Centrality questions & answers - II

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Last time - conception

- Tested different variants of N_a parameterization:
  - Default : $N_a = f N_{part} + (1 - f) N_{coll}$
  - PSD : $N_a = f - N_{part}$
  - Npart : $N_a = (N_{part})^f$
  - Ncoll : $N_a = (N_{coll})^f$
  - STAR : $N_a = \frac{(1-f)}{2} N_{part} + f N_{coll}$.
- All options result in similar fit qualities and identical event splitting in centrality classes
- Did not find any problems with the Glauber fit machinery:
  - ✓ fits converge with reasonable Chi2/NDF
  - ✓ varied allowed ranges for fit parameters → same results
  - ✓ fit shapes predict true multiplicities at N_{tracks} < Fit threshold
- Glauber fits to generated/reconstructed UrQMD/DCM-SMM/PHSD multiplicity distributions give unphysical fit parameters → problems of models ???
- Glauber fit machinery should be tested with real data multiplicity distributions from different experiments → STAR ???
- Meanwhile we can use the existing machinery for event characterization and move on with processing of large productions
- Centrality will remain to be a topic of research for years to come …….

Last time - track selection

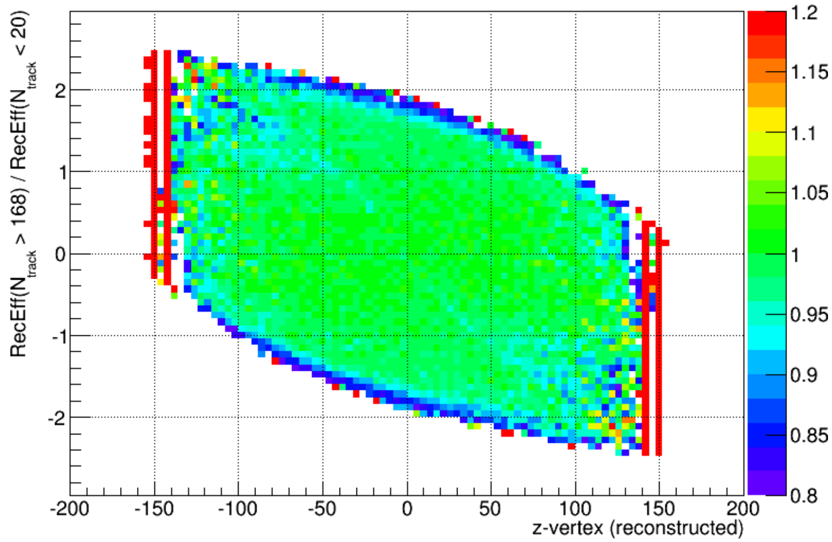
- Mean multiplicity and shape of distributions depends on track selections
- Last time it was demonstrated that event centrality categorization remains the same when track selections are varied in a reasonably wide range (nhits, DCA, p_T)
- Proposed to use track selection cuts that provided consistent centrality categorization and larger mean track multiplicity

nhits > 10; p_T > 0.1 GeV/c; DCA < 2.0 cm; $\|\eta\|$ < 0.5

- All studies we performed with a ‘narrow’ z-vertex cut of $|z\text{-vertex}| < 50$ cm to minimize effects of variation of track reconstruction efficiency
- Lets now have a look at more realistic situation …..

Detector acceptance and reconstruction efficiency

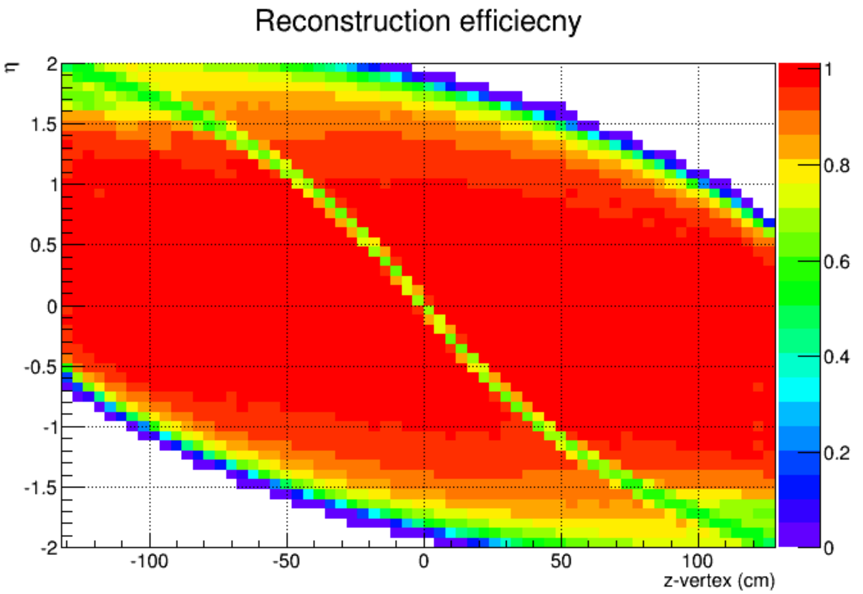
- DCM-QGSM-SMM (Request 26 mass production)
- Event selections:
  - ✓ reconstructed, z-vertex != 0
- Track cuts:
  - ✓ nhits > 10; p_T > 0.1 GeV/c; DCA < 2.0 cm; |η| < 0.5 → valid acceptance up to η ~ 2

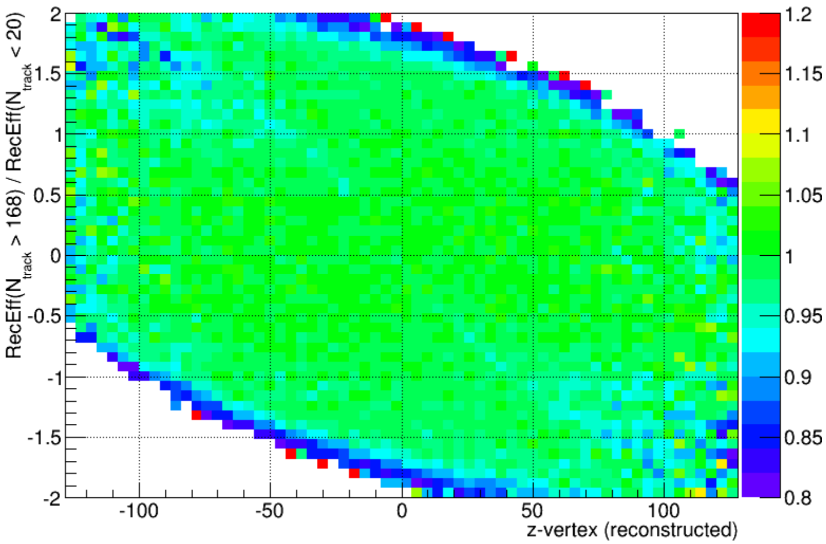


- z-vertex is reconstructed in TPC only in the limited range, |z-vertex| < 150 cm
- Reconstruction efficiency depends on event z-vertex and track pseudorapidity + membrane
- Multiplicity/centrality dependence of reconstruction efficiency

Same with zoom-in, $|\eta| < 2.0$

- Not interested in |z-vertex| > 120-130 cm → FFD at |z| ~ 140 cm



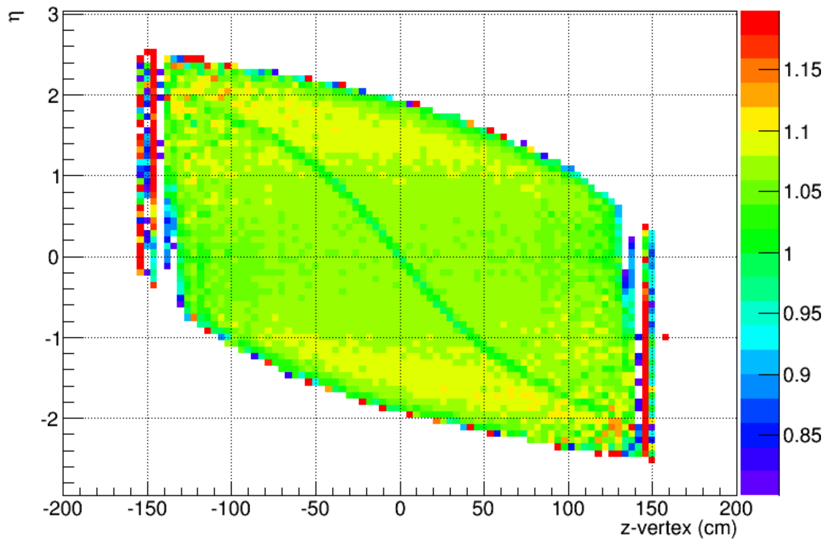


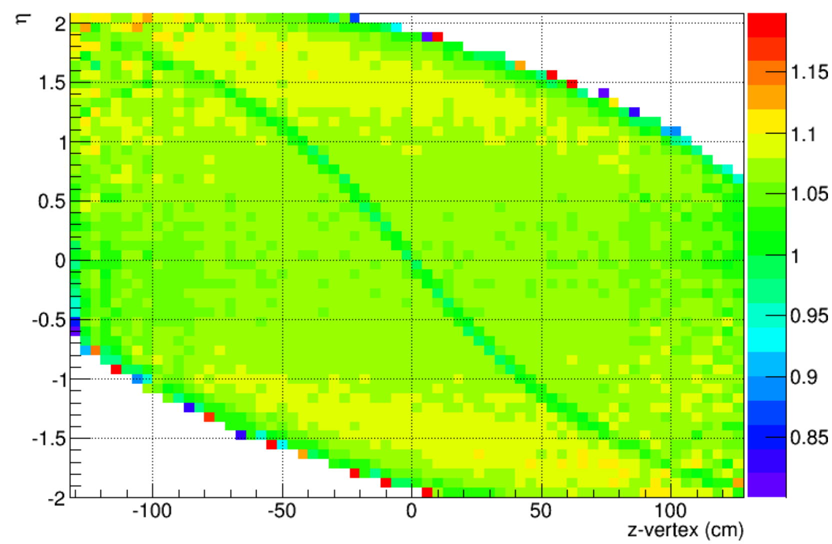
- With track selection $|\eta| < 0.5$, sample event multiplicity at |z-vertex| < 130 cm
- With track selection $|\eta| < 1.0$, sample event multiplicity at |z-vertex| < 100 cm
- With track selection $|\eta| < 1.5$, sample event multiplicity at |z-vertex| < 50 cm\
- Narrower $|\eta|$ selection → smaller centrality dependence of the reconstruction efficiency

Reconstruction efficiency vs. generator

- DCM-QGSM-SMM (Request 26) vs. UrQMD (Request 25)

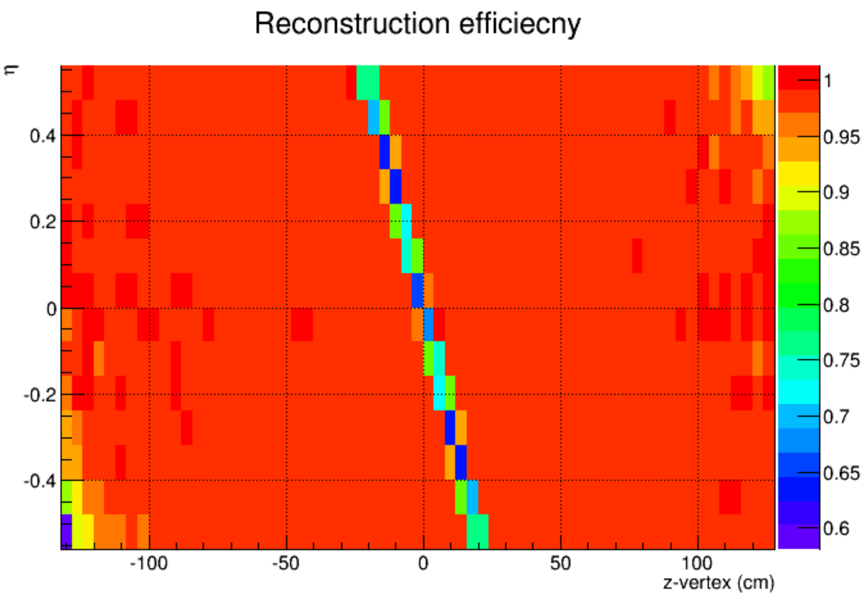
Ratio of efficiencies, DCM-SMM / UrQMD



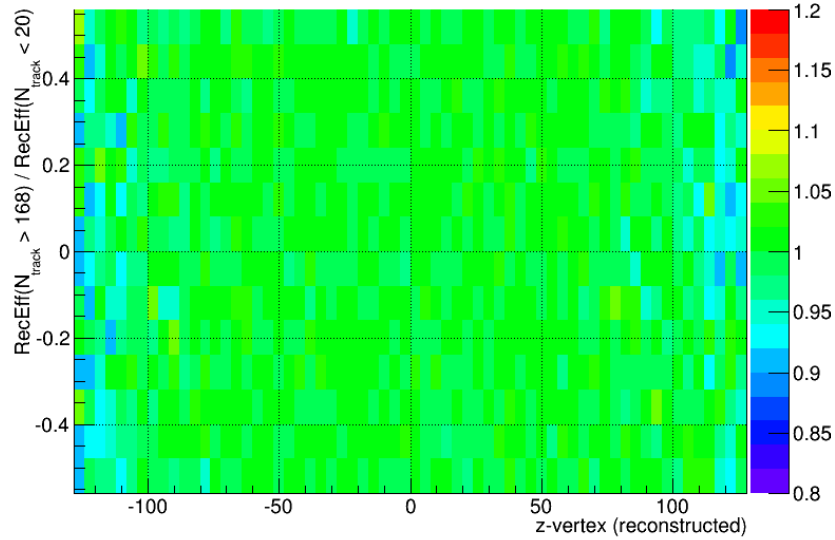


- Observe dependence of reconstruction efficiency on event generator
- With |η| < 0.5 selection, the dependence is rather weak.

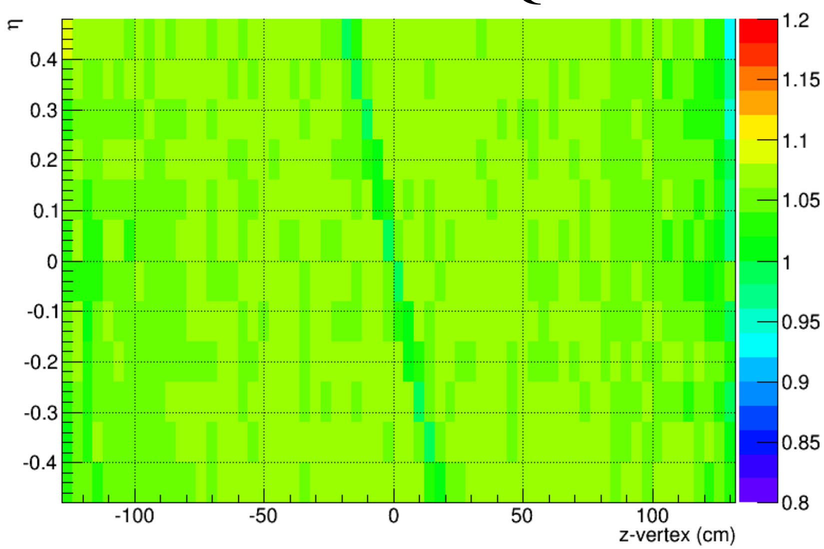
Summary for track selection, |η| < 0.5



Central / Peripheral



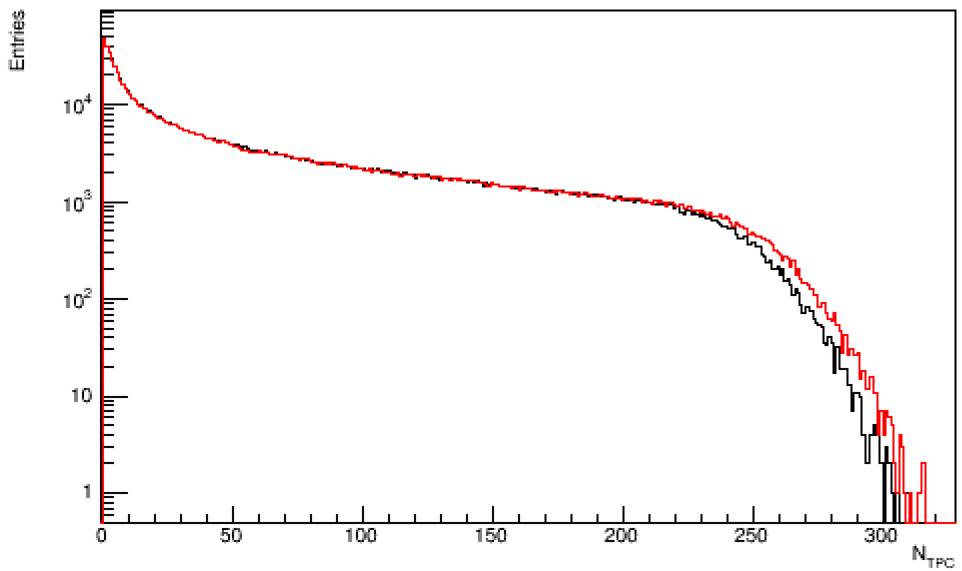
DCM-SMM / UrQMD



- Efficiency correction is most important for |z-vertex| < 20 cm → deficiency of central events due to lower efficiency from the central membrane
- Efficiency correction does not show strong dependence on multiplicity and event generator

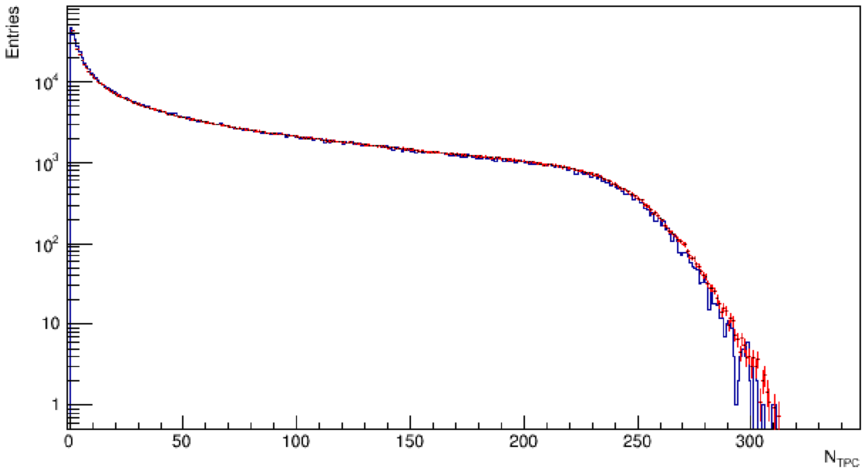
Multiplicity distributions

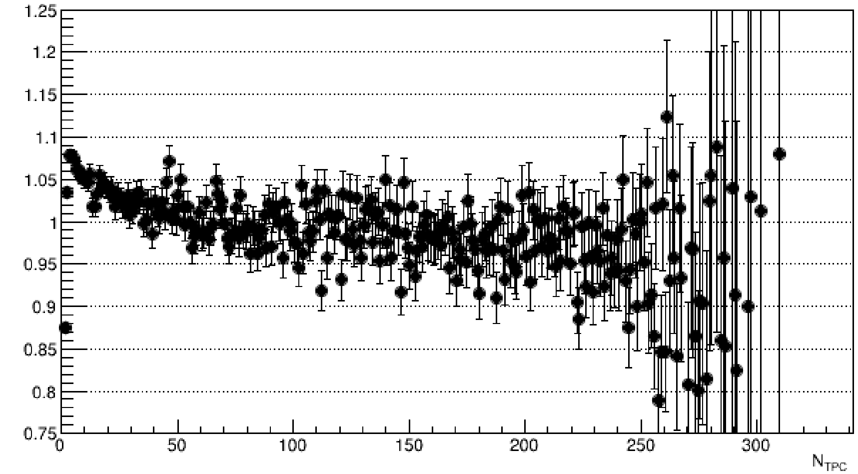
- DCM-QGSM-SMM (Request 26 mass production)
- Event selections:
  - ✓ reconstructed, z-vertex != 0
  - ✓ reconstructed |z-vertex| < 130 cm
- Track cuts:
  - ✓ nhits > 10; p_T > 0.1 GeV/c; DCA < 2.0 cm; |η| < 0.5 **with**/**without** efficiency corrections



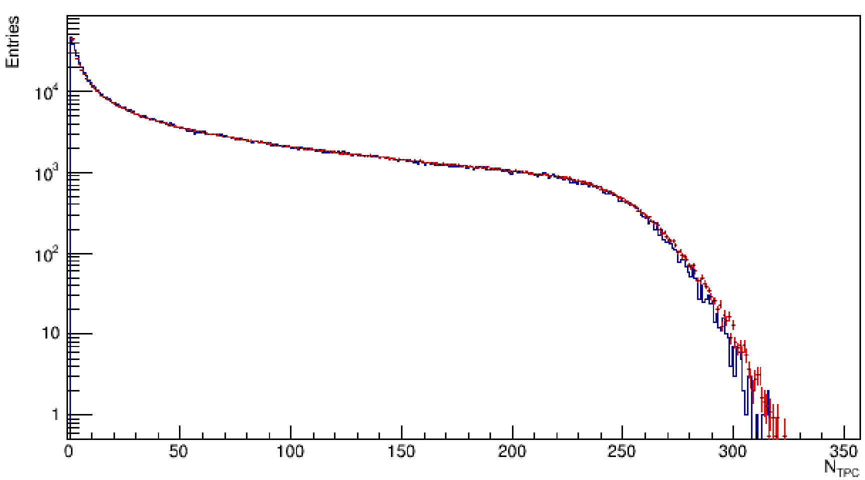
Glauber fits

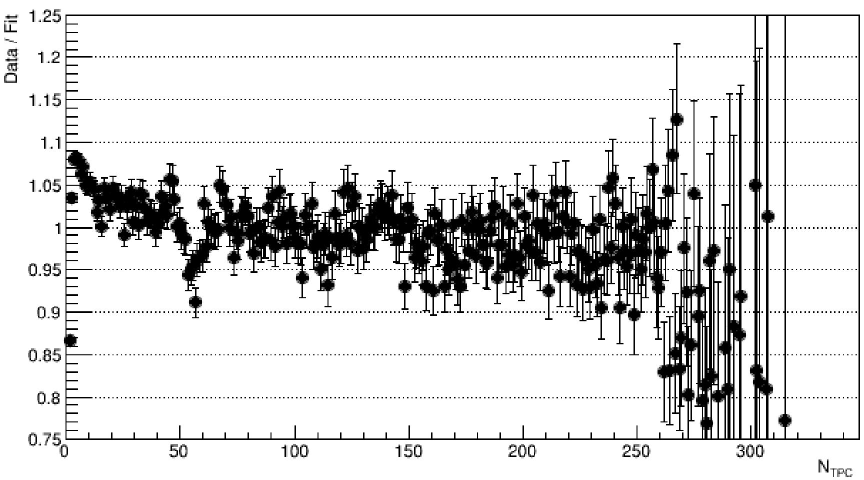
- No efficiency correction: f = 0.09 mu = 0.29 k = 15 chi2 = 1.3





- With efficiency correction: f = 0 mu = 0.29 k = 87 chi2 = 1.5





Fit results

- No efficiency correction: f = 0.09 mu = 0.29 k = 15 chi2 = 1.3

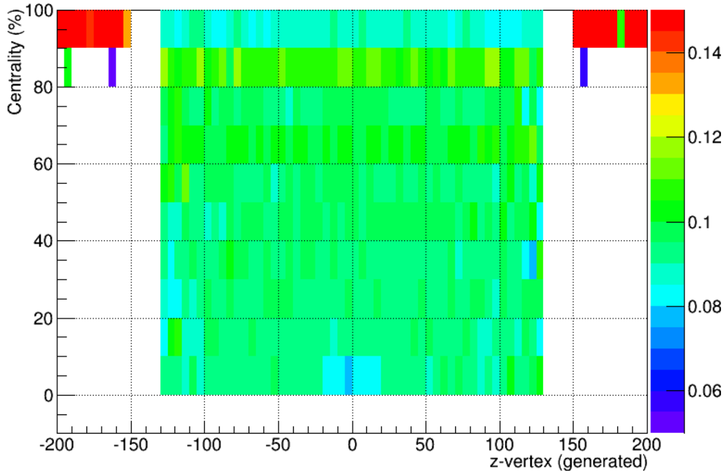
Cent, %	Mult_min	Mult_max	<b>, fm	RMS	bmin, fm	bmax, fm	<Npart>	RMS	Npart_min	Npart_max	<Ncoll>	RMS	Ncoll_min	Ncoll_max
0 - 10	171	314	2.91	1.10	1.31	4.16	338.98	34.12	294.88	391.33	730.34	91.43	611.11	873.61
10 - 20	120	171	5.17	0.73	4.16	6.01	257.30	30.31	223.55	294.88	511.12	68.77	426.92	611.11
20 - 30	83	120	6.72	0.62	6.01	7.37	194.39	25.50	168.53	223.55	356.26	53.27	295.19	426.92
30 - 40	56	83	7.97	0.58	7.37	8.52	144.99	21.50	124.55	168.53	243.20	41.37	199.03	295.19
40 - 50	36	56	9.06	0.57	8.52	9.56	105.56	18.29	88.90	124.55	160.40	32.34	128.28	199.03
50 - 60	22	36	10.04	0.58	9.56	10.53	74.21	15.22	60.49	88.90	100.82	24.44	77.37	128.28
60 - 70	12	22	10.97	0.62	10.53	11.41	49.12	12.69	38.87	60.49	58.64	18.28	43.06	77.37
70 - 80	6	12	11.88	0.69	11.41	12.27	29.97	10.04	23.31	38.87	30.97	12.60	22.36	43.06
80 - 90	3	6	12.70	0.80	12.27	13.30	17.43	7.69	11.79	23.31	15.74	8.32	10.23	22.36
90 - 100	1	2	14.00	1.03	13.30	14.89	6.32	4.47	0.07	11.79	4.74	4.03	-2.50	10.23

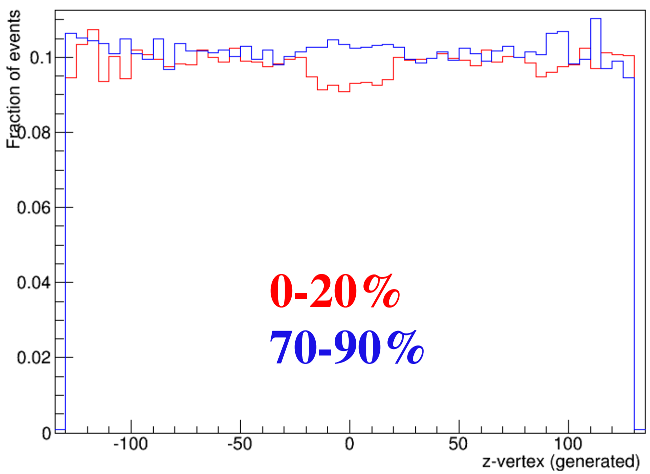
- With efficiency correction: f = 0 mu = 0.29 k = 87 chi2 = 1.5

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	175	327	2.91	1.10	1.32	4.17	338.84	34.16	294.55	391.26	730.19	91.22	610.27	874.18
10 - 20	122	175	5.19	0.73	4.17	6.03	256.68	30.30	222.79	294.55	509.54	68.13	425.03	610.27
20 - 30	84	122	6.74	0.62	6.03	7.39	193.58	25.42	167.55	222.79	354.38	52.39	292.96	425.03
30 - 40	56	84	8.00	0.58	7.39	8.54	144.00	21.56	123.65	167.55	241.03	40.89	197.13	292.96
40 - 50	36	56	9.08	0.57	8.54	9.58	104.68	18.11	88.33	123.65	158.58	31.41	127.12	197.13
50 - 60	22	36	10.05	0.58	9.58	10.53	73.92	15.12	60.32	88.33	100.22	23.89	76.99	127.12
60 - 70	12	22	10.97	0.62	10.53	11.40	49.14	12.64	39.00	60.32	58.62	17.97	43.20	76.99
70 - 80	6	12	11.87	0.69	11.40	12.26	30.12	10.05	23.53	39.00	31.14	12.45	22.59	43.20
80 - 90	3	6	12.69	0.80	12.26	13.28	17.62	7.72	11.90	23.53	15.92	8.30	10.29	22.59
90 - 100	1	2	13.99	1.03	13.28	14.89	6.37	4.52	0.13	11.90	4.77	4.05	-2.29	10.29

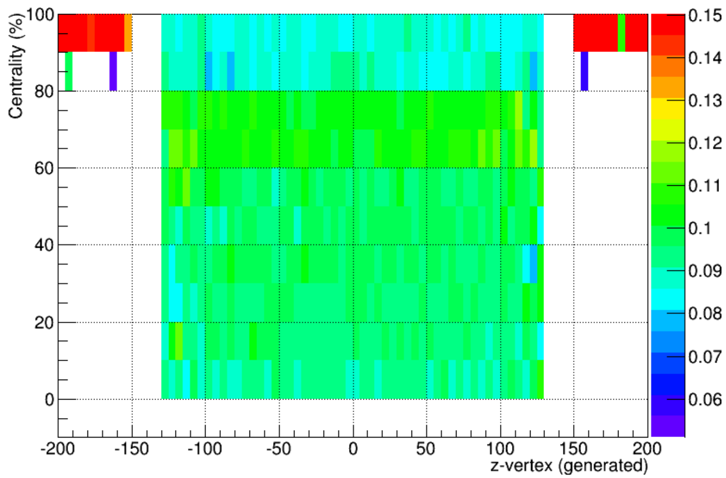
Fit results

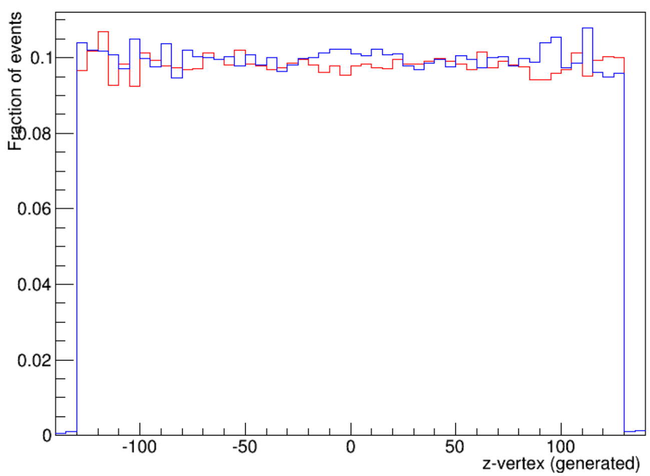
- No efficiency correction:





- With efficiency correction:





Conclusions

- The following approach can be used for event centrality categorization using TPC:
  - ✓ select events with a reconstructed |z-vertex| < 130 cm
  - ✓ sample multiplicity distribution for tracks with weights: nhits > 10; p_T > 0.1 GeV/c; DCA < 2.0 cm; |η| < 0.5, weight = 1/RecEff(z-vertex, η)
  - ✓ use sampled multiplicity distribution to characterize event centrality, [N_{min} – N_{max}]

- To characterize event, apply centrality class definitions [N_{min} – N_{max}] to event multiplicity sampled with the same track selections and weight = 1/RecEff(z-vertex, η) for each track