Simulation, reconstruction and analysis in Xe run

Sergei Merts

on behalf of BERDS Group

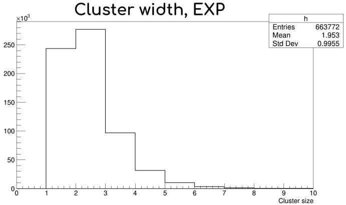
12/09/23

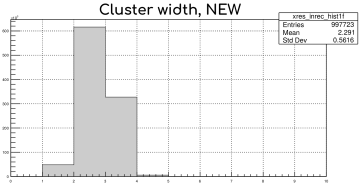
Update in FSD simulation

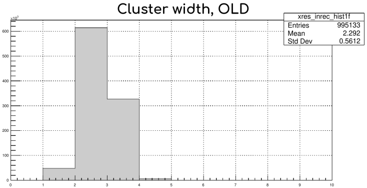
D.Baranov

- Realistic effects added in simulation.
- Track inclination is taken into account now.
- Previous version used only coordinate smoothing.

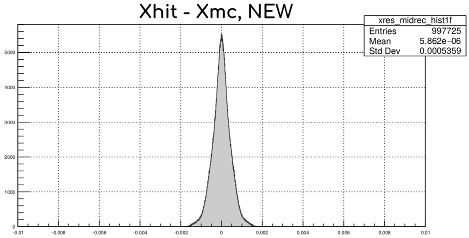
Cluster size for FSD-0

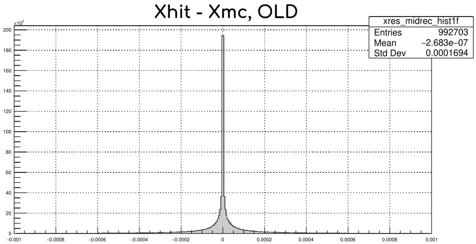


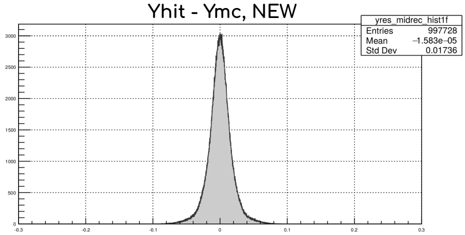


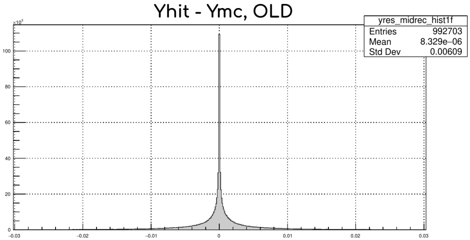


- There is difference between Exp and MC cases
- 1-strip clusters should be analized more detailed







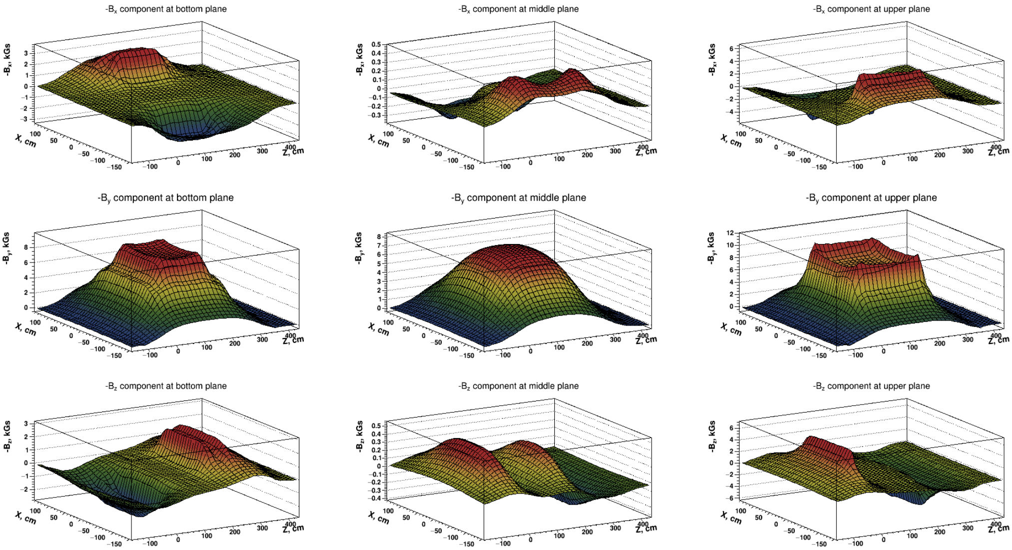


- Residuals became 3-4 times wider
- Comparison with experimental data needed

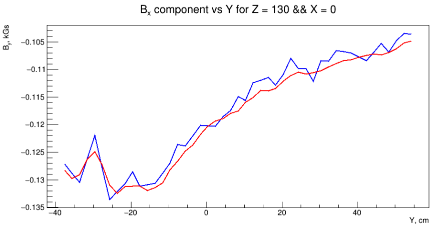
Analysis of magnetic field map

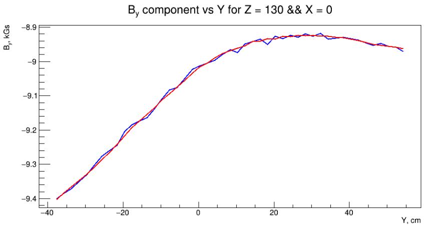
S.Lebedeva, S.Merts

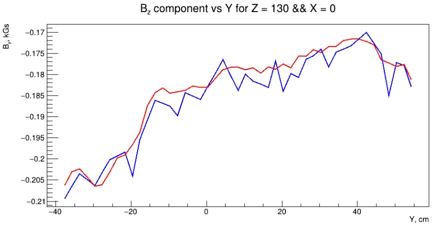
- Magnetic field map was created in the region of measurements
- To exclude inhomogeneity of created field map the smoothing procedure was done
- Smoothing was done as a moving average by three-point in each direction



$-B_x$ component at bottom plane
$-B_x$ component at middle plane
$-B_x$ component at upper plane
$-B_y$ component at bottom plane
$-B_y$ component at middle plane
$-B_y$ component at upper plane
$-B_z$ component at bottom plane
$-B_z$ component at middle plane
$-B_z$ component at upper plane
$-B_x$, kGs
$-B_y$, kGs
$-B_z$, kGs
X, cm
Z, cm







- Blue - basic inhomogeneous field
- Red - smoothed field

NEXT STEPS:

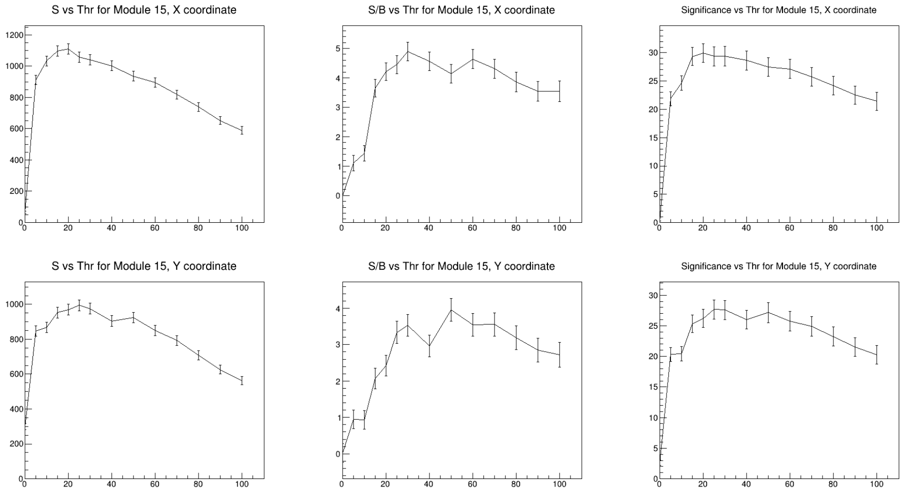
- Analyze and fix magnetic field map in region of SP-41 poles
- Extrapolate field map to the region of TOF-400
- Make better smoothing of the field

Analysis of thresholds in LCSC decoding

S.Lebedeva

Algorithm:

- Basic threshold was set around 0
- All digits with signal less than current threshold were eliminated in reconstruction
- Hits in LCSC were reconstructed
- Tracks from inner tracker were extrapolated to LCSC planes
- All hits to all tracks residuals were created and fitted by Gaus + Pol2 function
- Signal (S) and background (B) were extracted


S vs Thr for Module 15, X coordinate
S/B vs Thr for Module 15, X coordinate
Significance vs Thr for Module 15, X coordinate
S vs Thr for Module 15, Y coordinate
S/B vs Thr for Module 15, Y coordinate
Significance vs Thr for Module 15, Y coordinate

NEXT STEPS:

- Analyze thresholds on higher statistics
- Analyze thresholds for different zones of LCSC (different zones = different chips)
- Apply this procedure for other detectors

Global Tracking status

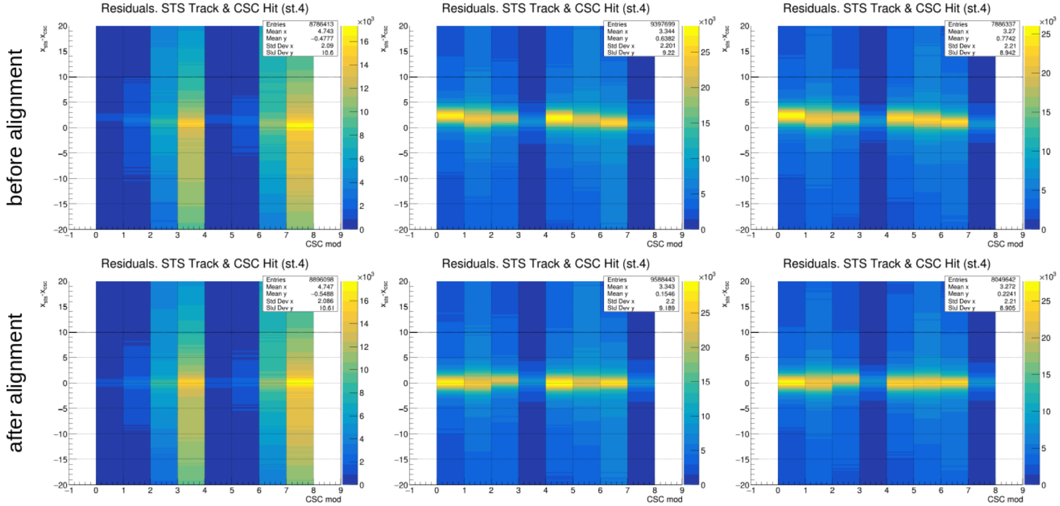
P.Alekseev, S.Merts

Outer alignment

- TOF-700 was aligned by modules (60 indepedent planes)
- LCSC was aligned by modules (8 indepedent planes)
- ScWall was aligned as a whole
- Aligment of TOF-400 is under preparation

Far CSC modules X residuals alignment

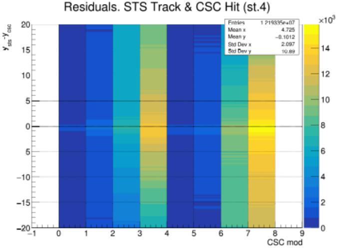
Run 7839 (no field) | Run 7830 | Run 8000

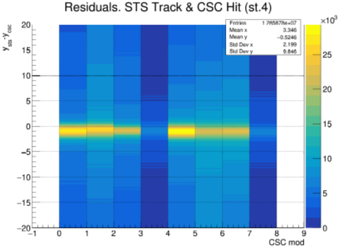


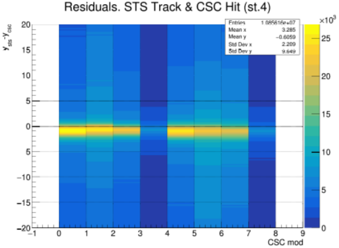
Far CSC modules Y residuals alignment

Run 7839 (no field) | Run 7830 | Run 8000

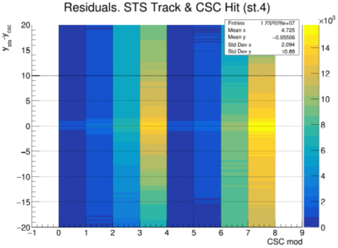
before alignment

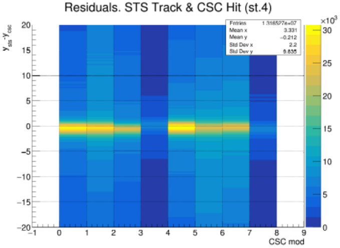


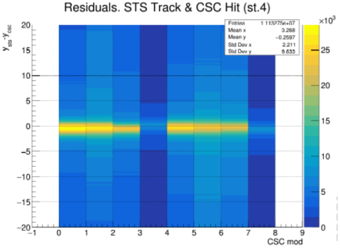




after alignment







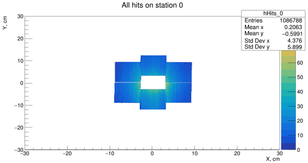
Detector	Is in Global Track	Alignment	Local Reco	Comment
Inner Tracker	✓	✓	✓	Core of global track
sCSC	✗	✗	✓	
LCSC	✓	✓	✓	Not in current mass production
TOF-400	✓	✓✗	✓✗	Alignment and corrections to proton peak needed
TOF-700	✓	✓	✓✗	Corrections to proton peak needed
DCH	✗	✗	✓✗	There are problems with Xe multiplicity
ScWall	✓	✓	✓	
FHCal	✗	✗	✓	

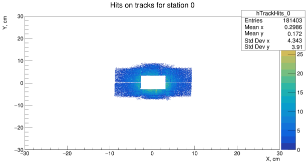
- In current mass production Global track = FSD + GEM + TOF400 + TOF700 + SCWall
- LCSC added into Global Track after mass production started
- More detailed alignment for TOF400 needed

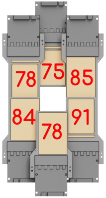
Analysis of the inner tracker efficiency

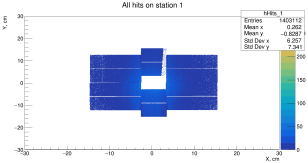
INPUT DATA:

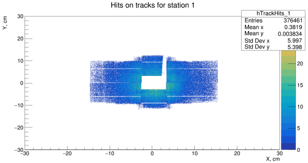
- 25k experimental events (run 8000)
- Number of tracks in vertex: 2+
- Vertex cut: $|X_{vrt} - X_{trg}| < 5$cm, $|Y_{vrt} - Y_{trg}| < 5$cm, $|Z_{vrt} - Z_{trg}| < 5$cm
- Hits on track cut: 2FSD + 4GEM
- Range for hits on track:
  FSD: dx = 0.12 cm, dy = 1.20 cm
  GEM: dx = 0.30 cm, dy = 1.20 cm

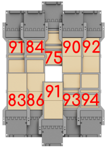

All hits on station 0
hHits_0
Entries 1086788
Mean x 0.2063
Mean y −0.5991
Std Dev x 4.376
Std Dev y 5.899
Y, cm
X, cm

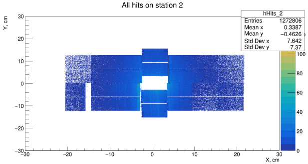

Hits on tracks for station 0
hTrackHits_0
Entries 181403
Mean x 0.2986
Mean y 0.172
Std Dev x 4.343
Std Dev y 3.91
Y, cm
X, cm

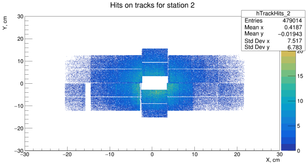

78
75
85
84
91
78

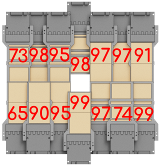

All hits on station 1
hHits_1
Entries 1403112
Mean x 0.262
Mean y −0.8287
Std Dev x 6.257
Std Dev y 7.341
Y, cm
X, cm

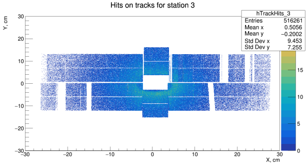

Hits on tracks for station 1
hTrackHits_1
Entries 376461
Mean x 0.3819
Mean y 0.003834
Std Dev x 5.997
Std Dev y 5.398
Y, cm
X, cm

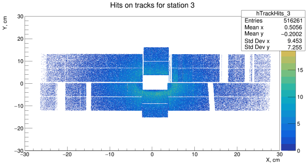

91
84
75
90
92
83
86
91
93
94

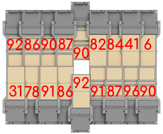

All hits on station 2
hHits_2
Entries 1272806
Mean x 0.3387
Mean y −0.4626
Std Dev x 7.642
Std Dev y 7.37
Y, cm
X, cm

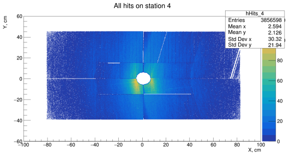

Hits on tracks for station 2
hTrackHits_2
Entries 479014
Mean x 0.4187
Mean y −0.01943
Std Dev x 7.517
Std Dev y 6.783
Y, cm
X, cm

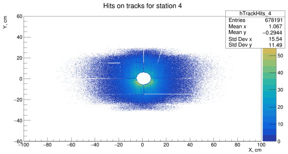

73 98 95
98
97 97 91
99
65 90 95
97 74 99

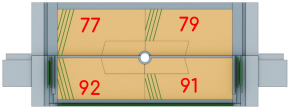

Hits on tracks for station 3
hTrackHits_3
Entries 516261
Mean x 0.5056
Mean y −0.2002
Std Dev x 9.453
Std Dev y 7.255
Y, cm
X, cm

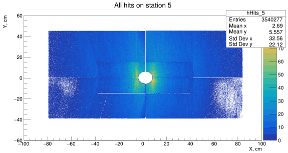

Hits on tracks for station 3
hTrackHits_3
Entries 516261
Mean x 0.5056
Mean y −0.2002
Std Dev x 9.453
Std Dev y 7.255
Y, cm
X, cm

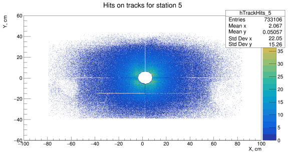

92 86 90 87
90
82 84 41 6
92
31 78 91 86
91 87 96 90

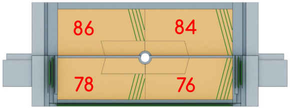

All hits on station 4
hHits_4
Entries 3856598
Mean x 2.594
Mean y 2.126
Std Dev x 30.32
Std Dev y 21.94
Y, cm
X, cm

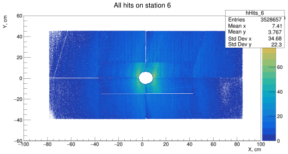

Hits on tracks for station 4
hTrackHits_4
Entries 678191
Mean x 1.067
Mean y −0.2944
Std Dev x 15.54
Std Dev y 11.49
Y, cm
X, cm

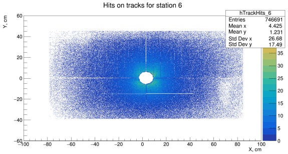

77
79
92
91

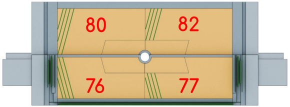

All hits on station 5
hHits_5
Entries 3540277
Mean x 2.69
Mean y 5.557
Std Dev x 32.56
Std Dev y 22.12
Y, cm
X, cm

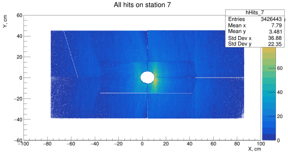

Hits on tracks for station 5
hTrackHits_5
Entries 733106
Mean x 2.067
Mean y 0.05057
Std Dev x 22.05
Std Dev y 15.26
Y, cm
X, cm

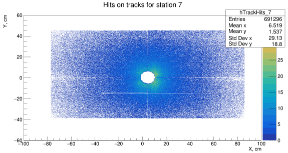

86
84
78
76

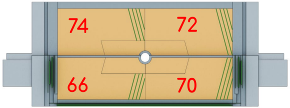

All hits on station 6
hHits_6
Entries 3528657
Mean x 7.41
Mean y 3.767
Std Dev x 34.68
Std Dev y 22.3
Y, cm
X, cm

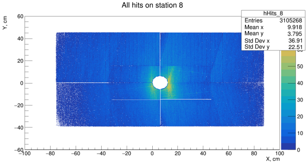

Hits on tracks for station 6
hTrackHits_6
Entries 746691
Mean x 4.425
Mean y 1.231
Std Dev x 26.68
Std Dev y 17.49
Y, cm
X, cm

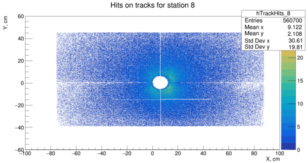

80
82
76
77

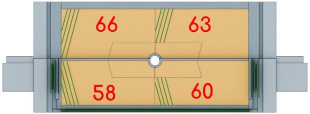

All hits on station 7
hHits_7
Entries 3426443
Mean x 7.79
Mean y 3.481
Std Dev x 36.88
Std Dev y 22.35
Y, cm
X, cm

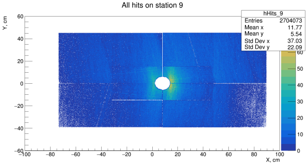

Hits on tracks for station 7
hTrackHits_7
Entries 691296
Mean x 6.519
Mean y 1.537
Std Dev x 29.13
Std Dev y 18.8
Y, cm
X, cm

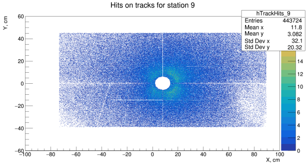

74
72
66
70

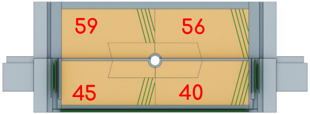

All hits on station 8
hHits_8
Entries 3105268
Mean x 9.918
Mean y 3.795
Std Dev x 36.91
Std Dev y 22.51
Y, cm
X, cm

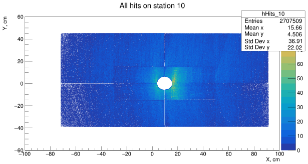

Hits on tracks for station 8
hTrackHits_8
Entries 560700
Mean x 9.122
Mean y 2.108
Std Dev x 30.61
Std Dev y 19.81
Y, cm
X, cm

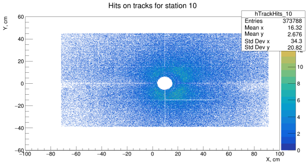

66
63
58
60

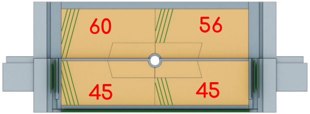

All hits on station 9
hHits_9
Entries 2704073
Mean x 11.77
Mean y 5.54
Std Dev x 37.03
Std Dev y 22.09
Y, cm
X, cm


Hits on tracks for station 9
hTrackHits_9
Entries 443724
Mean x 11.8
Mean y 3.082
Std Dev x 32.1
Std Dev y 20.32
Y, cm
X, cm


59
56
45
40


All hits on station 10
hHits_10
Entries 2707509
Mean x 15.66
Mean y 4.506
Std Dev x 36.91
Std Dev y 22.02
Y, cm
X, cm


Hits on tracks for station 10
hTrackHits_10
Entries 373788
Mean x 16.32
Mean y 2.676
Std Dev x 34.3
Std Dev y 20.82
Y, cm
X, cm


60
56
45
45

BM@N

Total station efficiency

Station number	0	1	2	3	4	5	6	7	8	9	10
2FSD + 4GEM	81.1	85.9	95.2	86.0	83.6	81.4	78.8	70.6	61.9	50.6	51.8
3FSD + 4GEM	87.6	98.0	89.5	82.4	91.2	85.2	77.3	65.9	56.6	47.7	46.2
3FSD + 5GEM	85.9	98.2	90.3	84.5	90.8	84.5	76.7	66.5	59.7	49.3	47.5
3FSD + 6GEM	84.8	98.6	92.6	86.3	87.8	82.1	74.5	63.5	58.2	50.5	47.4

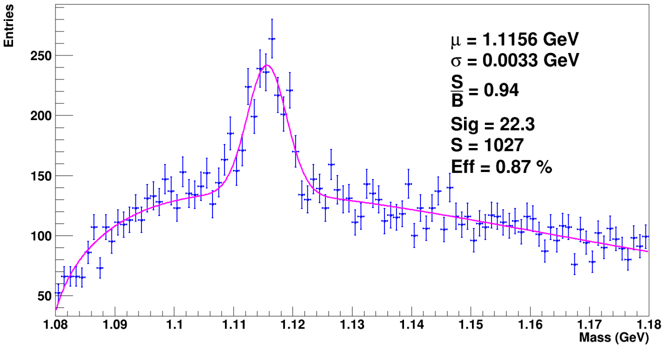
- Efficiency is depended on both the tracking algorithm and the detector conditions (like gas flow direction)
- More detailed analysis neede for this complicated task
- For different cuts tables presented in back up slides

Feasibility study of Λ-hyperon production

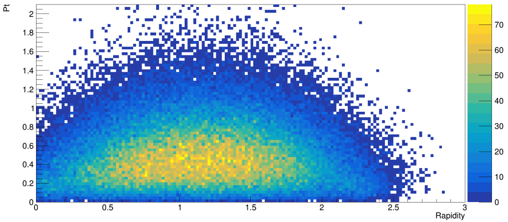
R.Barak

INPUT DATA:

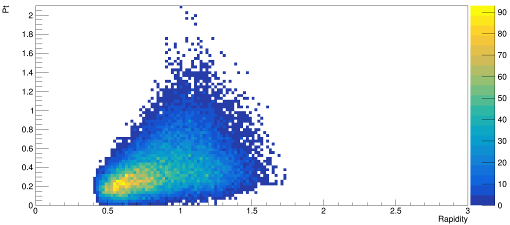
- 100k Xe+CsI @ 3.8 AGeV events (generator DCMSMM)
- All active/passive volumes added (like BD, target, beam pipe)
- Realistic coordinate and angle beam smoothing added



Pt vs rapidity lambda's after simulation



Pt vs rapidity lambda's after reconstruction and application of the cuts



NEXT STEPS:

- Extract signals for PtY bins
- Estimate the efficiency of Λ-hyperon reconstruction
- Work with experimental data

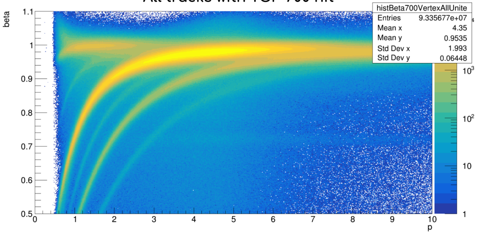
Analysis of fragment production in Xe run

I.Kozlov

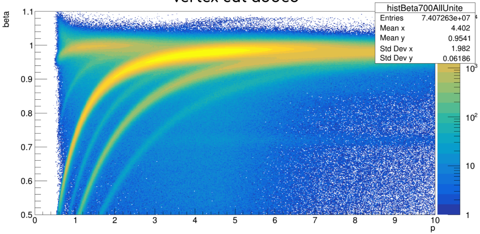
INPUT DATA:

- 30m experimental events
- Number of tracks in vertex: 2+
- Vertex cut: $|X_{vrt} - X_{trg}| < 5cm$, $|Y_{vrt} - Y_{trg}| < 5cm$, $|Z_{vrt} - Z_{trg}| < 5cm$
- Hits number cut: 6+

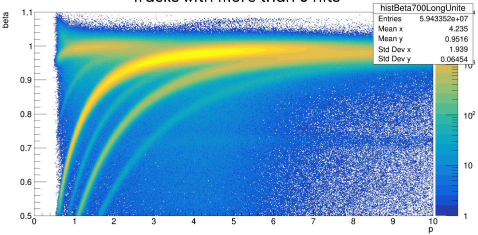
All tracks with TOF-700 hit



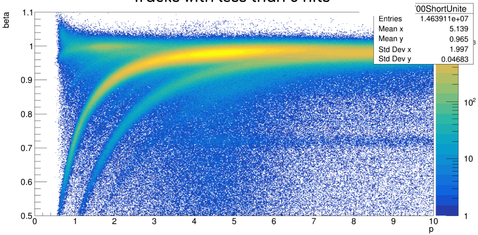
Vertex cut added

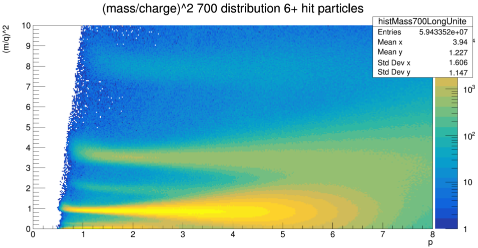


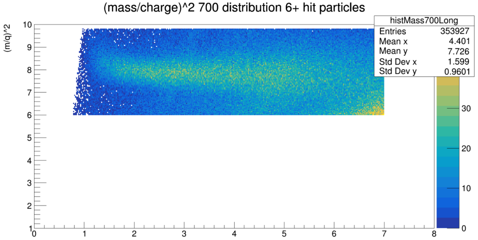
Tracks with more than 5 hits

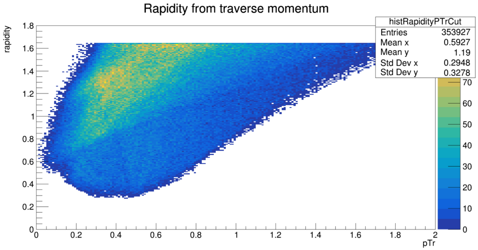


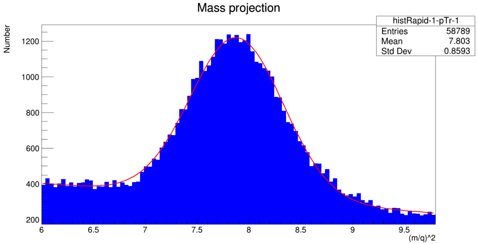
Tracks with less than 6 hits




(mass/charge)^2 700 distribution 6+ hit particles
histMass700LongUnite
Entries 5.943352e+07
Mean x 3.94
Mean y 1.227
Std Dev x 1.606
Std Dev y 1.147
(m/q)^2
p


(mass/charge)^2 700 distribution 6+ hit particles
histMass700Long
Entries 353927
Mean x 4.401
Mean y 7.726
Std Dev x 1.599
Std Dev y 0.9601
(m/q)^2


Rapidity from traverse momentum
histRapidityPTrCut
Entries 353927
Mean x 0.5927
Mean y 1.19
Std Dev x 0.2948
Std Dev y 0.3278
rapidity
pTr


Mass projection
histRapid-1-pTr-1
Entries 58789
Mean 7.803
Std Dev 0.8593
Number
(m/q)^2

NEXT STEPS:

- Signal extraction for 2D PtY bins
- Better track selection (after LCSC hits added and TOF-700 calibration finished)
- MC vs experimental data comparison and efficiency estimation
- Trigger efficiency estimation

Thank you

Back up

Efficiency of FSD-0

Upper modules

Module number	0	1	2
2FSD + 4GEM	85.0	75.4	78.2
3FSD + 4GEM	92.3	79.6	84.0
3FSD + 5GEM	91.7	72.4	84.1
3FSD + 6GEM	91.2	65.7	84.5

Lower modules

Module number	3	4	5
2FSD + 4GEM	90.7	77.7	84.4
3FSD + 4GEM	98.8	98.5	91.8
3FSD + 5GEM	98.6	97.8	92.3
3FSD + 6GEM	98.6	97.1	92.7

Efficiency of FSD-1

Upper modules

Module number	0	1	2	3	4
2FSD + 4GEM	92.3	89.9	74.7	84.1	91.0
3FSD + 4GEM	98.1	99.5	97.7	96.3	97.6
3FSD + 5GEM	98.4	99.3	97.9	97.1	97.4
3FSD + 6GEM	97.8	99.5	98.0	98.5	98.2

Lower modules

Module number	5	6	7	8	9
2FSD + 4GEM	93.9	92.8	91.2	85.5	83.1
3FSD + 4GEM	100.0	100.0	99.5	99.5	92.3
3FSD + 5GEM	100.0	100.0	100.0	99.9	92.0
3FSD + 6GEM	100.0	100.0	100.0	100.0	91.2

Efficiency of FSD-2

Upper modules

Module number	0	1	2	3	4	5	6
2FSD + 4GEM	90.9	96.7	96.6	98.3	95.4	97.5	73.0
3FSD + 4GEM	53.3	93.8	94.6	92.6	93.6	96.7	37.1
3FSD + 5GEM	51.4	94.2	94.4	96.7	94.3	97.4	37.5
3FSD + 6GEM	55.2	95.1	94.1	99.0	97.2	97.6	40.8

Lower modules

Module number	7	8	9	10	11	12	13
2FSD + 4GEM	98.9	74.0	97.4	98.5	94.7	90.4	65.4
3FSD + 4GEM	98.6	49.5	90.8	93.3	90.2	86.6	29.6
3FSD + 5GEM	98.1	53.2	90.7	87.8	91.8	89.4	33.9
3FSD + 6GEM	97.6	61.9	96.0	75.0	98.0	91.9	42.3

Efficiency of FSD-3

Upper modules

Module number	0	1	2	3	4	5	6	7	8
2FSD + 4GEM	6.1	40.6	83.9	81.8	89.6	87.4	90.4	86.2	91.5
3FSD + 4GEM	0.0	13.6	80.3	88.8	83.7	84.4	90.1	78.1	57.1
3FSD + 5GEM	0.0	8.2	81.3	91.7	81.2	86.1	91.2	81.7	50.0
3FSD + 6GEM	0.0	9.2	84.9	93.1	83.7	86.7	92.4	82.9	50.0

Lower modules

Module number	9	10	11	12	13	14	15	16	17
2FSD + 4GEM	90.1	95.6	86.9	90.6	92.0	85.5	91.3	78.4	31.0
3FSD + 4GEM	100.0	94.0	84.1	93.3	77.8	87.3	92.1	67.7	0.0
3FSD + 5GEM	100.0	95.1	83.0	92.0	92.4	89.4	92.4	69.7	0.0
3FSD + 6GEM	100.0	96.1	83.9	92.5	100.0	94.0	93.3	71.7	0.0

Efficiency of GEM-0

Module number	0	1	2	3
2FSD + 4GEM	78.9	76.9	90.5	91.5
3FSD + 4GEM	91.9	90.0	92.4	91.5
3FSD + 5GEM	91.2	90.0	91.8	91.2
3FSD + 6GEM	87.7	87.6	88.5	88.1

Efficiency of GEM-1

Module number	0	1	2	3
2FSD + 4GEM	83.7	85.6	76.2	78.2
3FSD + 4GEM	88.2	87.3	82.3	80.0
3FSD + 5GEM	87.9	86.7	80.1	78.5
3FSD + 6GEM	85.8	84.5	75.5	75.0

Efficiency of GEM-2

Module number	0	1	2	3
2FSD + 4GEM	81.6	80.4	76.9	75.8
3FSD + 4GEM	82.2	76.1	76.0	73.6
3FSD + 5GEM	82.4	76.0	73.3	72.1
3FSD + 6GEM	81.3	74.9	66.9	68.8

Efficiency of GEM-3

Module number	0	1	2	3
2FSD + 4GEM	72.4	73.5	69.6	65.9
3FSD + 4GEM	69.8	67.1	63.9	60.4
3FSD + 5GEM	71.7	67.1	63.2	59.7
3FSD + 6GEM	70.0	64.4	57.3	55.5

Efficiency of GEM-4

Module number	0	1	2	3
2FSD + 4GEM	62.5	66.2	60.0	57.6
3FSD + 4GEM	59.8	58.6	54.5	50.5
3FSD + 5GEM	63.9	60.7	56.5	53.5
3FSD + 6GEM	63.7	59.9	49.8	51.0

Efficiency of GEM-5

Module number	0	1	2	3
2FSD + 4GEM	55.6	59.0	39.8	45.0
3FSD + 4GEM	52.3	50.7	41.1	40.4
3FSD + 5GEM	54.6	52.7	41.3	40.7
3FSD + 6GEM	56.3	54.0	39.6	40.9

Efficiency of GEM-6

Module number	0	1	2	3
2FSD + 4GEM	55.5	59.5	45.4	45.1
3FSD + 4GEM	49.6	49.9	42.1	38.3
3FSD + 5GEM	51.6	51.5	42.2	38.6
3FSD + 6GEM	51.1	50.9	39.7	38.7