Charged and identified hadron spectra in Kr + Kr, O + O and Xe + Xe collisions at $\sqrt{s_{NN}} = 6$ GeV using UrQMD model

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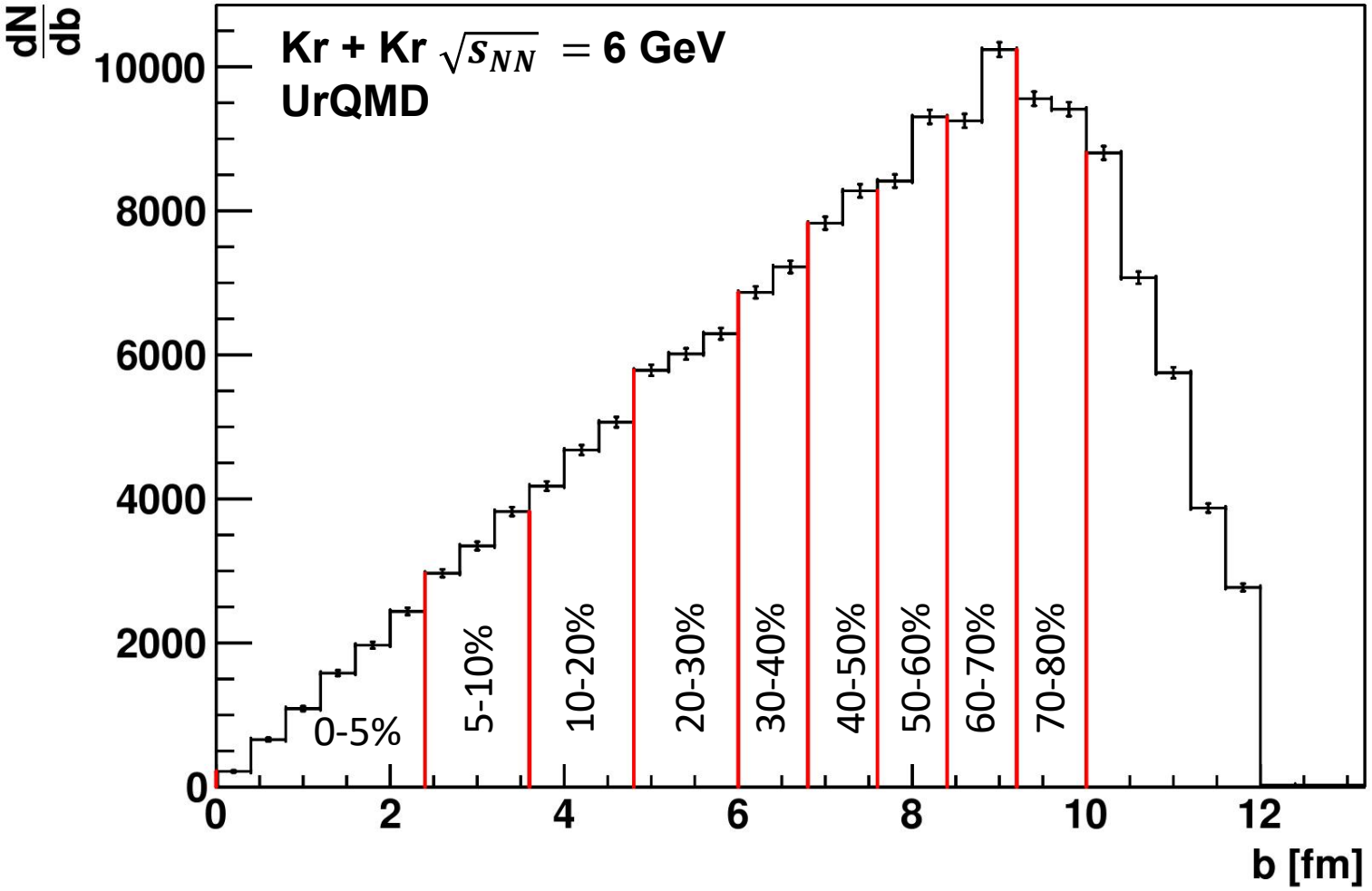
Collision centrality determiantion using impact parameter

System: Kr + Kr $\sqrt{s_{NN}} = 6$ GeV
UrQMD, statistics: ~1.7×10^5 events

Impact parameter

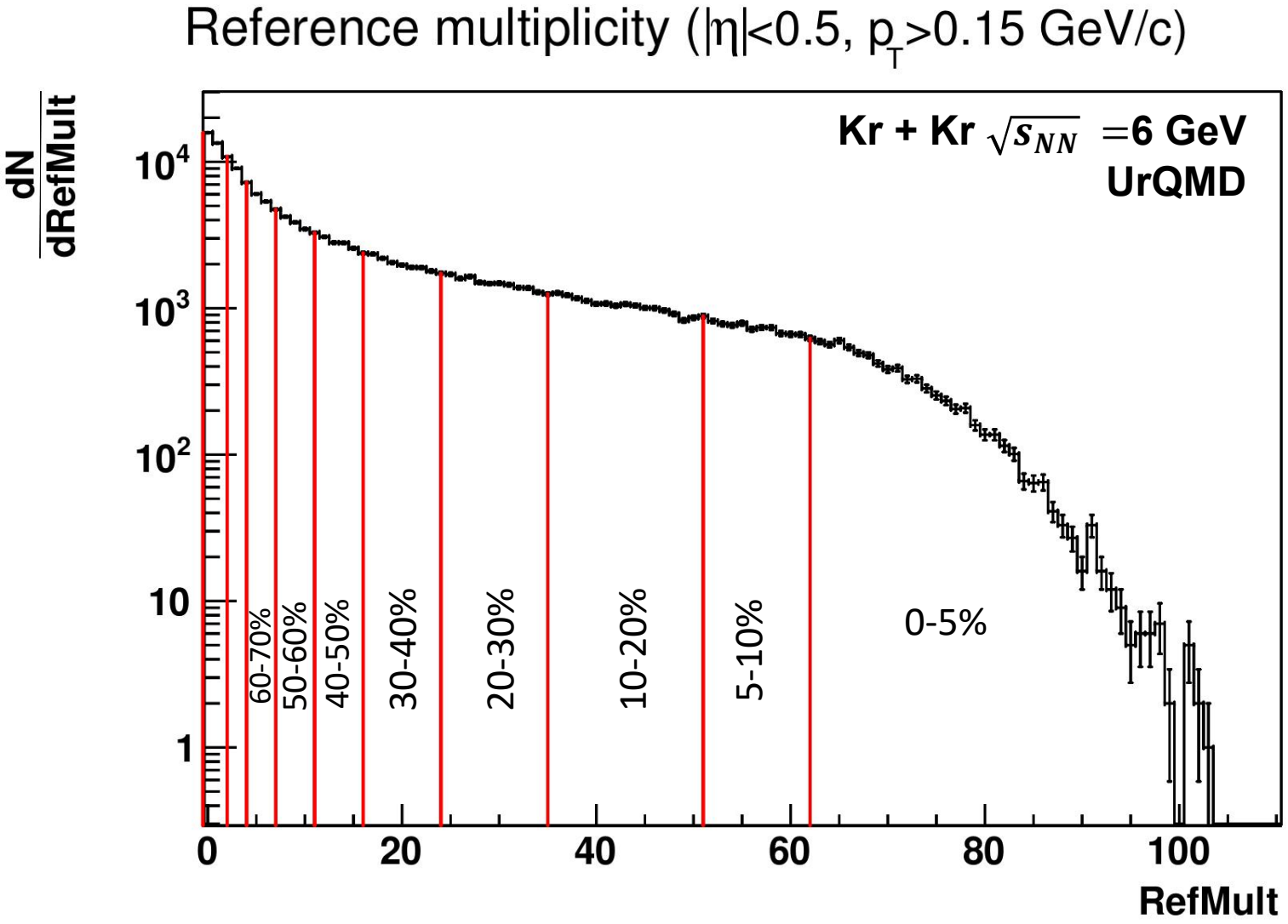


Centrality	Impact parameter b, fm	Fraction
0 - 5%	0 - 2.4	0.04825
5 - 10%	2.4 - 3.6	0.10979
10 - 20%	3.6 - 4.8	0.19429
20 - 30%	4.8 - 6.0	0.30410
30 - 40%	6.0 - 6.8	0.38961
40 - 50%	6.8 - 7.6	0.48736
50 - 60%	7.6 - 8.4	0.59489
60 - 70%	8.4 - 9.2	0.71316
70 - 80%	9.2 - 10.0	0.82828

Collision centrality determiantion using reference multiplicity ($|\eta| < 0.5$)

System: Kr + Kr $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~1.7×10^5 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 0.5$ and $p_T > 0.15$ GeV/c**



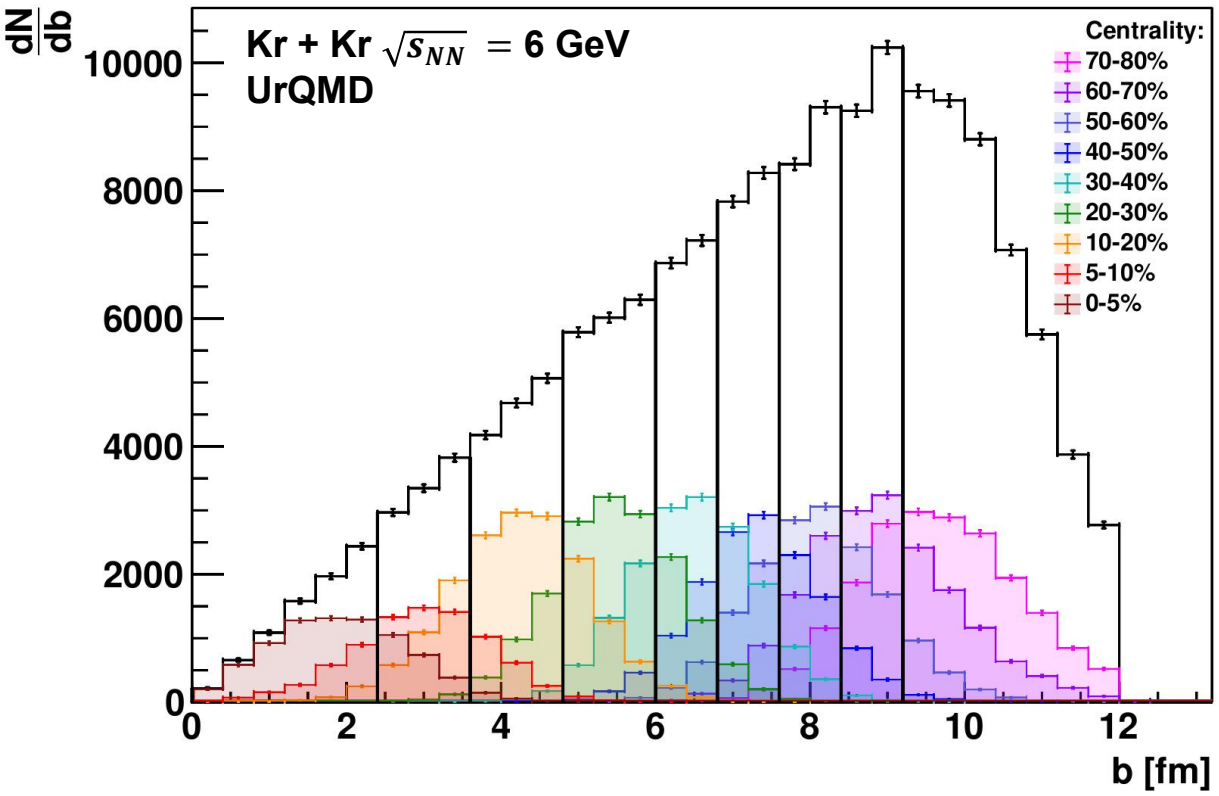
Centrality	RefMult	Fraction
0 - 5%	62 - 112	0.04851
5 - 10%	51 - 62	0.09845
10 - 20%	35 - 51	0.20111
20 - 30%	24 - 35	0.30202
30 - 40%	16 - 24	0.40236
40 - 50%	11 - 16	0.49051
50 - 60%	7 - 11	0.58925
60 - 70%	4 - 7	0.70217
70 - 80%	2 - 4	0.82256

Collision centrality determiantion using reference multiplicity ($|\eta| < 0.5$)

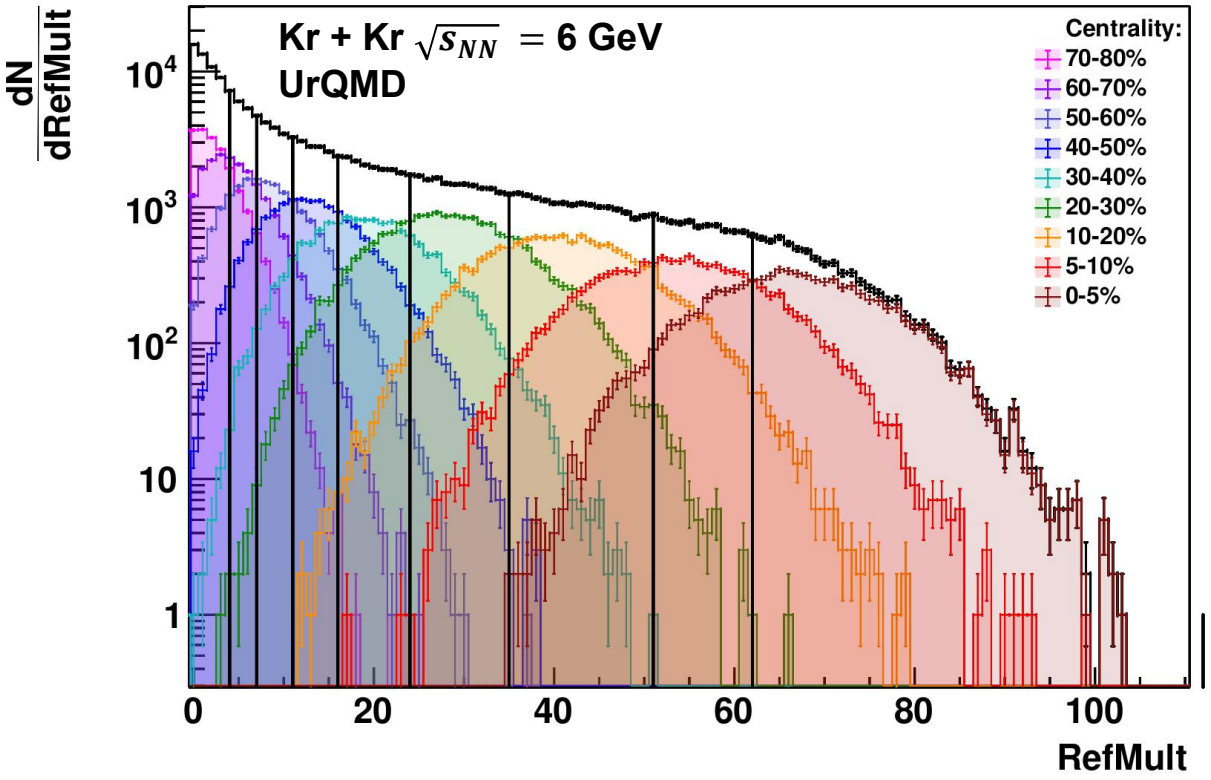
System: Kr + Kr $\sqrt{s_{NN}} = 6$ GeV, UrQMD, statistics: ~1.7×10^5 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 0.5$ and $p_T > 0.15$ GeV/c**

Impact parameter



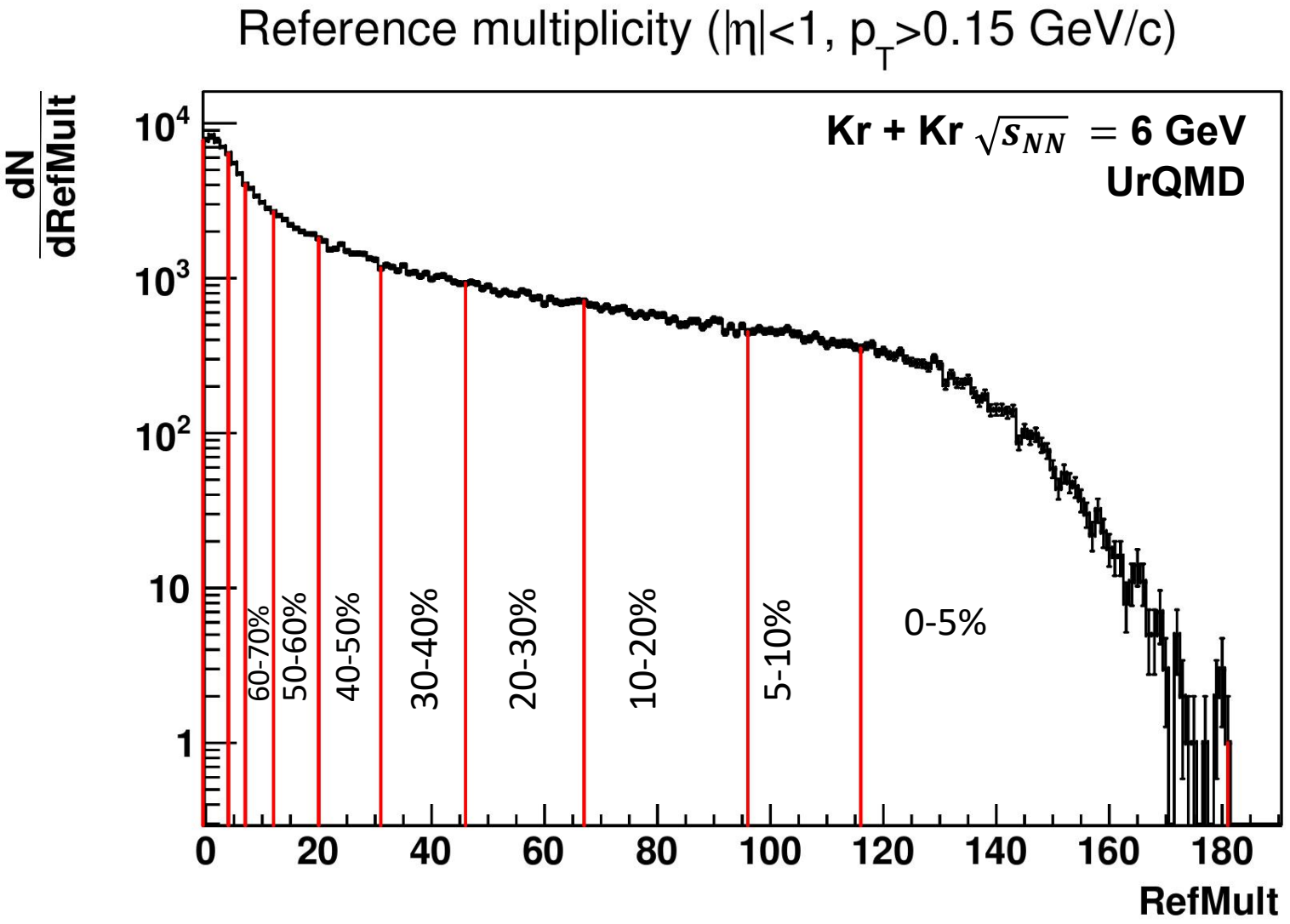
Reference multiplicity ($|\eta|<0.5$, $p_T>0.15$ GeV/c)



Collision centrality determiantion using reference multiplicity ($|\eta| < 1.0$)

System: Kr + Kr $\sqrt{s_{NN}} = 6$ GeV, UrQMD, statistics: ~1.7×10^5 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 1.0$ and $p_T > 0.15$ GeV/c**



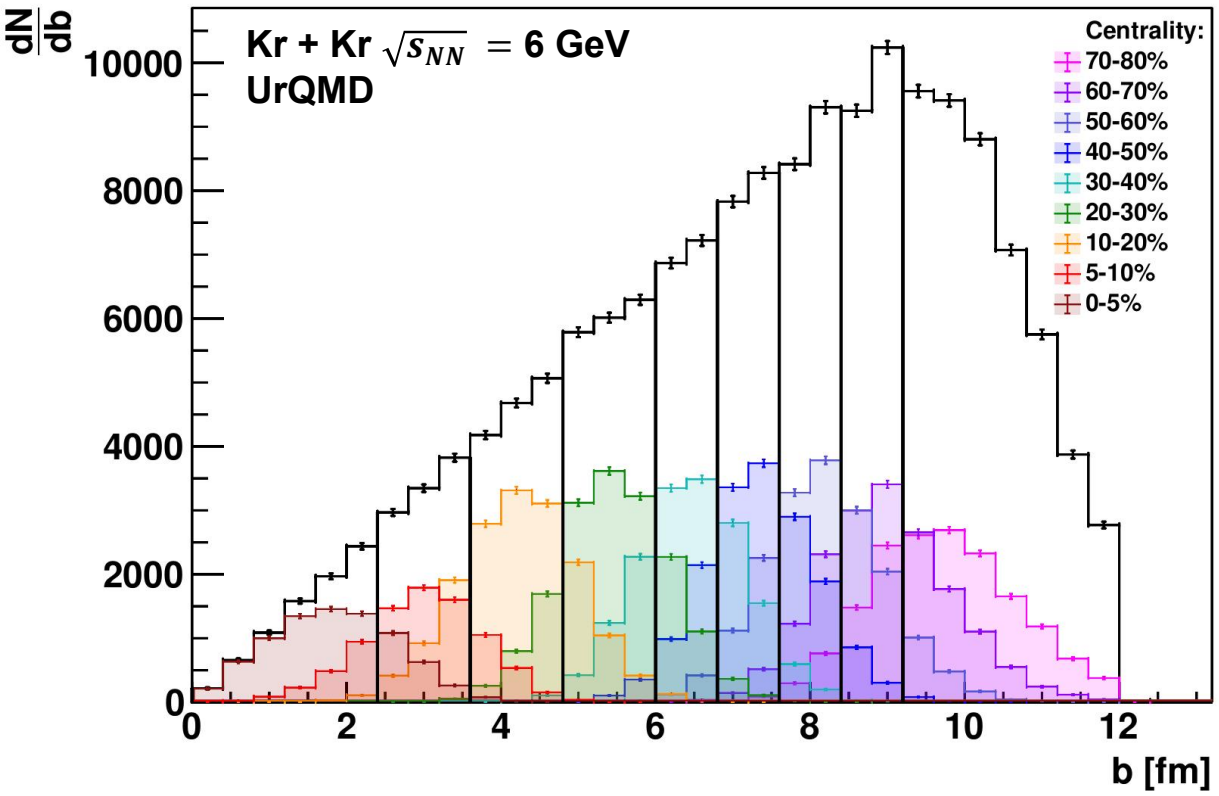
Centrality	RefMult	Fraction
0 - 5%	116 - 181	0.04918
5 - 10%	96 - 116	0.10029
10 - 20%	67 - 96	0.19986
20 - 30%	46 - 67	0.30084
30 - 40%	31 - 46	0.39844
40 - 50%	20 - 31	0.50015
50 - 60%	12 - 20	0.60801
60 - 70%	7 - 12	0.71200
70 - 80%	4 - 7	0.81301

Collision centrality determiantion using reference multiplicity ($|\eta| < 1.0$)

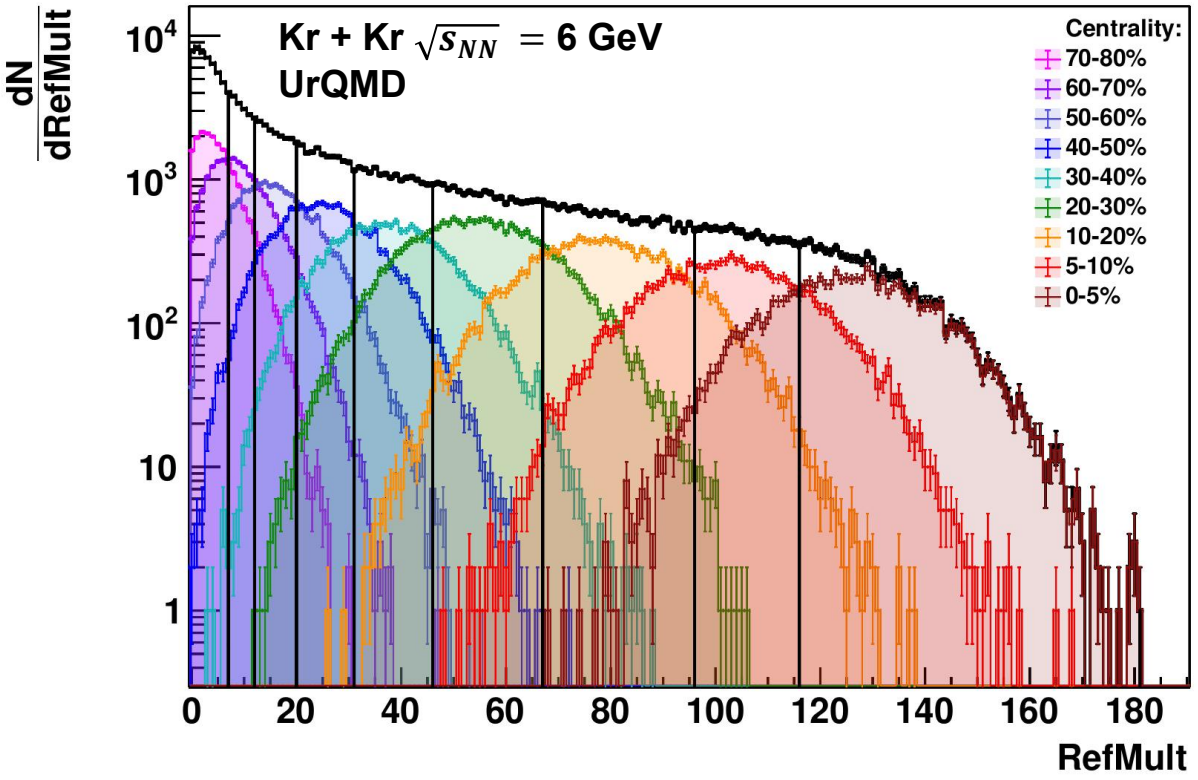
System: Kr + Kr $\sqrt{s_{NN}} = 6$ GeV, UrQMD, statistics: ~1.7×10^5 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 1.0$ and $p_T > 0.15$ GeV/c**

Impact parameter

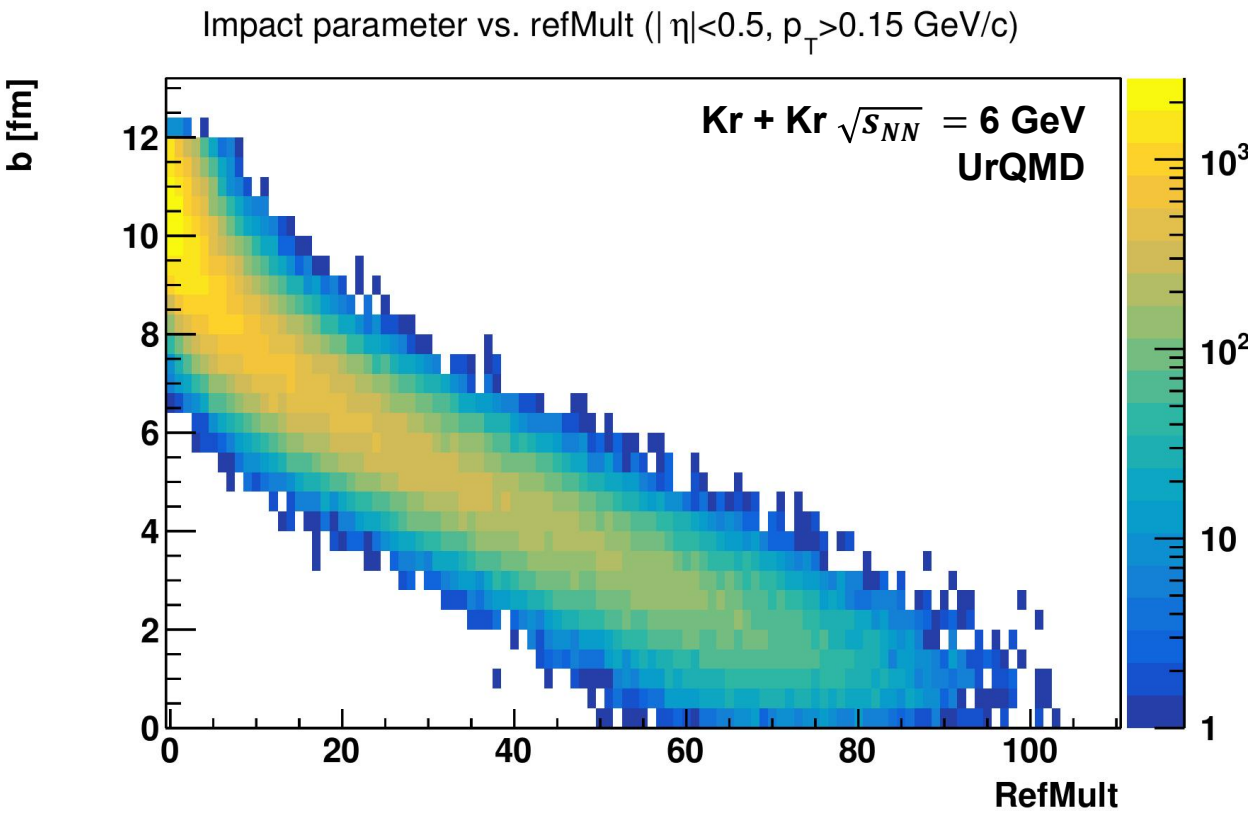


Reference multiplicity ($|\eta|<1$, $p_T>0.15$ GeV/c)

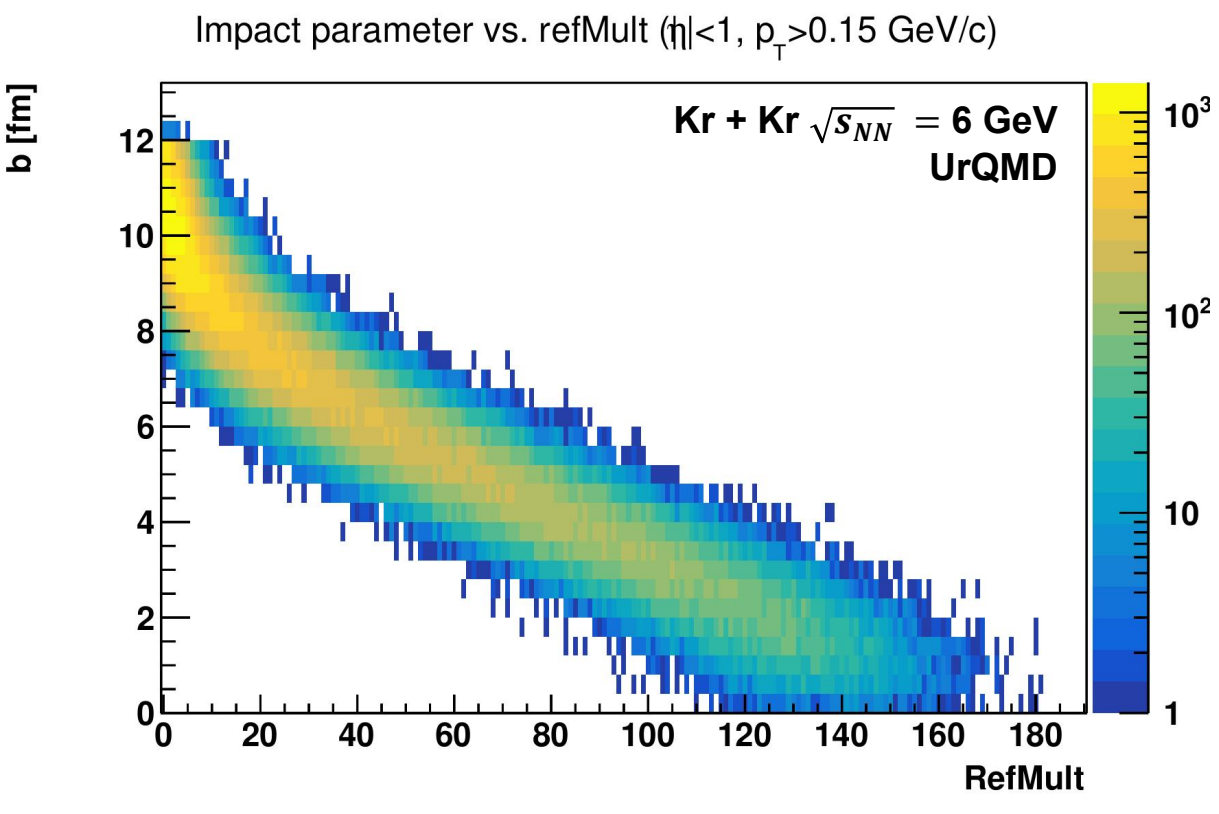


Impact parameter vs RefMult

System: Kr + Kr $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~1.7×10^5 events



Reference multiplicity is calculated as a number of charged particles with **|η| < 0.5 and p_T > 0.15 GeV/c**



Reference multiplicity is calculated as a number of charged particles with **|η| < 1.0 and p_T > 0.15 GeV/c**

Collision centrality determiantion - comparison

Centrality	RefMult ($|\eta| < 0.5$)	Fraction	RefMult($|\eta| < 1.0$)	Fraction	Impact parameter b, fm	Fraction
0 - 5%	62 - 112	0.04851	116 - 181	0.04918	0 - 2.4	0.04825
5 - 10%	51 - 62	0.09845	96 - 116	0.10029	2.4 - 3.6	0.10979
10 - 20%	35 - 51	0.20111	67 - 96	0.19986	3.6 - 4.8	0.19429
20 - 30%	24 - 35	0.30202	46 - 67	0.30084	4.8 - 6.0	0.30410
30 - 40%	16 - 24	0.40236	31 - 46	0.39844	6.0 - 6.8	0.38961
40 - 50%	11 - 16	0.49051	20 - 31	0.50015	6.8 - 7.6	0.48736
50 - 60%	7 - 11	0.58925	12 - 20	0.60801	7.6 - 8.4	0.59489
60 - 70%	4 - 7	0.70217	7 - 12	0.71200	8.4 - 9.2	0.71316
70 - 80%	2 - 4	0.82256	4 - 7	0.81301	9.2 - 10.0	0.82828

Data & Cuts

System: Kr + Kr $\sqrt{s_{NN}} = 6$ GeV

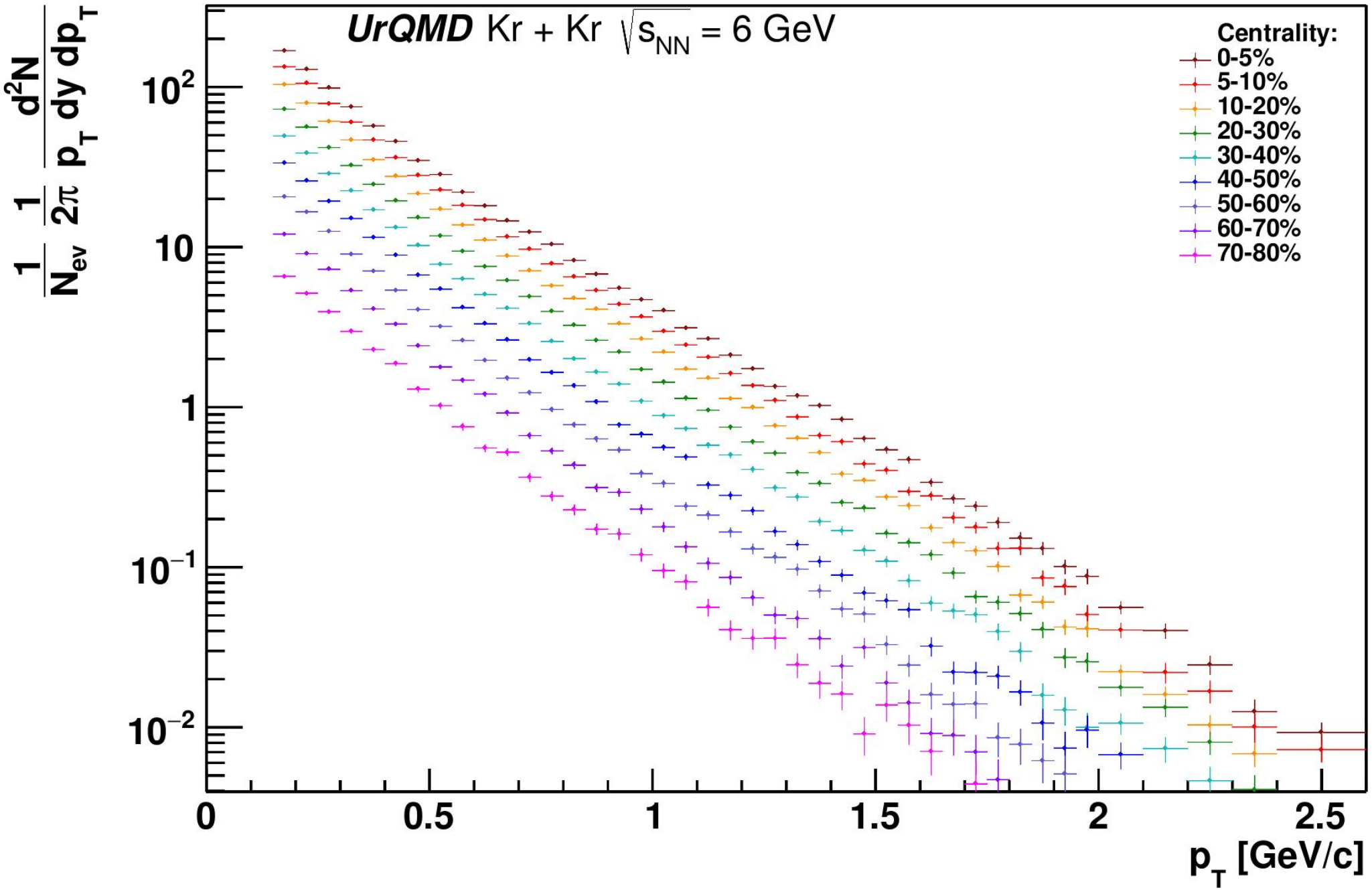
UrQMD, statistics: ~1.7×10^5 events

Track cuts:

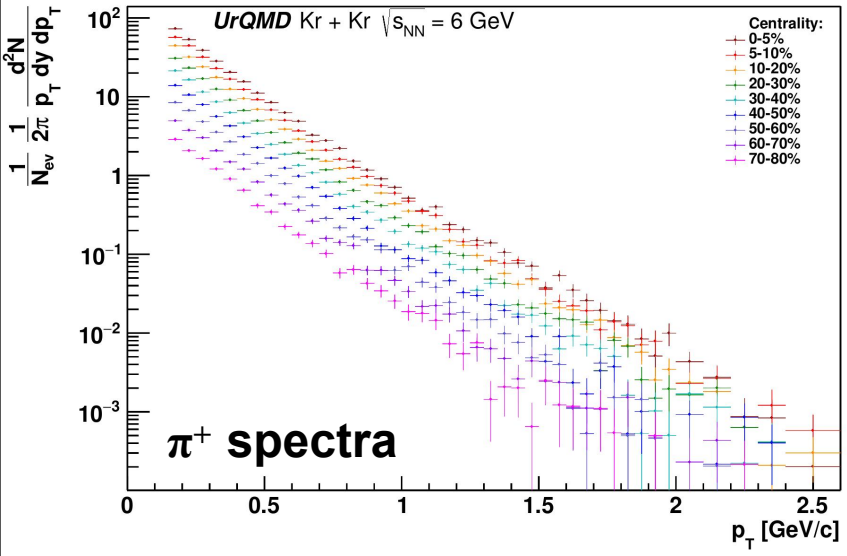
- $|y| < 0.1$
- $|\eta| < 1.0$
- $p_T > 0.15$ GeV/c

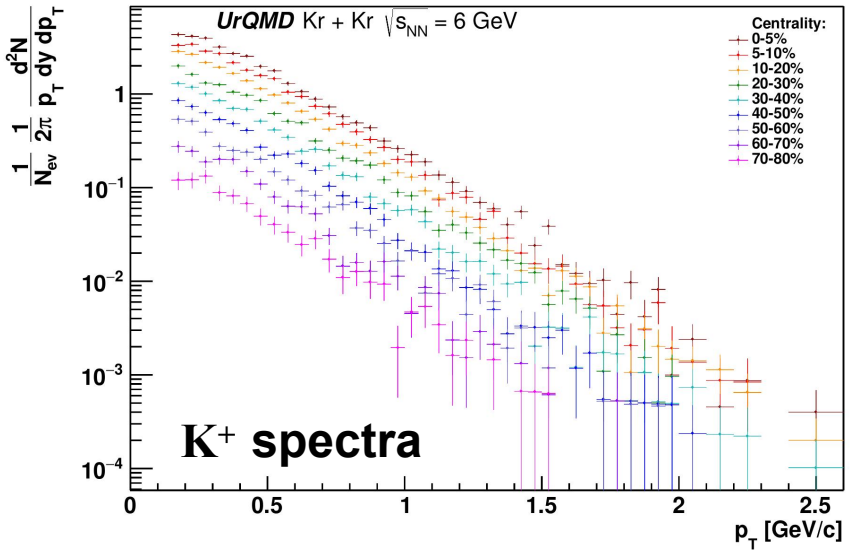
Centrality is calculated using **reference multiplicity** ($|\eta| < 1.0$, $p_T > 0.15$ GeV/c)

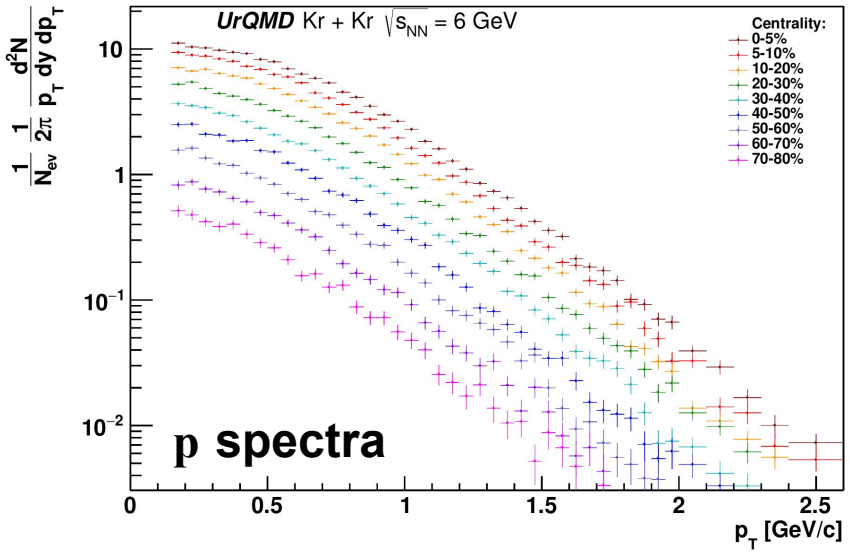
Charged hadron spectra for different centrality classes (RefMult10)

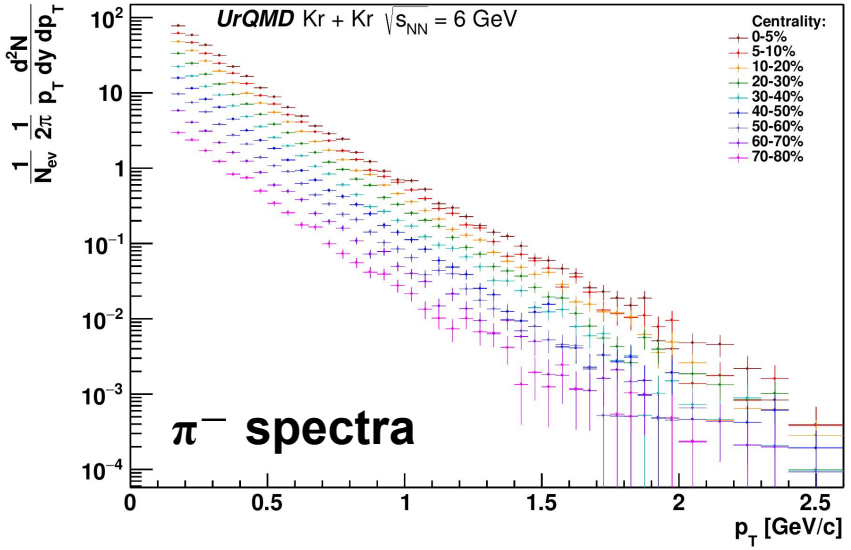


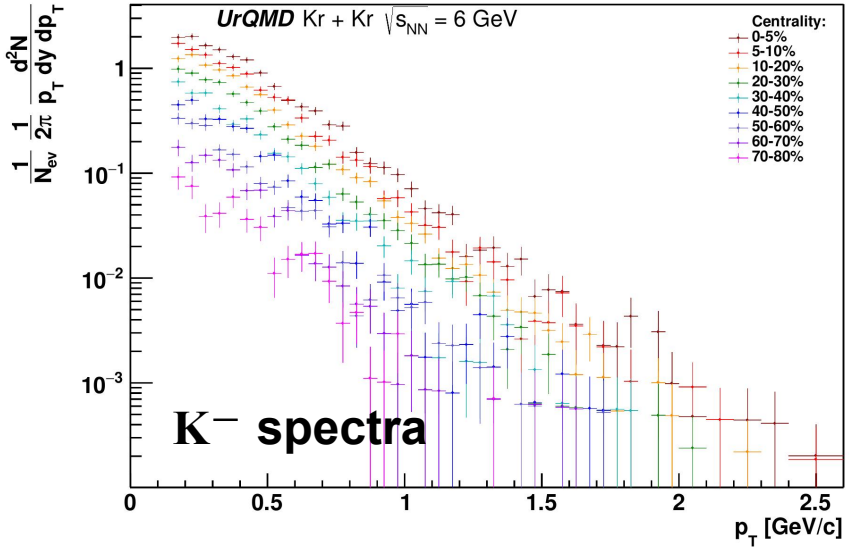
Identified hadron spectra for different centrality classes (RefMult10)

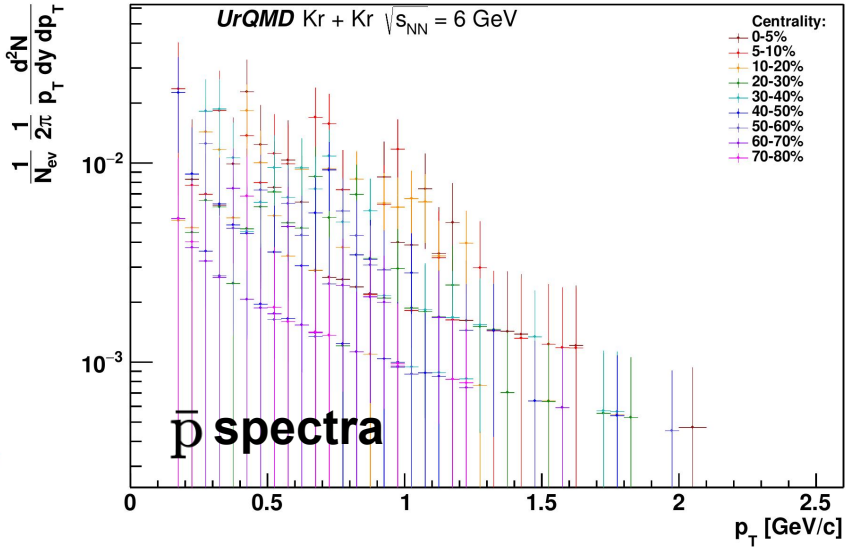






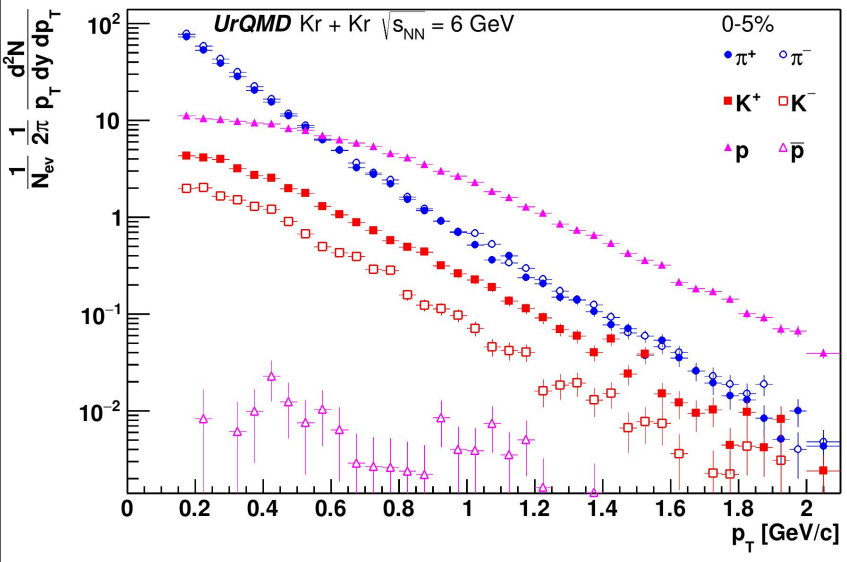


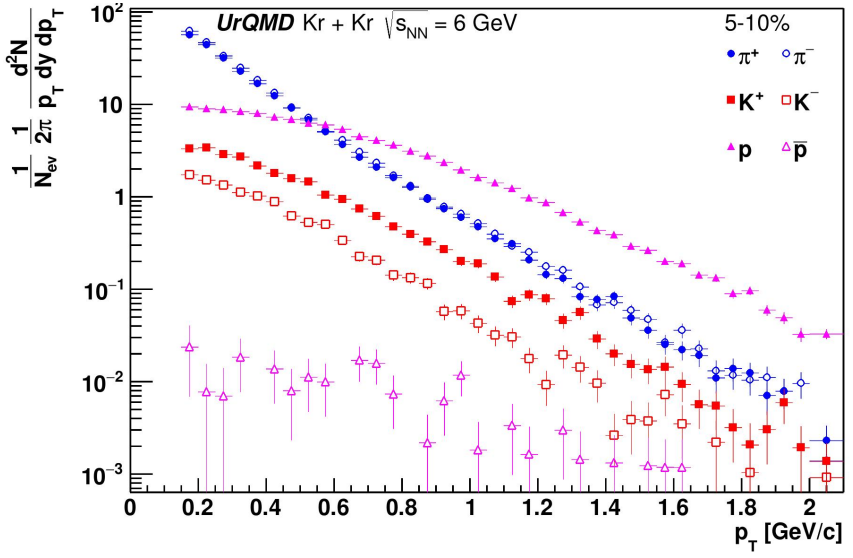


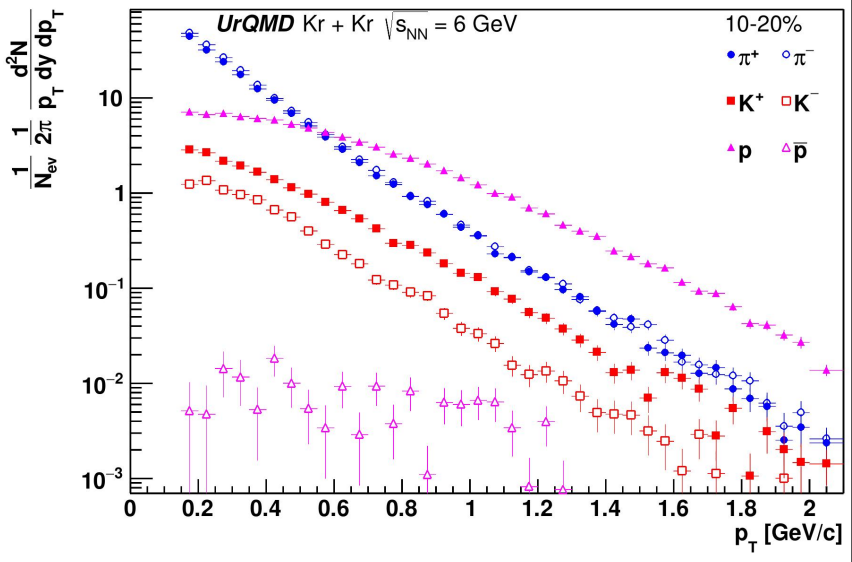


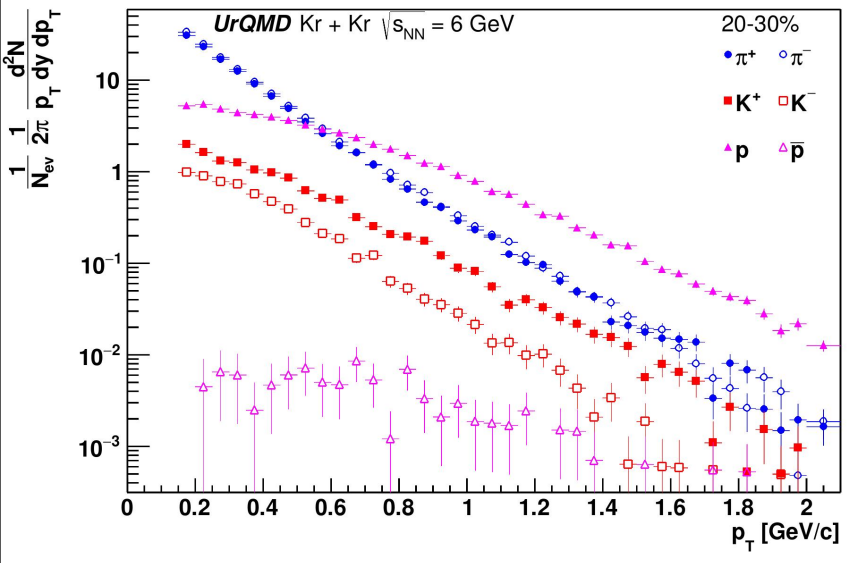
- Increasing statistics for Kr + Kr collisions at $\sqrt{s_{NN}} = 6$ GeV - in progress

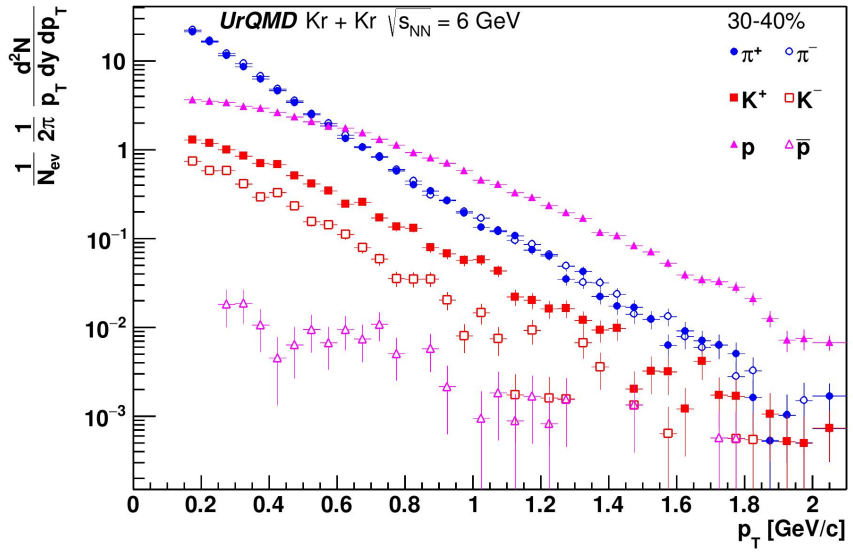
Identified hadron spectra for different centrality classes (RefMult10)

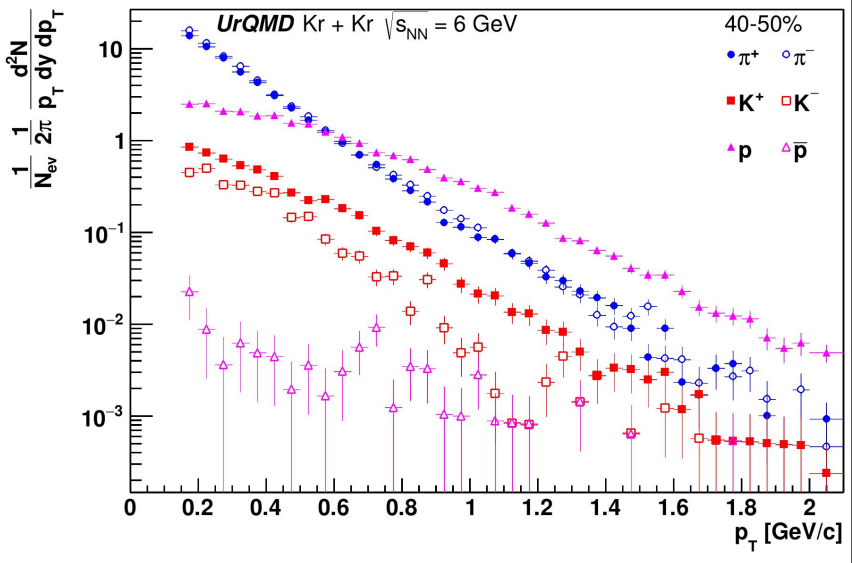












- Increasing statistics for Kr + Kr collisions at $\sqrt{s_{NN}} = 6$ GeV - in progress

Fitting spectra using blast wave model

$$\frac{dN}{p_T dp_T} \propto \int_0^R r dr\, m_T I_0\left(\frac{p_T \sinh\rho(r)}{T_{\mathrm{kin}}}\right) K_1\left(\frac{m_T \cosh\rho(r)}{T_{\mathrm{kin}}}\right)$$

m_T - transverse mass of a hadron

$\rho(r) = \tanh^{-1}\beta$

I_0, K_1 - the modified Bessel functions

$\beta = \beta_S (r/R)^n$

β_S - the surface velocity

r/R - the relative radial position in the thermal source

$\langle\beta\rangle = \frac{2}{2+n}\beta_S$ - average transverse radial flow velocity

n - the exponent of flow velosity profile

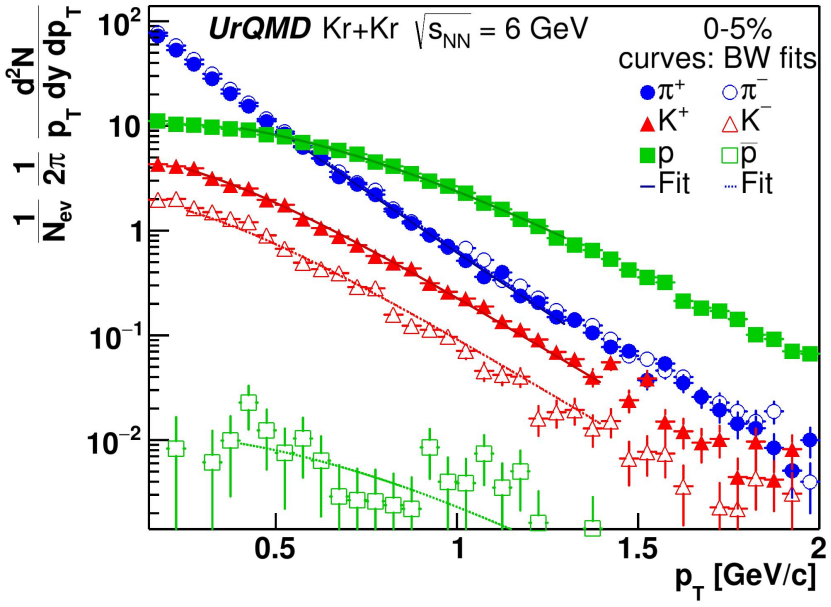
p_T fit ranges:

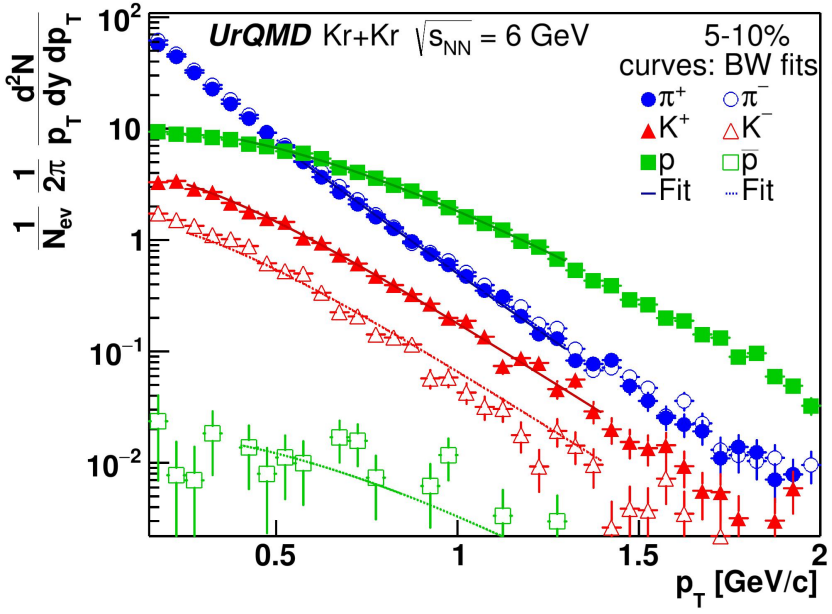
π: 0.5 - 1.3 GeV/c

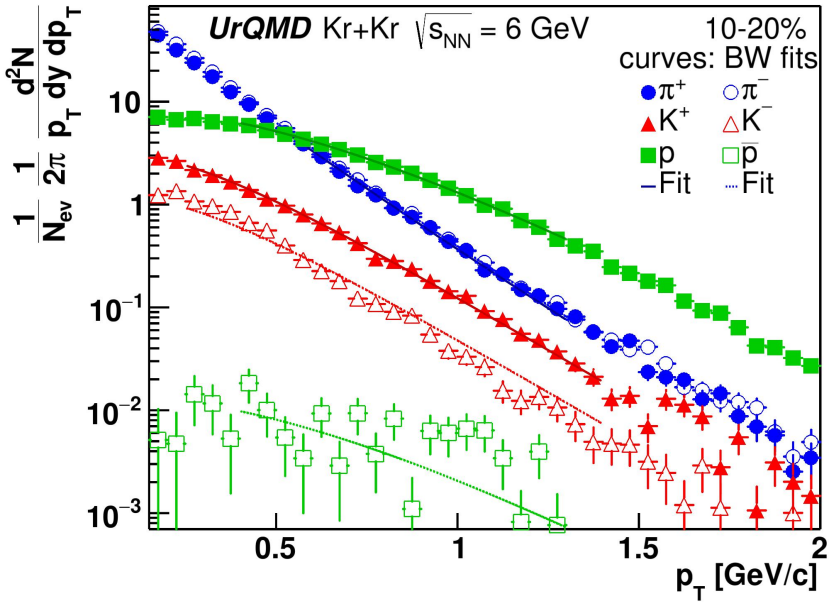
K: 0.25 - 1.4 GeV/c

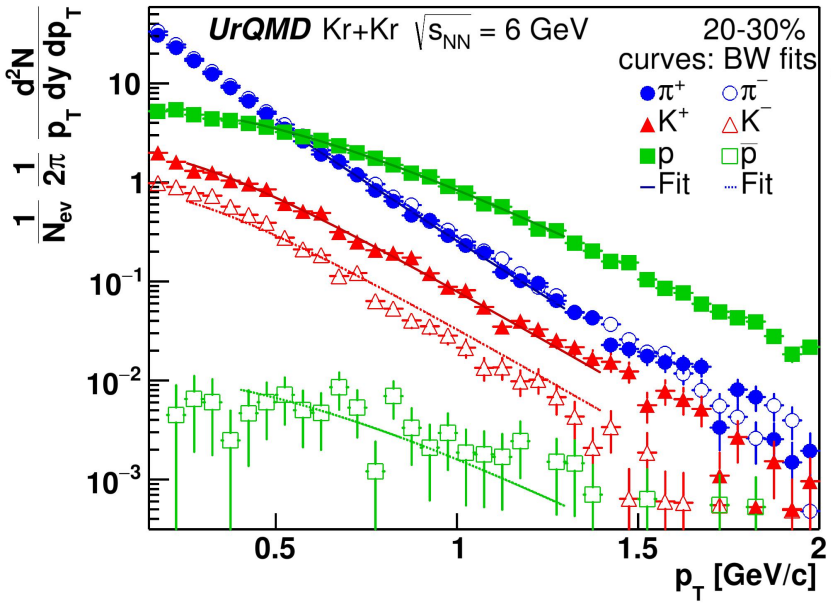
p($\overline{\mathrm{p}}$): 0.4 - 1.3 GeV/c

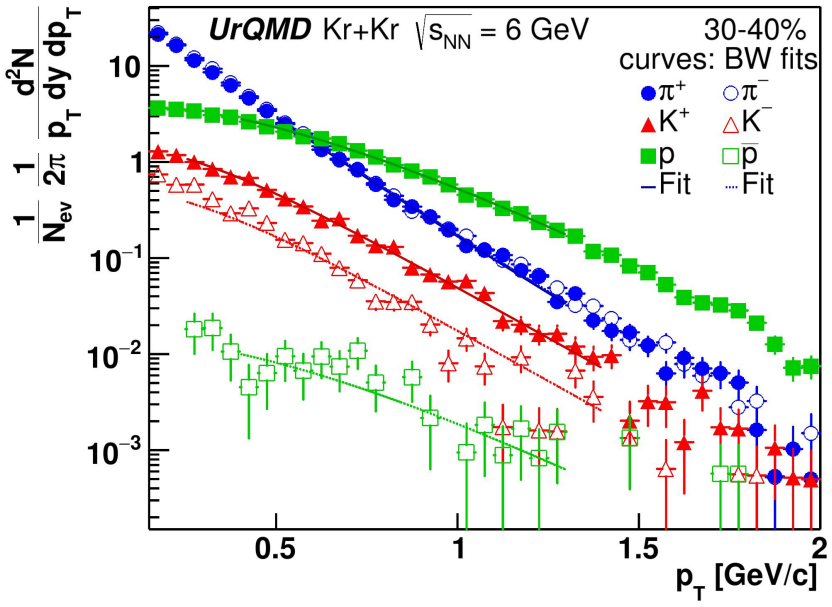
Fitted hadron spectra for different centrality classes (same *n*)

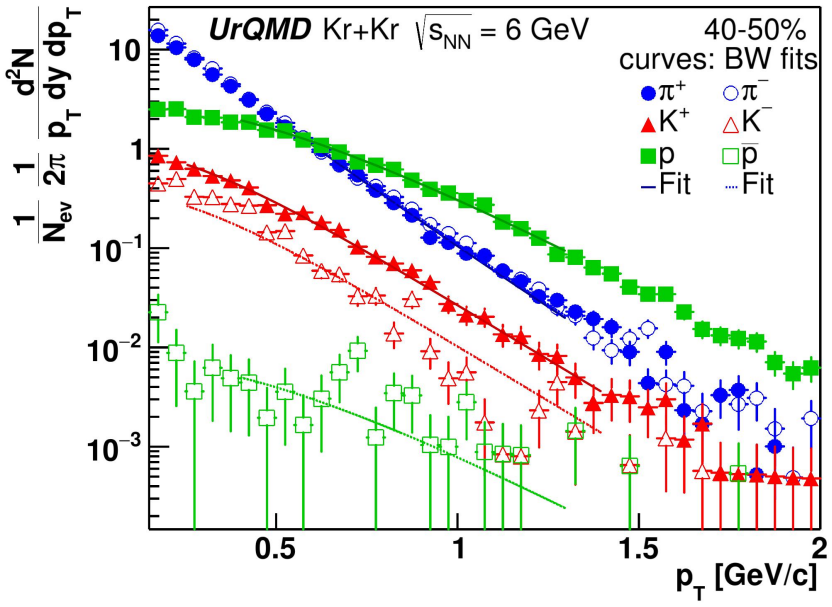












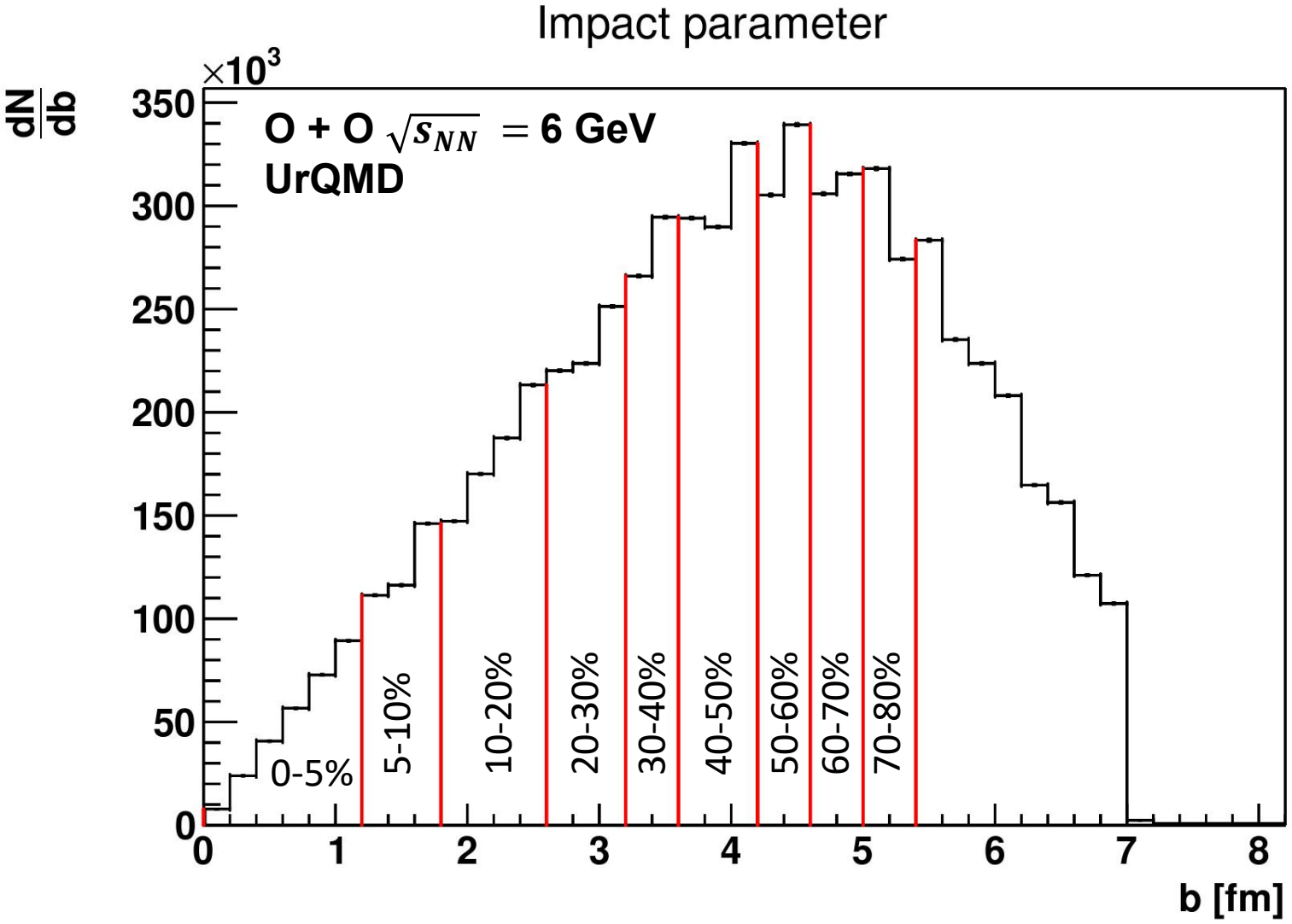
Fitted hadron spectra for different centrality classes (same *n*)

Collision centrality	**β**	$\mathbf{T_{kin}}$, МэВ	**n**	$\boldsymbol{\chi^2/ndf}$
0 - 5%	0.398 ± 0.006	116 ± 2	0.7 ± 0.2	1.88
5 - 10%	0.371 ± 0.008	121 ± 3	0.9 ± 0.3	1.74
10 - 20%	0.350 ± 0.005	119 ± 2	1.2 ± 0.5	2.29
20 - 30%	0.33 ± 0.01	127 ± 3	1.0 ± 0.4	2.19
30 - 40%	0.322 ± 0.011	120 ± 3	1.4 ± 0.3	2.3
40 - 50%	0.269 ± 0.014	124 ± 4	1.7 ± 0.5	2.5

Collision centrality determiantion using impact parameter

System: O + O $\sqrt{s_{NN}} = 6$ GeV

UrQMD, statistics: ~ 7×10^6 events

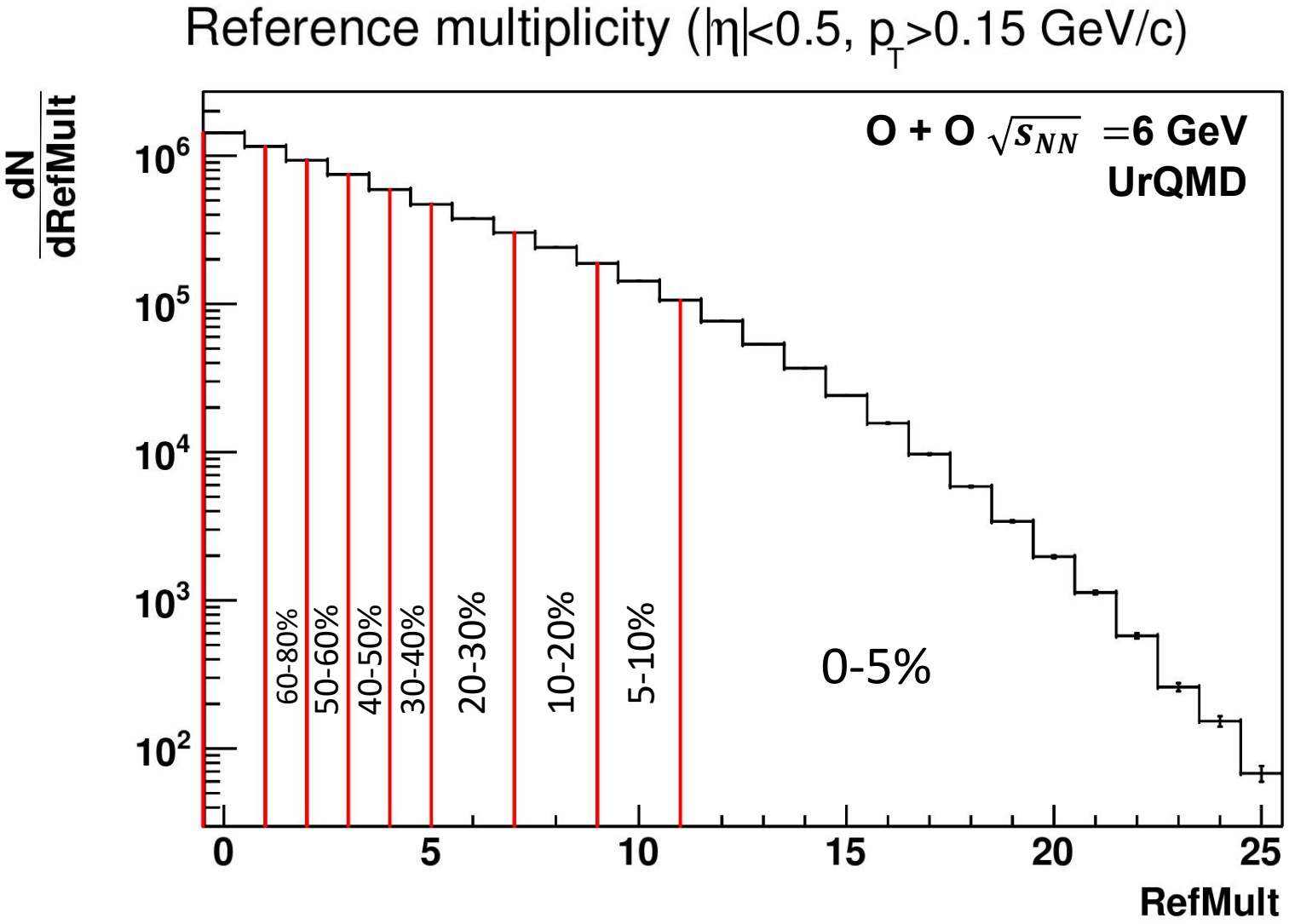


Centrality	Impact parameter b, fm	Fraction
0 - 5%	0 - 1.2	0.04213
5 - 10%	1.2 - 1.8	0.09619
10 - 20%	1.8 - 2.6	0.20008
20 - 30%	2.6 - 3.2	0.30063
30 - 40%	3.2 - 3.6	0.38171
40 - 50%	3.6 - 4.2	0.51394
50 - 60%	4.2 - 4.6	0.60717
60 - 70%	4.6 - 5.0	0.69705
70 - 80%	5.0 - 5.4	0.78271

Collision centrality determiantion using reference multiplicity ($|\eta| < 0.5$)

System: O + O $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~7×10^6 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 0.5$ and $p_T > 0.15$ GeV/c**

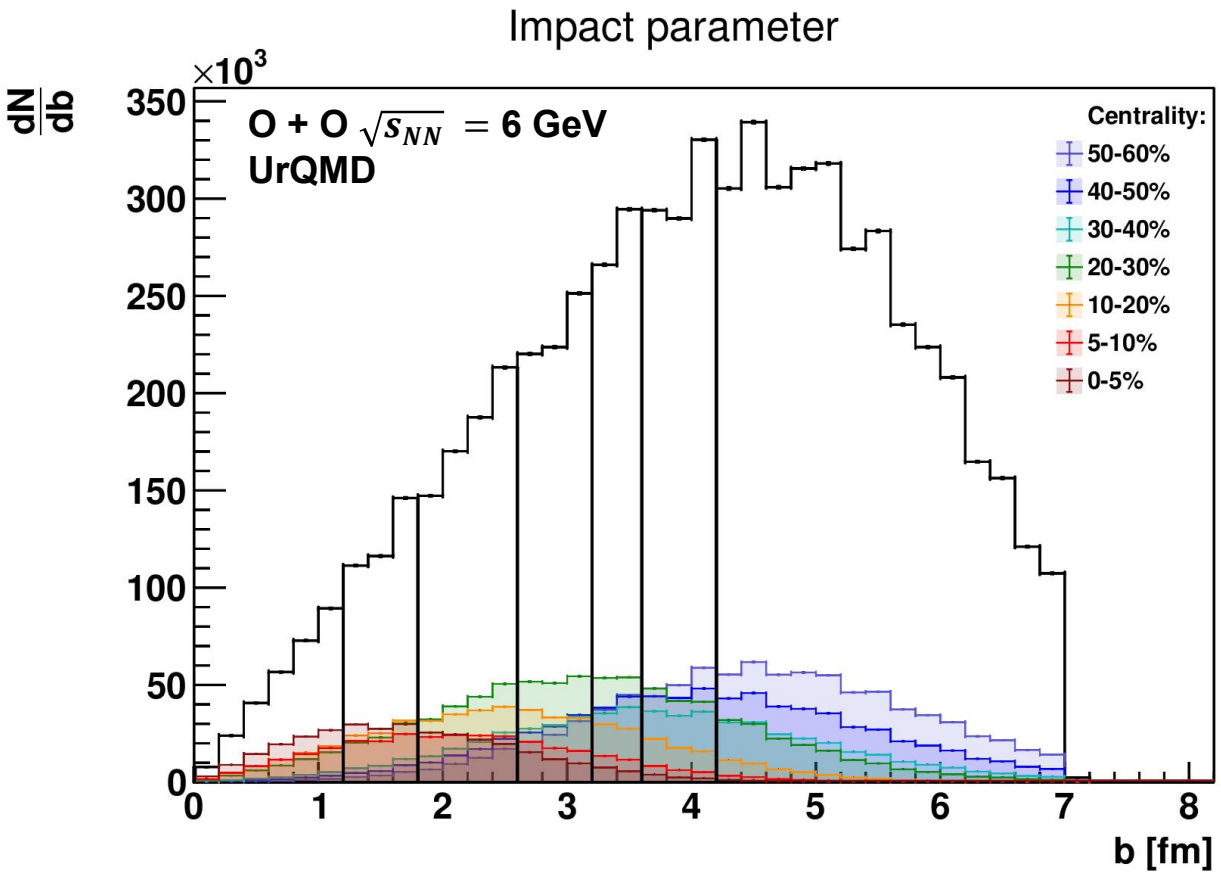


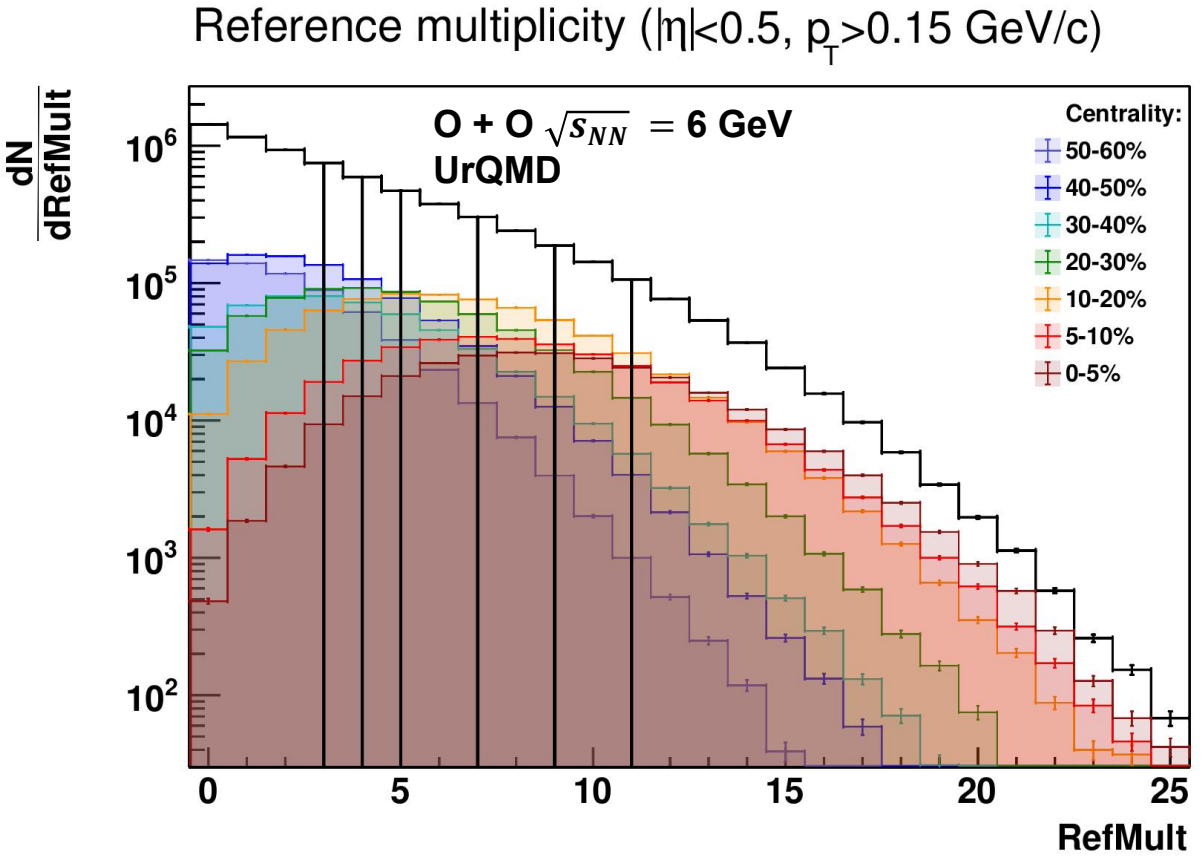
Centrality	RefMult	Fraction
0 - 5%	11 - 30	0.04862
5 - 10%	9 - 11	0.09640
10 - 20%	7 - 9	0.17501
20 - 30%	5 - 7	0.29746
30 - 40%	4 - 5	0.38304
40 - 50%	3 - 4	0.49131
50 - 60%	2 - 3	0.62619
60 - 80%	1 - 2	0.79341

Collision centrality determiantion using reference multiplicity ($|\eta| < 0.5$)

System: O + O $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~7×10^6 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 0.5$ and $p_T > 0.15$ GeV/c**

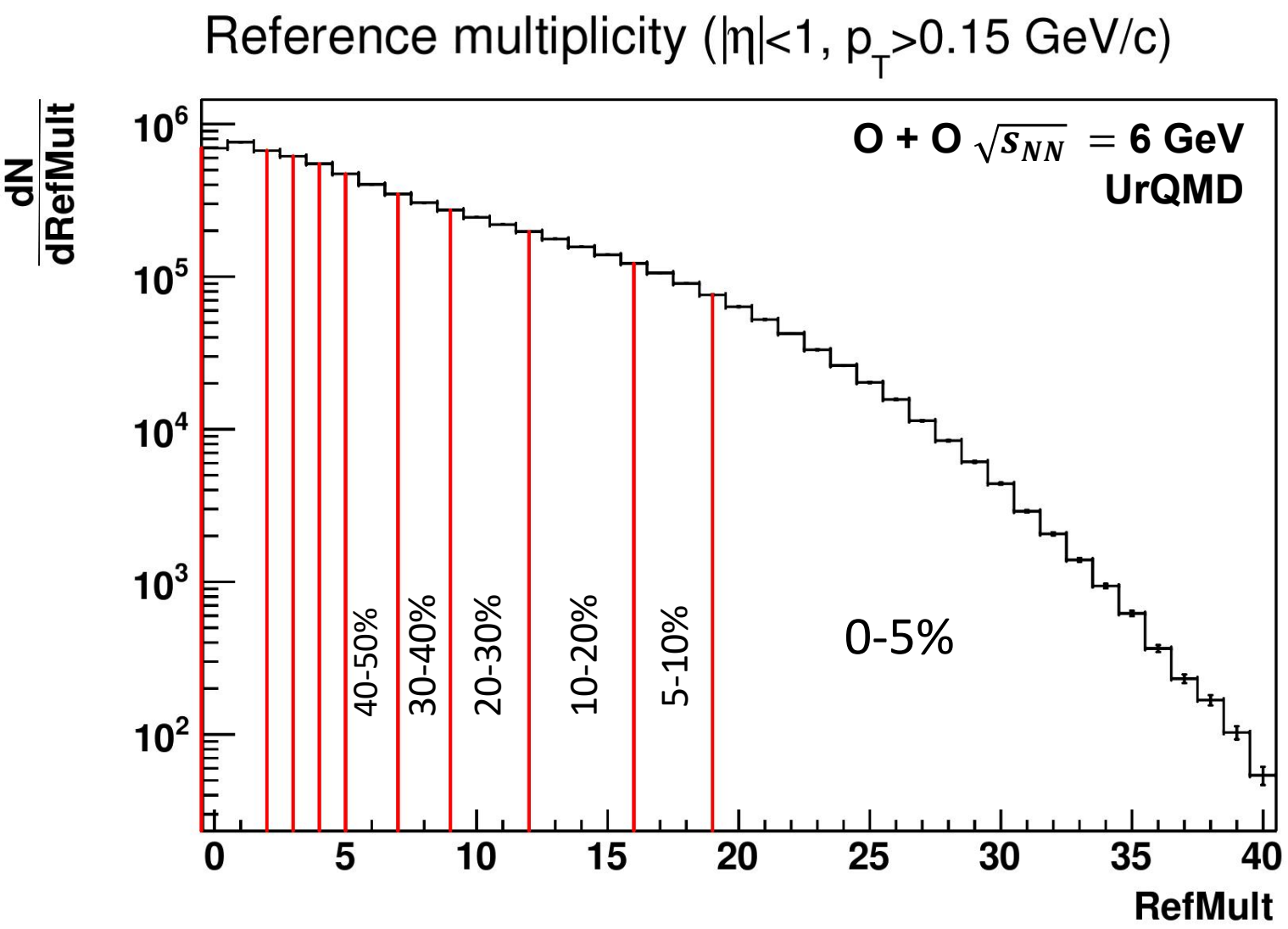




Collision centrality determiantion using reference multiplicity ($|\eta| < 1.0$)

System: O + O $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~7×10^6 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 1.0$ and $p_T > 0.15$ GeV/c**

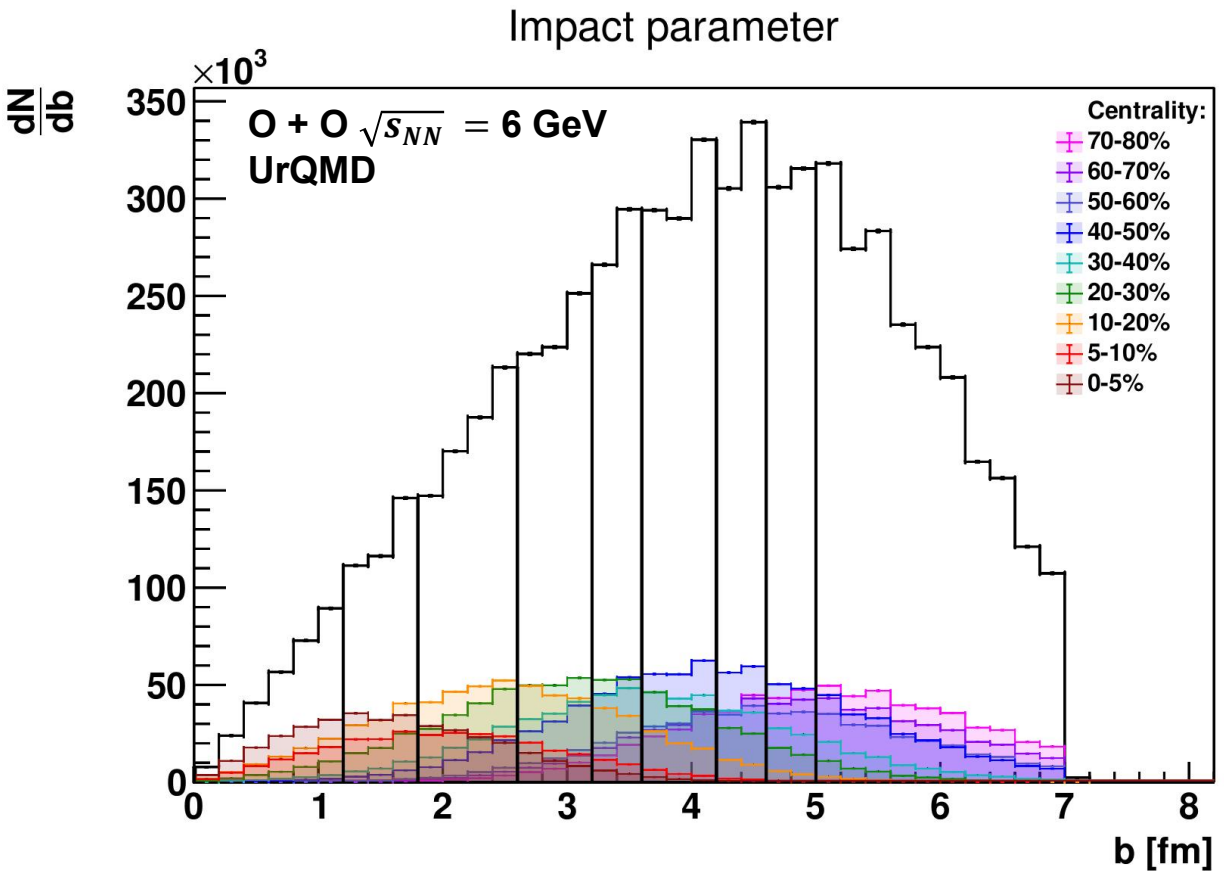


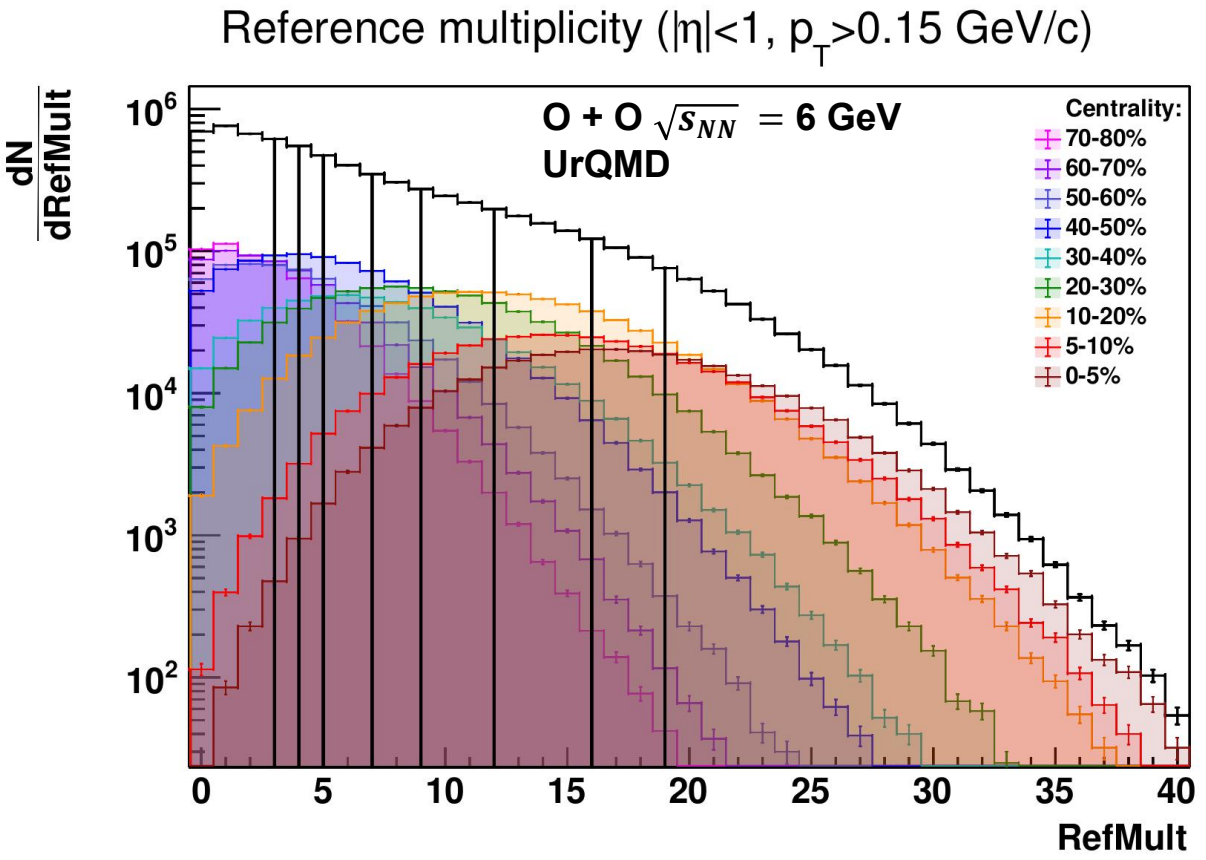
Centrality	RefMult	Fraction
0 - 5%	19 - 48	0.05333
5 - 10%	16 - 19	0.09935
10 - 20%	12 - 16	0.19625
20 - 30%	9 - 12	0.30292
30 - 40%	7 - 9	0.39747
40 - 50%	5 - 7	0.52390
50 - 60%	4 - 5	0.60342
60 - 70%	3 - 4	0.69244
70 - 80%	2 - 3	0.78930

Collision centrality determiantion using reference multiplicity ($|\eta| < 1.0$)

System: O + O $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~7×10^6 events

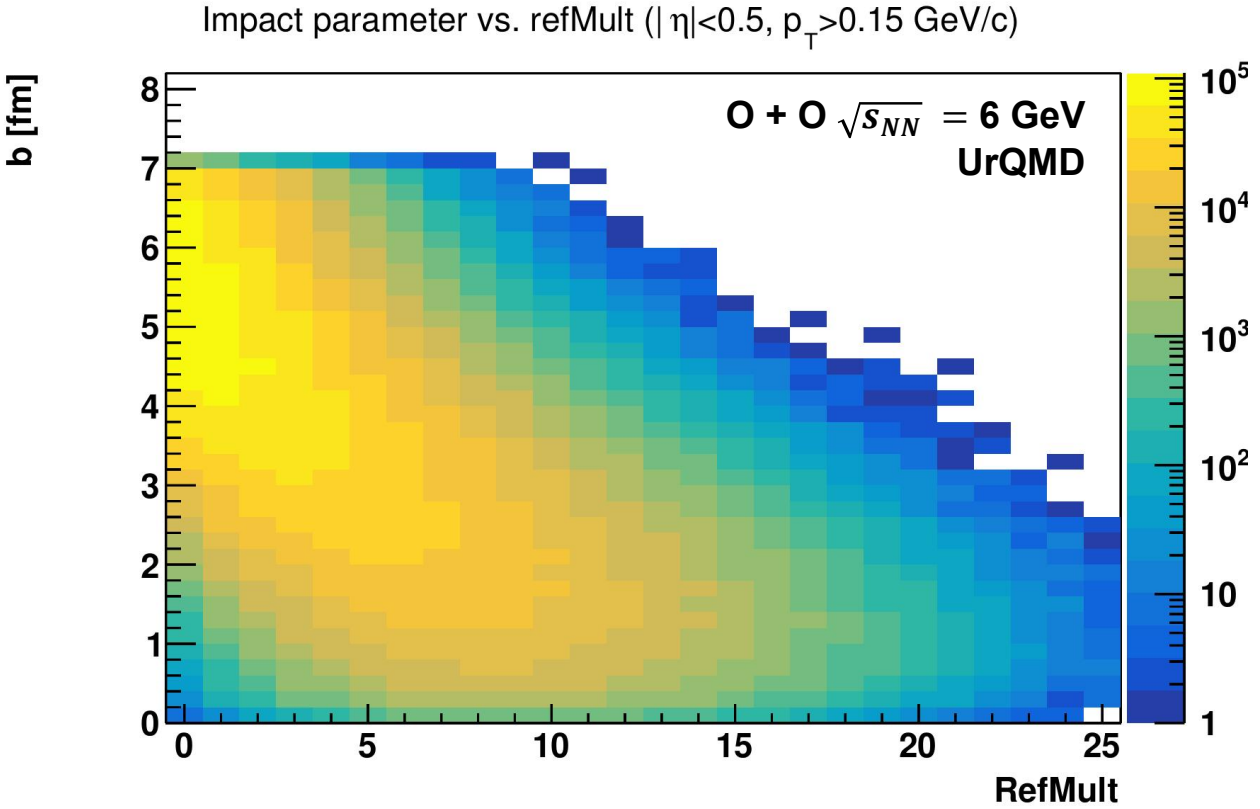
Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 1.0$ and $p_T > 0.15$ GeV/c**



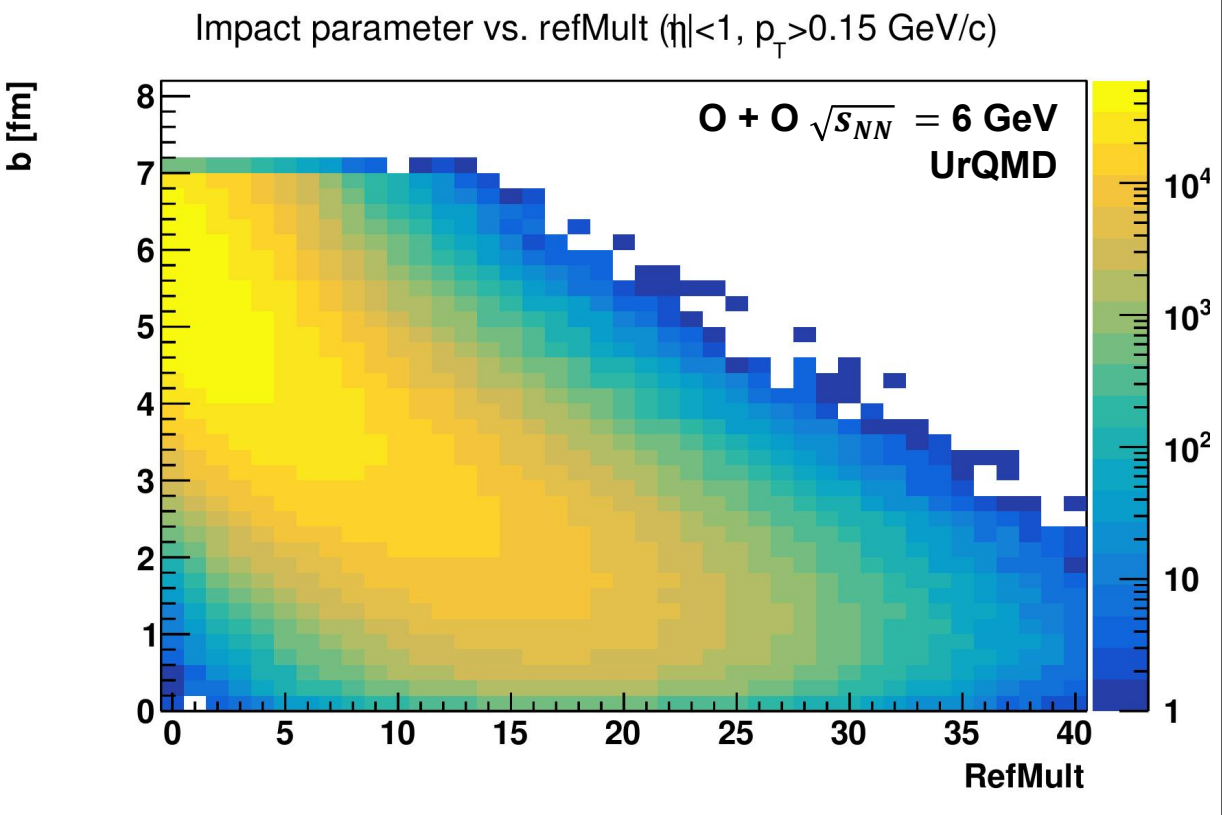


Impact parameter vs RefMult

System: O + O $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~7×10^6 events



Reference multiplicity is calculated as a number of charged particles with **|η| < 0.5 and p_T > 0.15 GeV/c**



Reference multiplicity is calculated as a number of charged particles with **|η| < 1.0 and p_T > 0.15 GeV/c**

Collision centrality determiantion - comparison

Centrality	RefMult ($\|\eta\| < 0.5$)	Fraction	RefMult($\|\eta\| < 1.0$)	Fraction	Impact parameter b, fm	Fraction
0 - 5%	11 - 30	0.04862	19 - 48	0.05333	0 - 1.2	0.04213
5 - 10%	9 - 11	0.09640	16 - 19	0.09935	1.2 - 1.8	0.09619
10 - 20%	7 - 9	0.17501	12 - 16	0.19625	1.8 - 2.6	0.20008
20 - 30%	5 - 7	0.29746	9 - 12	0.30292	2.6 - 3.2	0.30063
30 - 40%	4 - 5	0.38304	7 - 9	0.39747	3.2 - 3.6	0.38171
40 - 50%	3 - 4	0.49131	5 - 7	0.52390	3.6 - 4.2	0.51394
50 - 60%	2 - 3	0.62619	4 - 5	0.60342	4.2 - 4.6	0.60717
60 - 70%	1 - 2	0.79341	3 - 4	0.69244	4.6 - 5.0	0.69705
70 - 80%			2 - 3	0.78930	5.0 - 5.4	0.78271

Data & Cuts

System: O + O $\sqrt{s_{NN}} = 6$ GeV

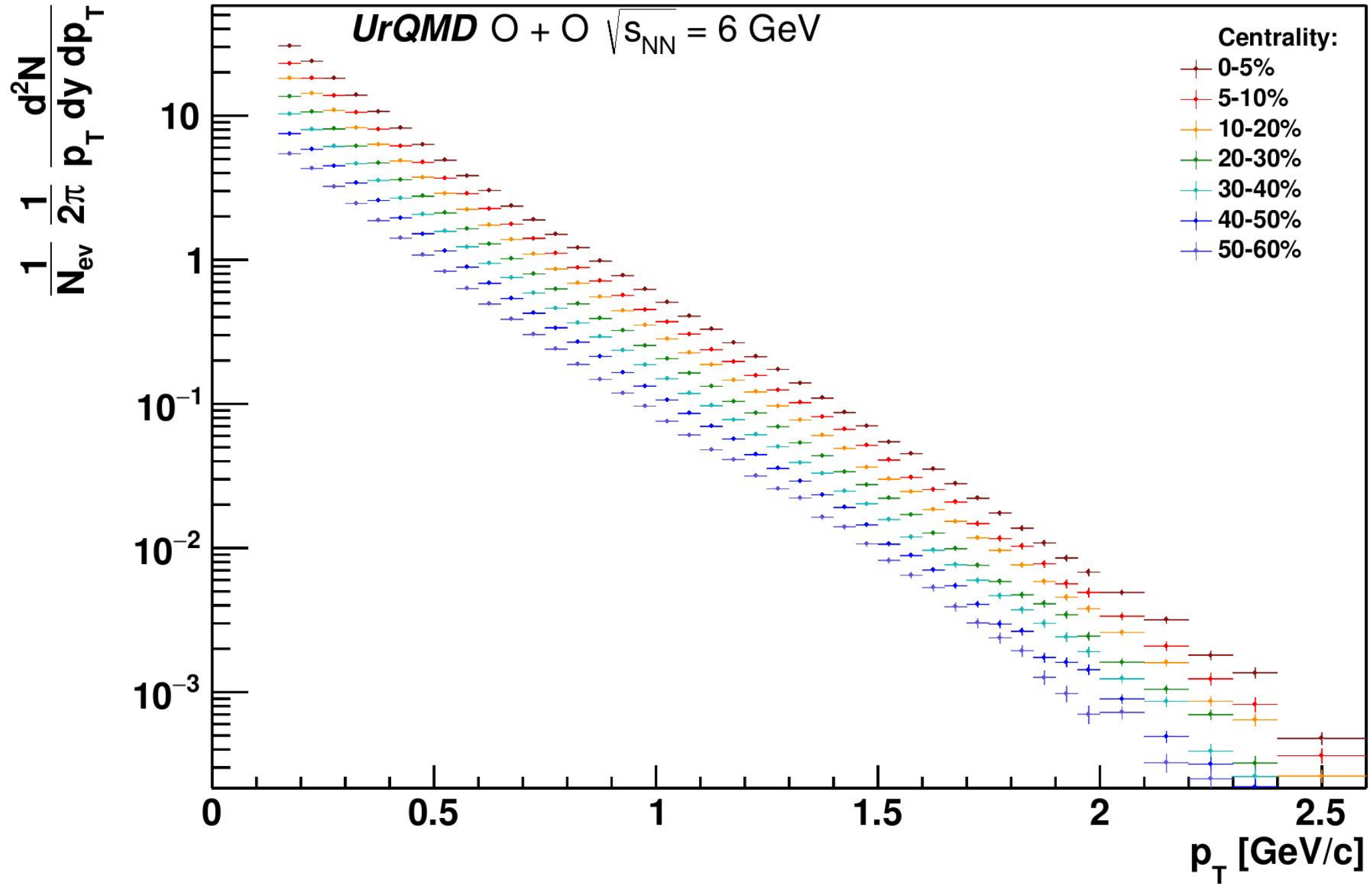
UrQMD, statistics: ~7×10^6 events

Track cuts:

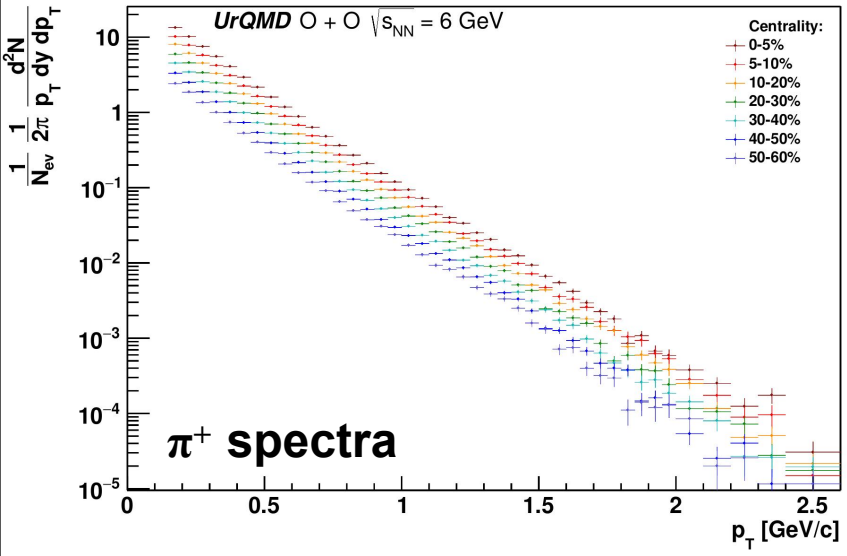
- $|y| < 0.1$
- $|\eta| < 1.0$
- $p_T > 0.15$ GeV/c

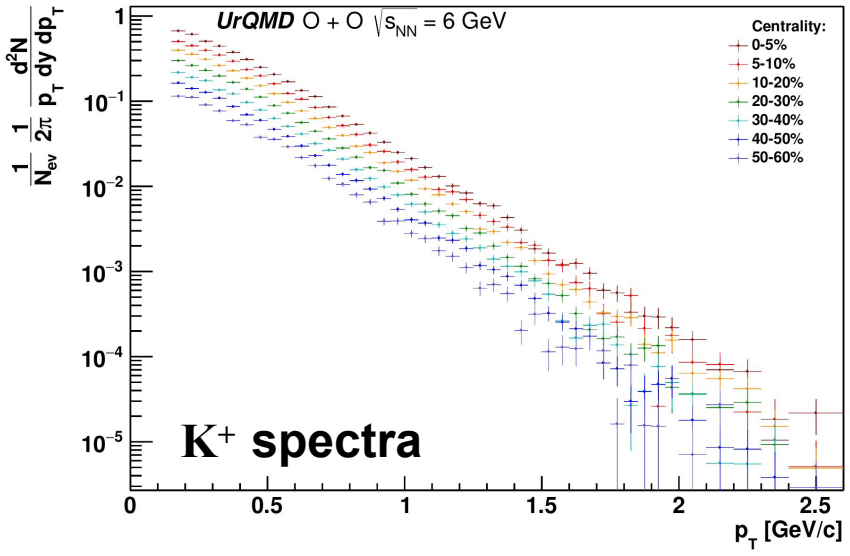
Centrality is calculated using **reference multiplicity** ($|\eta| < 1.0$, $p_T > 0.15$ GeV/c)

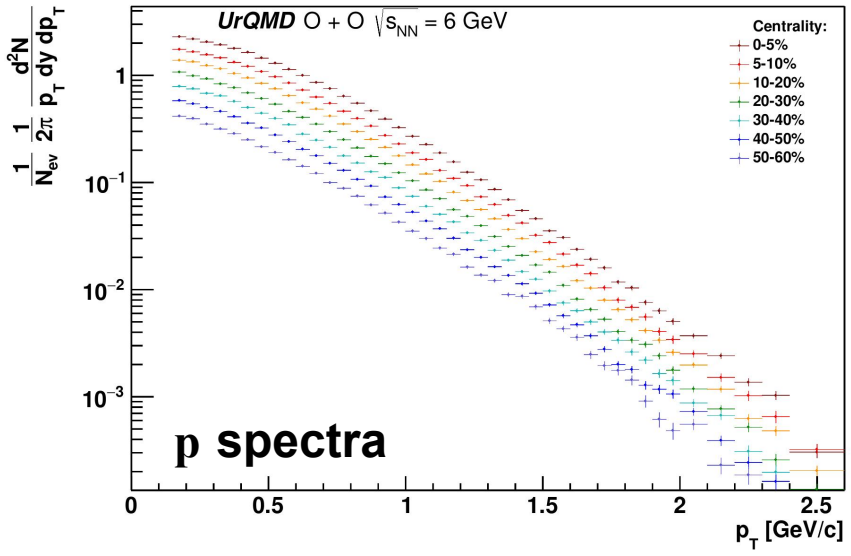
Charged hadron spectra for different centrality classes (RefMult10)

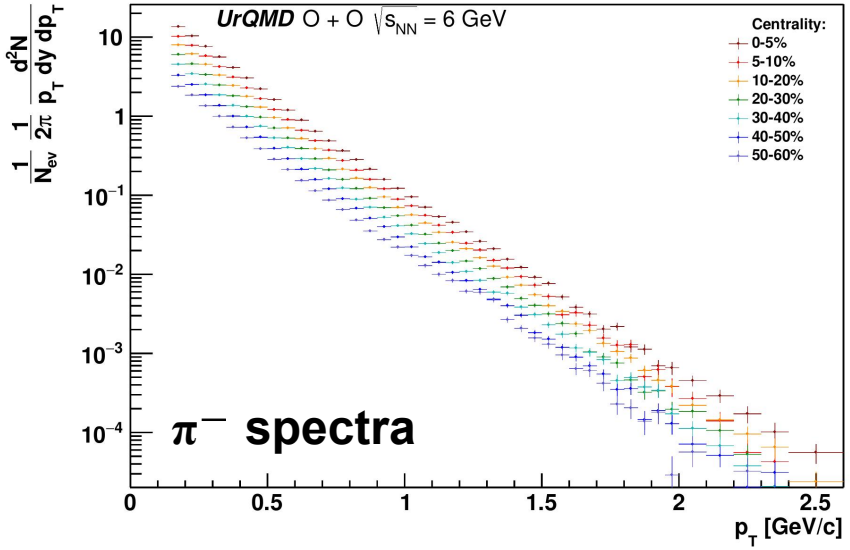


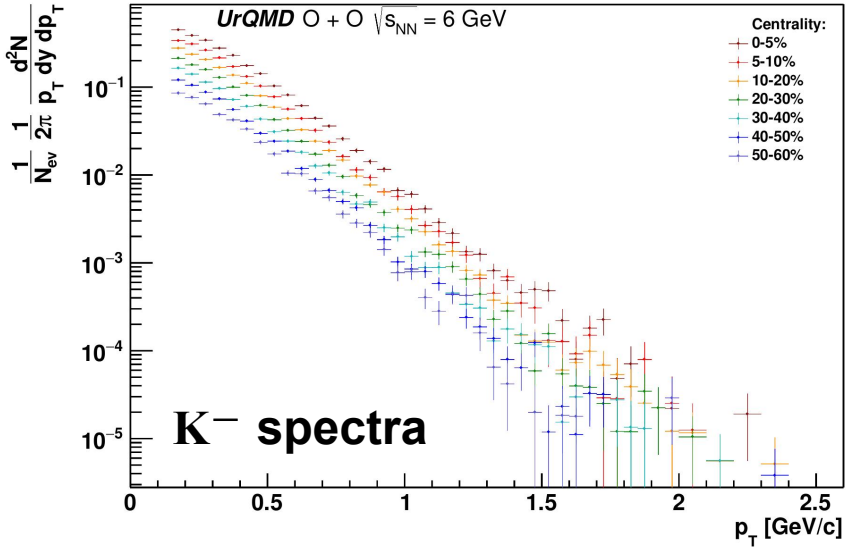
Identified hadron spectra for different centrality classes (RefMult10)

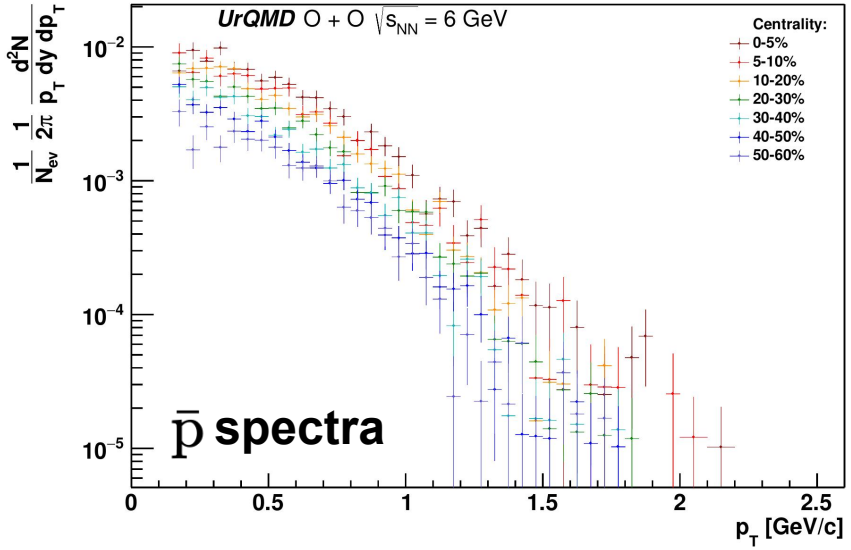




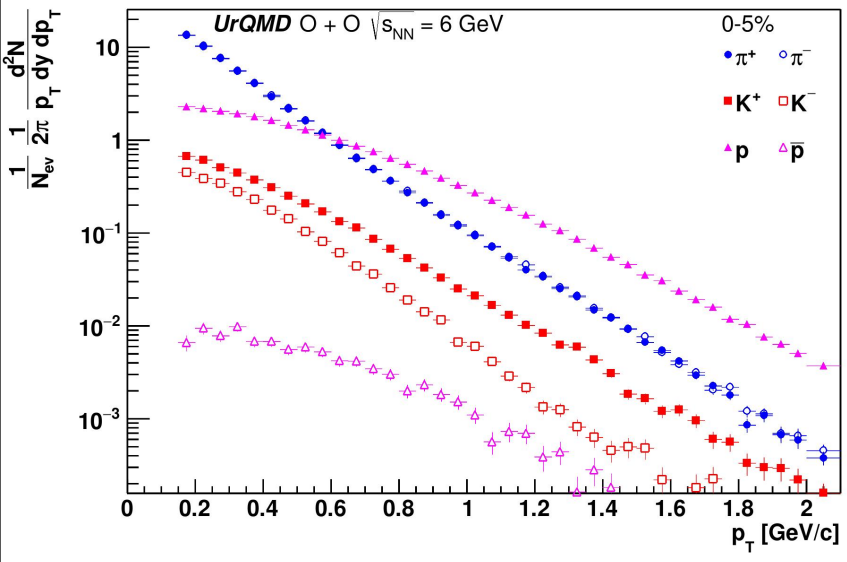


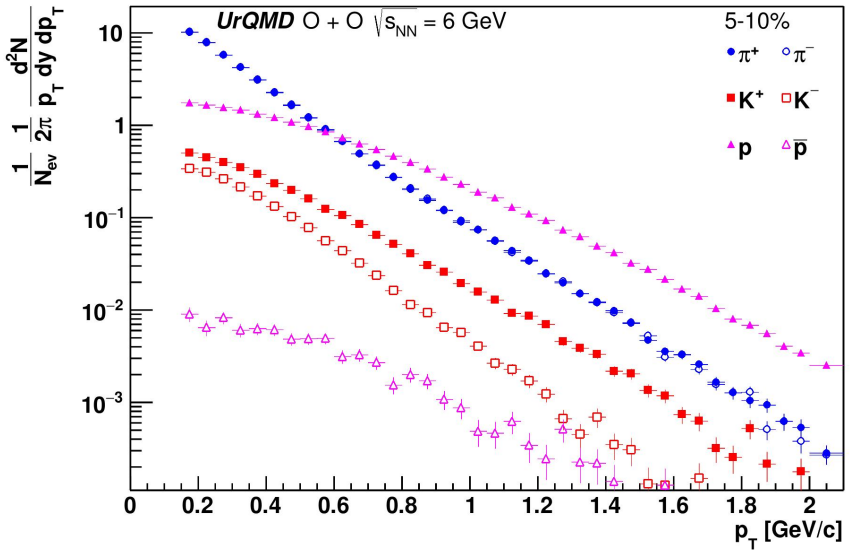


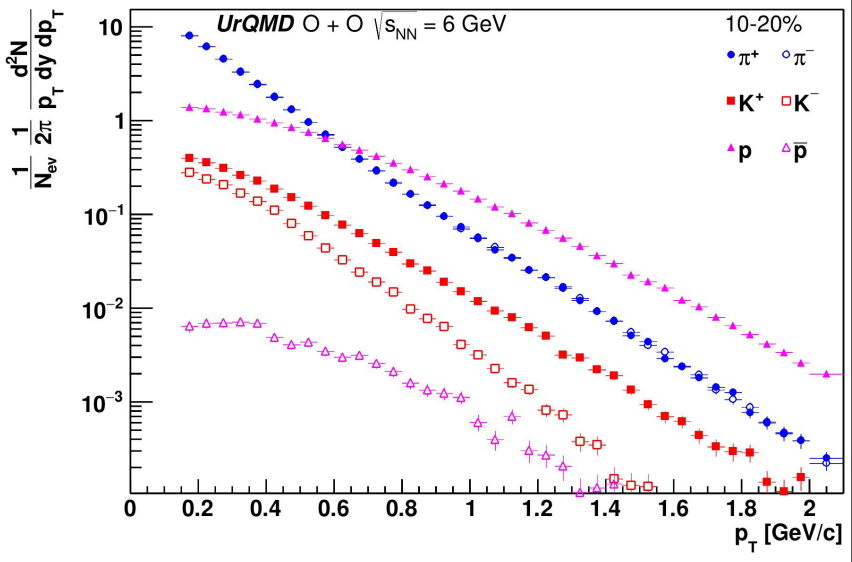


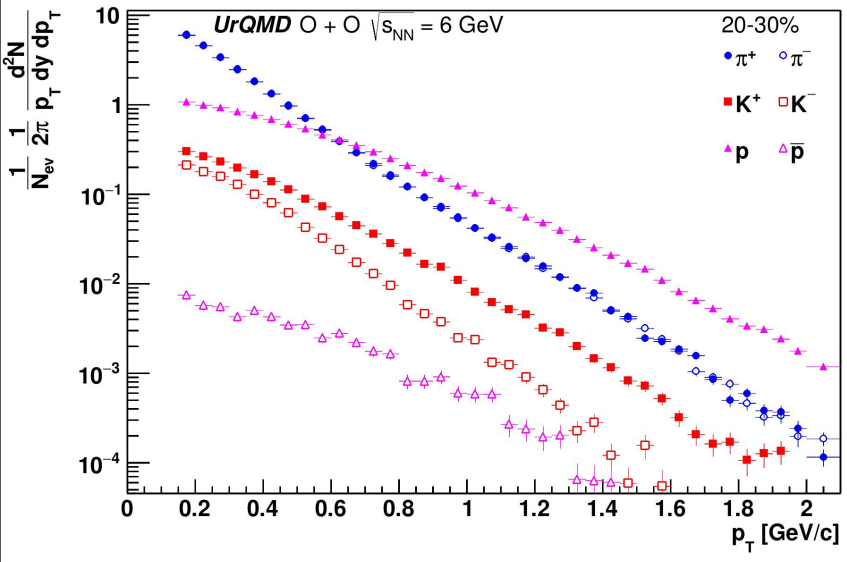


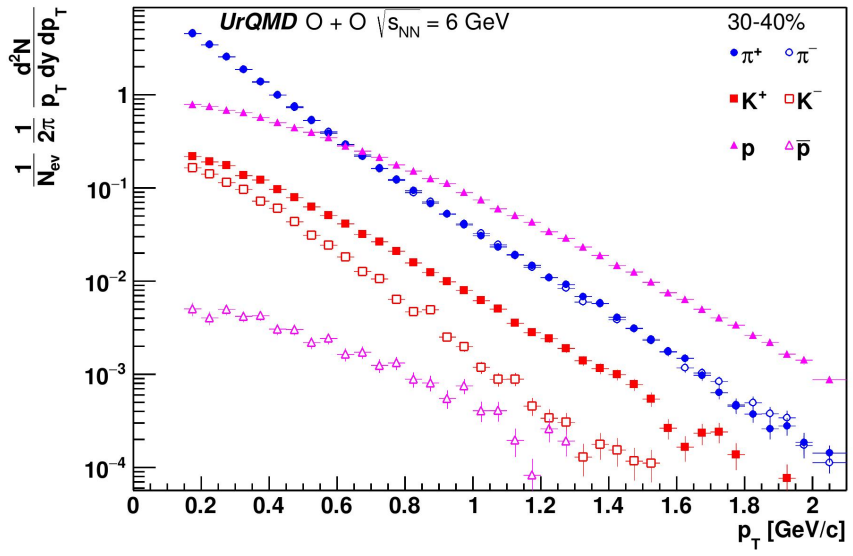
Identified hadron spectra for different centrality classes (RefMult10)

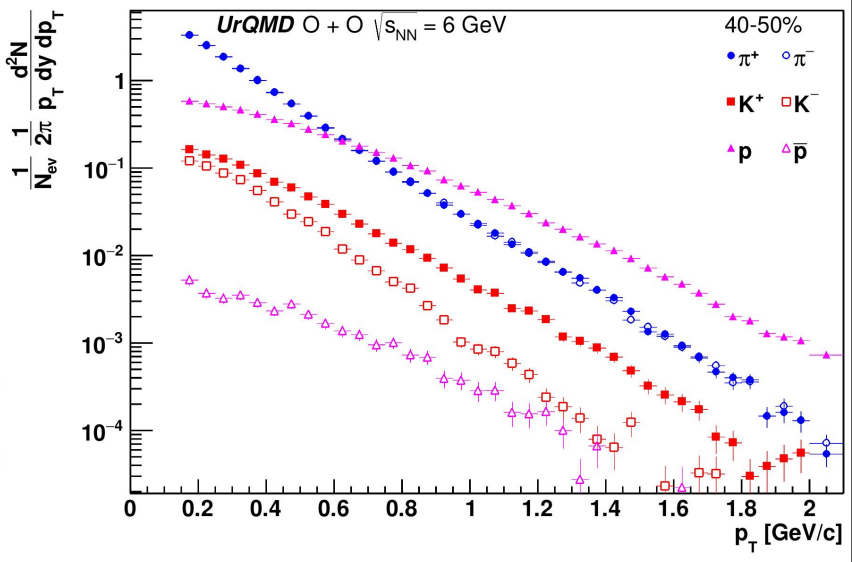




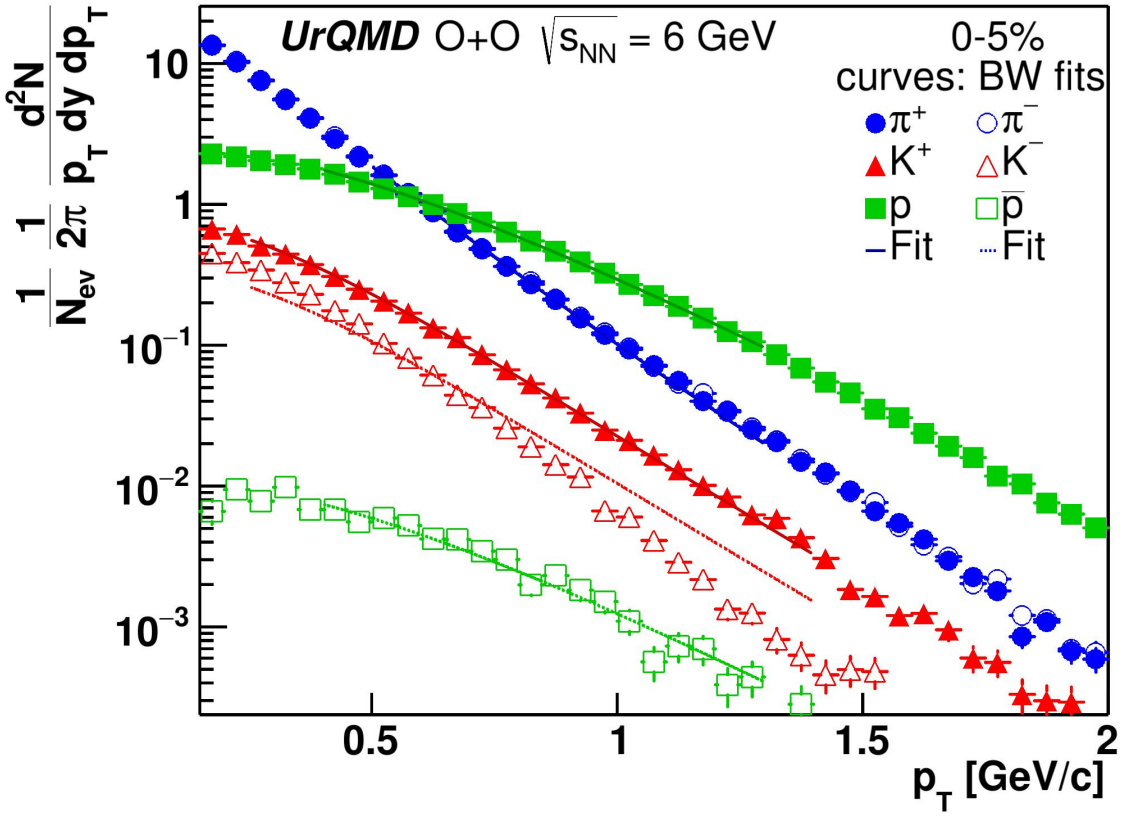








same *n* for all particles

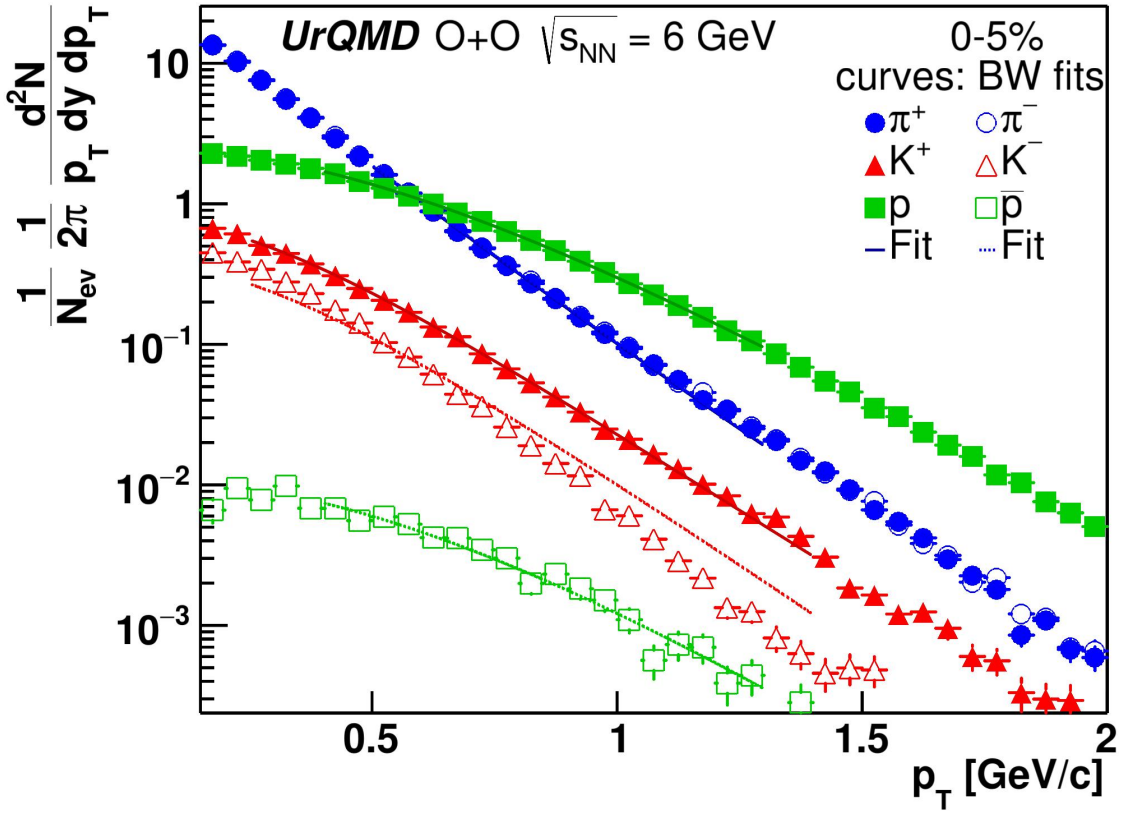


$\beta = 0.288 \pm 0.003$

$T_{kin} = 119 \pm 1$ MeV

$\chi^2/ndf = 14.4$

same *n* for all particles
exept K^-

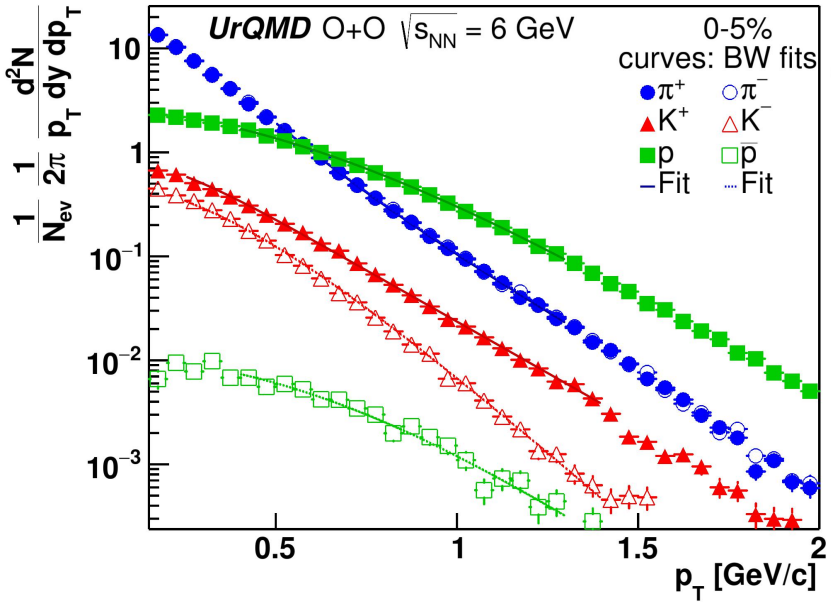


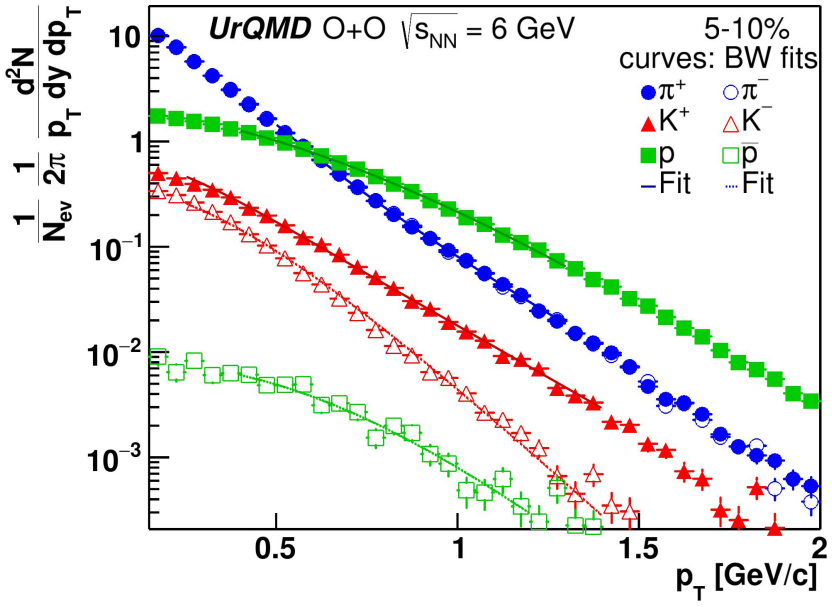
$\beta =$

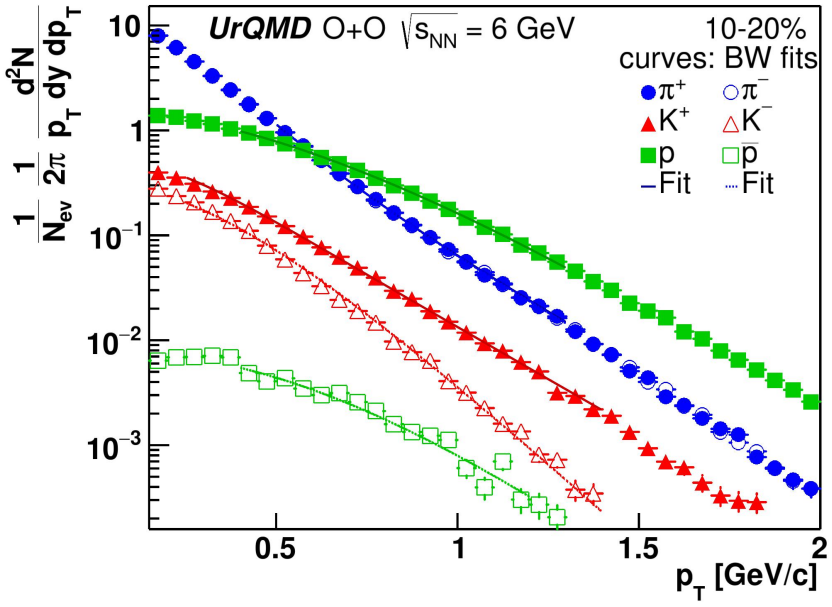
$T_{kin} =$

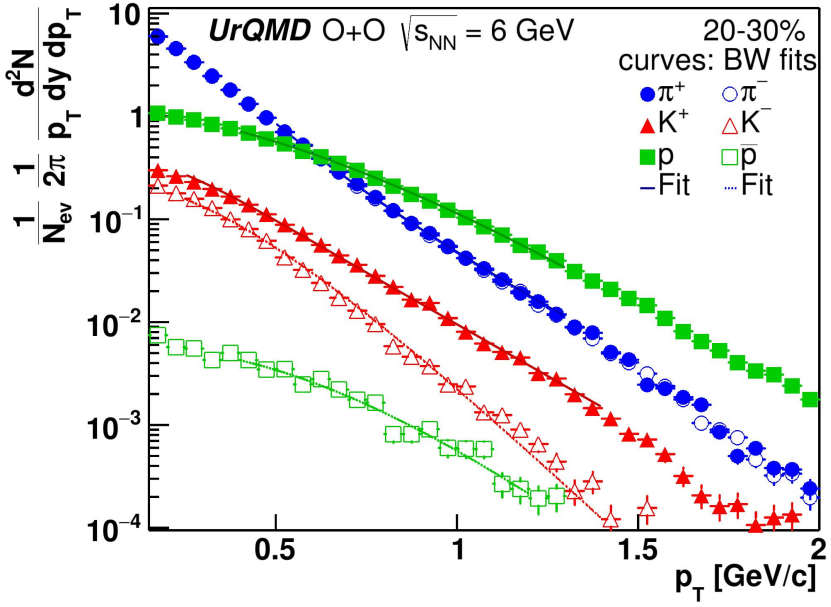
$\chi^2/ndf =$

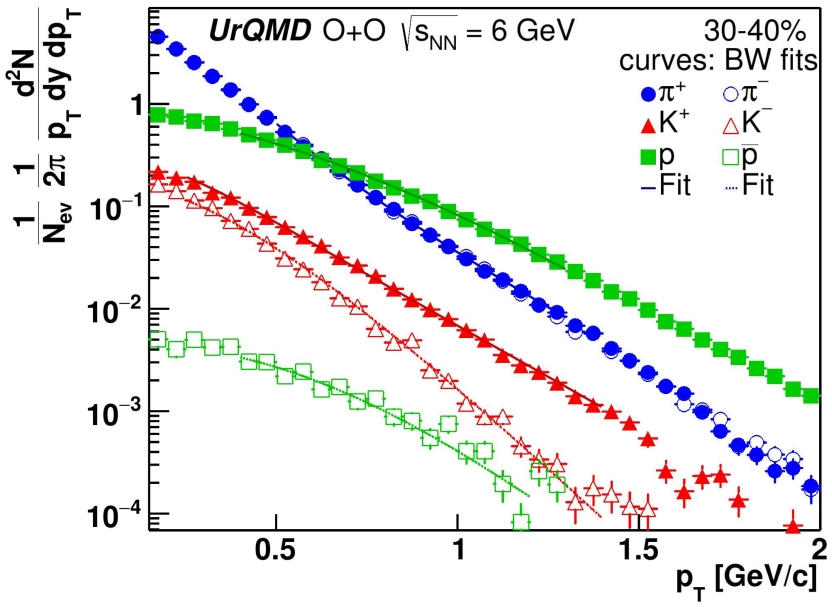
Fitted hadron spectra for different centrality classes (different *n*)

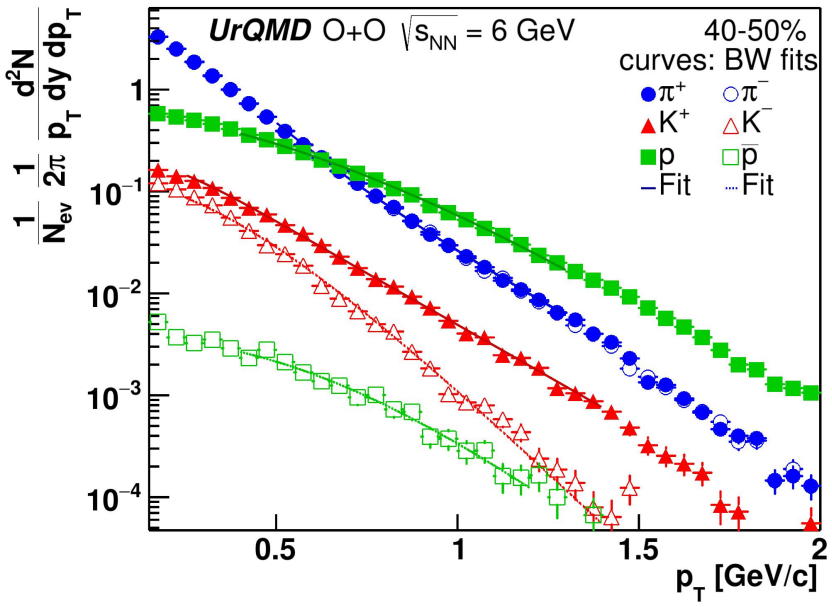












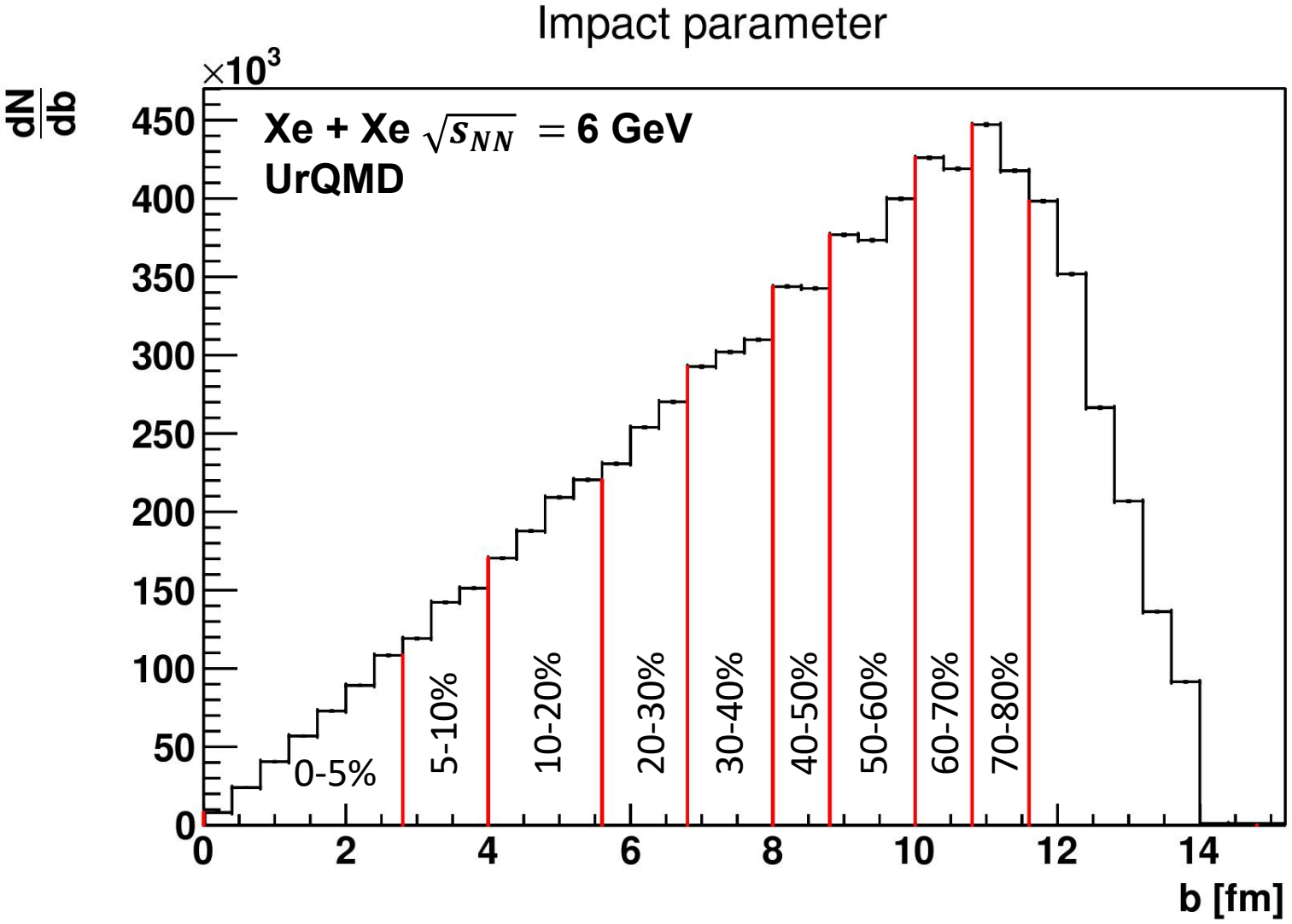
Fitted hadron spectra for different centrality classes (same *n*)

Collision centrality	**β**	$\mathbf{T_{kin}}$, МэВ	$\boldsymbol{\chi^2/ndf}$
0 - 5%	0.366 ± 0.004	87 ± 2	1.76
5 - 10%	0.360 ± 0.005	84 ± 3	2.02
10 - 20%	0.350 ± 0.003	88 ± 2	2.55
20 - 30%	0.352 ± 0.002	83 ± 1	3.11
30 - 40%	0.350 ± 0.004	83 ± 3	2.6
40 - 50%	0.354 ± 0.005	79 ± 3	2.4

Collision centrality determiantion using impact parameter

System: Xe + Xe $\sqrt{s_{NN}} = 6$ GeV

UrQMD, statistics: ~ 8×10^6 events

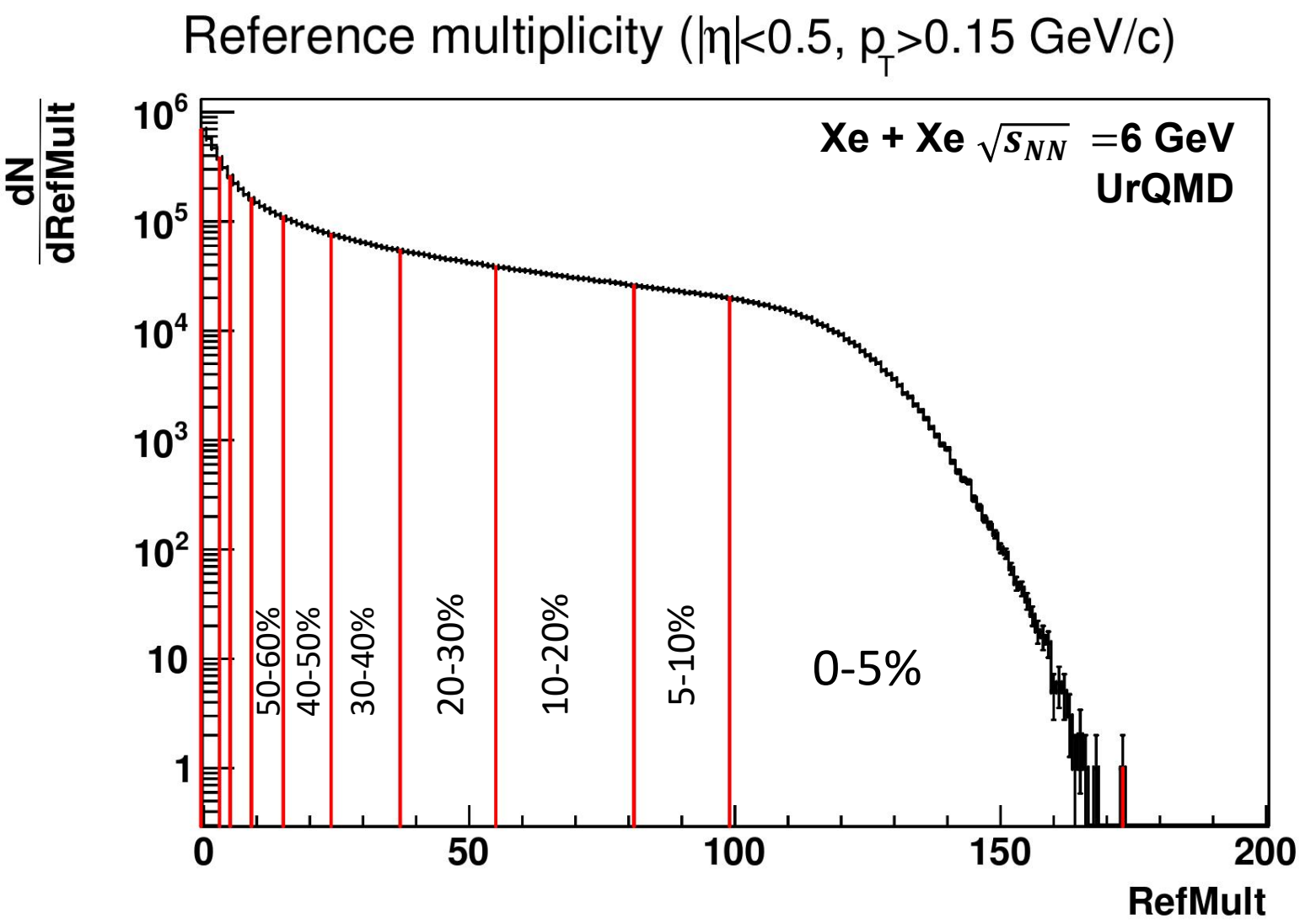


Centrality	Impact parameter b, fm	Fraction
0 - 5%	0 - 2.8	0.04843
5 - 10%	2.8 - 4.0	0.09840
10 - 20%	4.0 - 5.6	0.19380
20 - 30%	5.6 - 6.8	0.28520
30 - 40%	6.8 - 8.0	0.39474
40 - 50%	8.0 - 8.8	0.47785
50 - 60%	8.8 - 10.0	0.61711
60 - 70%	10.0 - 10.8	0.71944
70 - 80%	10.8 - 11.6	0.82416

Collision centrality determiantion using reference multiplicity ($|\eta| < 0.5$)

System: Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~8×10^6 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 0.5$ and $p_T > 0.15$ GeV/c**

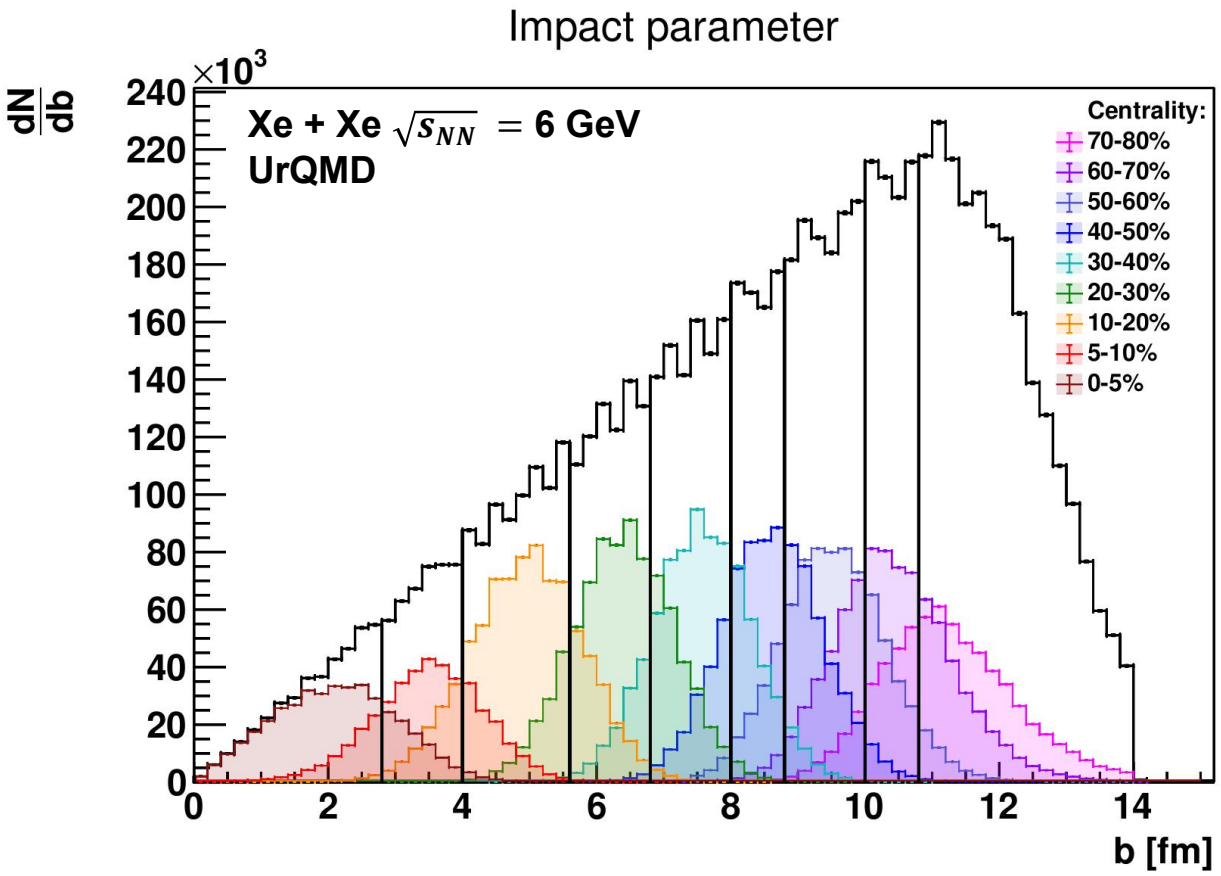


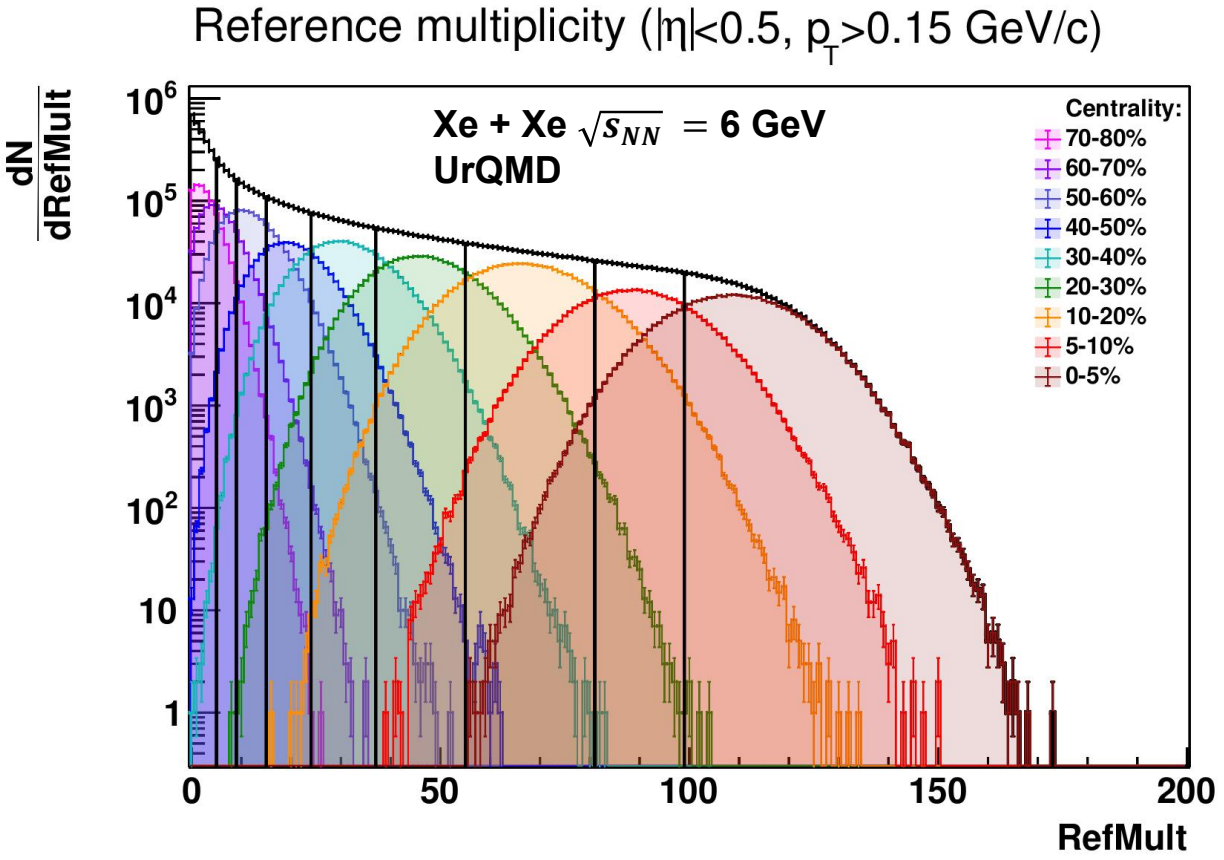
Centrality	RefMult	Fraction
0 - 5%	99 - 173	0.04974
5 - 10%	81 - 99	0.09997
10 - 20%	55 - 81	0.20081
20 - 30%	37 - 55	0.30150
30 - 40%	24 - 37	0.40360
40 - 50%	15 - 24	0.50439
50 - 60%	9 - 15	0.60303
60 - 70%	5 - 9	0.70659
70 - 80%	3 - 5	0.79010

Collision centrality determiantion using reference multiplicity ($|\eta| < 0.5$)

System: Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~8×10^6 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 0.5$ and $p_T > 0.15$ GeV/c**

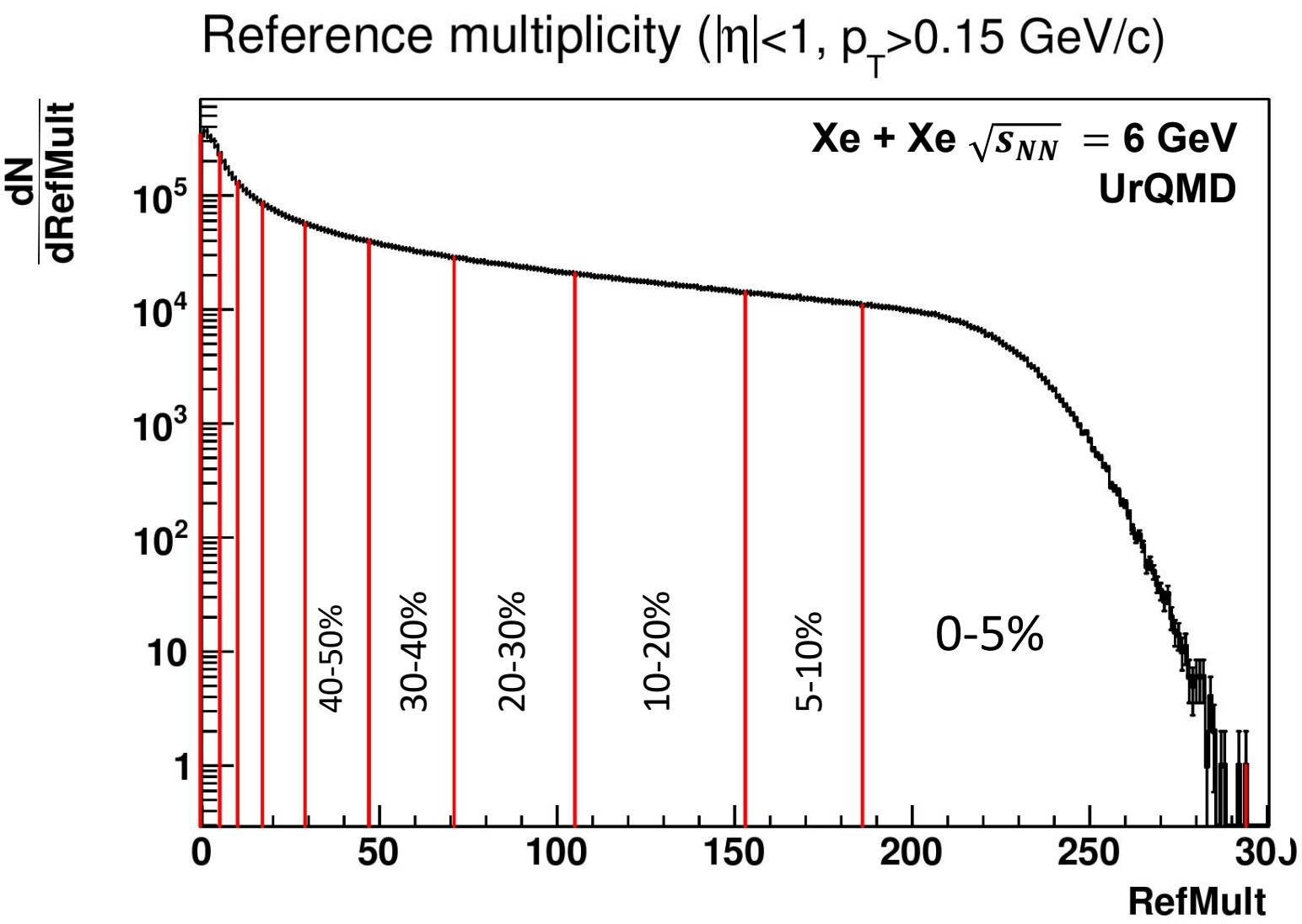




Collision centrality determiantion using reference multiplicity ($|\eta| < 1.0$)

System: Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~8×10^6 events

Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 1.0$ and $p_T > 0.15$ GeV/c**

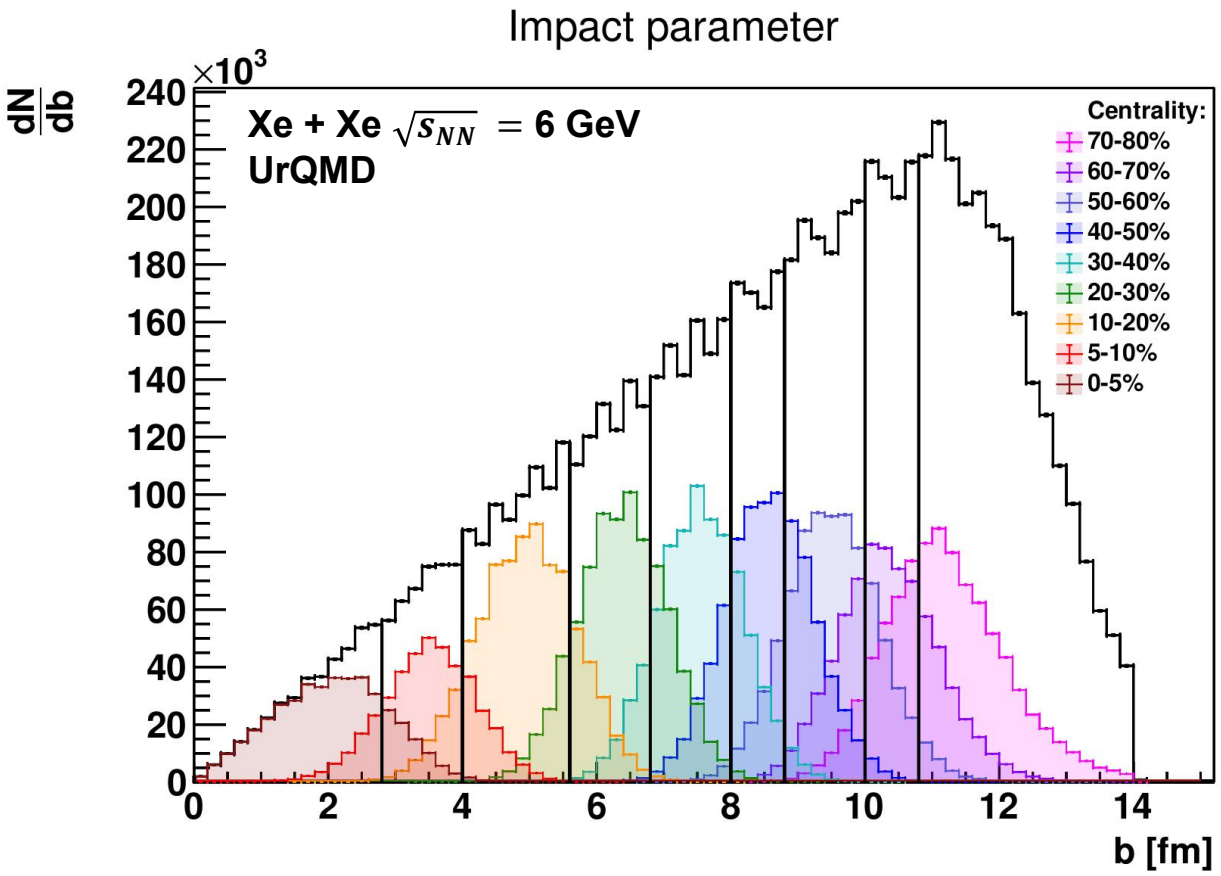


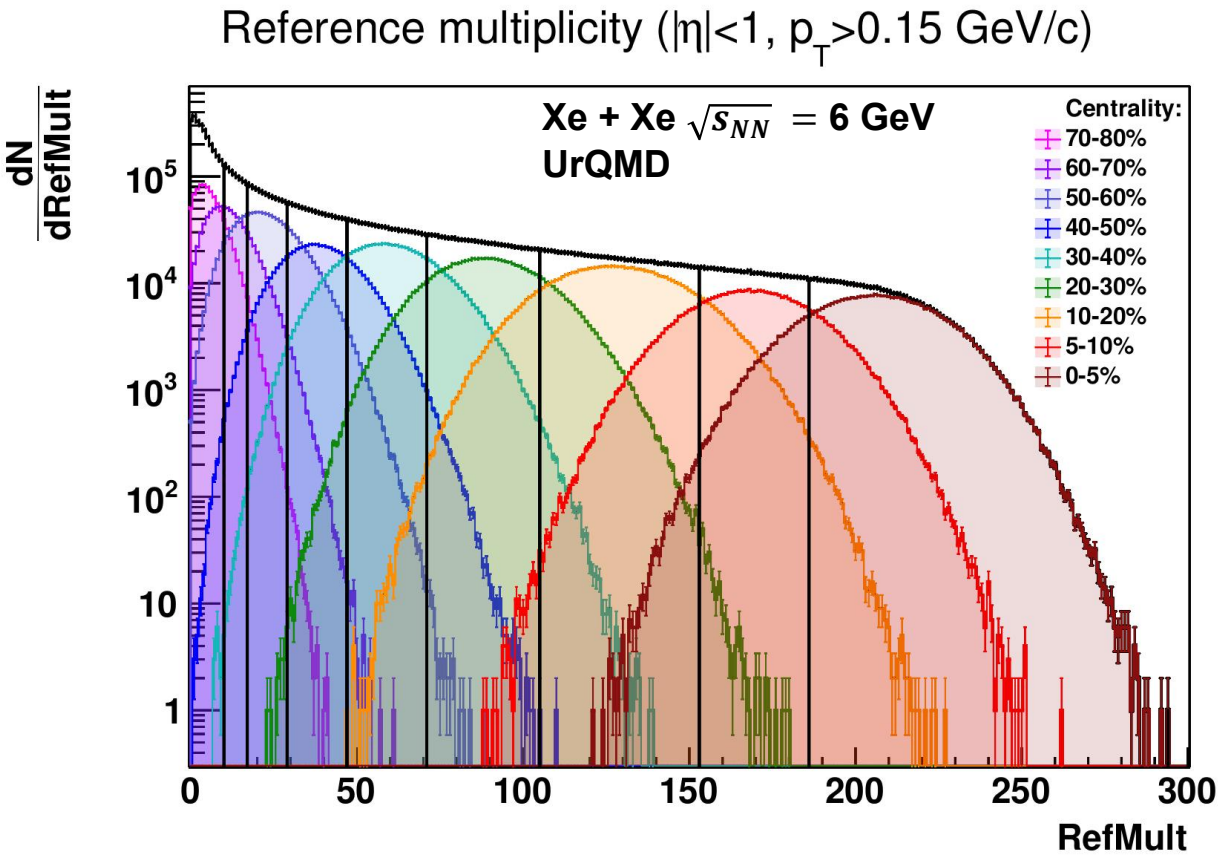
Centrality	RefMult	Fraction
0 - 5%	186 - 294	0.05037
5 - 10%	153 - 186	0.10082
10 - 20%	105 - 153	0.20068
20 - 30%	71 - 105	0.30112
30 - 40%	47 - 71	0.39905
40 - 50%	29 - 47	0.50256
50 - 60%	17 - 29	0.60429
60 - 70%	10 - 17	0.69522
70 - 80%	5 - 10	0.80455

Collision centrality determiantion using reference multiplicity ($|\eta| < 1.0$)

System: Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~8×10^6 events

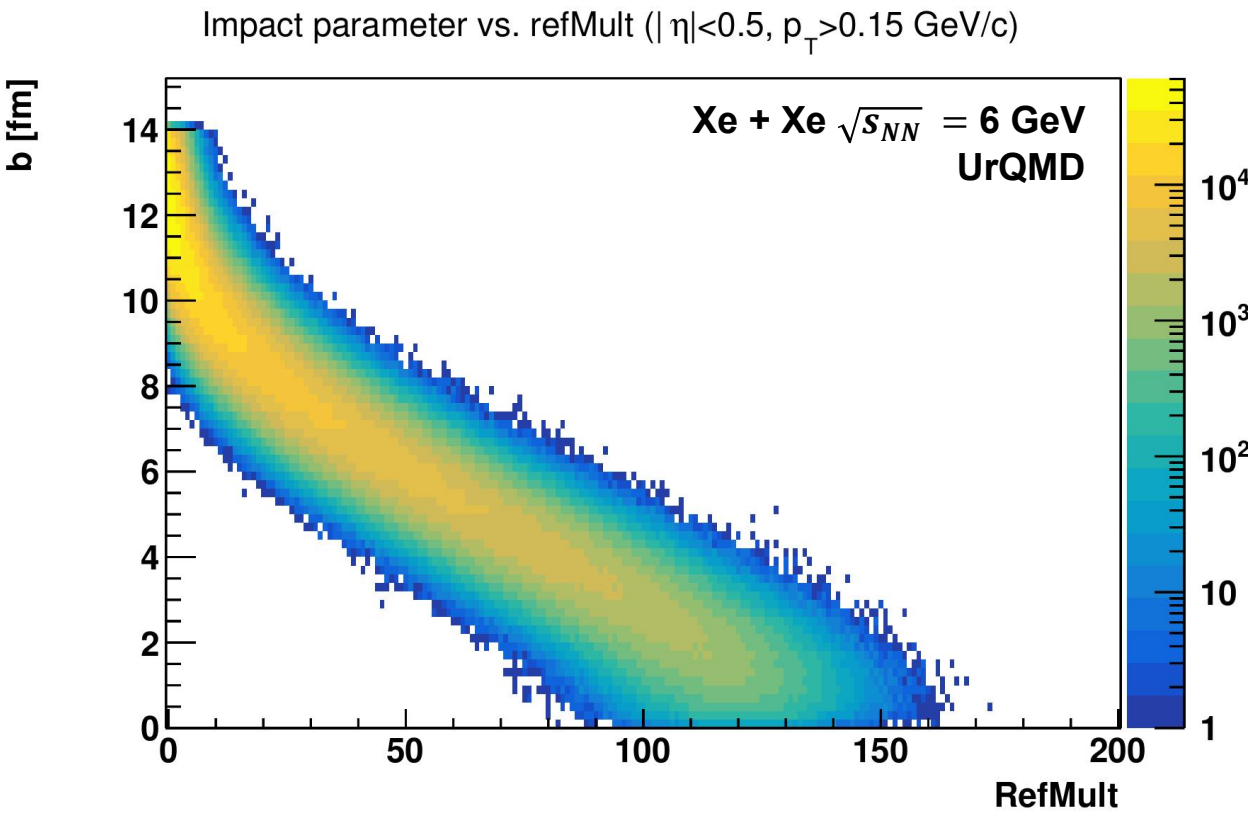
Reference multiplicity (RefMult) is calculated as a number of charged particles with **$|\eta| < 1.0$ and $p_T > 0.15$ GeV/c**



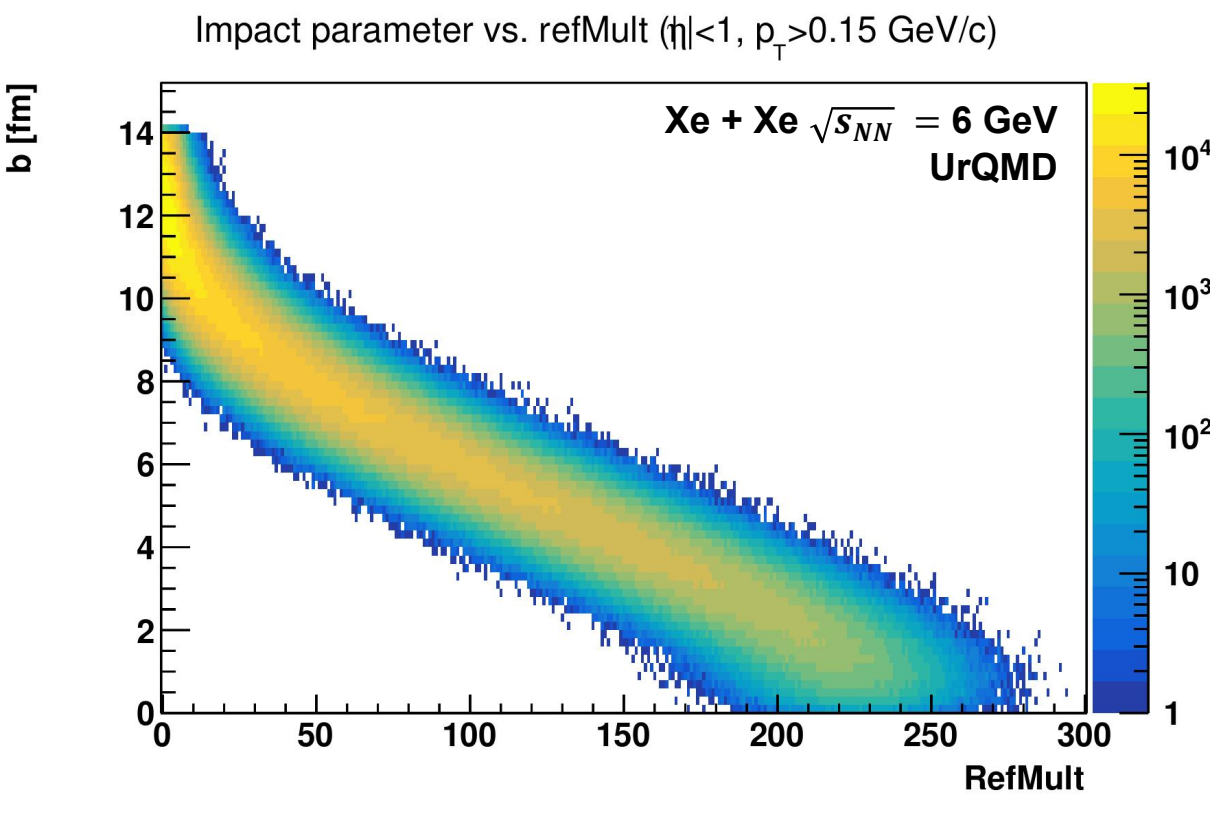


Impact parameter vs RefMult

System: Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV, UrQMD, statistics: ~8×10^6 events



Reference multiplicity is calculated as a number of charged particles with **|η| < 0.5 and p_T > 0.15 GeV/c**



Reference multiplicity is calculated as a number of charged particles with **|η| < 1.0 and p_T > 0.15 GeV/c**

Collision centrality determiantion - comparison

Centrality	RefMult ($|\eta| < 0.5$)	Fraction	RefMult($|\eta| < 1.0$)	Fraction	Impact parameter b, fm	Fraction
0 - 5%	99 - 173	0.04974	186 - 294	0.05037	0 - 2.8	0.04843
5 - 10%	81 - 99	0.09997	153 - 186	0.10082	2.8 - 4.0	0.09840
10 - 20%	55 - 81	0.20081	105 - 153	0.20068	4.0 - 5.6	0.19380
20 - 30%	37 - 55	0.30150	71 - 105	0.30112	5.6 - 6.8	0.28520
30 - 40%	24 - 37	0.40360	47 - 71	0.39905	6.8 - 8.0	0.39474
40 - 50%	15 - 24	0.50439	29 - 47	0.50256	8.0 - 8.8	0.47785
50 - 60%	9 - 15	0.60303	17 - 29	0.60429	8.8 - 10.0	0.61711
60 - 70%	5 - 9	0.70659	10 - 17	0.69522	10.0 - 10.8	0.71944
70 - 80%	3 - 5	0.79010	5 - 10	0.80455	10.8 - 11.6	0.82416

Data & Cuts

System: Xe + Xe $\sqrt{s_{NN}} = 6$ GeV

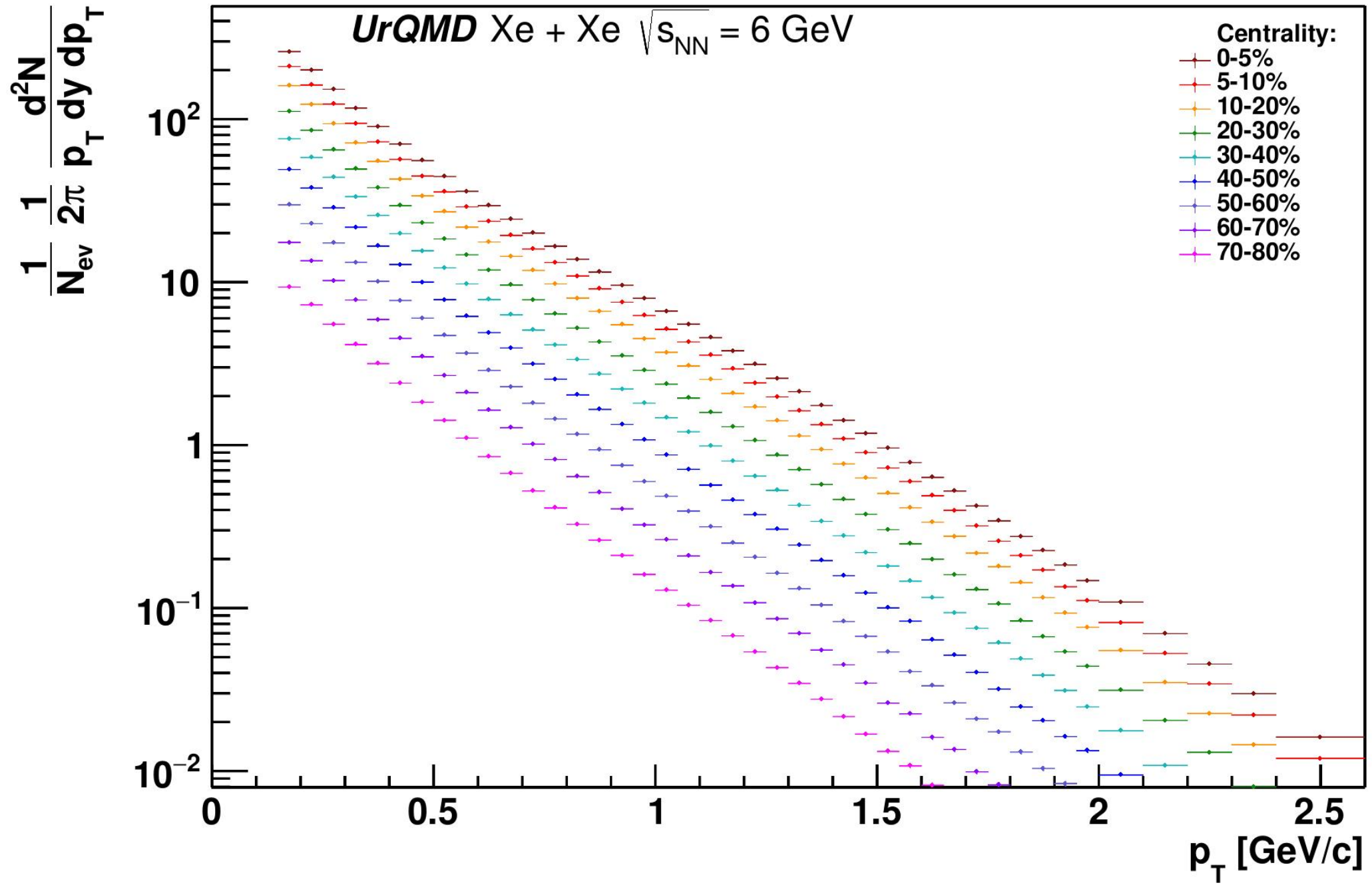
UrQMD, statistics: ~8×10^6 events

Track cuts:

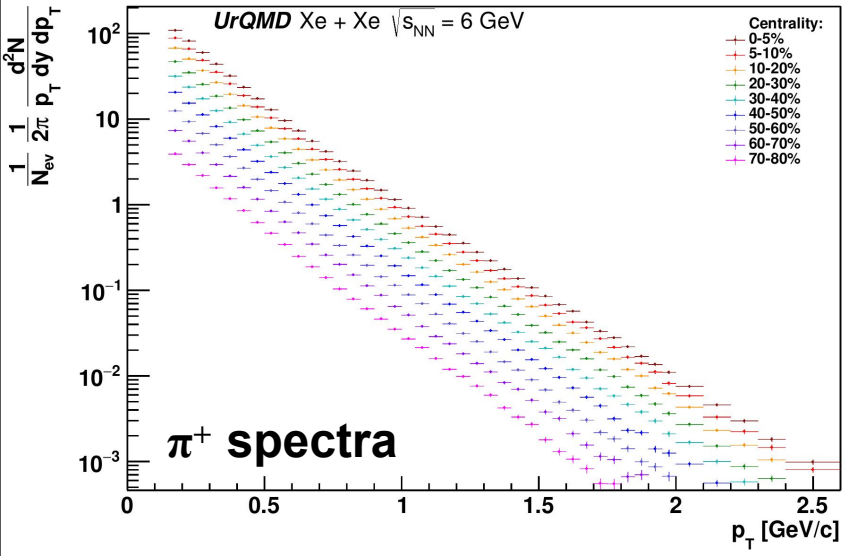
- $|y| < 0.1$
- $|\eta| < 1.0$
- $p_T > 0.15$ GeV/c

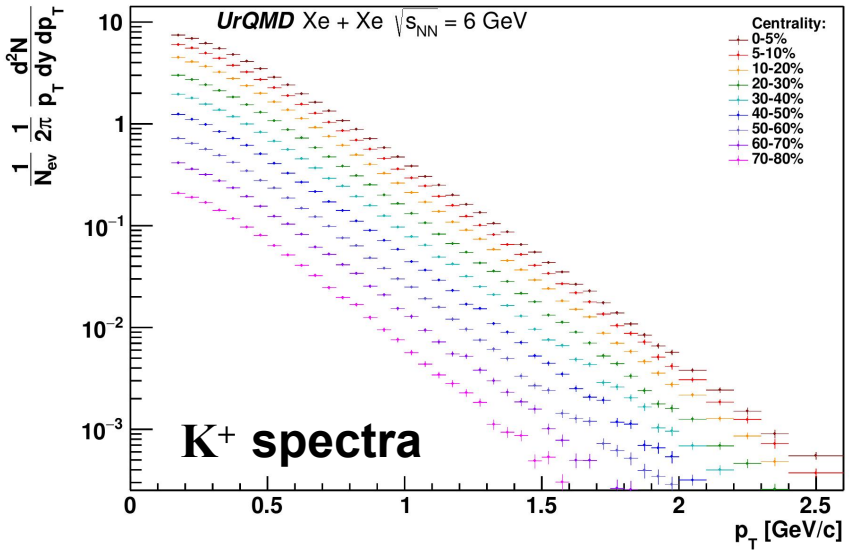
Centrality is calculated using **reference multiplicity** ($|\eta| < 1.0$, $p_T > 0.15$ GeV/c)

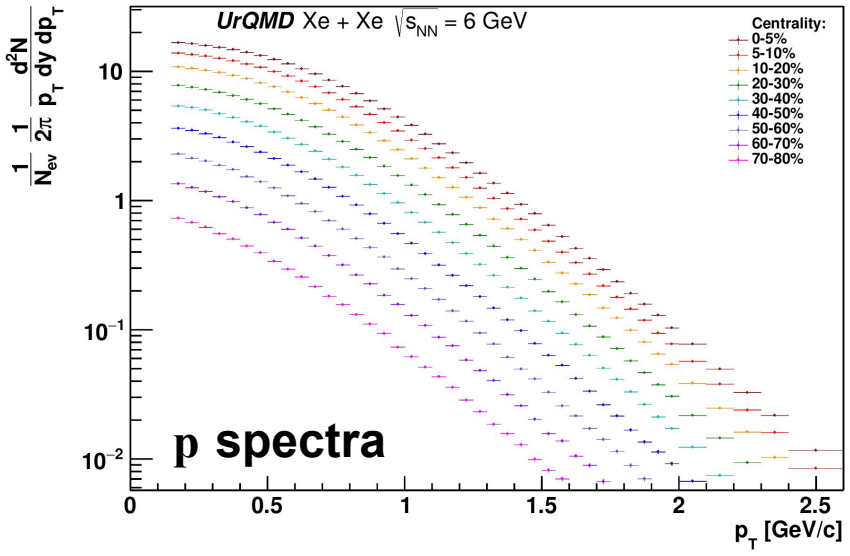
Charged hadron spectra for different centrality classes (RefMult10)

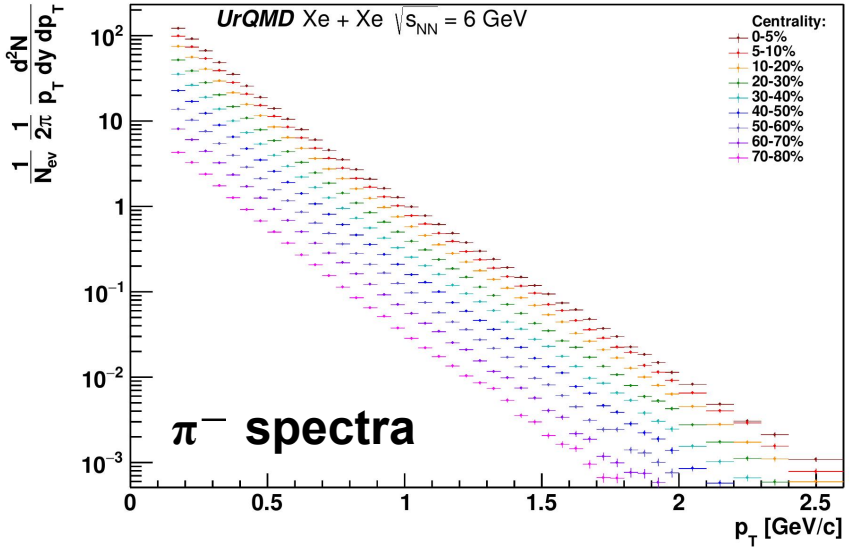


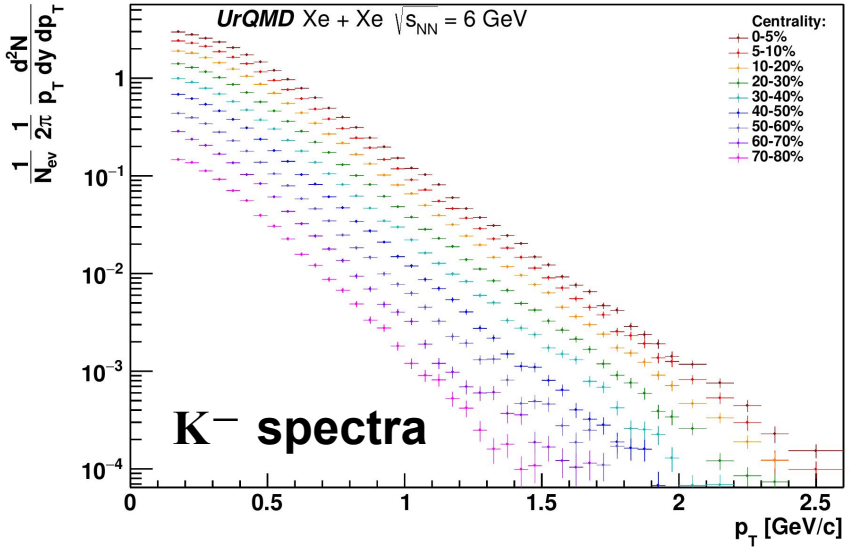
Identified hadron spectra for different centrality classes (RefMult10)

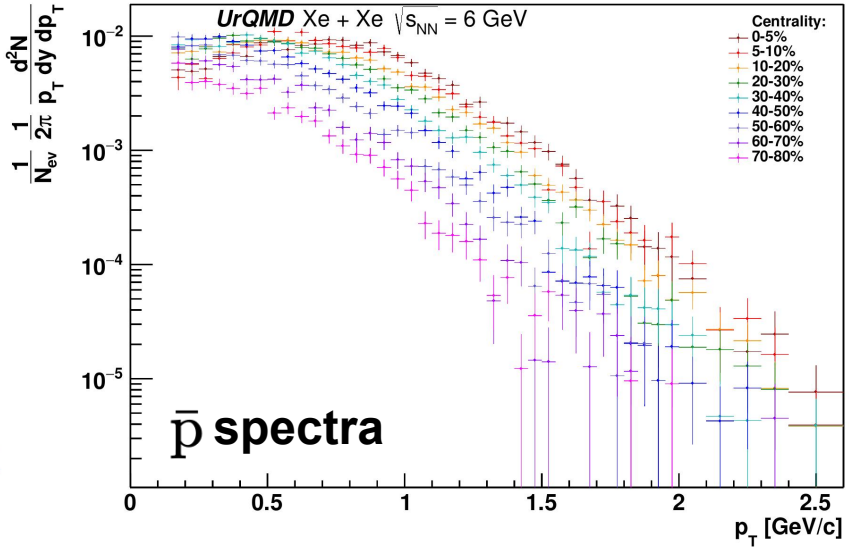












Identified hadron spectra for different centrality classes (RefMult10)