Centrality & PID wagons for MPD-FXT

V. Riabov

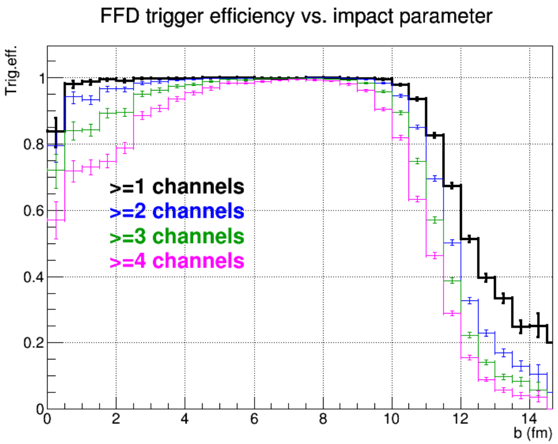
Outline

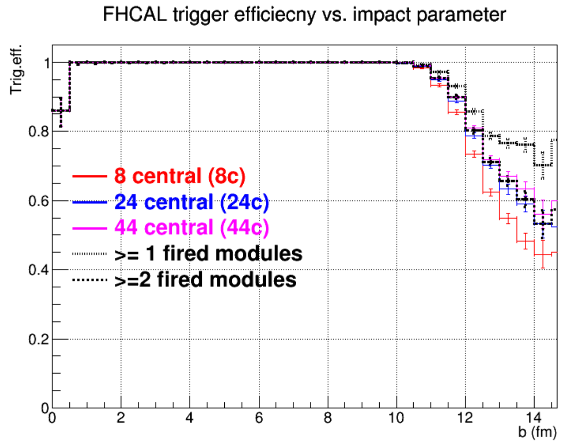
- Request 35 mass production for MPD-FXT:
  - ✓ Xe (T = 2.5 AGeV) + W, 15M events, UrQMD (mean field)
  - ✓ Vertex: z = -85 cm, y = 1.4 cm, x = 0 cm, all smeared within wire diameter of 100 um
  - ✓ stable resonances, decayed by Geant4
- Production includes later fixes for vertex reconstruction by A. Zinchenko
- So far, the only MPD-FXT production in the latest configuration, Request 36 is in progress
- Need centrality (wagon) and PID parameterizations (wagon) for the MPD-FXT productions

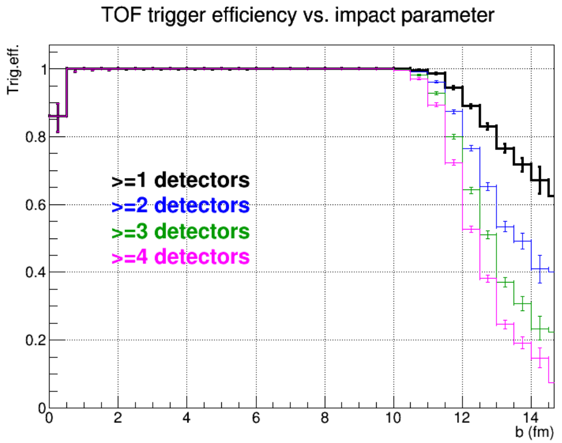
Centrality wagon

Trigger efficiency

- Xe+W, DCM-QGSM-SMM, 1M events





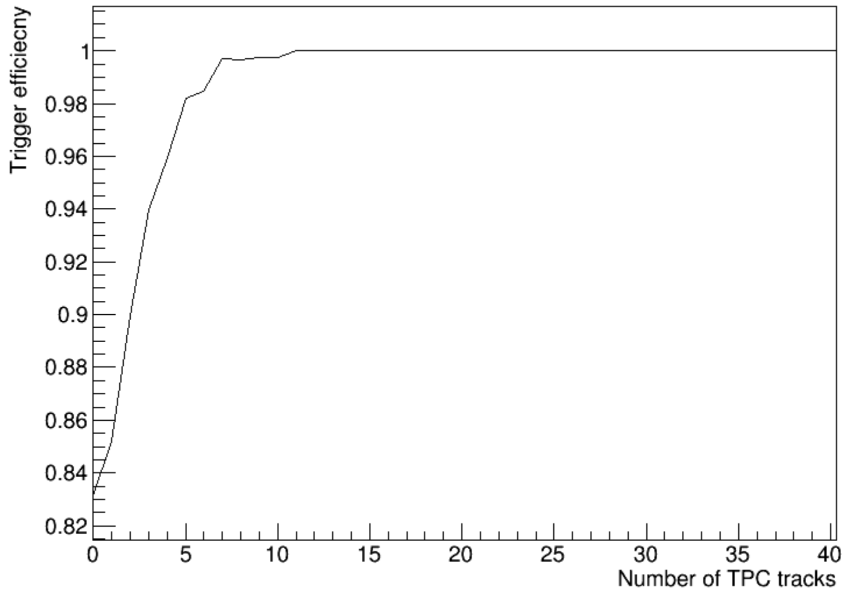


FFD: 88%, 83%, 78%, 73%
FHCAL: 96%, 95%, 94%, 91%
TOF: 97%, 94%, 92%, 89%

- Similar to what we did for BiBi@9.2, select FHCAL (>=1 module) as a reference → 96%
- Event z-vertex is fixed → no need to worry about vertex dependence of trigger efficiency

Emulation of trigger efficiency in UrQMD

- No fragments in UrQMD → response of forward detectors is not realistic
- Trigger efficiency is emulated as a function of multiplicity
- TPC track selections:
  - ✓ N_hits > 24
  - ✓ DCA_x,y,z < 2 cm
  - ✓ $p_T > 0.1$ GeV/c
  - ✓ $|\eta_{CMS}| < 1.0$

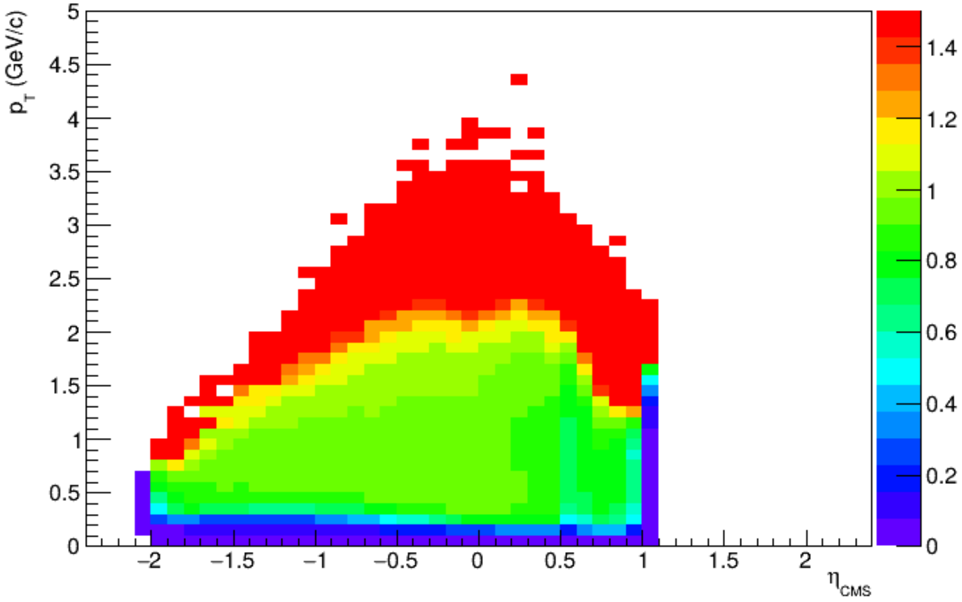


TrigEffMult[0] = 0.831362;
TrigEffMult[1] = 0.851975;
TrigEffMult[2] = 0.899569;
TrigEffMult[3] = 0.939525;
TrigEffMult[4] = 0.959645;
TrigEffMult[5] = 0.981835;
TrigEffMult[6] = 0.984791;
TrigEffMult[7] = 0.996891;
TrigEffMult[8] = 0.996606;
TrigEffMult[9] = 0.997582;
TrigEffMult[10] = 0.997323;
TrigEffMult[11] = 1;

Track reconstruction efficiency

- Request 35, Xe+W
- TPC track selections:
  - ✓ N_hits > 24
  - ✓ DCA_x,y,z < 2 cm

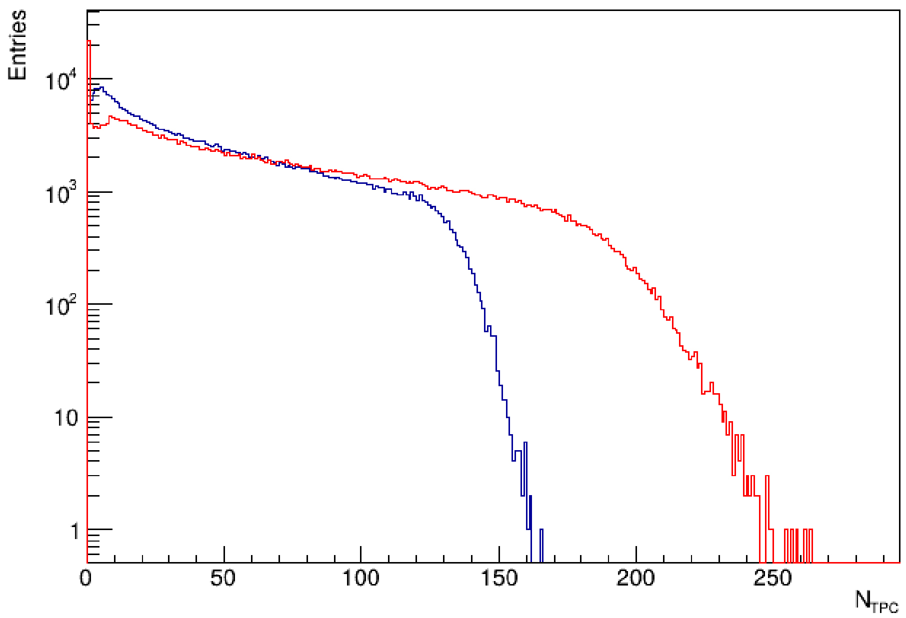
RecEff(η_{CMS}, p_T)



- At high p_T have a problem of momentum misreconstruction for primary protons → eff > 1
- Fraction of such tracks is miserable → total multiplicity is not affected (+ corrected for)

Track multiplicity

- Request 35, Xe+W
- TPC track selections:
  - ✓ N_hits > 24
  - ✓ DCA_x,y,z < 2 cm
  - ✓ $p_T > 0.1$ GeV/c
  - ✓ $|\eta_{CMS}| < 1.0$



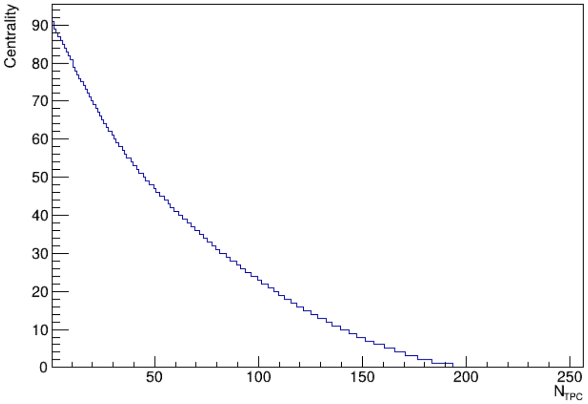
Blue: reconstructed tracks

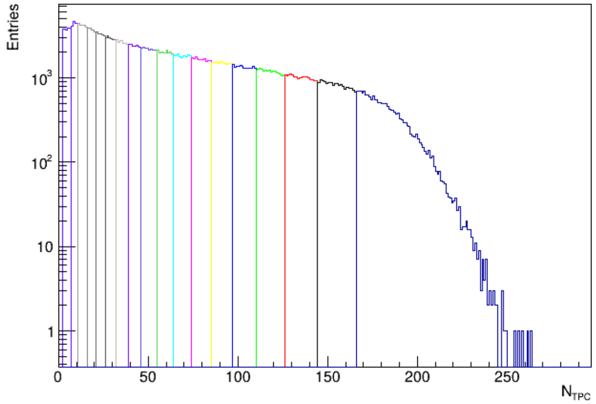
Red: reconstructed tracks / RecEff(η_{CMS}, p_T)

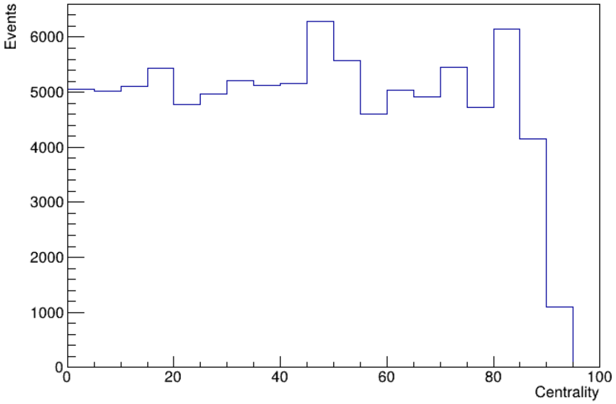
- 5% of events have zero multiplicity → centrality sampled with TPC multiplicity is 91%

TPC centrality, summary

- Only for good events:
  - ✓ reconstructed vertex: z-vertex !=0
  - ✓ number of tracks: $N_{TPC} > 0$, track selections: nhits > 24; $p_T > 0.1$ GeV/c; DCA < 2.0 cm; $|\eta_{CMS}| < 1.0$
  - ✓ corrections for reconstruction efficiency RecEff(η_{CMS}, p_T)
  - ✓ Rndm() > TrigEff[N_{TPC}]
- Resulting multiplicity distribution samples ~91% of the total cross section
- Centrality is defined as percentile of the total multiplicity with maximum of 91%



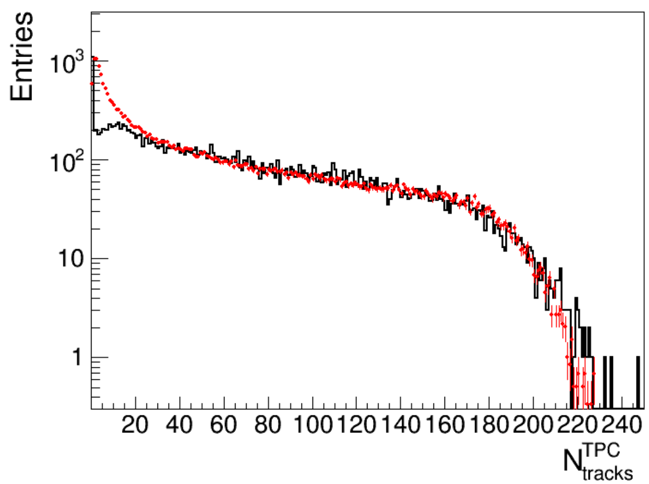


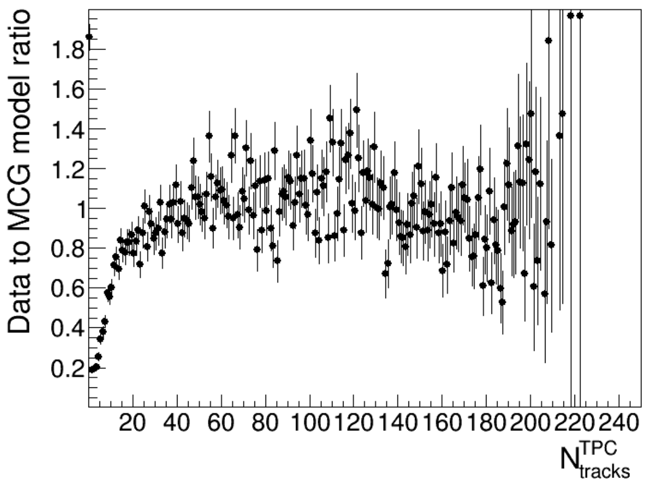


Glauber fits, Request 35

- Only for good events:
  - ✓ reconstructed vertex: z-vertex !=0
  - ✓ track selections: nhits > 24; p_T > 0.1 GeV/c; DCA < 2.0 cm; $|\eta_{CMS}|$ < 1.0
  - ✓ corrections for reconstruction efficiency RecEff(η_{CMS}, p_T)
  - ✓ Rndm() > TrigEff[N_{TPC}]
- Fit range: 20-230

f = 0.99 mu = 0.70 k = 32 chi2 = 1.2

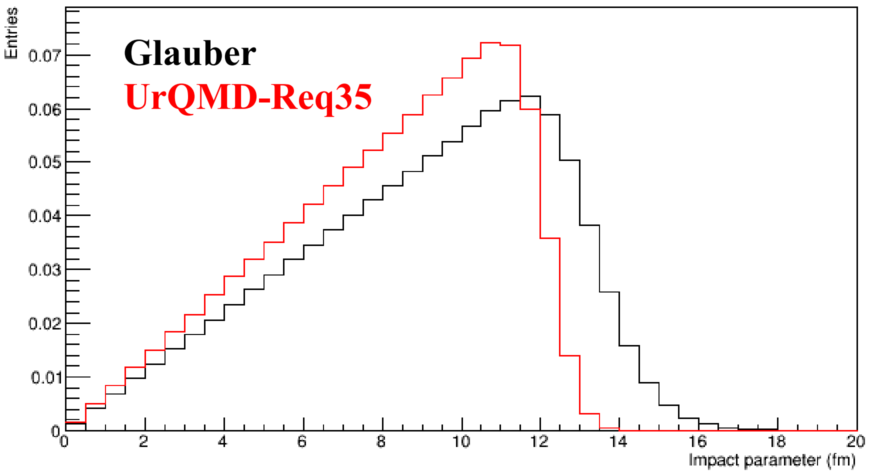


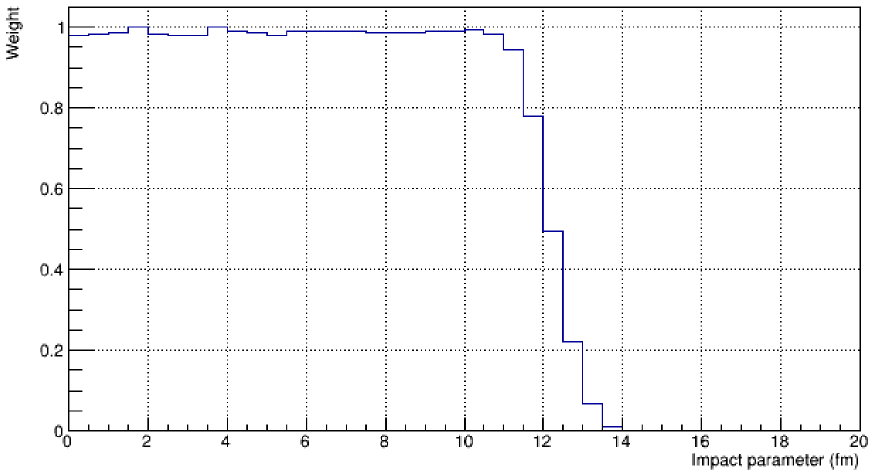


- Predicted trigger efficiency: Integral(data, zero excluded) / Integral (fit) = 80%
- Not quite the ideal expected 91% → why?

Impact parameter distributions, UrQMD vs. Glauber

- Lets compare impact parameter distributions in Glauber and UrQMD-Req35
- Distributions are different at b > 12 fm → different nuclear densities ???
- Glauber can be reweighted to have the same b-distribution as in UrQMD-Req35

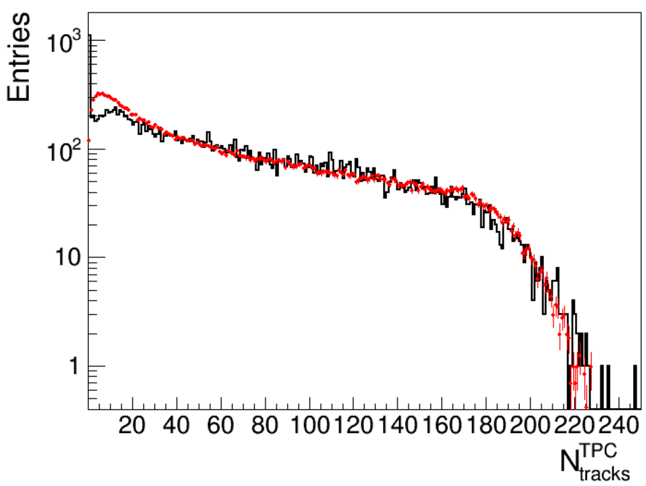


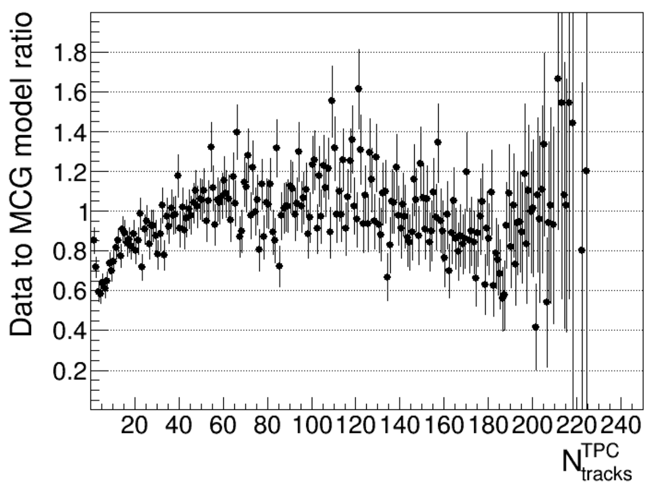


Reweighted Glauber fits, Request 35

- Only for good events:
  - ✓ reconstructed vertex: z-vertex !=0
  - ✓ track selections: nhits > 24; p_T > 0.1 GeV/c; DCA < 2.0 cm; $|\eta_{CMS}|$ < 1.0
  - ✓ corrections for reconstruction efficiency RecEff(η_{CMS}, p_T)
  - ✓ Rndm() > TrigEff[N_{TPC}]
- Fit range: 20-230

f = 0.98 mu = 0.69 k = 82 chi2 = 1.2



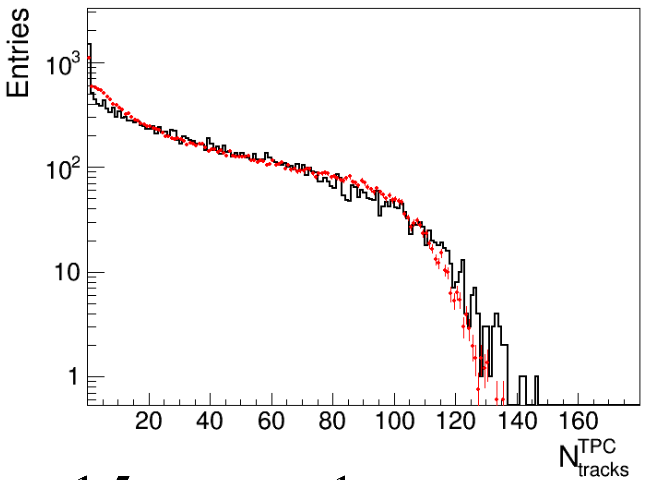


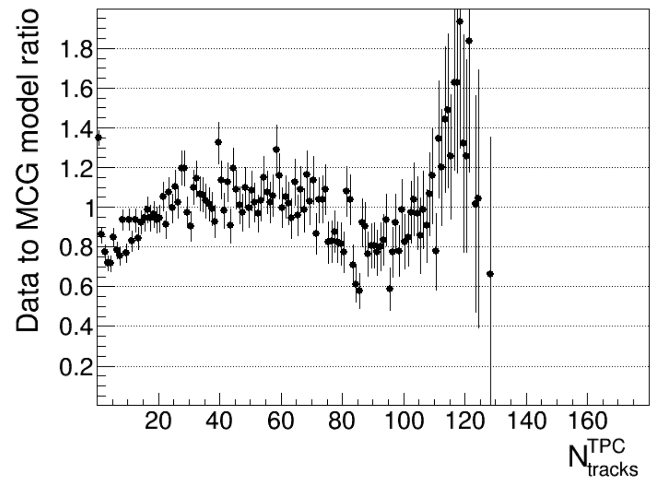
- Predicted trigger efficiency: Integral(data, zero excluded) / Integral (fit) = 92%
- Very close to the ideal expected 91%
- Multiplicity dependence of efficiency is not quite as predicted by DCM-QGSM-SMM

Reweighted Glauber fits, Request 35 (different rapidity ranges for track multiplicity)

- $|\eta_{CMS}| < 0.5$

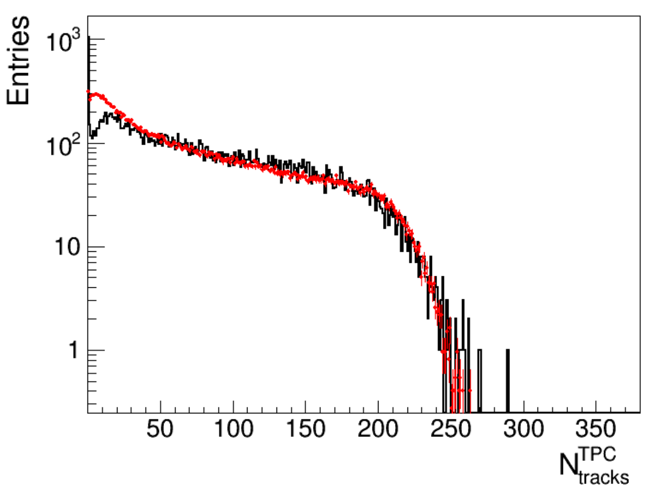
f = 1.00 mu = 0.78 k = 1 chi2 = 1.3, EFF = 89%

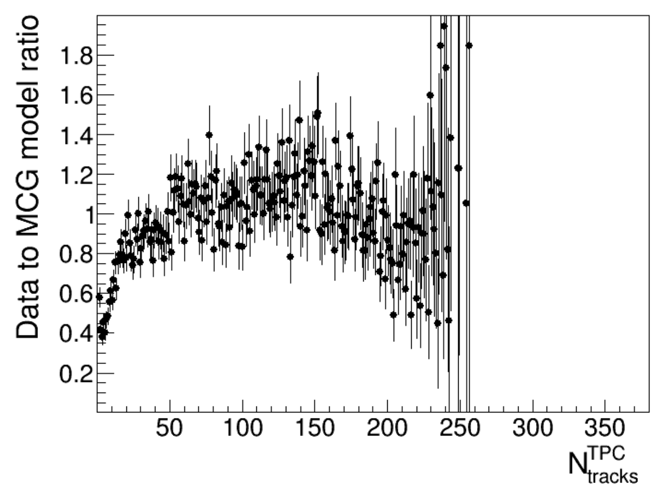




- $-1.5 < \eta_{CMS} < 1$

f = 0.94 mu = 0.37 k = 1 chi2 = 1.3, EFF = 93%





Glauber: b, N_{part}, N_{coll}

- $|\eta_{CMS}| < 1.0$

Cent, %	Mult_min	Mult_max	<b>, fm	RMS	bmin, fm	bmax, fm	<Npart>	RMS	Npart_min	Npart_max	<Ncoll>	RMS	Ncoll_min	Ncoll_max
0 - 10	147	229	2.70	1.04	1.33	3.80	236.00	22.92	206.98	269.36	436.58	61.32	369.83	514.29
10 - 20	112	147	4.70	0.76	3.80	5.46	181.71	21.73	158.59	206.98	312.88	54.89	262.55	369.83
20 - 30	85	112	6.11	0.63	5.46	6.68	137.78	17.78	120.04	158.59	218.56	42.57	182.69	262.55
30 - 40	63	85	7.20	0.60	6.68	7.72	103.93	15.45	88.79	120.04	151.57	33.71	123.34	182.69
40 - 50	45	63	8.21	0.59	7.72	8.67	75.39	12.86	63.46	88.79	99.82	25.66	79.78	123.34
50 - 60	31	45	9.12	0.61	8.67	9.55	52.74	10.61	43.38	63.46	62.71	18.65	48.80	79.78
60 - 70	20	31	9.96	0.64	9.55	10.35	35.22	8.53	28.13	43.38	37.26	12.97	28.01	48.80
70 - 80	12	20	10.72	0.66	10.35	11.06	22.13	6.53	17.13	28.13	20.78	8.43	15.13	28.01
80 - 90	6	12	11.38	0.65	11.06	11.68	12.89	4.89	9.17	17.13	10.80	5.30	7.33	15.13
90 - 100	1	5	11.99	0.62	11.68	12.33	5.68	2.91	1.98	9.17	4.13	2.61	0.54	7.33

- $|\eta_{CMS}| < 0.5$

Cent, %	Mult_min	Mult_max	<b>, fm	RMS	bmin, fm	bmax, fm	<Npart>	RMS	Npart_min	Npart_max	<Ncoll>	RMS	Ncoll_min	Ncoll_max
0 - 10	82	131	2.69	1.08	1.50	3.69	235.87	24.37	210.17	264.21	437.16	63.49	377.45	504.24
10 - 20	63	82	4.52	0.90	3.69	5.25	187.03	25.76	164.96	210.17	324.91	62.42	276.39	377.45
20 - 30	48	63	5.89	0.76	5.25	6.46	144.74	22.33	127.18	164.96	233.38	50.98	197.22	276.39
30 - 40	36	48	6.99	0.70	6.46	7.49	110.75	19.25	95.84	127.18	164.78	40.54	136.53	197.22
40 - 50	26	36	7.95	0.70	7.49	8.41	82.66	16.89	70.24	95.84	112.59	32.63	91.22	136.53
50 - 60	18	26	8.85	0.69	8.41	9.27	59.28	14.02	49.76	70.24	73.24	24.53	58.46	91.22
60 - 70	12	18	9.67	0.71	9.27	10.05	41.24	11.51	33.78	49.76	45.92	17.93	35.60	58.46
70 - 80	7	12	10.42	0.73	10.05	10.78	27.23	9.27	21.45	33.78	27.13	12.54	20.13	35.60
80 - 90	3	7	11.13	0.71	10.78	11.49	16.30	6.93	11.58	21.45	14.38	7.87	9.57	20.13
90 - 100	1	2	11.88	0.66	11.49	12.31	7.05	4.20	2.45	11.58	5.36	3.93	1.44	9.57

- $-1.5 < \eta_{CMS} < 1$

Cent, %	Mult_min	Mult_max	<b>, fm	RMS	bmin, fm	bmax, fm	<Npart>	RMS	Npart_min	Npart_max	<Ncoll>	RMS	Ncoll_min	Ncoll_max
0 - 10	168	260	2.66	1.03	1.34	3.74	237.02	22.54	208.87	268.62	438.76	60.68	373.82	513.28
10 - 20	128	168	4.63	0.76	3.74	5.38	183.87	21.46	160.77	208.87	317.72	55.07	267.12	373.82
20 - 30	97	128	6.04	0.62	5.38	6.62	139.99	17.61	121.91	160.77	223.12	42.74	186.52	267.12
30 - 40	72	97	7.16	0.59	6.62	7.66	105.42	15.13	90.58	121.91	154.26	33.75	126.65	186.52
40 - 50	52	72	8.13	0.58	7.66	8.58	77.46	12.73	65.59	90.58	103.43	25.77	83.16	126.65
50 - 60	36	52	9.02	0.60	8.58	9.43	55.23	10.60	46.01	65.59	66.49	19.17	52.50	83.16
60 - 70	24	36	9.82	0.62	9.43	10.19	37.85	8.47	31.02	46.01	40.78	13.31	31.66	52.50
70 - 80	15	24	10.53	0.63	10.19	10.88	25.05	6.64	19.66	31.02	24.18	8.98	17.91	31.66
80 - 90	7	15	11.22	0.65	10.88	11.56	14.92	5.23	10.60	19.66	12.85	5.95	8.61	17.91
90 - 100	1	6	11.93	0.64	11.56	12.36	6.38	3.29	1.99	10.60	4.76	3.01	0.92	8.61

- Consistent values for all rapidity selections
- Significantly worse resolution at $|\eta_{CMS}| < 0.5$ → make $|\eta_{CMS}| < 1.0$ a default one

Centrality wagon

- evCentrality wagon was updated to work with Req35 production
- pCentr.txt file:

[riabovvg@ncx101 macros_FXT]$ cat pCentr.txt
#-------Parameters used for analysis------
Event selection: defined in the header, please do not change the cuts

Track selection: defined in the header, please do not change the cuts
mNofHitsCut 24
mEtaCut 1.0
mPtminCut 0.1
mDcaCut 2.0

Production selection:
mProdGenerator Req35-UrQMD // Production-Generator
mInFileConvert nTr_Centr_Req35-UrQMD.root // input file with track-to-centrality converter

Track efficiecny corrections:
mInFileTrEff TrackRecEff_FXT.root // input file with track reconstruction efficiecnies

- Needed files are stored in mpdroot/physics/pairKK/macros_FTX/

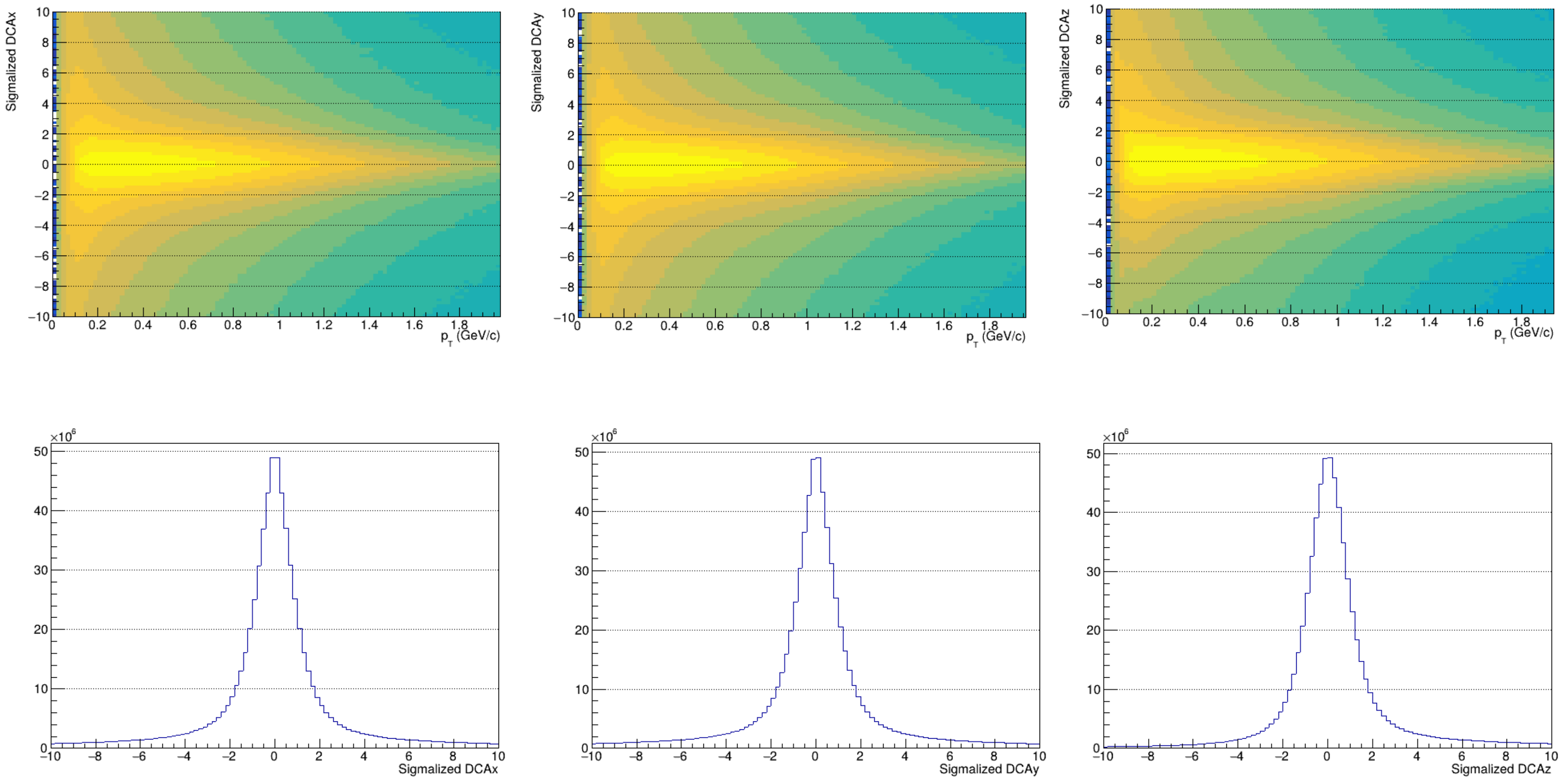
PID wagon

DCA selections

- DCA_x,y,z n·σ selections → p_T, rapidity and centrality dependent → parameterization of the mean and width of DCA distributions (sigmalization) vs. p_T, rapidity and centrality → apply n-σ cuts for selection of primary tracks
- Sigmalization of DCA is done using the inclusive sample of reconstructed charged particle tracks with:
  - ✓ number of TPC hits > 24
- DCA_x,y and DCA_z distributions are accumulated differentially:
  - ✓ 30 bins in η: $-1.5 < \eta_{CMS} < 1.5$
  - ✓ 10 centrality bins: 0 – 100%
  - ✓ 25 p_T bins: 0.05 – 2.55 GeV/c
- Number of bins and ranges are driven by available statistics
- Processed the whole statistics of Req35-UrQMD production – 15M events

Results

- Sigmalized DCAx, DCAy and DCAz

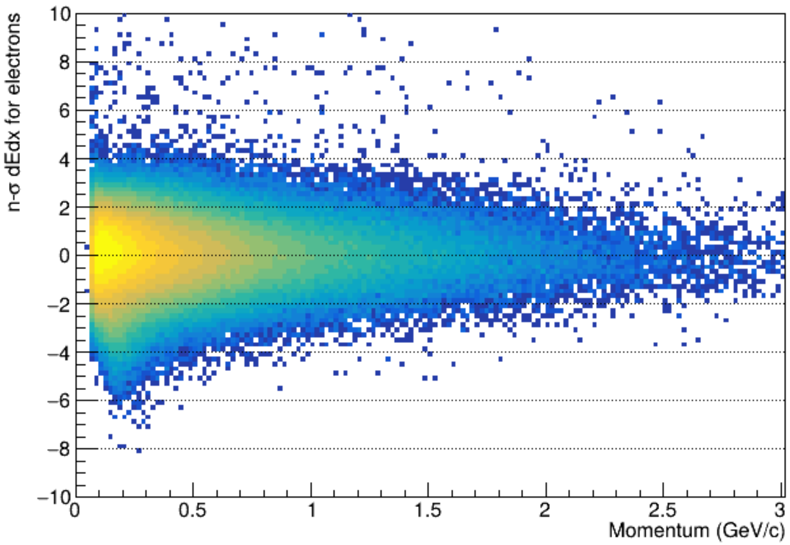


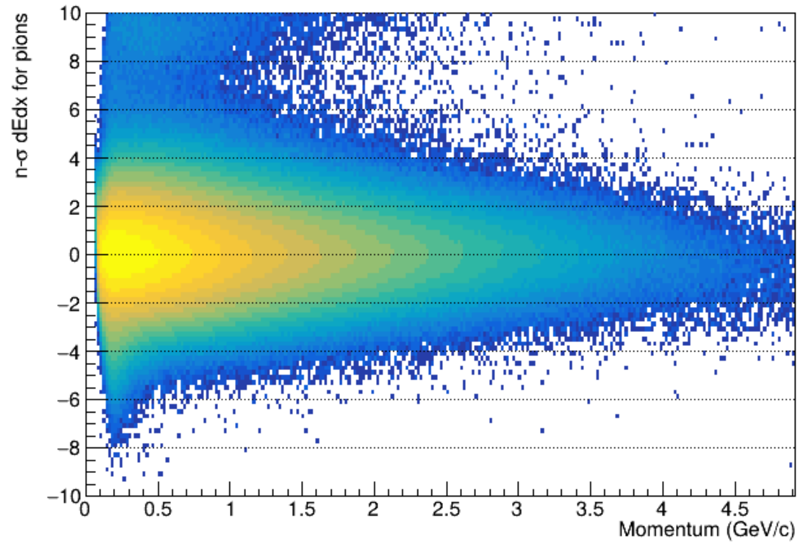
dE/dx parameterizations

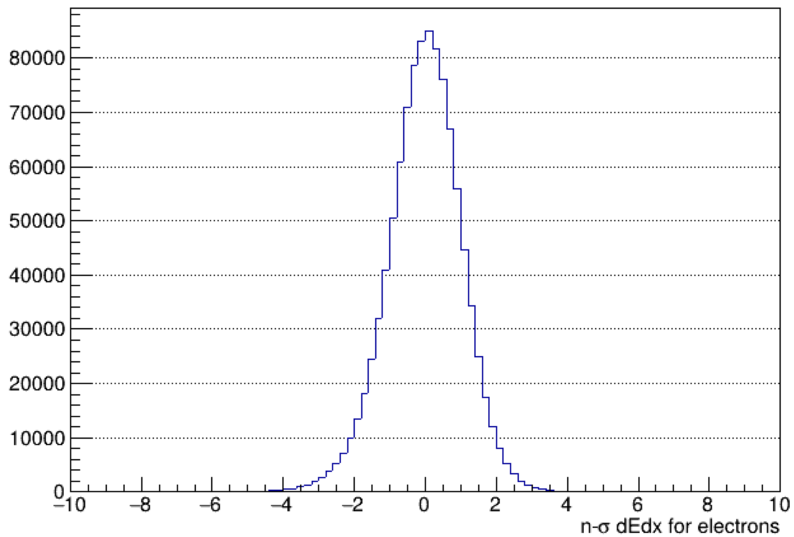
- Inclusive selected tracks:
  - ✓ hits > 24
  - ✓ $|\eta_{CMS}| < 1.5$
  - ✓ |DCA_x,y,z| < 2 σ

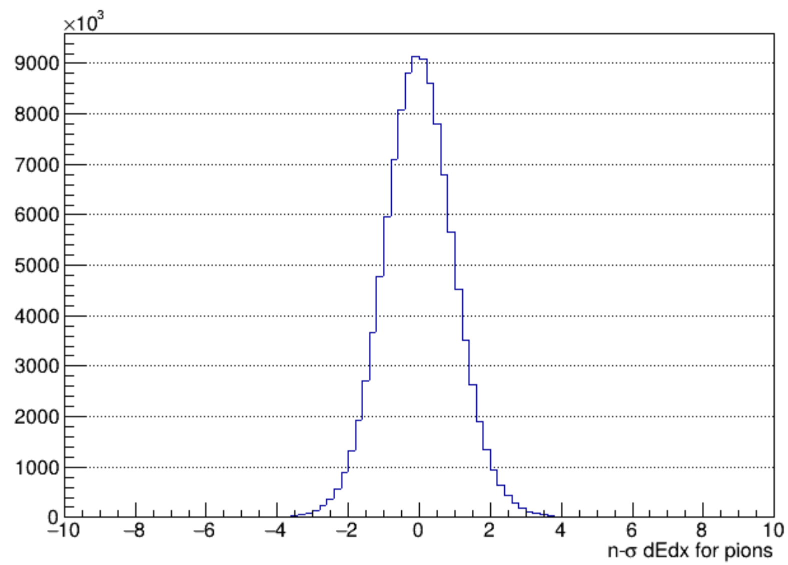
- dE/dx is parameterized vs. momentum for e/π/K/p, tracks were identified by MC info
- Parameterizations for light nuclei are left unchanged (as in Req.25)

Results: electrons and pions

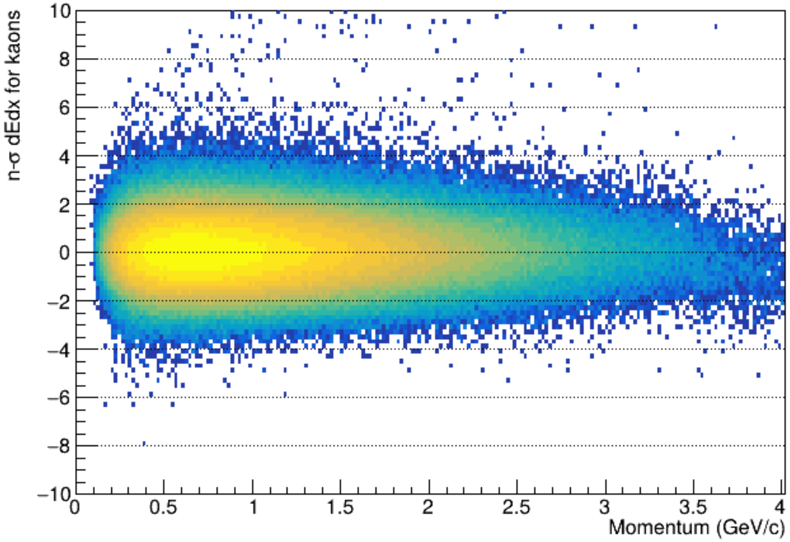


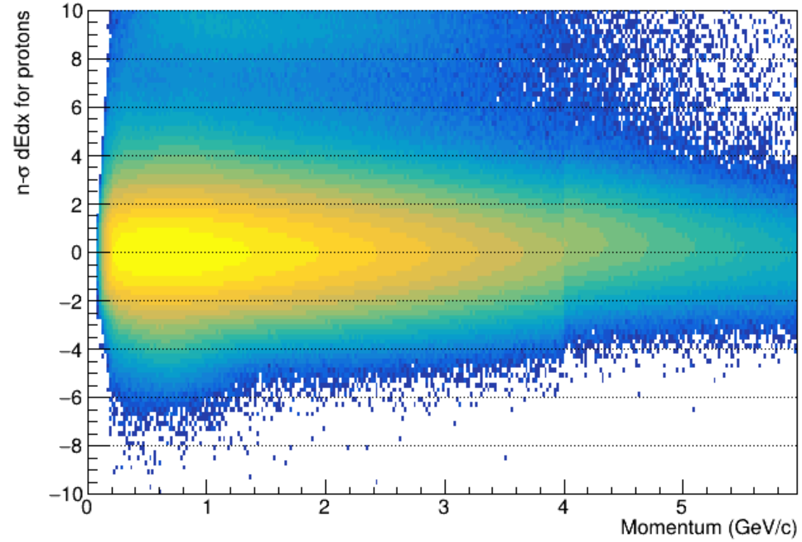


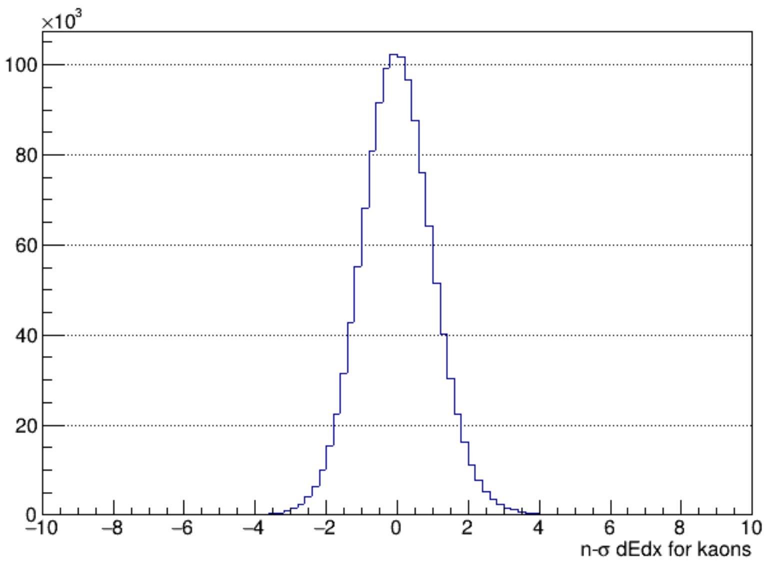


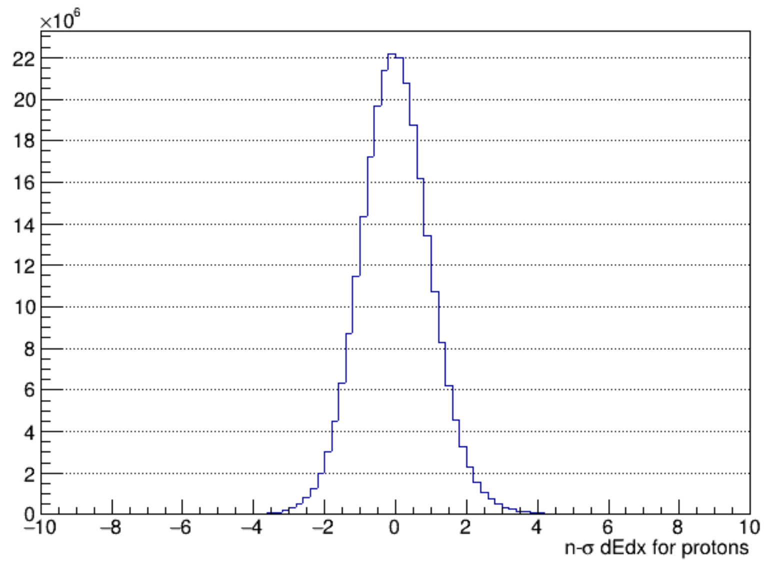


Results: kaons and protons



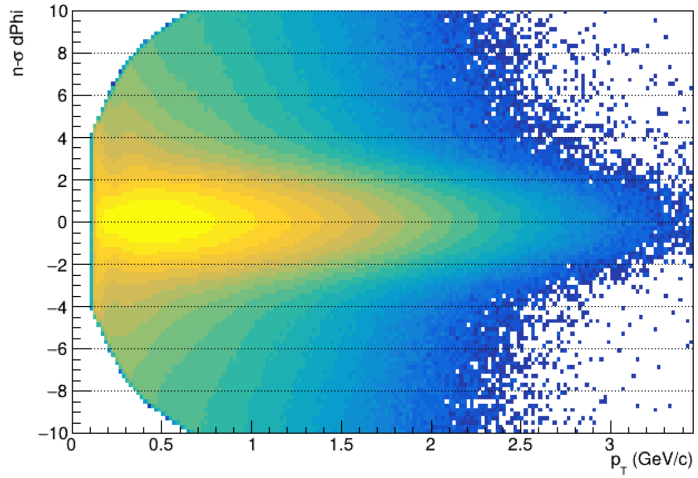


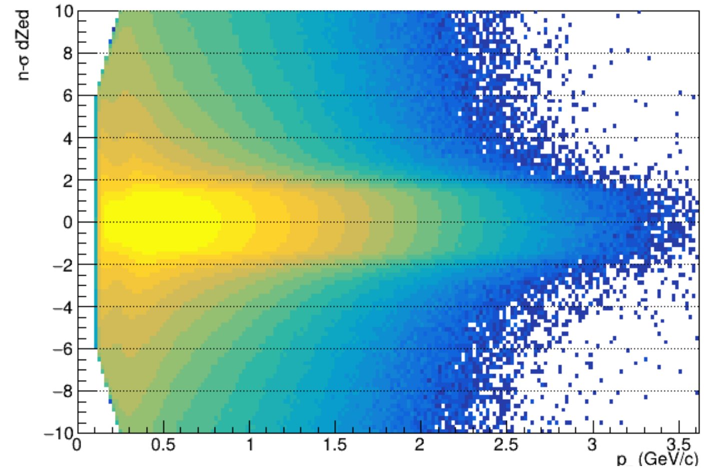


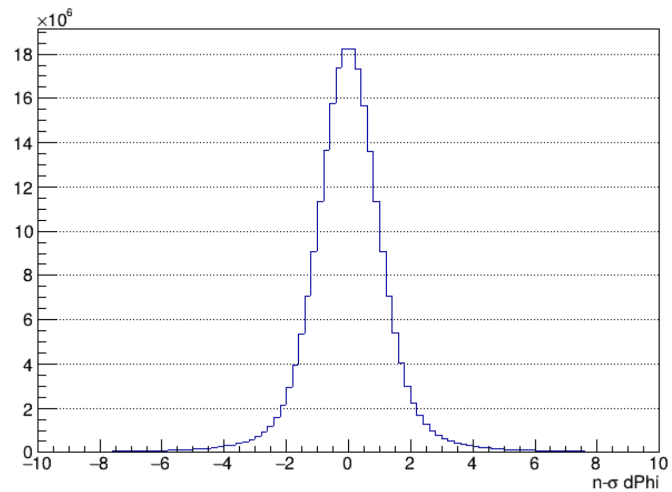


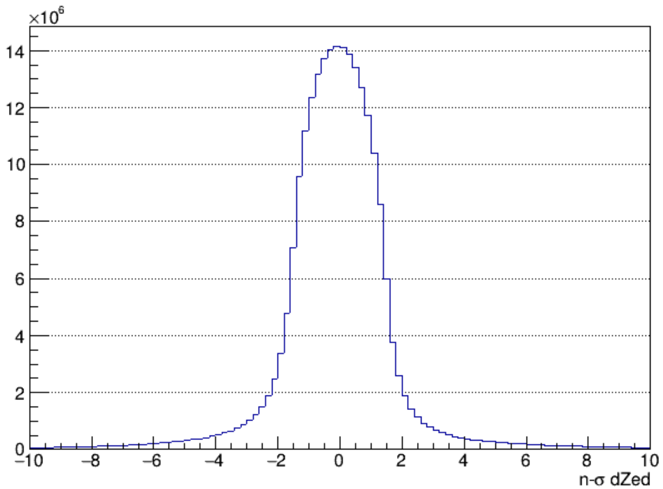
Track-to-TOF matching

- Track is matched if mpdtrack->GetTofFlag() == 2 || mpdtrack->GetTofFlag() == 6
- dPhi (separately for $h^{\pm}$) and dZed are parameterized vs. p_T







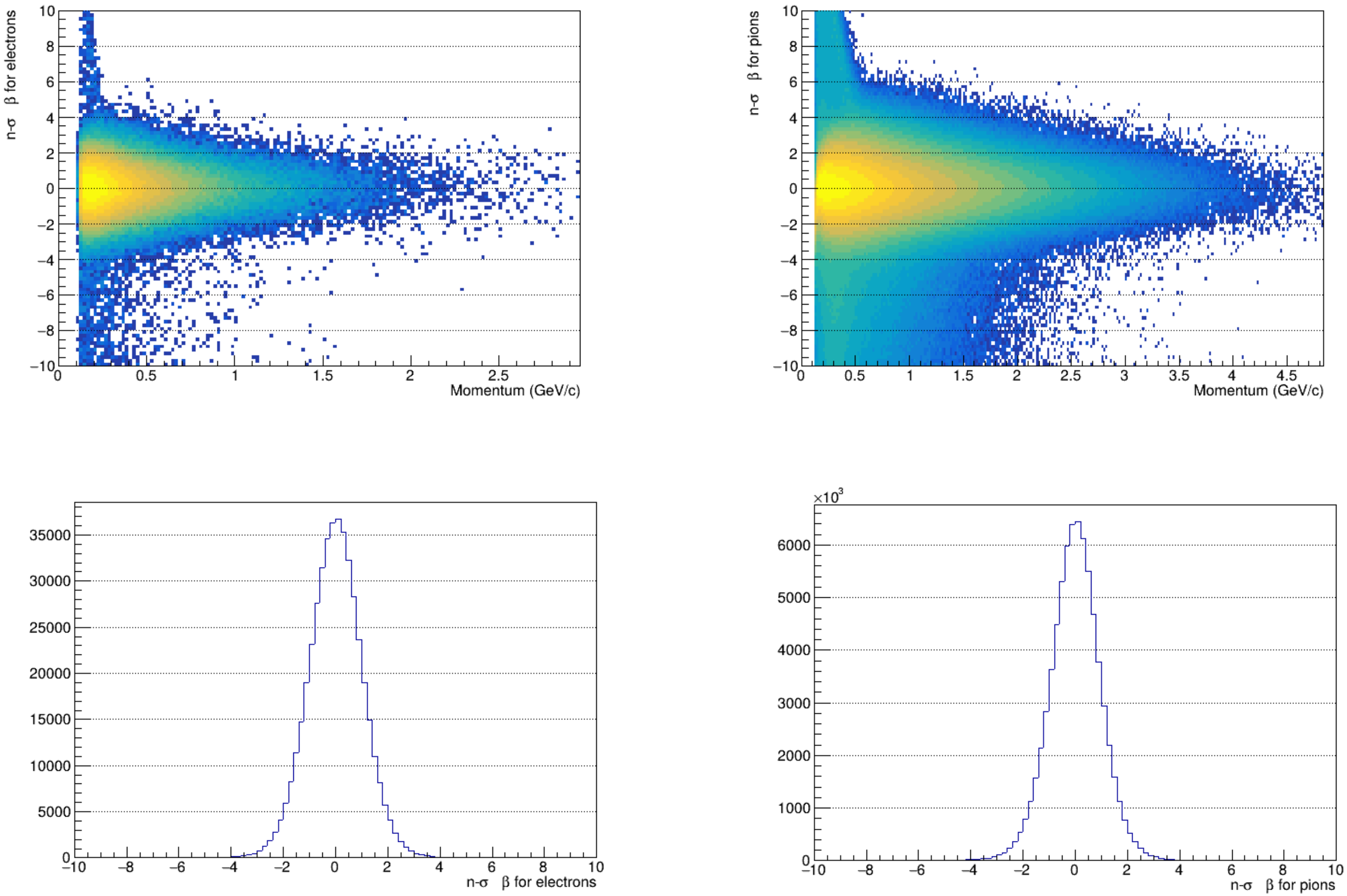


TOF β parameterization

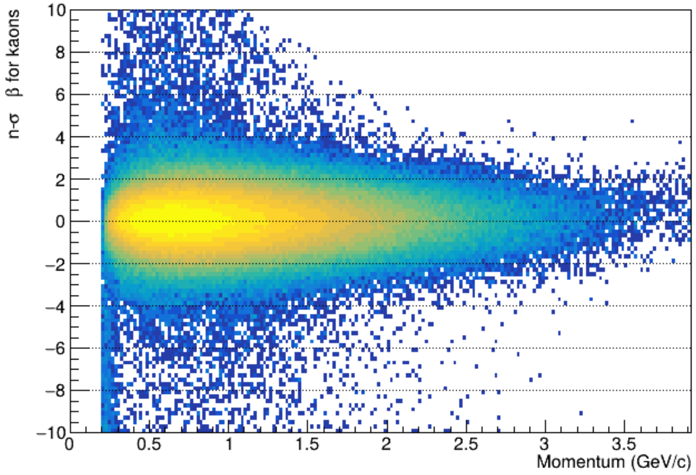
- Selected tracks:
  - ✓ hits > 24
  - ✓ $|\eta| < 1.5$
  - ✓ $|DCA\_x,y,z| < 2\ \sigma$

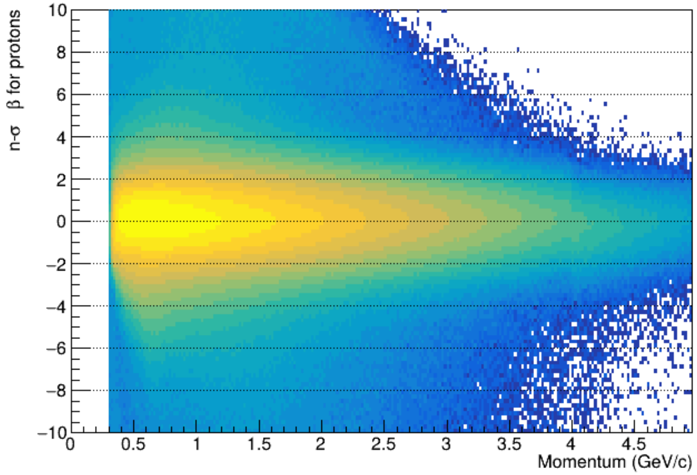
- Beta is parameterized vs. momentum for e/π/K/p, tracks were identified by MC info
- Parameterizations for light nuclei are left unchanged (as in Req.25)

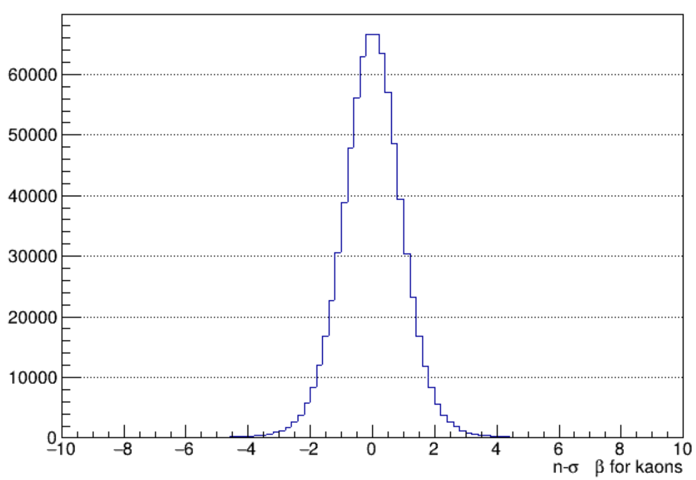
Results: electrons and pions

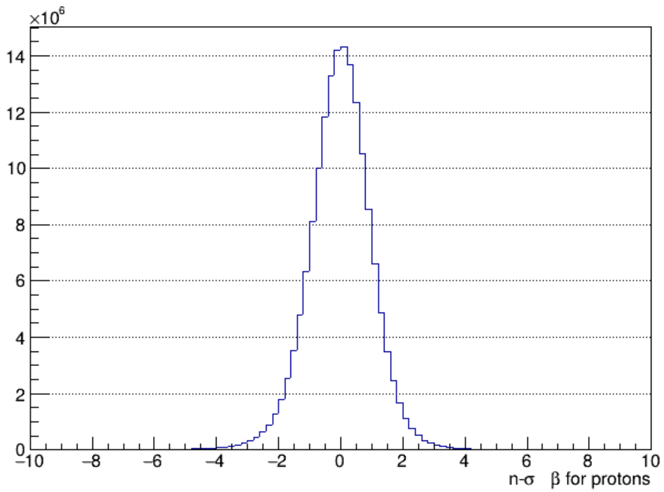


Results: kaons and protons



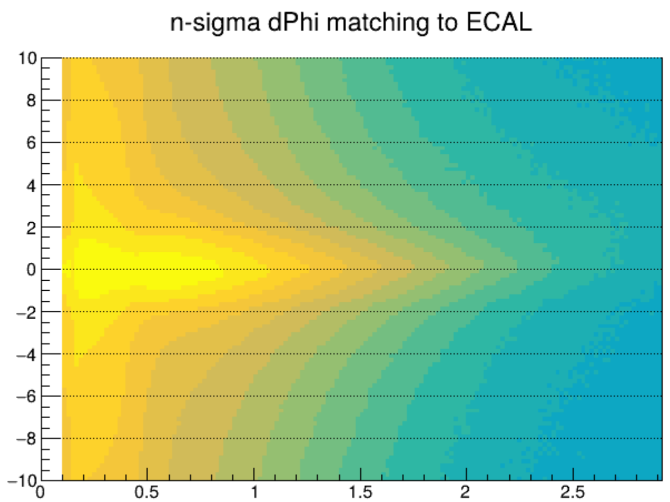


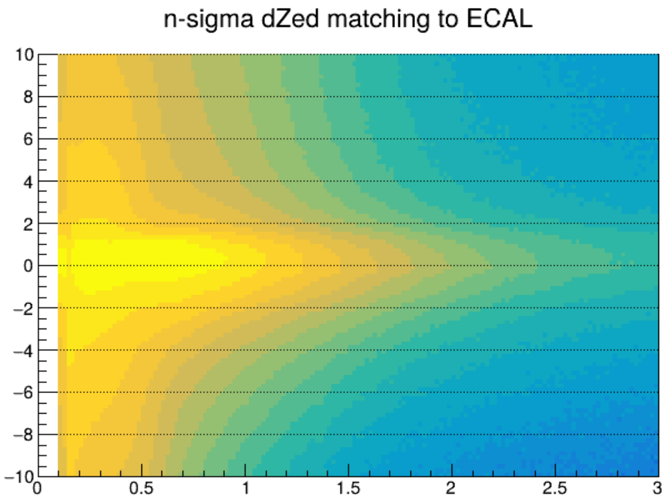


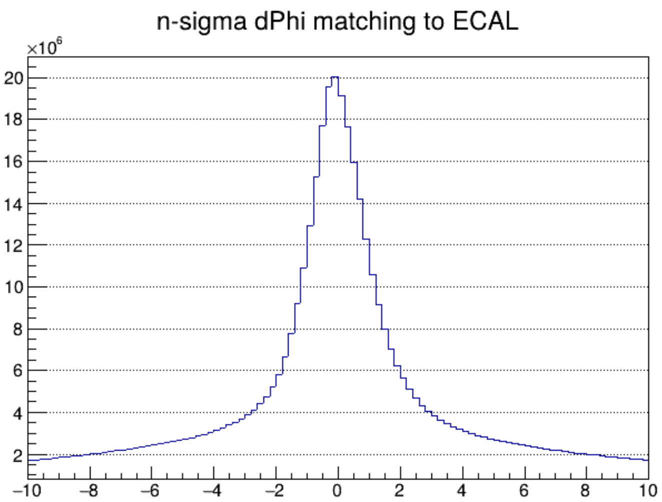


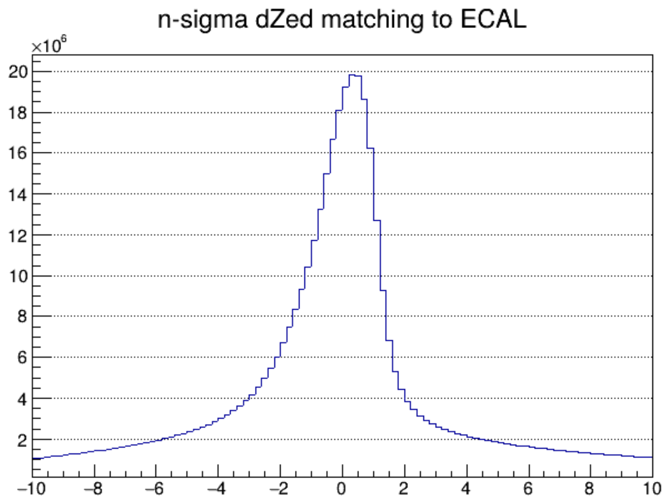
Track-to-ECAL matching

- dPhi and dZed are parameterized vs. p_T

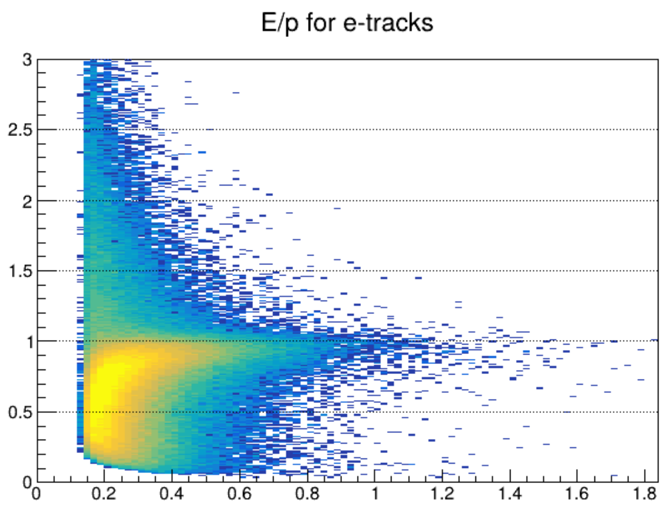


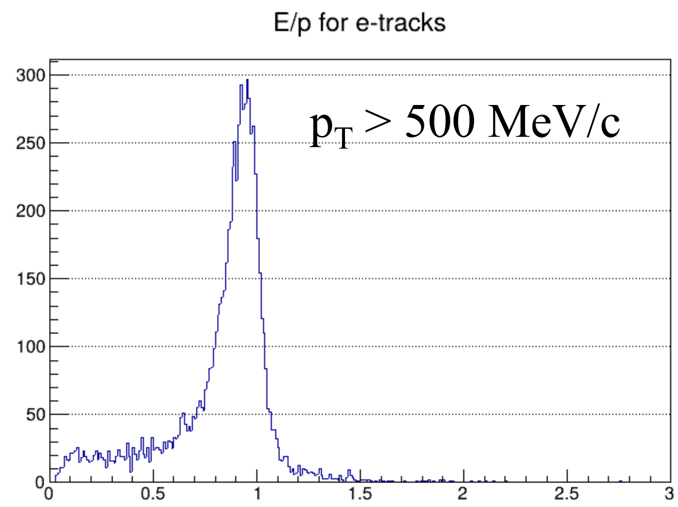






E/p for electrons





- Observe offset in ECAL energy scale compared to CLD mode → pay attention

Refits and constrained tracks

```
TVector3 mom3 = mpdtrack->GetMomConstr(); // track constrained to primary vertex

TVector3 mom3  = mpdtrack->GetMomK(); // Kaon refit

TVector3 mom3  = mpdtrack->GetMomConstrK(); // Kaon refit + constrained to PV

TVector3 mom3  = mpdtrack->GetMomP(); // Proton refit

TVector3 mom3   = mpdtrack->GetMomConstrP(); // Proton refit + constrained to PV
```

Conclusions

- DCA, matching, dE/dx and beta-TOF parameterizations for e/π/K/p are available
- We should use centralized n-sigma parameterized variables → report any problems