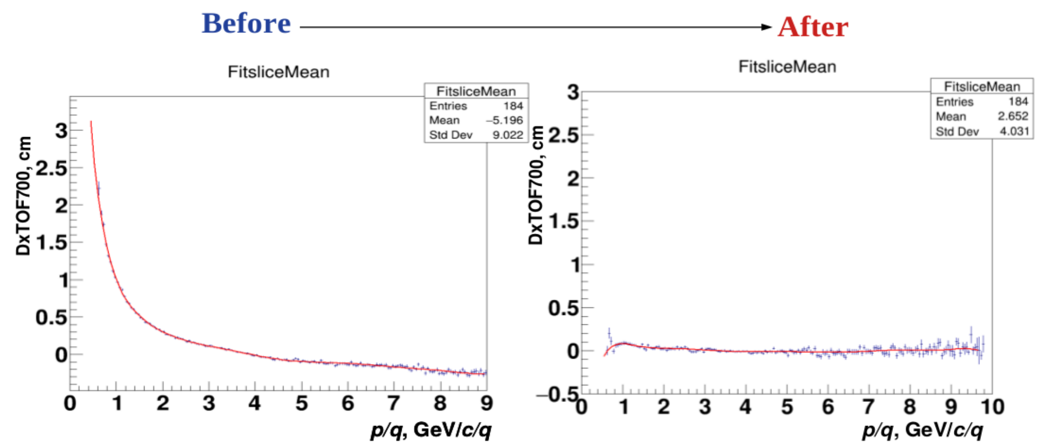
DX Corrections TOF400



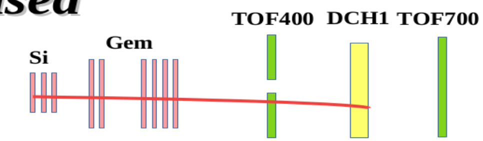
Negligible shifts of mean values of the order of a few millimeters.

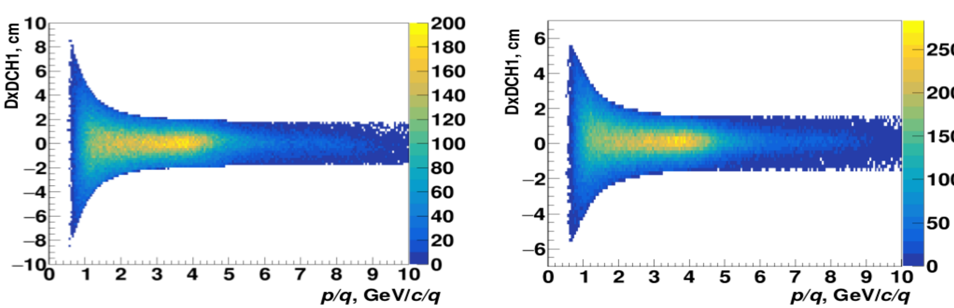
8

DX Corrections TOF700



New Momentum-based Si-GEM-DCH Matching Criteria

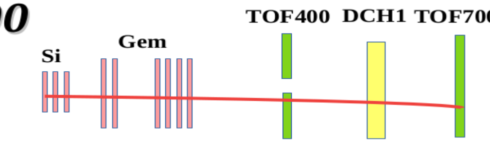


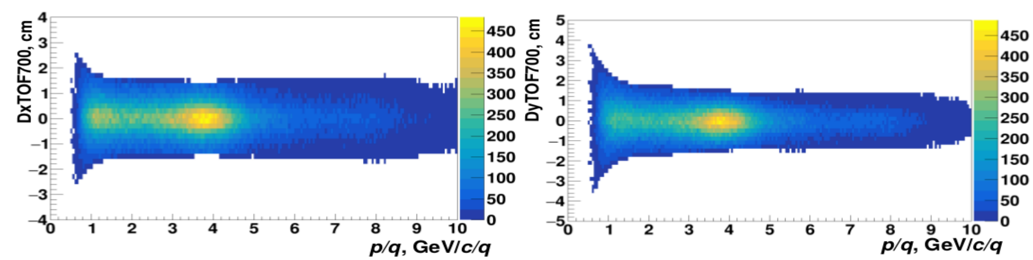


Matching criteria:
±2σDx, ±2σDy

11

New Momentum-based Si-GEM-DCH-TOF700 Matching Criteria



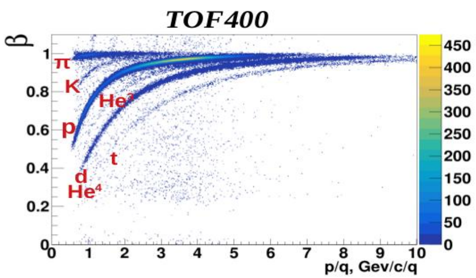


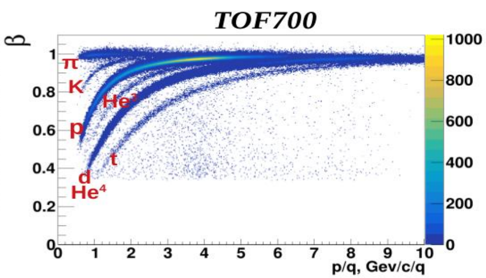
Matching criteria:
±2σDx, ±2σDy

Much narrower Dx in low momenta for TOF700

Current Progress in TOF700 Particle Identification in Argon data run 7 - III
Lalyo Kovachev

Beta vs momentum



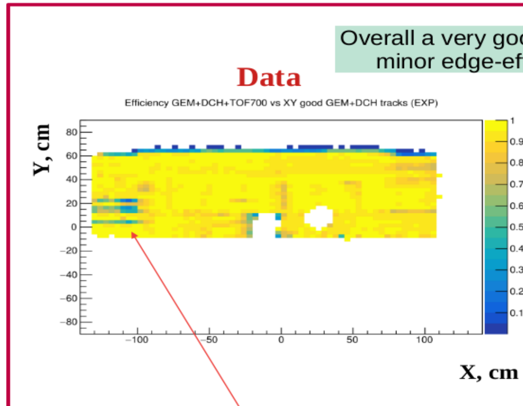


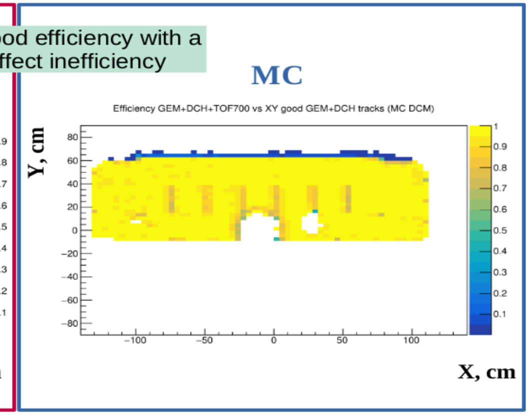
Input Gem tracks are filtered through Drift Chamber but **a lot of tracks** which enter in to TOF400 acceptance do not enter in acceptance of Drift Chamber

New matching criteria allows to identify more particles in low momentum intervals and improve **particle separation** in **TOF700** detector

XY-Efficiency for a good track Si-GEM + DCH matching with hit TOF700.

Overall a very good efficiency with a minor edge-effect inefficiency

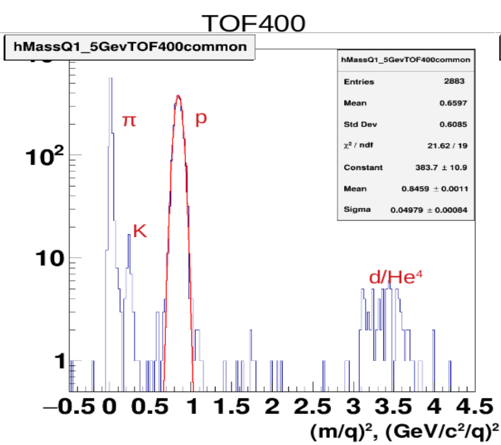


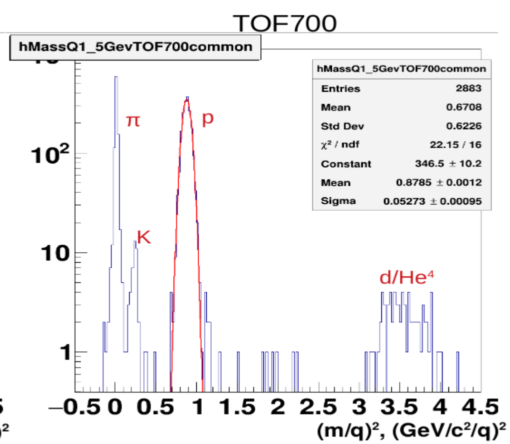


Decreased efficiency for negatively charged particles due to not optimal calibration due to low statistics. This is understood and will be fixed.

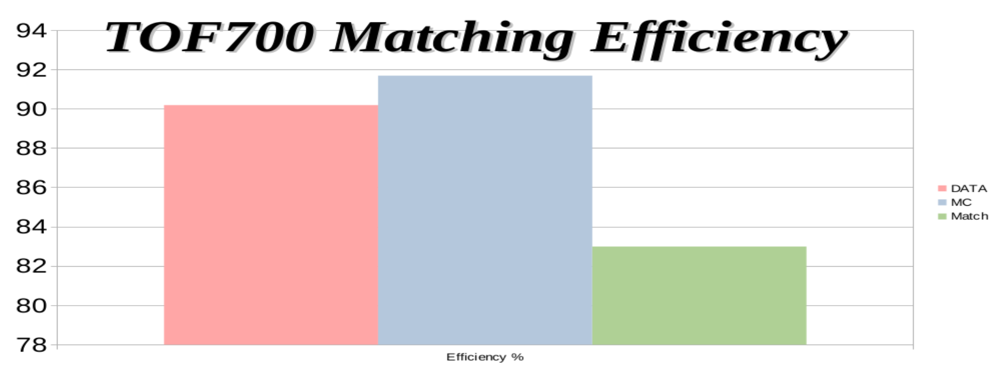
15

Particles mass square of <u>common</u> tracks of momenta below 1.5 GeV





We check the **(m/q)²** of each track, reconstructed by each system, to see if it is within a peak that corresponds to the same particle hypothesis



$E_{DATA} = \frac{N_{matched\ tracks}}{N_{goodtracks}}$	$E_{MC} = \frac{N_{matched\ tracks}}{N_{goodt\ tracks}}$	$E_{correct\ identifeid\ tr} = \frac{N_{correct\ idf\ trs}}{N_{idf\ tracks}}$
DATA	**MC**	**Correct Identified**
90.2%	**91.7%**	**83.1% (of ~16% common)**

Analysis of fragment production in C+p reaction on the SRC data – I Andrey Driuk

The SRC experiment

1. Carbon beam
2. Liquid Hydrogen Target
3. Two arms register protons

Trigger	LH	Lead 1	Lead 2	Lead 3
SRCT2	**19.29**	0	0.80	0.37
SRCT	**5.75**	0	0	0
SRC1	0.61	0	0.27	0.51
SRC2	0.56	0	0.33	0.22
SRC IT	0.55	**25.67**	0.39	0.34
SRC NIT	1.16	0	0.35	0.30
SRC BT	0.52	0	0	0

Table 1. Statistic in the experiment (millions)

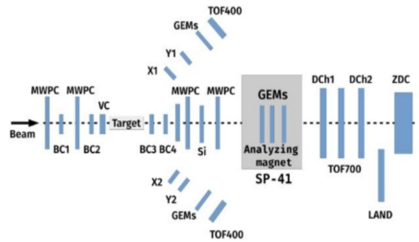


Fig. 1 The SRC facility

4. Patsyuk, M., Kahlbow, J., Laskaris, G. et al. Unperturbed inverse kinematics nucleon knockout measurements with a carbon beam. Nat. Phys. (2021). https://doi.org/10.1038/s41567-021-01193-4

2

Beam counters (BC triggers)

BC3 and BC4 triggers were used in the experiment for:

1. events selection
2. total event charge estimation

Status:

a) Geometry of BC triggers was added in simulation and reconstruction

b) We implemented classes (based on Nikita Lashmanov's files) that write MC points in simulation and hits in reconstruction procedure

c) We also calibrate BC3 and BC4 in order to find charge

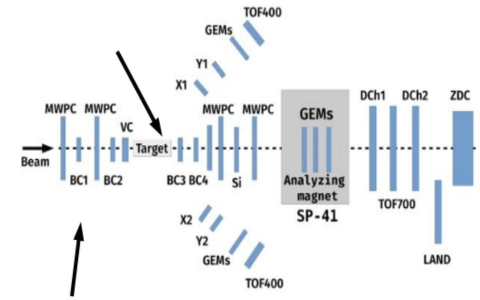


Fig 2. BC triggers in the facility

5

Calibration of BC triggers

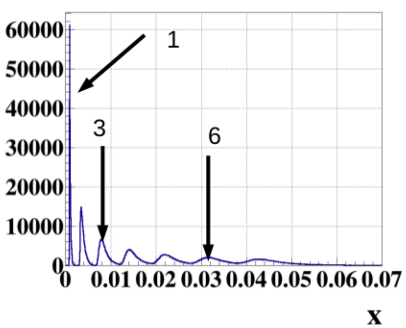


Fig 3. Mean energy loss of events in BC3 and BC4

1. Simple ION generator was used for calibration
2. Calibration was done by H, Li and C peaks
3. Parabolic model of calibration used

$$z_{out} = a * x^2 + b * x + c, \quad x = \sqrt{Eloss_{BC3} * Eloss_{BC4}}$$

6

Calibration of BC triggers

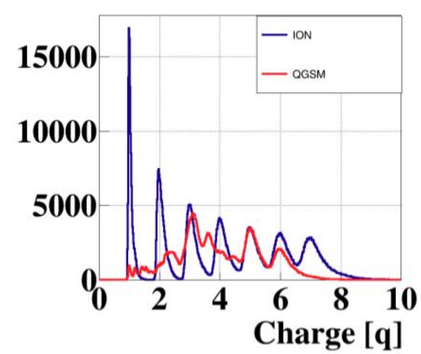


Fig 4. Calibration for ION generator and QGSM

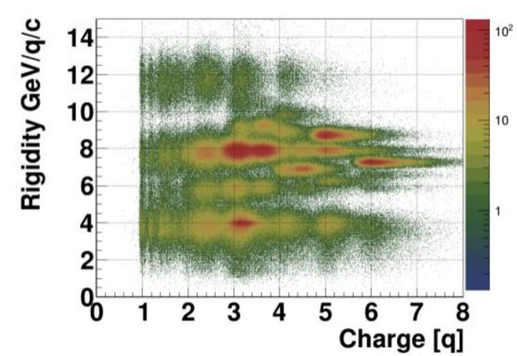


Fig 5. Fragments in simulation generator - QGSM

7

Alignment of arm detectors in experimental data

1. The both arms were aligned as a whole system.
2. Then the each arm were aligned separately.

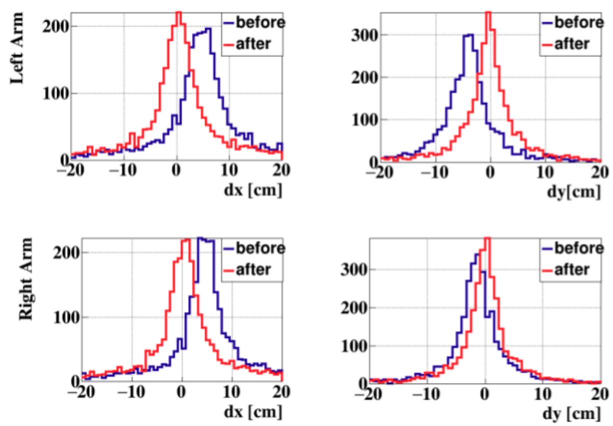


Fig. 6 Residuals in TOF Before (blue)/after (red)

8

Vertex of liquid hydrogen target

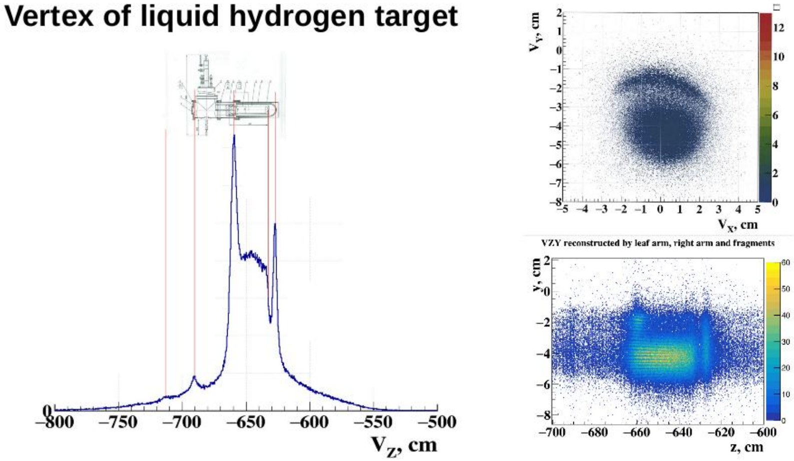


Fig. 9 Vertex reconstruction for the liquid hydrogen target

11

Plane of the reaction

How we can be sure that arm detectors register protons?
1. Analysis of time from TOF detectors – not finished yet
2. p_t-balance – we suppose inelastic scattering, protons have to be in one plane

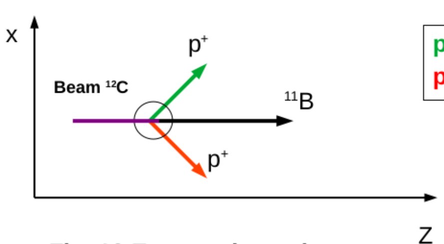


Fig. 12 Expected reaction

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

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

14

Summary

1. BC triggers were added in simulation and reconstruction procedures. Events could be selected by outgoing charge in simulated data.
2. Arm detectors were aligned by two-step procedure.
3. Vertex reconstruction procedure was modified. Good agreement between reconstructed vertex and target schemes is seen.
4. Good estimations of the reaction plane angles allows us to investigate p_t-balance of the reactions

Acknowledgments: We are extremely grateful to Alexey Stavinsky and Mikhail Kapishin for their help and advice.

16

Application of the Vector Finder toolkit for track reconstruction in BM@N – I
Alexander Zinchenko

BM@N

Tracker performance

BM@N

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COMPUTER TECHNOLOGIES
IN PHYSICS

Vector Finder—A Toolkit for Track Finding in the MPD Experiment

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Received July 4, 2020; revised August 31, 2020; accepted September 1, 2020

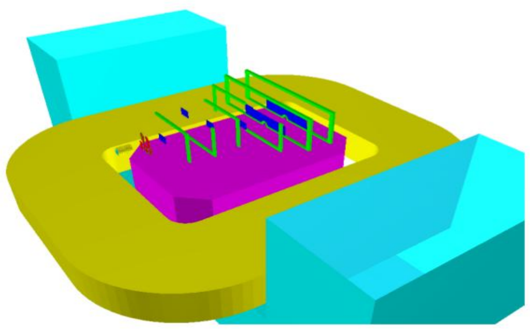
Abstract—A track reconstruction method based on a constrained combinatorial search for track candidates, i.e. combinations of detector hits possibly belonging to a track, is presented. The algorithm has been implemented as a Vector Finder software toolkit containing a track reconstruction procedure and tools to determine hit acceptance windows (a priori constraints) for the track search. Track reconstruction results for high multiplicity simulated events (~1000 particles in the detector acceptance) are shown demonstrating good performance of the approach proposed.

DOI: 10.1134/S1547477121010131

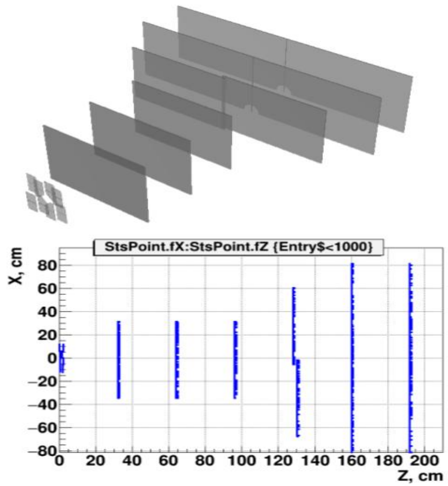
106 accesses for 2 months

Detector geometry

BM@N



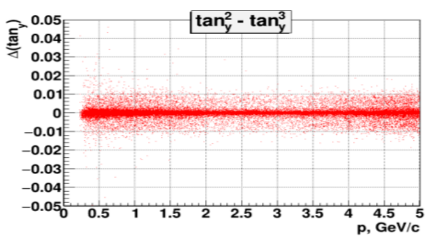
Field: ~0.6 T

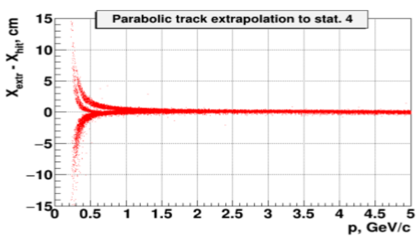


Hit acceptance window size

BM@N

D(tan_y) on consecutive stations
Parabolic extrapolation in X-Z plane





Current tracking strategy

BM@N

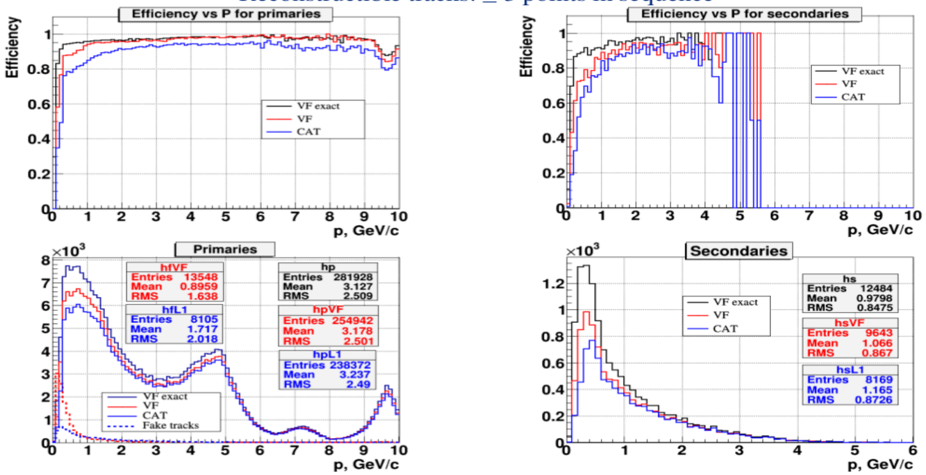
Start from the last station and go upstream.
Start from the last but one, etc.
Allow missing station (jump over one station).
Perform 6 passes:

1. Narrow windows, >= 6 hits
2. Narrow windows, >= 5 hits
3. Wide windows, >= 6 hits
4. Wide windows, >= 5 hits
5. Wide windows, >= 4 hits
6. Wide windows, >= 3 hits

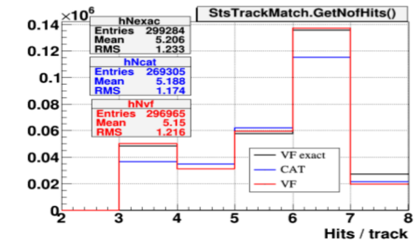
Application of the Vector Finder toolkit for track reconstruction in BM@N – II
Alexander Zinchenko

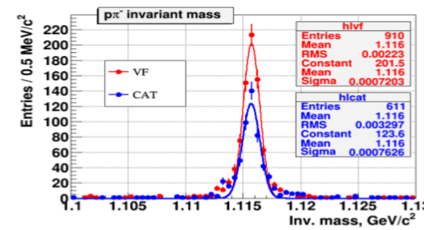
Tracking performance

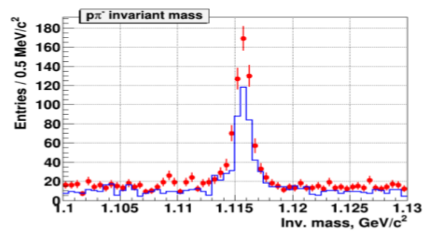
Reconstructible tracks: ≥ 3 points in sequence



Λ reconsruction







Cuts: $\chi^2_p > 1$, $\chi^2_\pi > 2$, path > 1 cm, $\chi^2_\Lambda < 20$, angle$_\Lambda < 0.2$

Summary and outlook

- ✓ Vector Finder toolkit has been adapted to BM@N central tracker configuration in run6.
- ✓ It demonstrates some improvement over the CAT package.
- ✓ The plan is to try to adapt VF to configurations of runs 7 and 8 as well as to use more realistic detector geometries with passive material.

Summary

- ✓ Analysis efforts in several directions: Run6, Run7 PID, Run7 V0s, SRC, preparations for future runs.

At last we can see a light at the end of the tunnel.