Blast wave fits of charged hadron spectra in Kr + Kr, Xe + Xe and O + O collisions at $\sqrt{s_{NN}}$ = 6 GeV

Anastasiia Vasilieva

2025-10-14

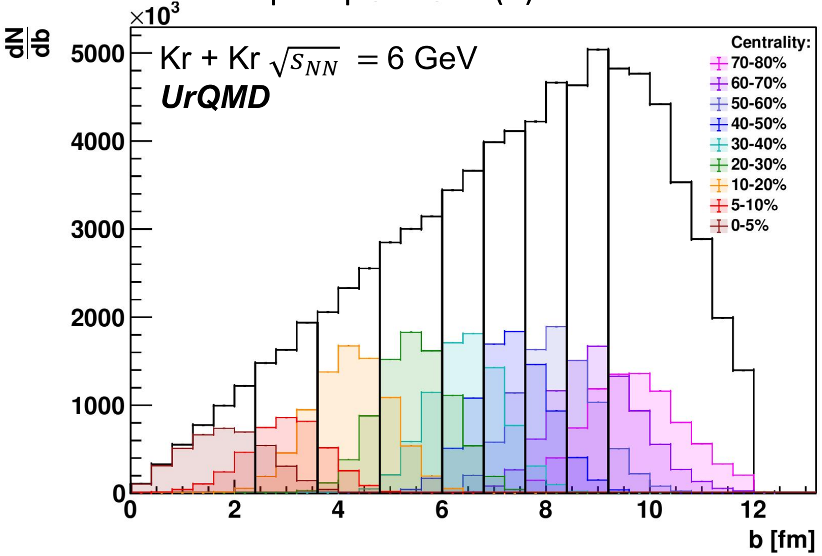
Collision centrality determiantion (1)

System: **Kr + Kr $\sqrt{s_{NN}}$ = 6 GeV**, **UrQMD**
Statistics: 91 M events

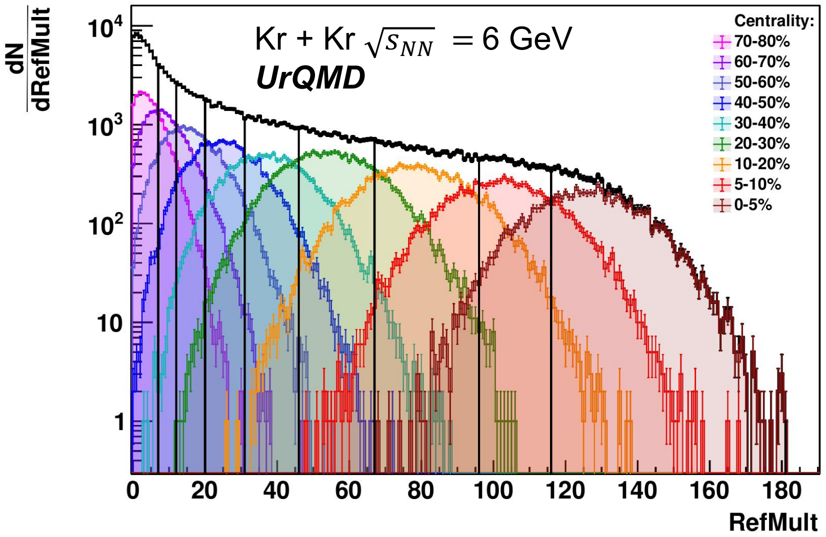
- The centrality of an event is defined by the percentile of the reaction total cross-section and characterized by the **impact parameter**.
- Experimentally, it can be estimated by the **reference multiplicity** calculated as a number of charged particles with **$|\eta| < 1.0$** and **$p_T > 0.15$ GeV/c**.

Centrality, %	Impact parameter, fm	Reference multiplicity
0 - 5	0 - 2.4	116 - 181
5 - 10	2.4 - 3.6	96 - 116
10 - 20	3.6 - 4.8	67 - 96
20 - 30	4.8 - 6.0	46 - 67
30 - 40	6.0 - 6.8	31 - 46
40 - 50	6.8 - 7.6	20 - 31
50 - 60	7.6 - 8.4	12 - 20
60 - 70	8.4 - 9.2	7 - 12
70-80	9.2 - 10.0	4 - 7

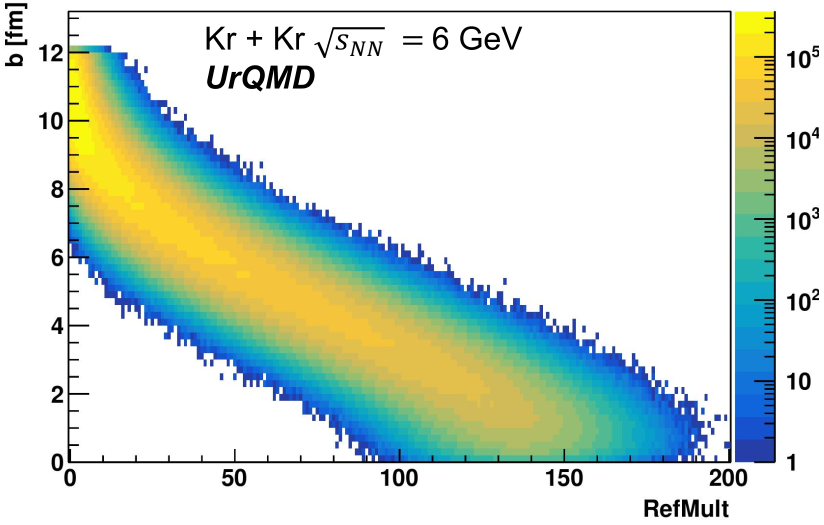
Impact parametr (b) distribution



Reference multiplicity (RefMult) distribution



Impact parametr vs. Reference multiplicity



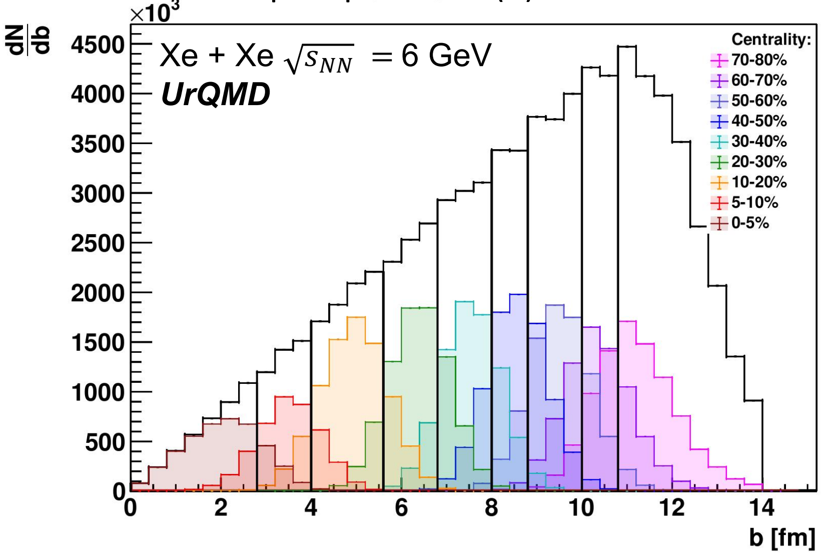
Collision centrality determiantion (2)

System: **Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV**, **UrQMD**
Statistics: 91 M events

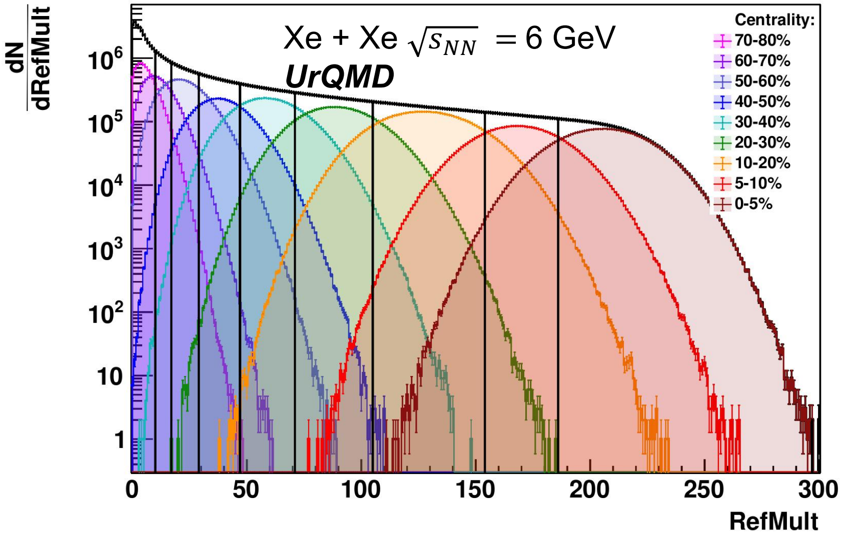
- The centrality of an event is defined by the percentile of the reaction total cross-section and characterized by the **impact parameter**.
- Experimentally, it can be estimated by the **reference multiplicity** calculated as a number of charged particles with **$|\eta| < 1.0$** and **$p_T > 0.15$ GeV/c**.

Centrality, %	Impact parameter, fm	Reference multiplicity
0 - 5	0 - 2.8	186 - 294
5 - 10	2.8 - 4.0	153 - 186
10 - 20	4.0 - 5.6	105 - 153
20 - 30	5.6 - 6.8	71 - 105
30 - 40	6.8 - 8.0	47 - 71
40 - 50	8.0 - 8.8	29 - 47
50 - 60	8.8 - 10.0	17 - 29
60 - 70	10.0 - 10.8	10 - 17
70-80	10.8 - 11.6	5 - 10

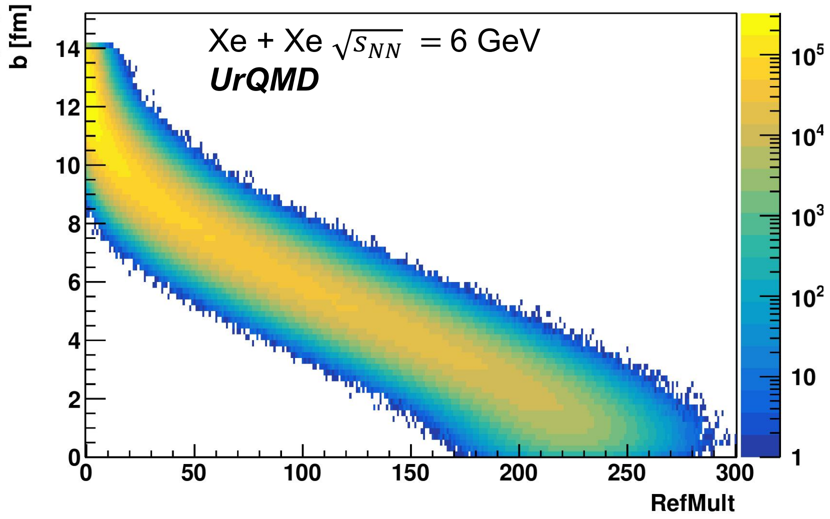
Impact parametr (b) distribution



Reference multiplicity (RefMult) distribution



Impact parametr vs. Reference multiplicity



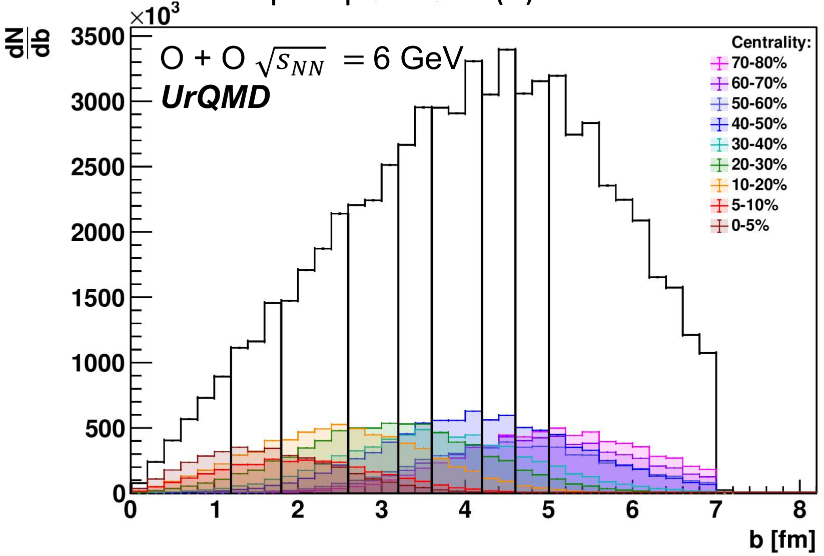
Collision centrality determiantion (3)

System: **O + O $\sqrt{s_{NN}}$ = 6 GeV**, **UrQMD**
Statistics: 76 M events

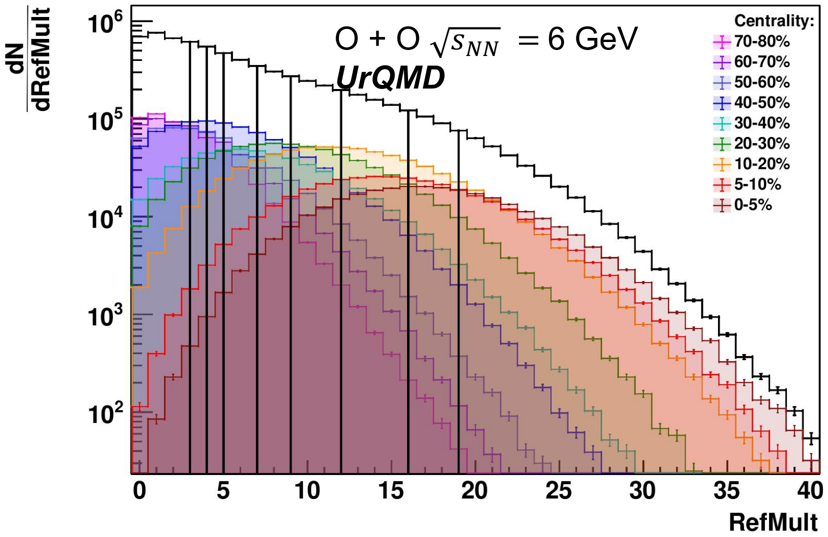
- The centrality of an event is defined by the percentile of the reaction total cross-section and characterized by the **impact parameter**.
- Experimentally, it can be estimated by the **reference multiplicity** calculated as a number of charged particles with **$|\eta| < 1.0$** and **p_T > 0.15 GeV/c**.

Centrality, %	Impact parameter, fm	Reference multiplicity
0 - 5	0 - 1.2	19 - 48
5 - 10	1.2 - 1.8	16 - 19
10 - 20	1.8 - 2.6	12 - 16
20 - 30	2.6 - 3.2	9 - 12
30 - 40	3.2 - 3.6	7 - 9
40 - 50	3.6 - 4.2	5 - 7
50 - 60	4.2 - 4.6	4 - 5
60 - 70	4.6 - 5.0	3 - 4
70-80	5.0 - 5.4	2 - 3

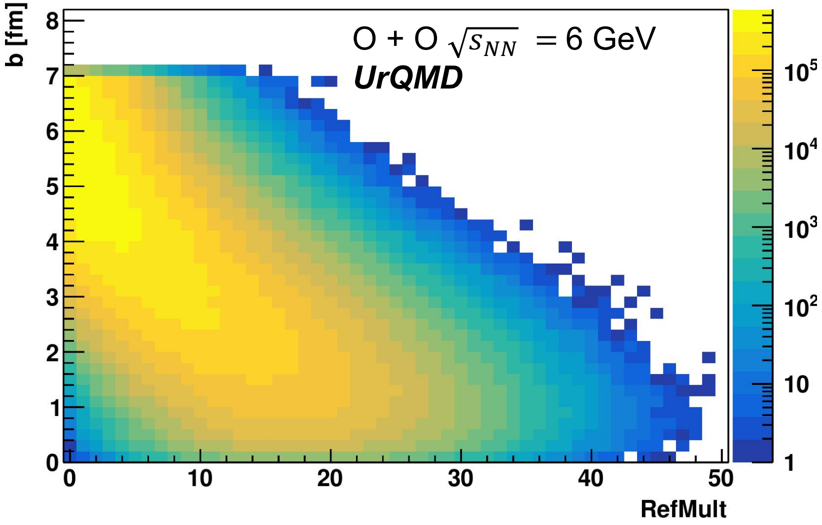
Impact parametr (b) distribution



Reference multiplicity (RefMult) distribution



Impact parametr vs. Reference multiplicity

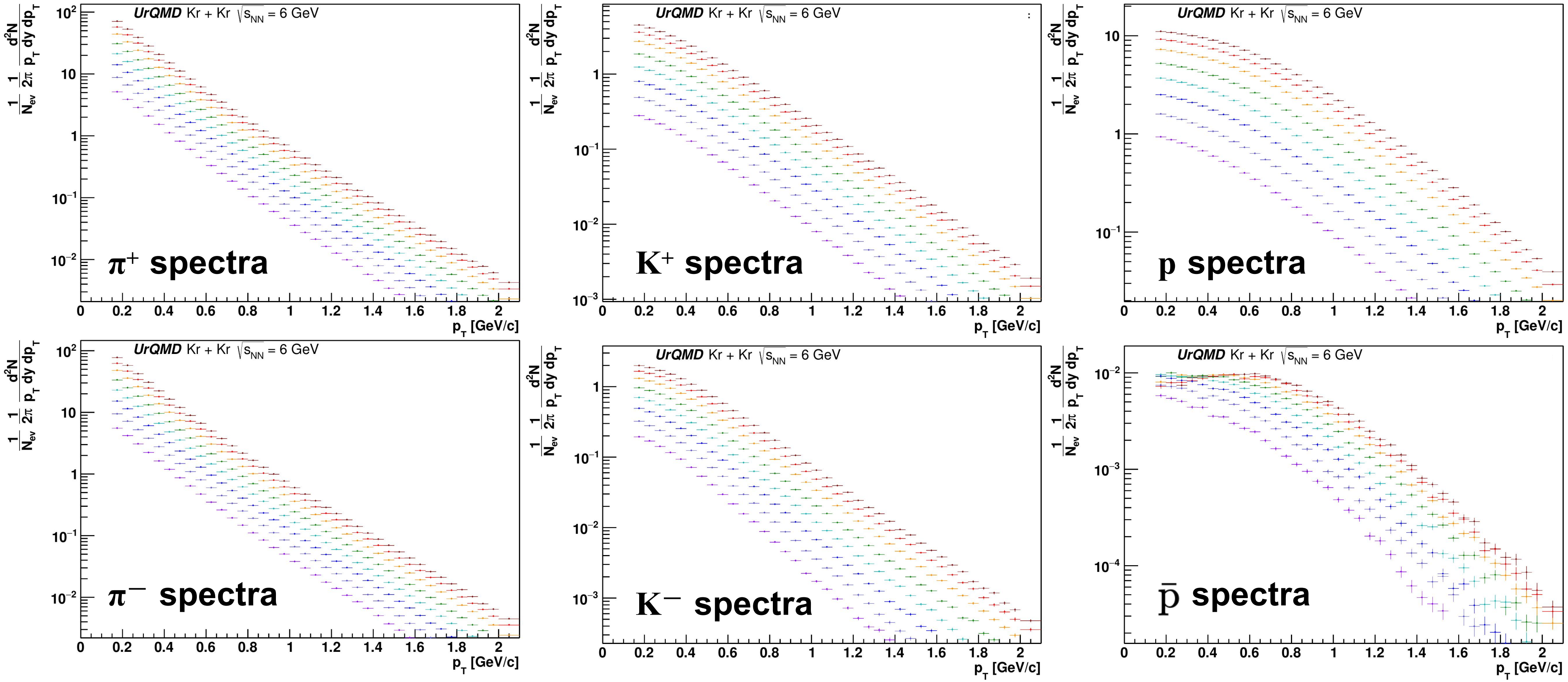


Identified hadron spectra for different centrality classes

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)



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

UrQMD

Statistics: 91 M events

Centrality:

- **0-5%**
- **5-10%**
- **10-20%**
- **20-30%**
- **30-40%**
- **40-50%**
- **50-60%**
- **60-70%**

Fitting spectra using blast wave model

- The blast wave model assumes that the particles are locally thermalized at a kinetic freeze-out temperature and are moving with a common transverse collective flow velocity.
- $\pi^{\pm}$, $K^{\pm}$, p, and $\overline{\mathrm{p}}$ particle spectra are fitted simultaneously with the 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 - the 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

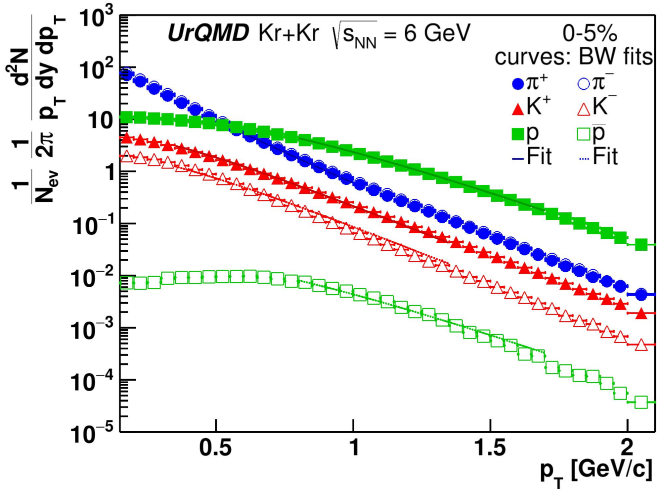
r/R - the relative radial position in the thermal source

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

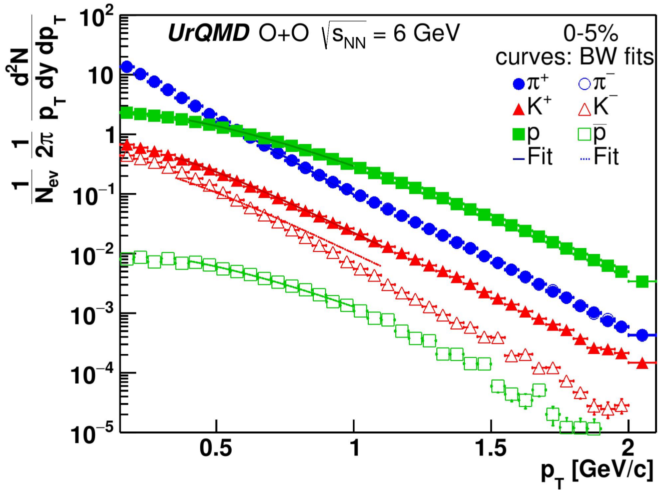
n - the exponent of flow velosity profile

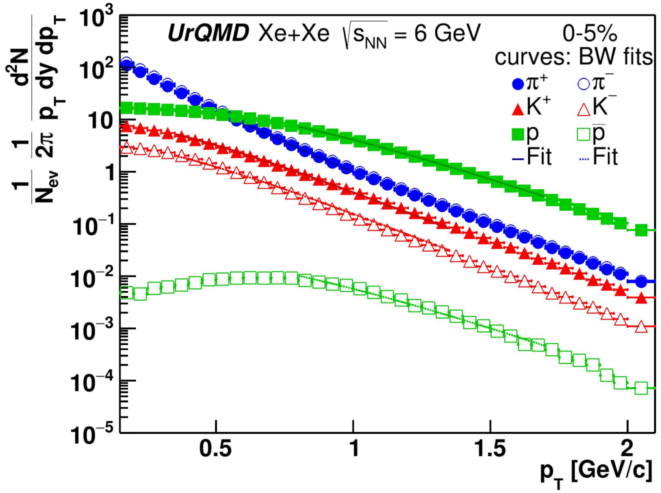
Phys.Rev.C48:2462-2475,1993

p_T fit ranges (Kr + Kr, Xe + Xe):
π: 0.5 - 1.0 GeV/c,
K: 0.35 - 1.35 GeV/c,
p($\overline{\mathrm{p}}$): 0.8 - 1.7 GeV/c



p_T fit ranges (O + O):
π: 0.5 - 1.0 GeV/c,
K: 0.35 - 1.1 GeV/c,
p($\overline{\mathrm{p}}$): 0.35 - 1.0 GeV/c



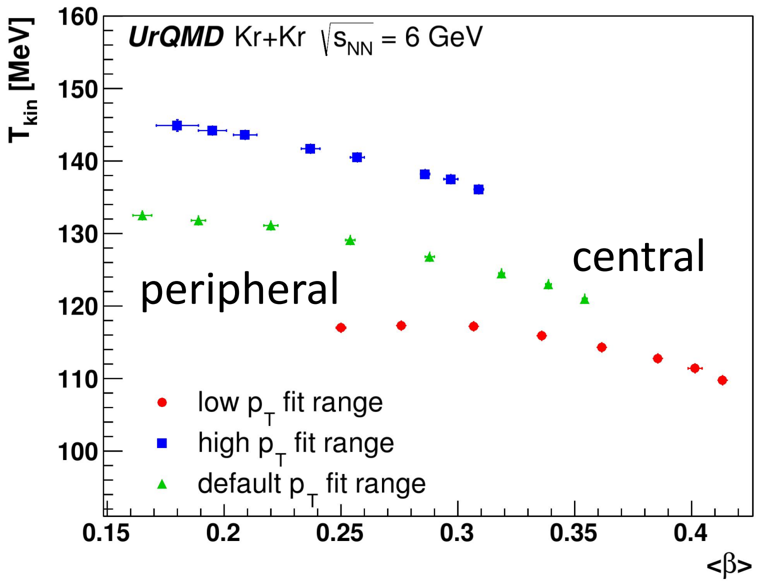


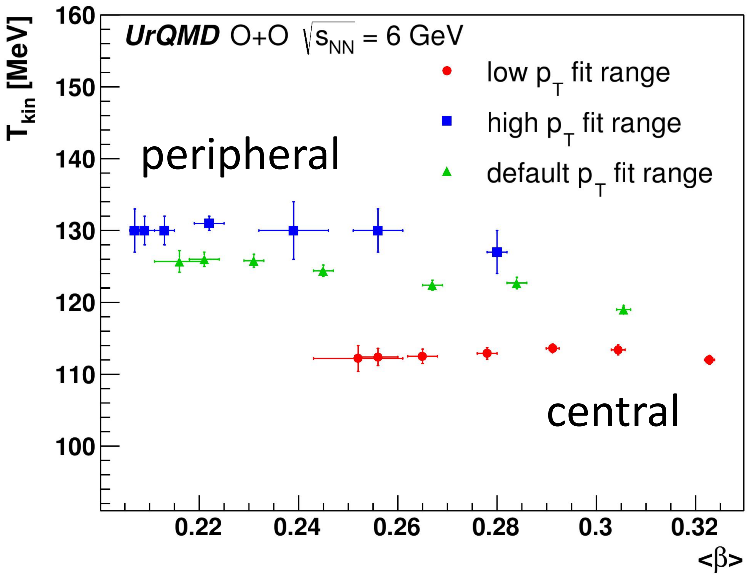
Impact of p_T fit ranges on the extracted parameters

- The blast wave model results are sensitive to the p_T fit ranges used for fitting.

- Difference between "low" p_T and "default" p_T results:
  - T_{kin}: 9-12%, $\langle\beta\rangle$: 13-50% for **Kr+Kr, Xe+Xe, Au+Au**;
  - T_{kin}: 6-11%, $\langle\beta\rangle$: 7-16% for **O+O**.

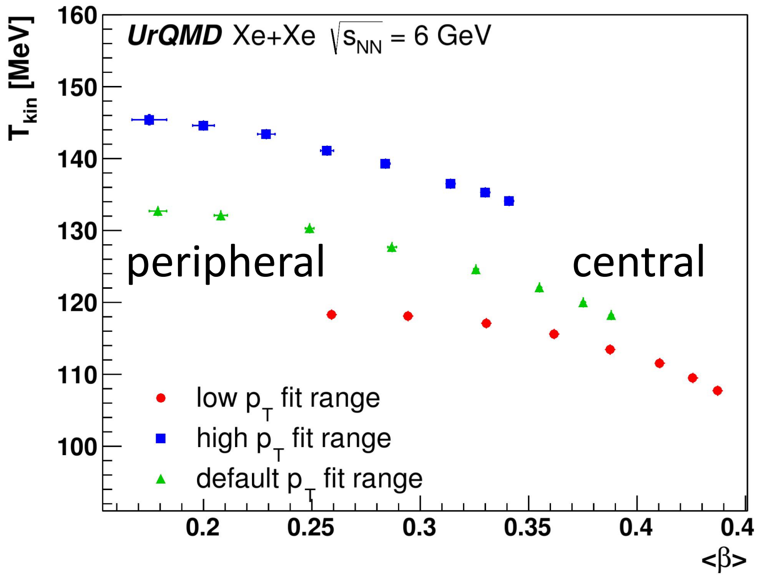
- Difference between "high" p_T and "default" p_T results:
  - T_{kin}: 9-14%, $\langle\beta\rangle$: 5-17% for **Kr+Kr, Xe+Xe, Au+Au**;
  - T_{kin}: 3-7%, $\langle\beta\rangle$: 4-8% for **O+O**.

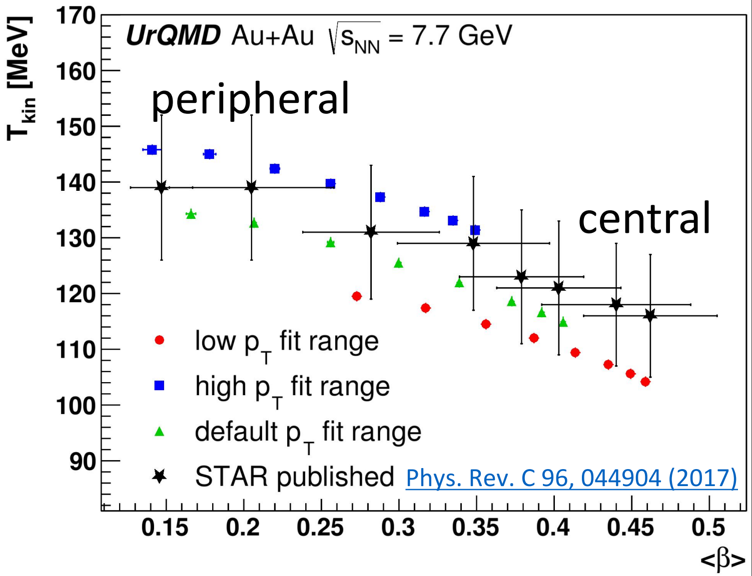




Fit ranges

	Kr+Kr, Xe+Xe, Au+Au	O+O
"low" p_T fit range, GeV/c	π: 0.5 - 0.8 K: 0.2 - 0.75 p: 0.35 - 1.2 $\bar{p}$: 0.75 - 1.2	π: 0.5 - 0.8 K: 0.35 - 1.35 p($\bar{p}$): 0.8 - 1.7
"default" p_T fit range, GeV/c	π: 0.5 - 1.0 K: 0.35 - 1.35 p($\bar{p}$): 0.8 - 1.7	π: 0.5 - 1.0 K: 0.35 - 1.1 p($\bar{p}$): 0.35 - 1.0
"high" p_T fit range, GeV/c	π: 0.7 - 1.3 K: 0.6 - 1.5 p($\bar{p}$): 1.0 - 2.0	π: 0.7 - 1.3 K: 0.5 - 1.4 p($\bar{p}$): 0.5 - 1.1





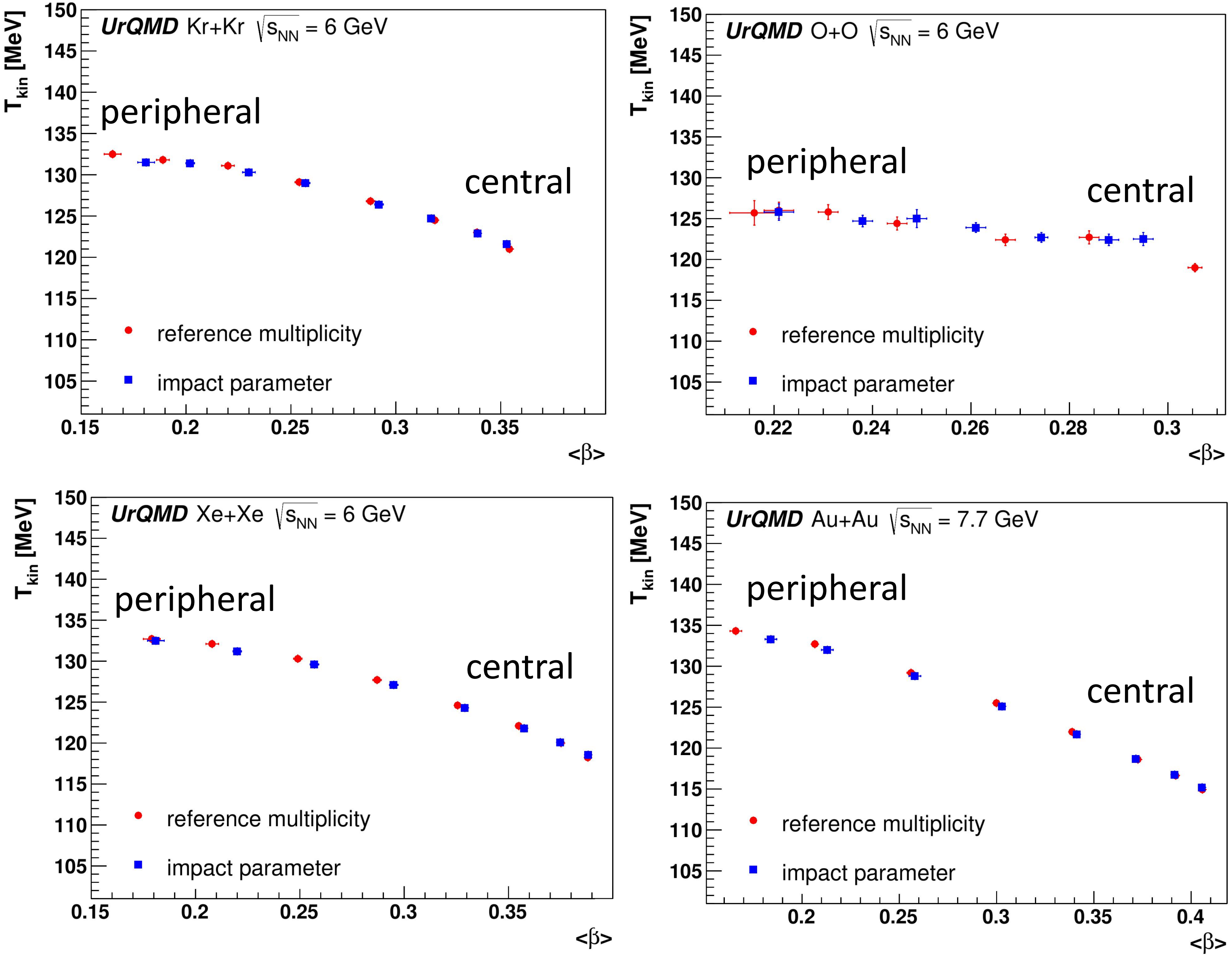
Impact of the centrality determination on the extracted parameters

- Comparison of the kinetic freeze-out parameters obtained with the impact parameter and reference multiplicity centrality determination is performed.

- Difference in $\mathbf{T_{kin}}$:
  - **Kr+Kr, Xe+Xe, Au+Au**: less than 1% for all centralities;
  - **O+O**: 3% for the most central bin, ~1% for other centralities.
- Difference in $\langle \boldsymbol{\beta} \rangle$:
  - **Kr+Kr**: up to 4%;
  - **Xe+Xe**: up to 6%;
  - **O+O**: up to 8%;
  - **Au+Au**: up to 10%.

Fit ranges

System	Kr+Kr, Xe+Xe, Au+Au	O+O
p_T fit ranges, GeV/c	π: 0.5 - 1.0 K: 0.35 - 1.35 p($\bar{p}$): 0.8 - 1.7	π: 0.5 - 1.0 K: 0.35 - 1.1 p($\bar{p}$): 0.35 - 1.0

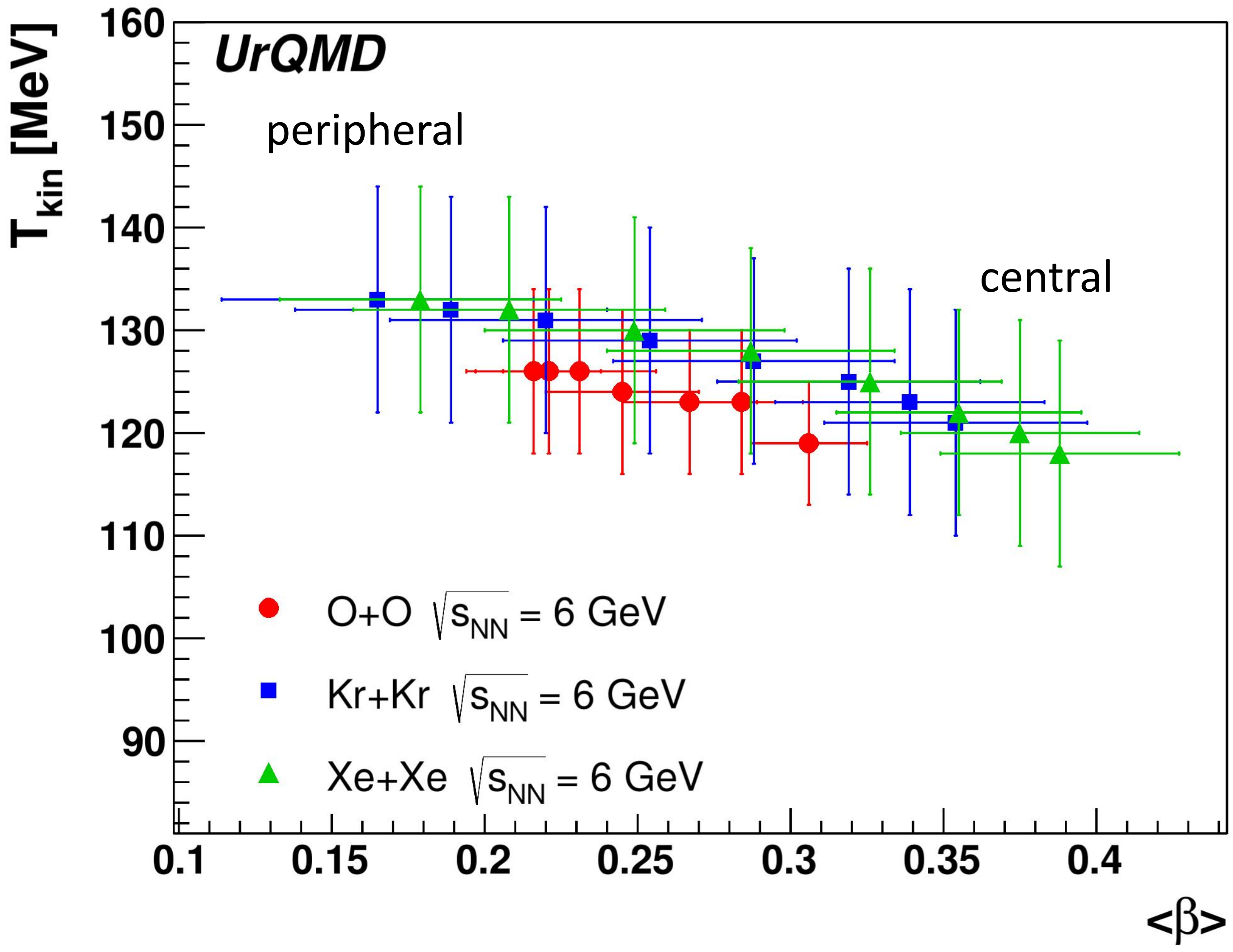


Comparison of kinematic freeze-out parameters between different systems

- The ⟨β⟩ decreases from central to peripheral collisions indicating more rapid expansion in central collisions.
- T_{kin} increases from central to peripheral collisions.
- Higher values of T_{kin} correspond to lower values of ⟨β⟩.

Fit ranges

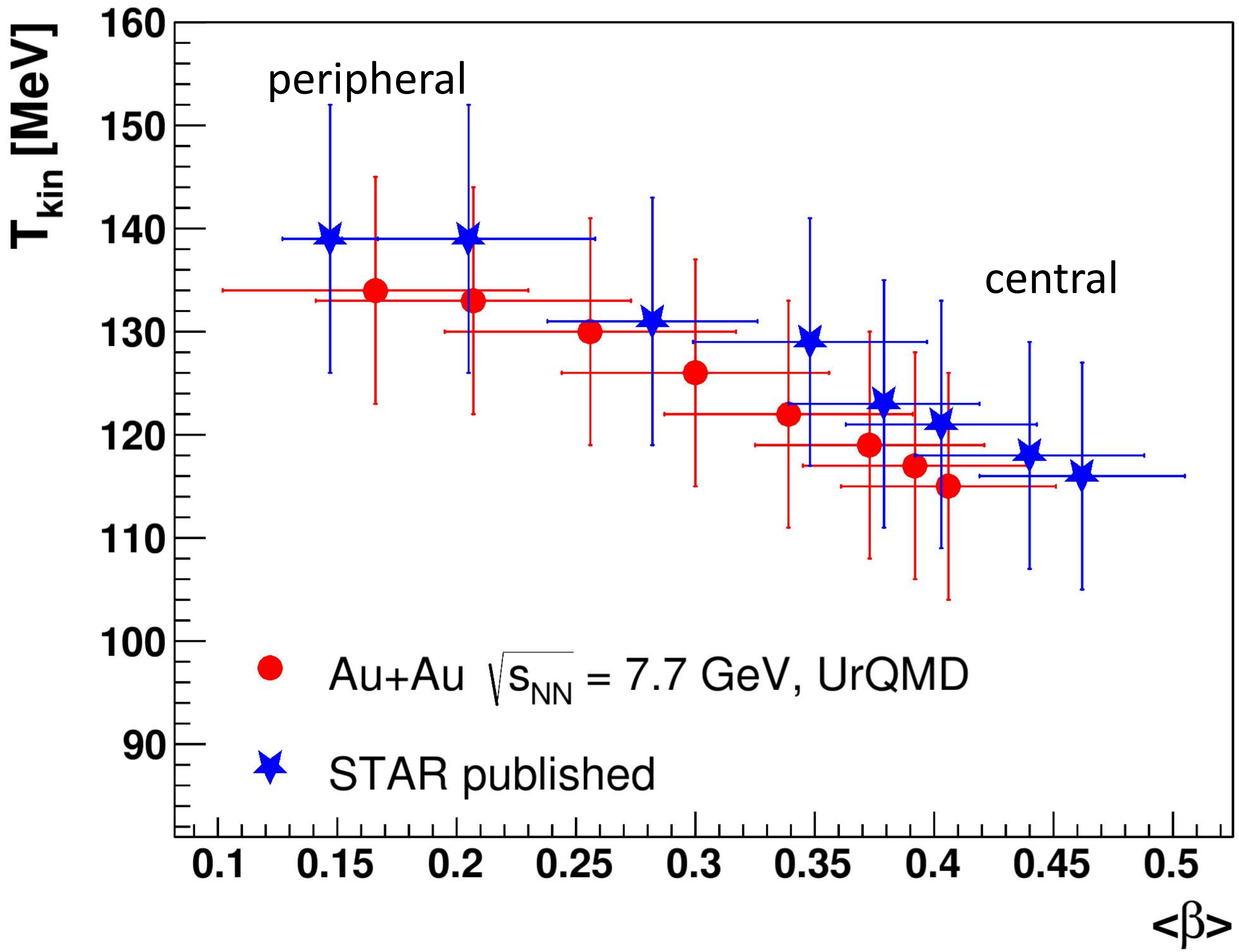
System	Kr+Kr, Xe+Xe	O+O
p_T fit ranges, GeV/c	π: 0.5 - 1.0 K: 0.35 - 1.35 $p(\bar{p})$: 0.8 - 1.7	π: 0.5 - 1.0 K: 0.35 - 1.1 $p(\bar{p})$: 0.35 - 1.0



Comparison of kinematic freeze-out parameters with STAR data

- The ⟨β⟩ decreases from central to peripheral collisions indicating more rapid expansion in central collisions.
- T_{kin} increases from central to peripheral collisions.
- Higher values of T_{kin} correspond to lower values of ⟨β⟩.
- **The obtained parameters are consistent** with previous results from the STAR collaboration within the uncertainties.

p_T fit ranges:
π: 0.5 - 1.0 GeV/c,
K: 0.35 - 1.35 GeV/c,
p($\overline{p}$): 0.8 - 1.7 GeV/c



Phys. Rev. C 96, 044904 (2017)

Backup slides

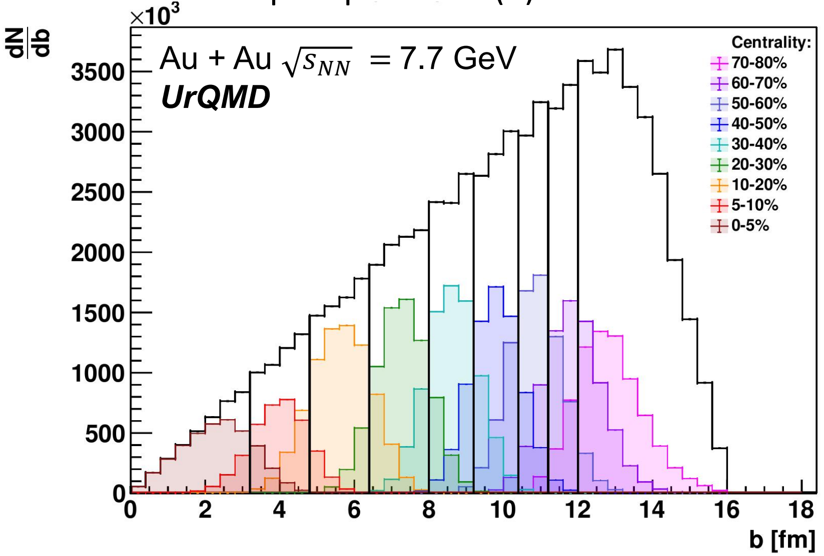
Collision centrality determiantion

System: **Au + Au** $\sqrt{s_{NN}}$ **= 7.7 GeV**, **UrQMD**
Statistics: 76 M events

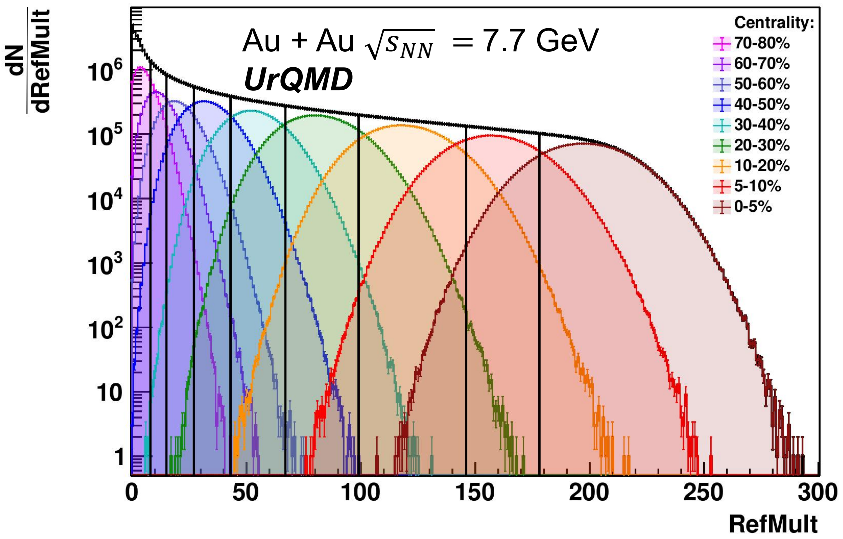
- The centrality of an event is defined by the percentile of the reaction total cross-section and characterized by the **impact parameter**.
- Experimentally, it can be estimated by the **reference multiplicity** calculated as a number of charged particles with **$|\eta| < 0.5$** and **$p_T > 0.15$ GeV/c**.

Centrality, %	Impact parameter, fm	Reference multiplicity
0 - 5	0 - 3.2	178 - 293
5 - 10	3.2 - 4.8	146 - 178
10 - 20	4.8 - 6.4	99 - 146
20 - 30	6.4 - 8.0	67 - 99
30 - 40	8.0 - 9.2	43 - 67
40 - 50	9.2 - 10.4	27 - 43
50 - 60	10.4 - 11.2	15 - 27
60 - 70	11.2 - 12.0	8 - 15
70-80	12.0 - 13.2	4 - 8

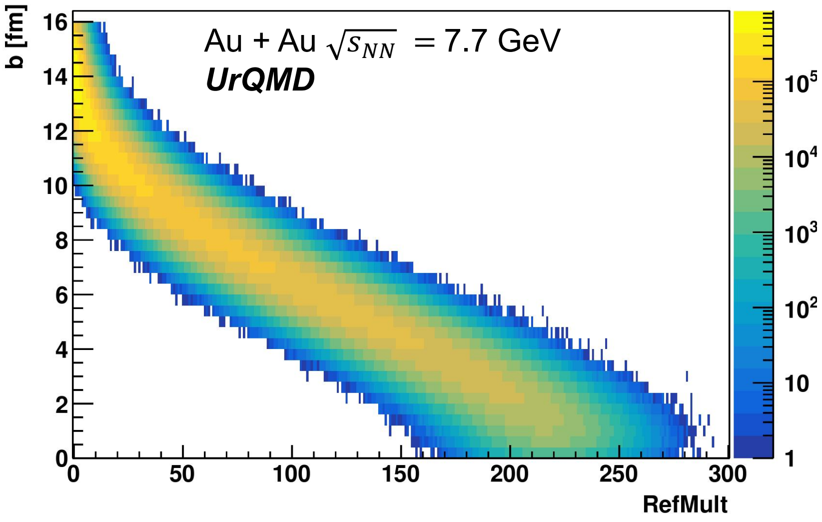
Impact parametr (b) distribution



Reference multiplicity (RefMult) distribution



Impact parametr vs. Reference multiplicity



Identified hadron spectra for different centrality classes

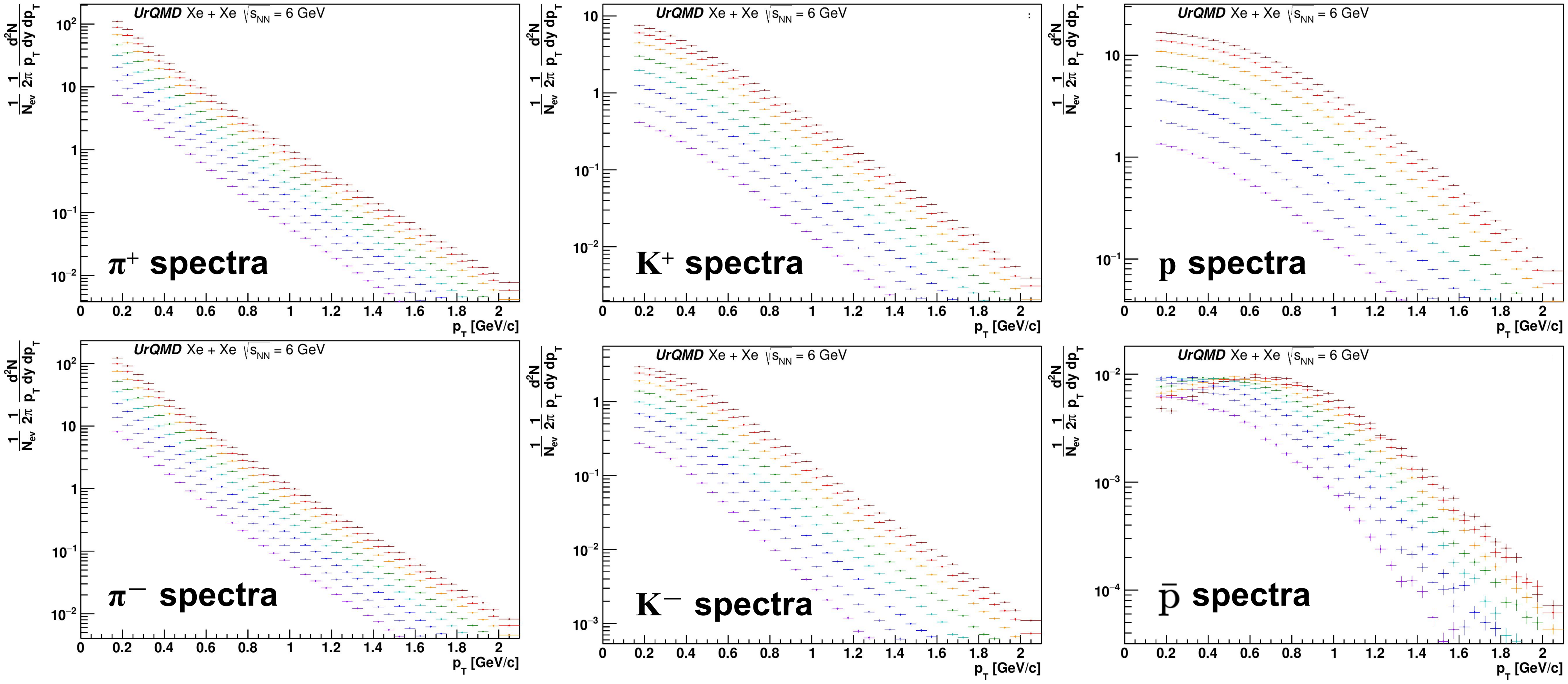
Track cuts:

$|y| < 0.1$

$|\eta| < 1.0$

$p_T > 0.15$ GeV/c

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



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

UrQMD

Statistics: 91 M events

Centrality:

- 0-5%
- 5-10%
- 10-20%
- 20-30%
- 30-40%
- 40-50%
- 50-60%
- 60-70%

Identified hadron spectra for different centrality classes

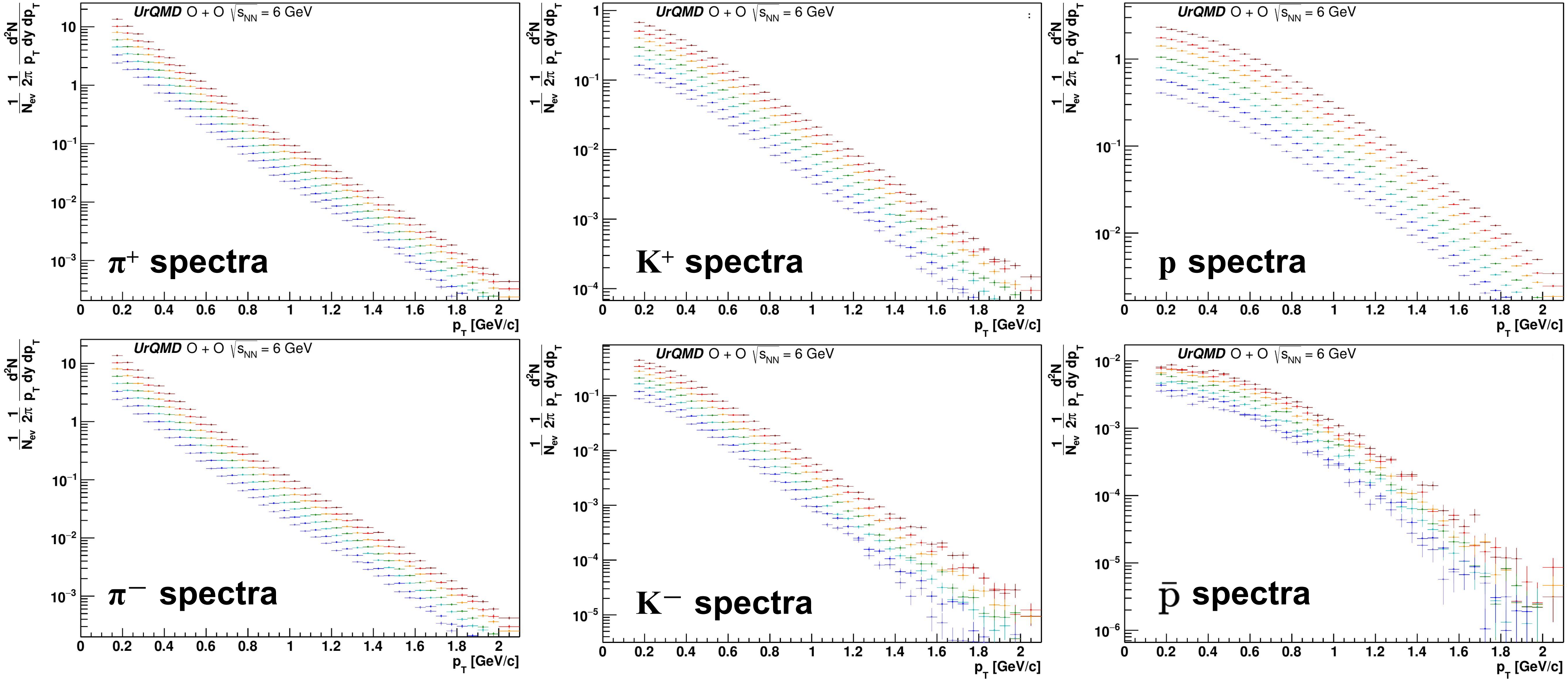
Track cuts:

$|y| < 0.1$

$|\eta| < 1.0$

$p_T > 0.15$ GeV/c

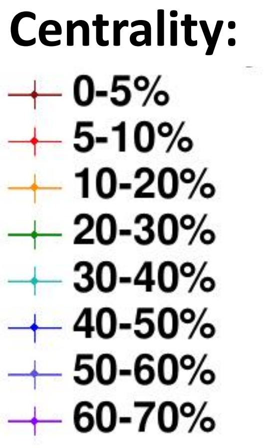
Centrality is calculated using **reference multiplicity** ($|\eta| < 1.0$, $p_T > 0.15$ GeV/c)



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

UrQMD

Statistics: 76 M events



Identified hadron spectra for different centrality classes

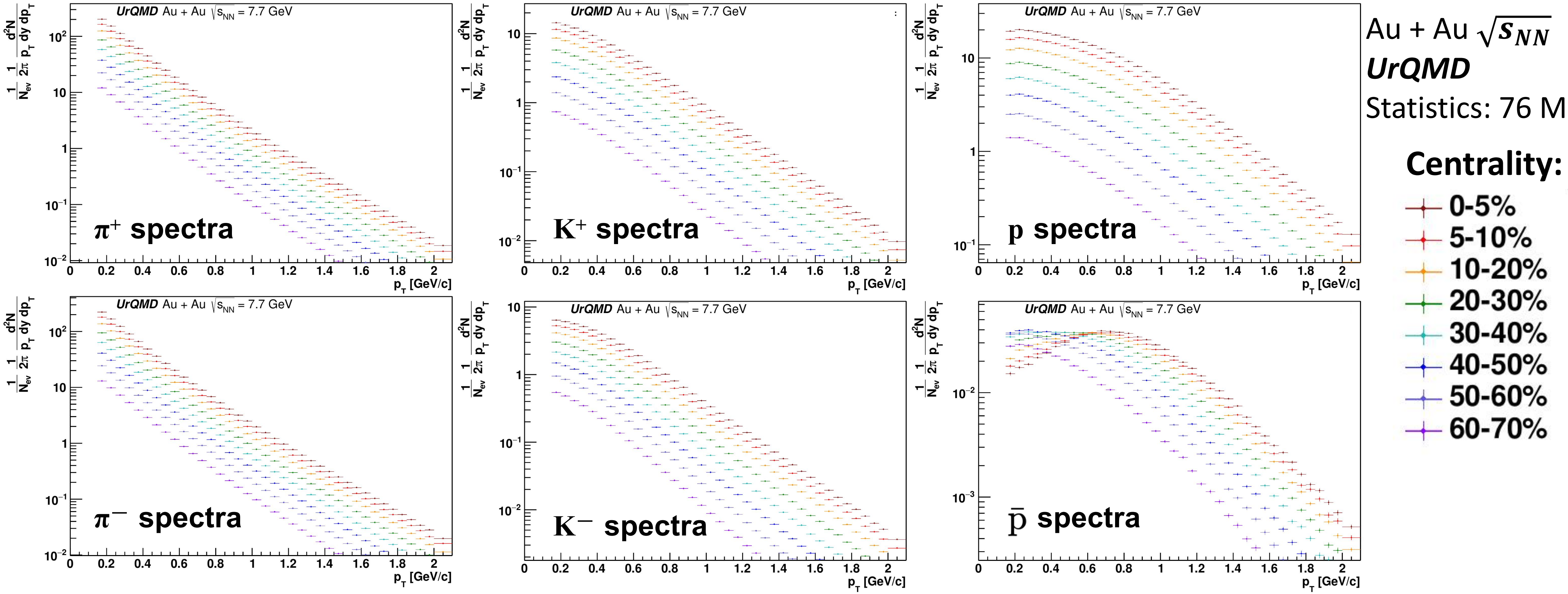
Track cuts:

$|y| < 0.1$

$|\eta| < 1.0$

$p_T > 0.15$ GeV/c

Centrality is calculated using **reference multiplicity** ($|\eta| < 0.5$, $p_T > 0.15$ GeV/c)



Au + Au $\sqrt{s_{NN}} = 7.7$ GeV

UrQMD

Statistics: 76 M events

Centrality:

Extracted freeze-out parameters

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

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	χ^2/NDF
0-5	0.354 ± 0.043	121 ± 11	181.7
5-10	0.339 ± 0.044	123 ± 11	190.9
10-20	0.319 ± 0.043	125 ± 11	331.8
20-30	0.288 ± 0.046	127 ± 10	305.2
30-40	0.254 ± 0.048	129 ± 11	252.3
40-50	0.220 ± 0.051	131 ± 11	206.5
50-60	0.189 ± 0.051	132 ± 11	169.1
60-70	0.165 ± 0.051	133 ± 11	116.5

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

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	χ^2/NDF
0-5	0.388 ± 0.039	118 ± 11	208.1
5-10	0.375 ± 0.039	120 ± 11	193.1
10-20	0.355 ± 0.040	122 ± 10	360.7
20-30	0.326 ± 0.043	125 ± 11	334.8
30-40	0.287 ± 0.047	128 ± 10	291.7
40-50	0.249 ± 0.049	130 ± 11	253.3
50-60	0.208 ± 0.051	132 ± 11	200.1
60-70	0.179 ± 0.046	133 ± 11	128.4

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

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	χ^2/NDF
0-5	0.306 ± 0.019	119 ± 6	95.4
5-10	0.284 ± 0.020	123 ± 7	71.8
10-20	0.267 ± 0.022	123 ± 7	120.4
20-30	0.245 ± 0.025	124 ± 8	112.8
30-40	0.231 ± 0.025	126 ± 8	71.7
40-50	0.221 ± 0.024	126 ± 8	75.8
50-60	0.216 ± 0.022	126 ± 8	37.4

Extracted freeze-out parameters for Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7 GeV

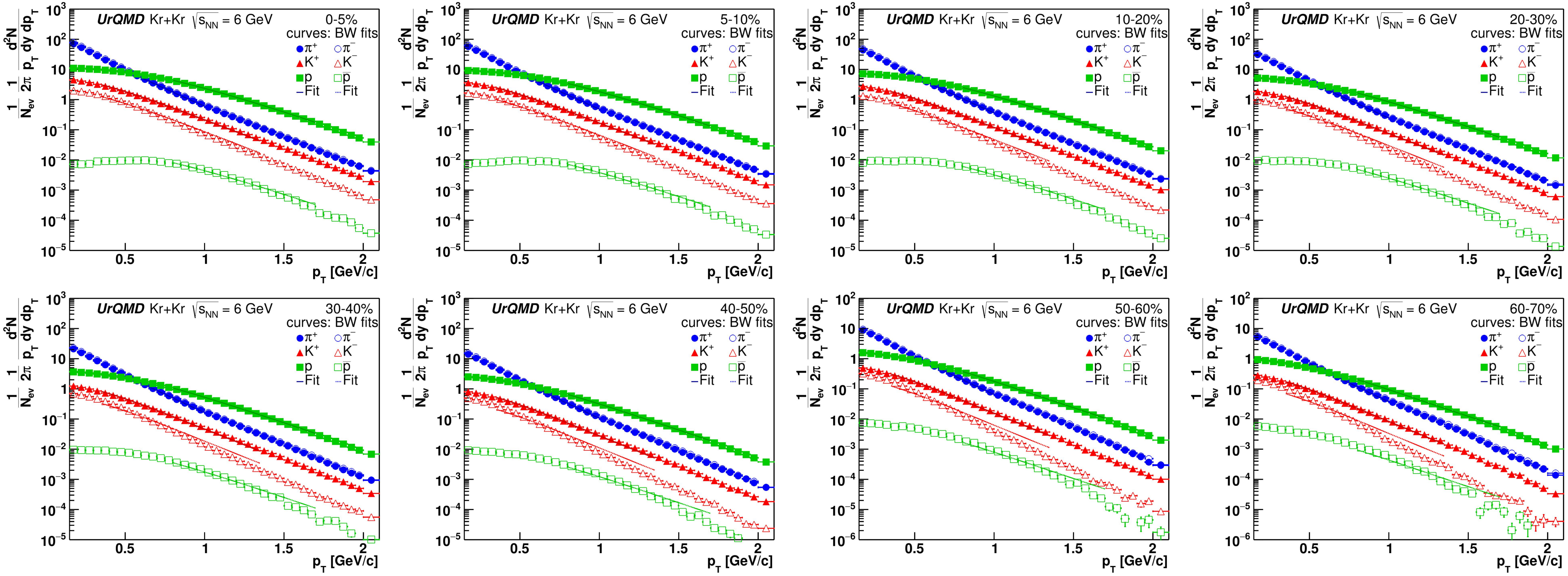
Центральность, %	$\langle\beta\rangle$ UrQMD	$\langle\beta\rangle$ STAR	T_{kin}, MeV UrQMD	T_{kin}, MeV STAR
0-5	0.406 ± 0.045	0.462 ± 0.043	115 ± 11	116 ± 11
5-10	0.392 ± 0.047	0.440 ± 0.048	117 ± 11	118 ± 11
10-20	0.373 ± 0.048	0.403 ± 0.040	119 ± 11	121 ± 12
20-30	0.339 ± 0.052	0.379 ± 0.040	122 ± 11	123 ± 12
30-40	0.300 ± 0.056	0.348 ± 0.049	126 ± 11	129 ± 12
40-50	0.256 ± 0.061	0.282 ± 0.044	130 ± 11	131 ± 12
50-60	0.207 ± 0.066	0.205 ± 0.053	133 ± 11	139 ± 13
60-70	0.166 ± 0.064	0.147 ± 0.020	134 ± 11	139 ± 13

STAR results are taken from Phys. Rev. C 96, 044904 (2017)

Blast wave fits of identified hadron spectra

System: **Kr + Kr** $\sqrt{s_{NN}}$ **= 6 GeV**, **UrQMD**
Statistics: 91 M events

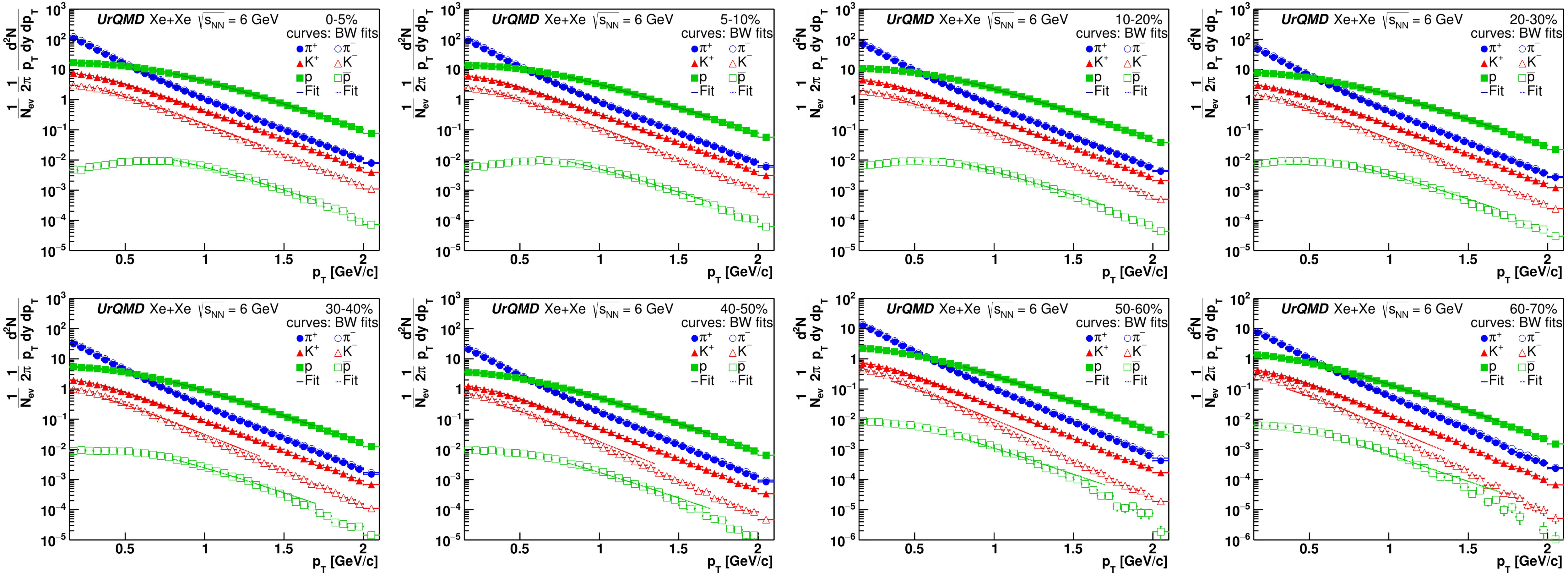
p_T fit ranges:
π: 0.5 - 1.0 GeV/c,
K: 0.35 - 1.35 GeV/c,
$p(\bar{p})$: 0.8 - 1.7 GeV/c



Blast wave fits of identified hadron spectra

System: **Xe + Xe $\sqrt{s_{NN}}$ = 6 GeV, UrQMD**
Statistics: 91 M events

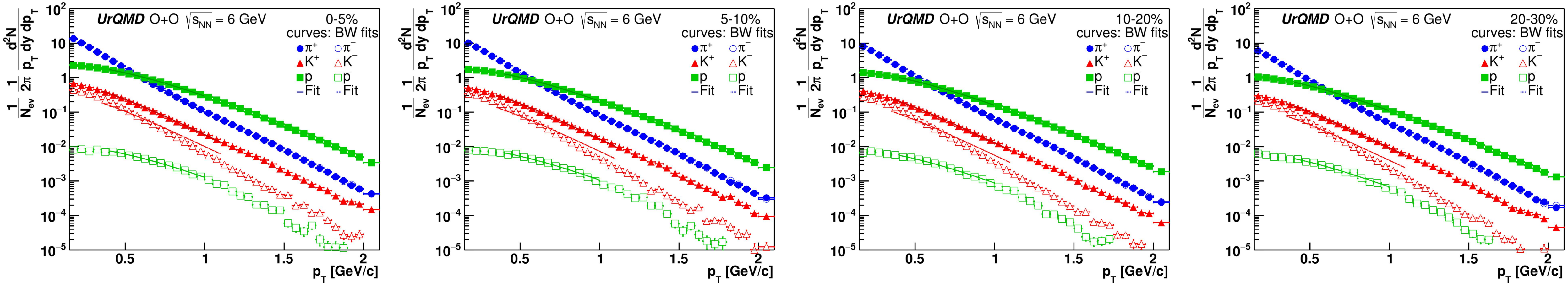
p_T fit ranges:
π: 0.5 - 1.0 GeV/c,
K: 0.35 - 1.35 GeV/c,
$p(\bar{p})$: 0.8 - 1.7 GeV/c

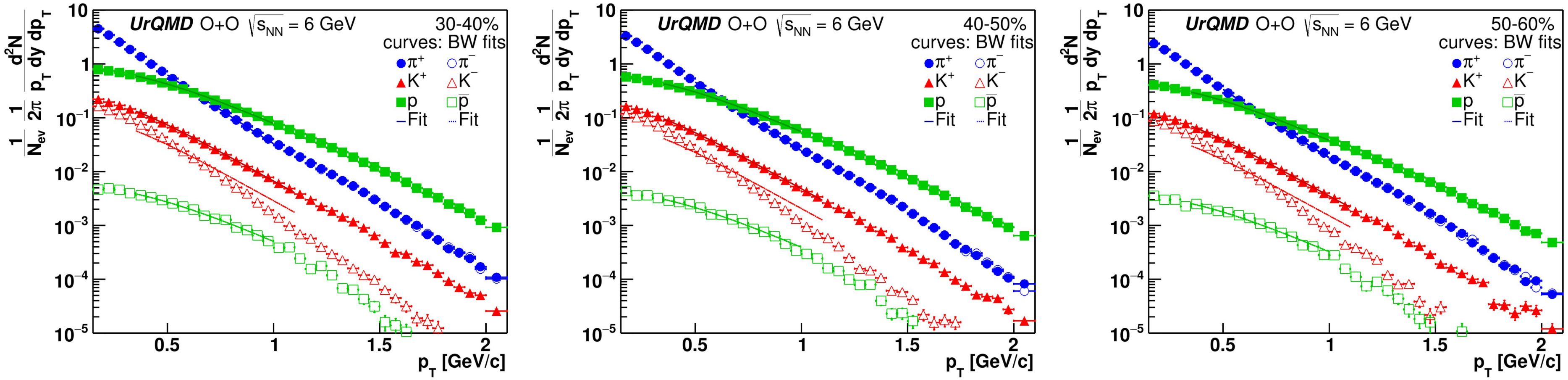


Blast wave fits of identified hadron spectra

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

Statistics: 76 M events





p_T fit ranges:

π: 0.5 - 1.0 GeV/c,

K: 0.35 - 1.1 GeV/c,

p($\bar{p}$): 0.35 - 1.0 GeV/c

Blast wave fits of identified hadron spectra

System: **Au + Au $\sqrt{s_{NN}}$ = 7.7 GeV**, **UrQMD**

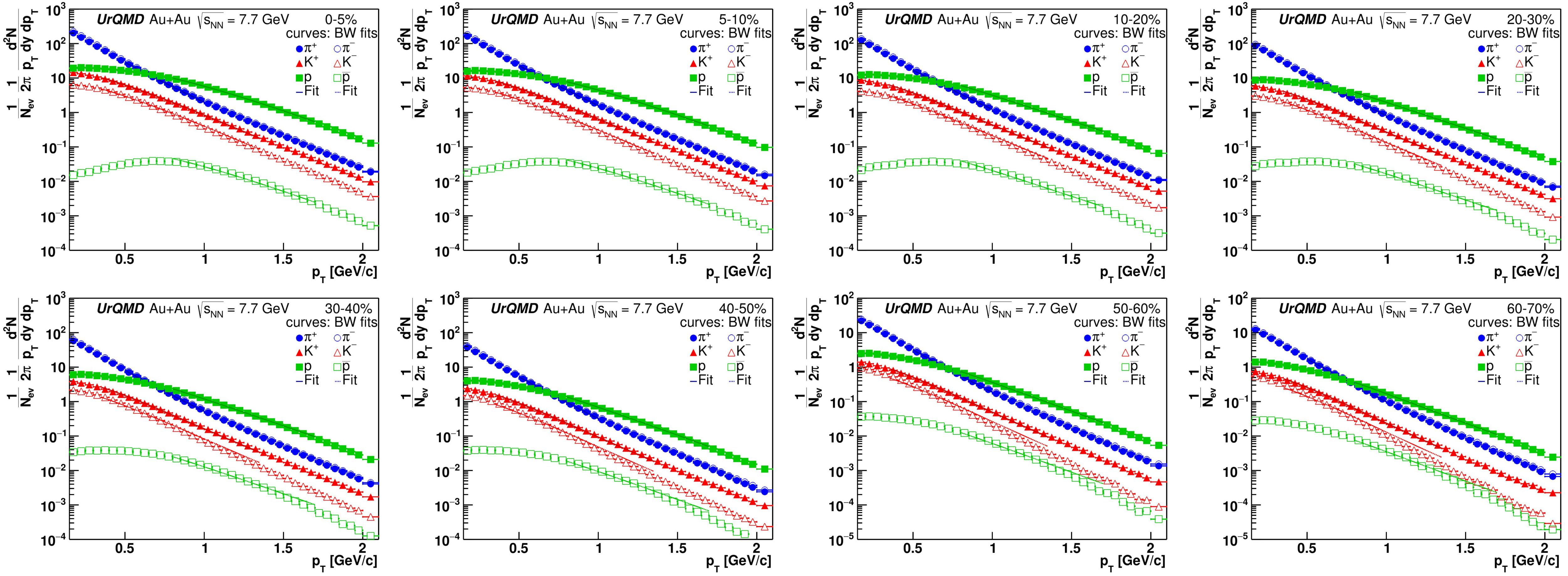
Statistics: 91 M events

p_T fit ranges:

π: 0.5 - 1.0 GeV/c,

K: 0.35 - 1.35 GeV/c,

p($\bar{p}$): 0.8 - 1.7 GeV/c



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

“default” p_T fit ranges

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.3543 ± 0.0010	121.0 ± 0.2	1.056 ± 0.012	181.7
5-10	0.3388 ± 0.0012	123.0 ± 0.2	1.14 ± 0.02	190.9
10-20	0.3187 ± 0.0012	124.5 ± 0.2	1.32 ± 0.02	331.8
20-30	0.288 ± 0.002	126.8 ± 0.2	1.64 ± 0.03	305.2
30-40	0.254 ± 0.002	129.1 ± 0.2	2.14 ± 0.05	252.3
40-50	0.220 ± 0.003	131.1 ± 0.3	2.90 ± 0.09	206.5
50-60	0.189 ± 0.003	131.8 ± 0.3	4.01 ± 0.14	169.1
60-70	0.165 ± 0.004	132.5 ± 0.4	5.2 ± 0.3	116.5
70-80	0.166 ± 0.005	130.9 ± 0.6	5.3 ± 0.3	77.6

“low” p_T fit ranges

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.4133 ± 0.0003	109.76 ± 0.14	0.609 ± 0.009	101.0
5-10	0.4015 ± 0.0003	111.4 ± 0.2	0.625 ± 0.010	110.5
10-20	0.3856 ± 0.0003	112.77 ± 0.14	0.679 ± 0.010	217.7
20-30	0.3616 ± 0.0004	114.3 ± 0.2	0.835 ± 0.013	223.4
30-40	0.3359 ± 0.0006	115.9 ± 0.2	1.06 ± 0.02	212.0
40-50	0.3068 ± 0.0009	117.2 ± 0.3	1.45 ± 0.03	193.1
50-60	0.2758 ± 0.0012	117.3 ± 0.3	2.14 ± 0.04	155.9
60-70	0.250 ± 0.002	117.0 ± 0.5	3.01 ± 0.06	107.3
70-80	0.237 ± 0.002	115.1 ± 0.7	3.89 ± 0.08	65.4

“default” p_T fit ranges (using impact parameter)

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.3529 ± 0.0012	121.6 ± 0.2	1.056 ± 0.014	179.4
5-10	0.3391 ± 0.0013	122.9 ± 0.2	1.14 ± 0.02	224.6
10-20	0.3169 ± 0.0013	124.7 ± 0.2	1.33 ± 0.02	278.9
20-30	0.292 ± 0.002	126.4 ± 0.2	1.61 ± 0.03	321.7
30-40	0.257 ± 0.002	129.0 ± 0.3	2.11 ± 0.05	215.2
40-50	0.230 ± 0.003	130.3 ± 0.3	2.68 ± 0.07	200.0
50-60	0.202 ± 0.002	131.4 ± 0.2	3.53 ± 0.08	168.5
60-70	0.181 ± 0.004	131.5 ± 0.4	4.4 ± 0.2	123.2
70-80	0.161 ± 0.004	131.5 ± 0.5	5.5 ± 0.2	83.6

“high” p_T fit ranges

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.309 ± 0.002	136.1 ± 0.3	1.06 ± 0.03	83.4
5-10	0.297 ± 0.003	137.5 ± 0.4	1.15 ± 0.04	71.4
10-20	0.286 ± 0.002	138.2 ± 0.3	1.19 ± 0.04	123.0
20-30	0.257 ± 0.003	140.5 ± 0.4	1.51 ± 0.05	102.6
30-40	0.237 ± 0.004	141.7 ± 0.4	1.71 ± 0.08	79.7
40-50	0.209 ± 0.005	143.6 ± 0.5	2.2 ± 0.2	65.1
50-60	0.195 ± 0.006	144.2 ± 0.5	2.5 ± 0.2	53.2
60-70	0.180 ± 0.009	144.9 ± 0.8	2.9 ± 0.3	36.3
70-80	0.175 ± 0.011	144.9 ± 1.0	3.4 ± 0.5	27.0

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

"default" p_T fit ranges

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.3881 ± 0.0007	118.24 ± 0.12	0.869 ± 0.007	208.1
5-10	0.3752 ± 0.0009	120.0 ± 0.2	0.914 ± 0.010	193.1
10-20	0.3550 ± 0.0008	122.08 ± 0.13	1.021 ± 0.009	360.7
20-30	0.3257 ± 0.0011	124.6 ± 0.2	1.21 ± 0.02	334.8
30-40	0.287 ± 0.002	127.7 ± 0.2	1.62 ± 0.03	291.7
40-50	0.249 ± 0.002	130.3 ± 0.2	2.20 ± 0.05	253.3
50-60	0.208 ± 0.003	132.1 ± 0.3	3.22 ± 0.11	200.1
60-70	0.179 ± 0.004	132.7 ± 0.4	4.3 ± 0.2	128.4
70-80	0.156 ± 0.006	132.4 ± 0.6	5.8 ± 0.4	100.1

"low" p_T fit ranges

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.4372 ± 0.0002	107.72 ± 0.11	0.564 ± 0.006	92.3
5-10	0.4258 ± 0.0002	109.49 ± 0.13	0.574 ± 0.007	92.4
10-20	0.4105 ± 0.0002	111.55 ± 0.11	0.567 ± 0.007	182.0
20-30	0.3876 ± 0.0003	113.44 ± 0.14	0.645 ± 0.010	196.4
30-40	0.3618 ± 0.0004	115.6 ± 0.2	0.763 ± 0.014	213.3
40-50	0.3305 ± 0.0006	117.1 ± 0.2	1.08 ± 0.02	222.2
50-60	0.2944 ± 0.0009	118.1 ± 0.3	1.66 ± 0.03	180.6
60-70	0.2591 ± 0.0014	118.3 ± 0.4	2.58 ± 0.05	123.2
70-80	0.240 ± 0.002	116.7 ± 0.5	3.35 ± 0.07	91.9

"default" p_T fit ranges (using impact parameter)

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.3882 ± 0.0007	118.57 ± 0.13	0.857 ± 0.008	201.1
5-10	0.3748 ± 0.0009	120.1 ± 0.2	0.919 ± 0.009	193.6
10-20	0.3575 ± 0.0008	121.81 ± 0.13	1.001 ± 0.009	338.0
20-30	0.3291 ± 0.0012	124.3 ± 0.2	1.20 ± 0.02	309.2
30-40	0.295 ± 0.002	127.1 ± 0.2	1.53 ± 0.02	319.6
40-50	0.257 ± 0.002	129.6 ± 0.3	2.07 ± 0.05	208.3
50-60	0.220 ± 0.002	131.2 ± 0.3	2.90 ± 0.08	260.3
60-70	0.181 ± 0.004	132.5 ± 0.4	4.3 ± 0.2	126.0
70-80	0.164 ± 0.005	132.3 ± 0.5	5.2 ± 0.3	87.6

"high" p_T fit ranges

Центральность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.341 ± 0.002	134.1 ± 0.2	0.85 ± 0.02	109.2
5-10	0.330 ± 0.002	135.3 ± 0.3	0.90 ± 0.02	95.4
10-20	0.314 ± 0.002	136.5 ± 0.2	0.99 ± 0.02	153.3
20-30	0.284 ± 0.002	139.3 ± 0.3	1.21 ± 0.03	128.3
30-40	0.257 ± 0.003	141.1 ± 0.4	1.47 ± 0.05	96.2
40-50	0.229 ± 0.004	143.4 ± 0.4	1.78 ± 0.09	78.7
50-60	0.200 ± 0.005	144.6 ± 0.5	2.3 ± 0.2	59.8
60-70	0.175 ± 0.008	145.4 ± 0.7	3.2 ± 0.3	38.6
70-80	0.173 ± 0.009	144.5 ± 0.8	3.2 ± 0.4	32.7

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

“default” p_T fit ranges

Централььность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.3055 ± 0.0014	119.0 ± 0.5	1.32 ± 0.08	95.4
5-10	0.284 ± 0.002	122.7 ± 0.8	1.52 ± 0.14	71.8
10-20	0.267 ± 0.002	122.4 ± 0.7	2.08 ± 0.07	120.4
20-30	0.245 ± 0.002	124.4 ± 0.8	2.53 ± 0.11	112.8
30-40	0.231 ± 0.002	125.8 ± 0.9	2.73 ± 0.14	71.7
40-50	0.221 ± 0.003	126.0 ± 1.0	3.17 ± 0.12	75.8
50-60	0.216 ± 0.005	125.7 ± 1.5	3.5 ± 0.2	37.4

“low” p_T fit ranges

Централььность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.3228 ± 0.0010	112.0 ± 0.6	1.37 ± 0.05	72.2
5-10	0.3044 ± 0.0014	113.4 ± 0.7	1.71 ± 0.06	56.9
10-20	0.2912 ± 0.0013	113.6 ± 0.6	2.05 ± 0.05	100.1
20-30	0.278 ± 0.002	112.9 ± 0.8	2.52 ± 0.05	93.2
30-40	0.265 ± 0.003	112.5 ± 1.0	3.05 ± 0.05	58.8
40-50	0.256 ± 0.004	112.4 ± 1.2	3.62 ± 0.04	61.4
50-60	0.252 ± 0.009	112.2 ± 1.8	3.88 ± 0.07	28.1

“default” p_T fit ranges (using impact parameter)

Централььность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.295 ± 0.002	122.5 ± 0.8	1.39 ± 0.12	62.5
5-10	0.288 ± 0.002	122.4 ± 0.7	1.57 ± 0.10	70.2
10-20	0.2743 ± 0.0013	122.7 ± 0.6	1.83 ± 0.08	119.2
20-30	0.261 ± 0.002	123.9 ± 0.6	2.07 ± 0.09	94.8
30-40	0.249 ± 0.002	125.0 ± 1.1	2.3 ± 0.2	57.1
40-50	0.238 ± 0.002	124.7 ± 0.7	2.62 ± 0.11	79.0
50-60	0.221 ± 0.003	125.8 ± 1.0	3.2 ± 0.2	47.8

“high” p_T fit ranges

Централььность, %	$\langle\beta\rangle$	T_{kin}, MeV	n	χ^2/NDF
0-5	0.280 ± 0.002	127 ± 3	1.8 ± 0.2	60.7
5-10	0.256 ± 0.005	130 ± 3	2.2 ± 0.2	43.6
10-20	0.239 ± 0.007	130 ± 4	2.7 ± 0.2	73.4
20-30	0.222 ± 0.003	131 ± 1	3.25 ± 0.08	65.7
30-40	0.213 ± 0.002	130 ± 2	3.67 ± 0.08	46.7
40-50	0.209 ± 0.002	130 ± 2	3.73 ± 0.09	51.4
50-60	0.207 ± 0.001	130 ± 3	3.89 ± 0.14	29.2

Au + Au $\sqrt{s_{NN}} = 7.7$ GeV

“default” p_T fit ranges

Центральность, %	$\langle\beta\rangle$ UrQMD	$\langle\beta\rangle$ STAR	T_{kin}, MeV UrQMD	T_{kin}, MeV STAR	n UrQMD	n STAR	χ^2/NDF
0-5	0.4058 ± 0.0005	0.462 ± 0.043	114.94 ± 0.08	116 ± 11	0.974 ± 0.005	0.5 ± 0.3	154.6
5-10	0.3921 ± 0.0006	0.440 ± 0.048	116.65 ± 0.10	118 ± 11	1.041 ± 0.006	0.5 ± 0.3	154.1
10-20	0.3727 ± 0.0005	0.403 ± 0.040	118.60 ± 0.08	121 ± 12	1.151 ± 0.006	0.8 ± 0.3	291.9
20-30	0.3389 ± 0.0008	0.379 ± 0.040	121.98 ± 0.12	123 ± 12	1.402 ± 0.011	0.9 ± 0.3	274.8
30-40	0.2999 ± 0.0011	0.348 ± 0.049	125.5 ± 0.2	129 ± 12	1.80 ± 0.02	0.8 ± 0.4	264.2
40-50	0.256 ± 0.002	0.282 ± 0.044	129.2 ± 0.2	131 ± 12	2.45 ± 0.04	1.6 ± 0.6	218.8
50-60	0.2066 ± 0.0009	0.205 ± 0.053	132.7 ± 0.2	139 ± 13	3.69 ± 0.03	2.0 ± 1.4	190.8
60-70	0.166 ± 0.003	0.147 ± 0.020	134.3 ± 0.3	139 ± 13	5.4 ± 0.2	5.0 ± 4.8	112.2
70-80	0.139 ± 0.003	0.106 ± 0.035	134.9 ± 0.4	140 ± 13	7.6 ± 0.4	5.0 ± 3.4	59.9

“high” p_T fit ranges

Центральность, %	$\langle\beta\rangle$ UrQMD	$\langle\beta\rangle$ STAR	T_{kin}, MeV UrQMD	T_{kin}, MeV STAR	n UrQMD	n STAR	χ^2/NDF
0-5	0.3492 ± 0.0012	0.462 ± 0.043	131.4 ± 0.2	116 ± 11	1.130 ± 0.012	0.5 ± 0.3	120.6
5-10	0.3349 ± 0.0014	0.440 ± 0.048	133.1 ± 0.2	118 ± 11	1.23 ± 0.02	0.5 ± 0.3	104.7
10-20	0.3165 ± 0.0012	0.403 ± 0.040	134.7 ± 0.2	121 ± 12	1.37 ± 0.02	0.8 ± 0.3	181.0
20-30	0.288 ± 0.002	0.379 ± 0.040	137.3 ± 0.3	123 ± 12	1.63 ± 0.02	0.9 ± 0.3	143.4
30-40	0.256 ± 0.002	0.348 ± 0.049	139.7 ± 0.3	129 ± 12	2.02 ± 0.04	0.8 ± 0.4	121.5
40-50	0.220 ± 0.003	0.282 ± 0.044	142.4 ± 0.35	131 ± 12	2.69 ± 0.07	1.6 ± 0.6	92.3
50-60	0.178 ± 0.004	0.205 ± 0.053	145.0 ± 0.4	139 ± 13	4.0 ± 0.2	2.0 ± 1.4	74.5
60-70	0.141 ± 0.006	0.147 ± 0.020	145.8 ± 0.6	139 ± 13	6.1 ± 0.5	5.0 ± 4.8	47.5
70-80	0.124 ± 0.006	0.106 ± 0.035	145.6 ± 0.6	140 ± 13	7.7 ± 0.6	5.0 ± 3.4	26.2

Au + Au $\sqrt{s_{NN}} = 7.7$ GeV

“low” p_T fit ranges

Центральность, %	$\langle\beta\rangle$ UrQMD	$\langle\beta\rangle$ STAR	T_{kin}, MeV UrQMD	T_{kin}, MeV STAR	n UrQMD	n STAR	χ^2/NDF
0-5	0.45890 ± 0.00014	0.462 ± 0.043	104.19 ± 0.06	116 ± 11	0.666 ± 0.003	0.5 ± 0.3	159.0
5-10	0.4494 ± 0.0008	0.440 ± 0.048	105.6 ± 0.1	118 ± 11	0.668 ± 0.005	0.5 ± 0.3	129.0
10-20	0.43500 ± 0.00014	0.403 ± 0.040	107.25 ± 0.08	121 ± 12	0.696 ± 0.004	0.8 ± 0.3	213.3
20-30	0.4137 ± 0.0002	0.379 ± 0.040	109.4 ± 0.1	123 ± 12	0.738 ± 0.006	0.9 ± 0.3	201.0
30-40	0.3870 ± 0.0003	0.348 ± 0.049	112.0 ± 0.1	129 ± 12	0.839 ± 0.009	0.8 ± 0.4	203.8
40-50	0.3561 ± 0.0005	0.282 ± 0.044	114.5 ± 0.2	131 ± 12	1.035 ± 0.014	1.6 ± 0.6	183.3
50-60	0.3173 ± 0.0007	0.205 ± 0.053	117.4 ± 0.2	139 ± 13	1.45 ± 0.02	2.0 ± 1.4	164.5
60-70	0.2728 ± 0.0012	0.147 ± 0.020	119.5 ± 0.3	139 ± 13	2.28 ± 0.04	5.0 ± 4.8	103.4
70-80	0.235 ± 0.002	0.106 ± 0.035	119.9 ± 0.5	140 ± 13	3.65 ± 0.07	5.0 ± 3.4	56.0

“default” p_T fit ranges (using impact parameter)

Центральность, %	$\langle\beta\rangle$ UrQMD	$\langle\beta\rangle$ STAR	T_{kin}, MeV UrQMD	T_{kin}, MeV STAR	n UrQMD	n STAR	χ^2/NDF
0-5	0.4056 ± 0.0005	0.462 ± 0.043	115.20 ± 0.08	116 ± 11	0.970 ± 0.009	0.5 ± 0.3	152.7
5-10	0.3915 ± 0.0006	0.440 ± 0.048	116.75 ± 0.09	118 ± 11	1.038 ± 0.006	0.5 ± 0.3	182.6
10-20	0.3716 ± 0.0006	0.403 ± 0.040	118.70 ± 0.10	121 ± 12	1.160 ± 0.007	0.8 ± 0.3	247.1
20-30	0.3412 ± 0.0007	0.379 ± 0.040	121.69 ± 0.11	123 ± 12	1.384 ± 0.010	0.9 ± 0.3	301.4
30-40	0.3028 ± 0.0011	0.348 ± 0.049	125.1 ± 0.2	129 ± 12	1.77 ± 0.02	0.8 ± 0.4	243.2
40-50	0.258 ± 0.003	0.282 ± 0.044	128.8 ± 0.2	131 ± 12	2.43 ± 0.04	1.6 ± 0.6	241.7
50-60	0.213 ± 0.003	0.205 ± 0.053	132.0 ± 0.3	139 ± 13	3.51 ± 0.09	2.0 ± 1.4	142.6
60-70	0.184 ± 0.003	0.147 ± 0.020	133.3 ± 0.3	139 ± 13	4.6 ± 0.2	5.0 ± 4.8	105.6
70-80	0.149 ± 0.003	0.106 ± 0.035	134.7 ± 0.3	140 ± 13	6.6 ± 0.2	5.0 ± 3.4	94.1