

# Centrality determination in MPD at NICA

MPD PWG1 meeting

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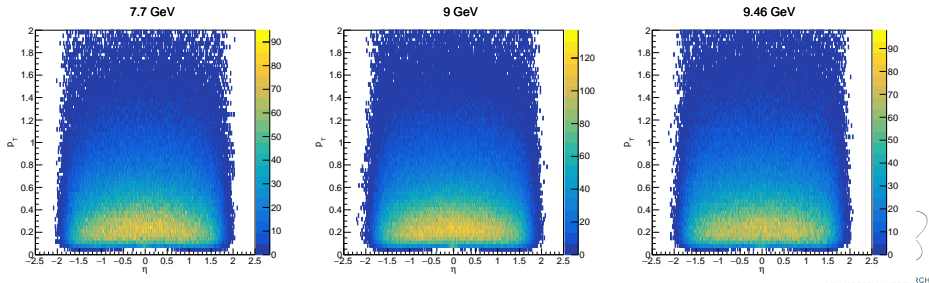
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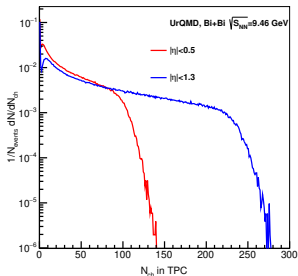
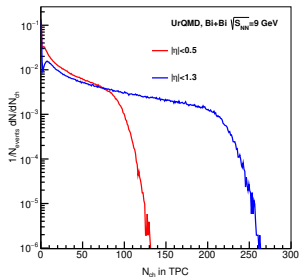
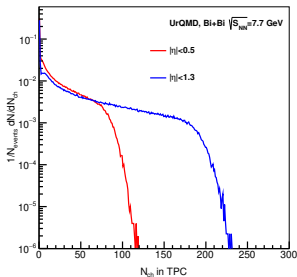
MexNICA

# Multiplicity selection

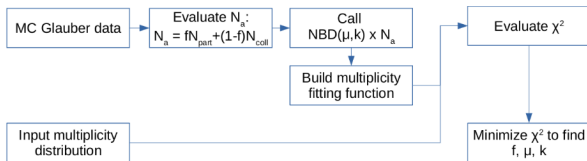
- $p_T > 0.15$  GeV/c
- $|\eta| < 0.5$  and  $|\eta| < 1.3$
- Only charged particles
- $N_{hits} > 16$
- Corrected DCA values with selection of primary particles [1].
- $\sim 600,000$  events.
- Bi+Bi collisions at 7.7, 9 and 9.46 GeV [2], [3] and [4] using UrQMD.



# Multiplicity distribution



# Multiplicity fit



## Definition

Negative Binomial Distribution ( $\mu = M^{max} / N_a^{max}$ ) [5]:

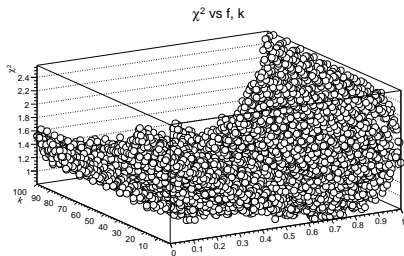
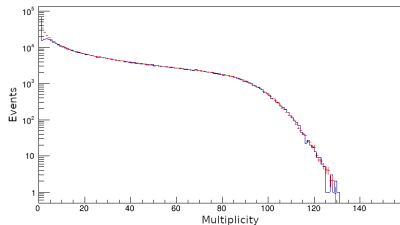
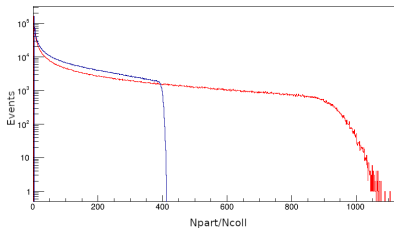
$$P(n) = \frac{\Gamma(n+k)}{\Gamma(n+1)\Gamma(k)} \frac{(\mu/k)^n}{(\mu/k+1)^{n+k}} \quad (1)$$

Number of ancestors (See slide 22 for different parametrizations):

$$N_a = fN_{part} + (1-f)N_{coll} \quad (2)$$

Glauber-based fit function:

$$F_{fit}(f, \mu, k) = \sum_1^{N_a} N_a \times P(N_{ch}) \quad (3)$$



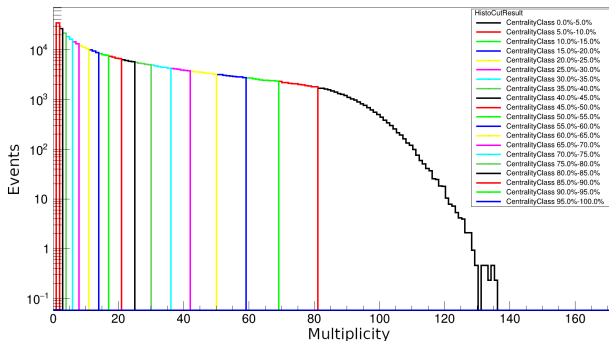
**Figure:** Bi + Bi collisions at 9 GeV.

# Centrality determination

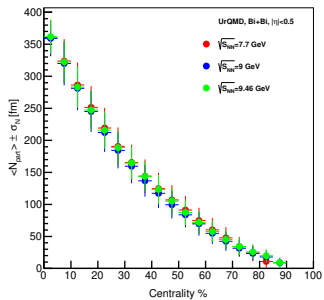
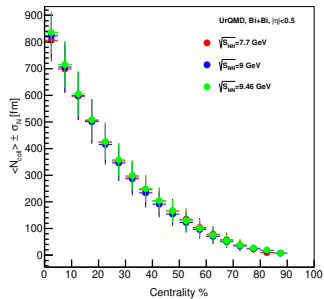
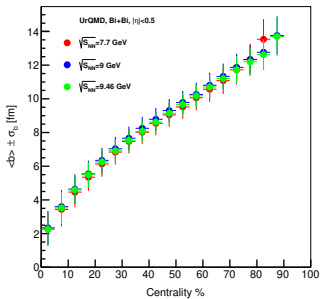
## Definition

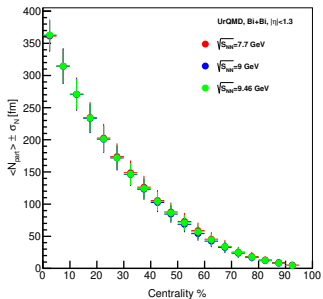
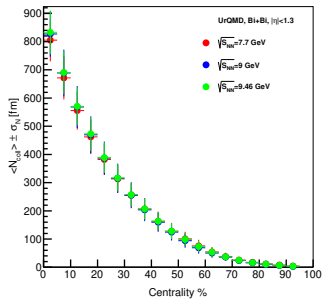
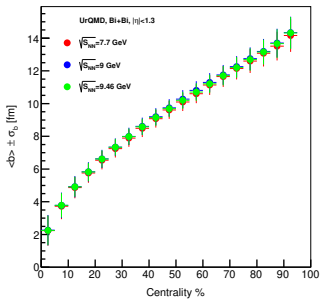
Centrality cuts:

$$c = \frac{\int_{N_{max}}^{N_i} \frac{dN_{ev}}{dN_{ch}} dN_{ch}}{\int_{N_{max}}^0 \frac{dN_{ev}}{dN_{ch}} dN_{ch}} \quad (4)$$

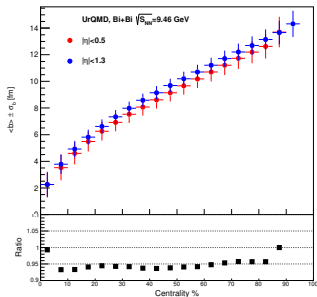
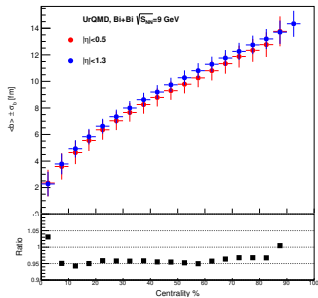
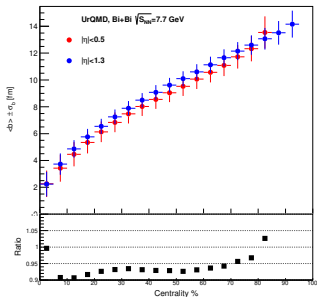


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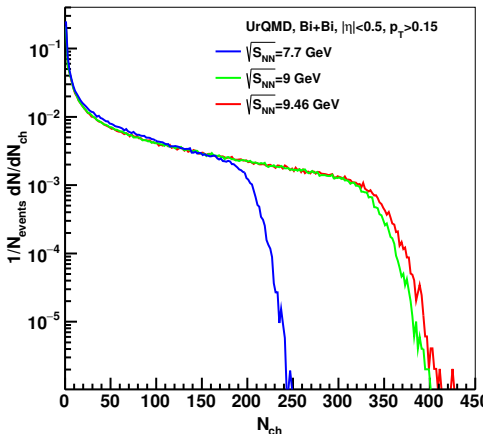


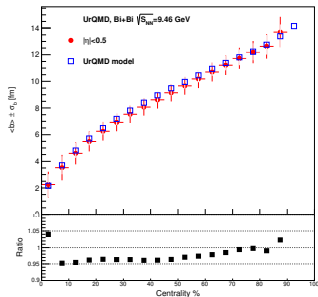
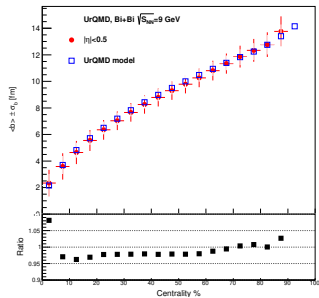
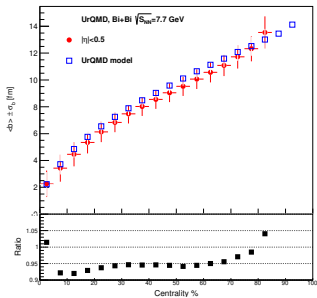




# UrQMD model

- $p_T > 0.15$  GeV/c
- $|\eta| < 0.5$
- Only charged particles
- $\sim 600,000$  events.
- Bi+Bi collisions at 7.7, 9 and 9.46 GeV using UrQMD test.f14 output files.





# Future work

- Obtain the results with the UrQMD model at 9, 7.7 and 9.46 GeV with cut in  $|\eta| < 1.3$  and compare it with the TPC results.
- Explore other montecarlos (PHSD and LAQGSM) and compare them with the results in UrQMD.
- Use the other parameterizations of the number of ancestors to compare with the current results (default).

# Thank you!



# References

- [1] DCA correction:  
[https://git.jinr.ru/nica/mpdroot/-/tree/pro/macro/physical\\_analysis/Flow](https://git.jinr.ru/nica/mpdroot/-/tree/pro/macro/physical_analysis/Flow)
- [2] Monte-Carlo request for @7.7 GeV events of the MPD collaboration for PWG3:  
<https://mpdforum.jinr.ru/t/request-9-pwg3-urqmd-flow-10m-min-bias-auau-bibi-7-7-gev/297>
- [3] Monte-Carlo request for @9 GeV events of the MPD collaboration for PWG3:  
<https://mpdforum.jinr.ru/t/request4-pwg3-urqmd-min-bias-bibi-9-gev/232>
- [4] Monte-Carlo request for @9.46 GeV events of the MPD collaboration for PWG4:  
<https://mpdforum.jinr.ru/t/request5-pwg4-dielectrons-10m-minbias-bibi-9-46/235>
- [5] Centrality determination:  
<https://github.com/FlowNICA/CentralityFramework>



# Backup slides



# Bi+Bi 7.7 GeV $|\eta| < 0.5$

**Best fit:**

$$f = 0.35 \pm 0.009, \mu = 0.116171 \pm 0.0948336, k = 100 \pm 9.536, \\ \chi^2 = 1.00229 \pm 0.124096$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	72	117	2.26	0.99	1.54	2.88	359.93	27.57	341.27	380.22	806.27	80.05	750.63	869.56
5 - 10	61	72	3.43	1.01	2.88	3.99	323.75	34.40	303.59	341.27	698.75	90.04	643.30	750.63
10 - 15	52	61	4.46	0.90	3.99	4.93	286.36	34.96	268.05	303.59	596.96	87.71	547.58	643.30
15 - 20	44	52	5.35	0.82	4.93	5.75	251.38	33.34	235.23	268.05	505.13	80.99	463.12	547.58
20 - 25	37	44	6.13	0.77	5.75	6.48	219.29	31.44	205.41	235.23	424.02	73.92	389.32	463.12
25 - 30	31	37	6.84	0.74	6.48	7.14	190.55	29.63	178.65	205.41	353.37	67.27	325.37	389.32
30 - 35	26	31	7.47	0.72	7.14	7.74	165.39	27.87	154.84	178.65	293.85	61.10	270.31	325.37
35 - 40	22	26	8.02	0.70	7.74	8.30	144.20	26.00	133.70	154.84	245.72	55.17	223.10	270.31
40 - 45	18	22	8.55	0.71	8.30	8.82	124.61	24.61	114.88	133.70	203.13	50.26	182.64	223.10
45 - 50	15	18	9.05	0.70	8.82	9.32	106.99	22.98	97.95	114.88	166.24	44.94	147.87	182.64
50 - 55	12	15	9.52	0.71	9.32	9.80	91.26	21.61	82.49	97.95	134.82	40.47	117.80	147.87
55 - 60	9	12	10.06	0.74	9.80	10.28	74.68	20.16	68.10	82.49	103.71	35.78	91.58	117.80
60 - 65	7	9	10.58	0.75	10.28	10.79	60.29	18.29	54.45	68.10	78.36	30.50	68.53	91.58
65 - 70	5	7	11.08	0.79	10.79	11.37	47.72	16.86	41.34	54.45	57.90	26.27	48.24	68.53
70 - 75	3	5	11.73	0.87	11.37	12.06	34.18	15.13	28.72	41.34	37.90	21.44	30.60	48.24
75 - 80	2	3	12.33	0.94	12.06	12.92	23.82	12.63	16.75	28.72	24.07	16.15	15.86	30.60
80 - 85	1	2	13.54	1.20	12.92	14.04	10.85	9.55	5.84	16.75	9.57	10.57	4.69	15.86



# Bi+Bi 9 GeV $|\eta| < 0.5$

**Best fit:**

$$f = 0.65 \pm 0.104, \mu = 0.164202 \pm 0.0730813, k = 5 \pm 79.24, \\ \chi^2 = 0.803798 \pm 0.130637$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	81	130	2.34	1.01	1.58	2.99	359.33	28.11	338.64	383.97	823.73	86.20	762.14	900.13
5 - 10	69	81	3.59	0.99	2.99	4.15	319.98	34.03	297.97	338.64	705.92	95.03	644.34	762.14
10 - 15	59	69	4.64	0.88	4.15	5.13	281.17	33.96	261.43	297.97	597.94	91.11	543.47	644.34
15 - 20	50	59	5.54	0.79	5.13	5.96	245.05	31.97	228.60	261.43	501.07	82.97	456.83	543.47
20 - 25	42	50	6.35	0.75	5.96	6.69	212.09	30.14	199.07	228.60	415.71	75.63	382.16	456.83
25 - 30	36	42	7.03	0.71	6.69	7.35	184.27	27.93	172.50	199.07	346.16	67.73	317.65	382.16
30 - 35	30	36	7.66	0.70	7.35	7.95	159.51	26.41	148.61	172.50	286.77	61.70	261.84	317.65
35 - 40	25	30	8.25	0.69	7.95	8.51	136.70	24.53	127.12	148.61	234.04	54.94	213.59	261.84
40 - 45	21	25	8.79	0.68	8.51	9.05	117.23	22.74	107.82	127.12	191.25	48.79	172.01	213.59
45 - 50	17	21	9.30	0.69	9.05	9.56	99.49	21.40	90.52	107.82	154.11	43.76	136.39	172.01
50 - 55	14	17	9.79	0.69	9.56	10.06	83.79	19.67	75.04	90.52	122.87	38.33	106.19	136.39
55 - 60	11	14	10.26	0.71	10.06	10.55	69.61	18.26	61.23	75.04	96.23	33.62	80.94	106.19
60 - 65	8	11	10.81	0.74	10.55	11.04	54.88	16.78	48.95	61.23	70.52	28.68	60.19	80.94
65 - 70	6	8	11.34	0.76	11.04	11.54	42.36	14.77	38.08	48.95	50.36	23.24	43.50	60.19
70 - 75	4	6	11.87	0.82	11.54	12.06	31.69	13.21	28.48	38.08	34.78	19.01	30.30	43.50
75 - 80	3	4	12.34	0.86	12.06	12.63	23.69	11.28	20.02	28.48	24.08	14.84	19.92	30.30
80 - 85	2	3	12.76	0.93	12.63	13.28	17.92	9.95	12.56	20.02	17.10	12.16	11.47	19.92
85 - 90	1	2	13.77	1.13	13.28	14.05	8.75	7.32	5.96	12.56	7.36	7.83	3.83	11.47



# Bi+Bi 9.46 GeV $|\eta| < 0.5$

**Best fit:**

$$f = 0.41 \pm 0.114, \mu = 0.143428 \pm 0.112919, k = 29 \pm 38.919,$$

$$\chi^2 = 0.84588 \pm 0.140643$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	88	146	2.25	0.97	1.41	2.93	361.86	26.57	340.55	388.36	836.16	80.59	771.95	917.08
5 - 10	74	88	3.53	0.95	2.93	4.12	322.52	32.96	299.50	340.55	715.47	88.79	651.92	771.95
10 - 15	63	74	4.59	0.82	4.12	5.08	283.24	32.38	263.73	299.50	605.24	83.43	551.61	651.92
15 - 20	53	63	5.49	0.75	5.08	5.88	247.40	30.78	232.08	263.73	508.45	76.66	466.71	551.61
20 - 25	45	53	6.26	0.70	5.88	6.58	216.04	28.70	203.71	232.08	426.57	68.96	393.87	466.71
25 - 30	38	45	6.92	0.67	6.58	7.21	188.78	27.10	177.96	203.71	357.87	63.01	330.62	393.87
30 - 35	32	38	7.53	0.66	7.21	7.80	164.50	25.44	154.43	177.96	298.80	57.03	275.15	330.62
35 - 40	27	32	8.08	0.65	7.80	8.36	143.52	23.87	132.84	154.43	249.74	51.69	226.29	275.15
40 - 45	22	27	8.61	0.65	8.36	8.90	123.47	22.56	113.07	132.84	204.86	46.95	183.29	226.29
45 - 50	18	22	9.14	0.65	8.90	9.43	104.99	20.93	95.07	113.07	165.33	41.68	145.74	183.29
50 - 55	14	18	9.67	0.67	9.43	9.94	87.58	19.65	78.82	95.07	130.10	37.28	113.46	145.74
55 - 60	11	14	10.18	0.68	9.94	10.44	72.01	17.96	64.34	78.82	100.42	32.16	86.33	113.46
60 - 65	8	11	10.70	0.71	10.44	10.93	57.64	16.67	51.59	64.34	74.93	27.97	64.16	86.33
65 - 70	6	8	11.21	0.73	10.93	11.42	45.17	14.86	40.47	51.59	54.46	23.13	46.64	64.16
70 - 75	4	6	11.73	0.79	11.42	11.93	34.19	13.49	30.77	40.47	38.11	19.32	33.10	46.64
75 - 80	3	4	12.20	0.83	11.93	12.49	25.92	11.68	22.11	30.77	26.80	15.40	22.47	33.10
80 - 85	2	3	12.63	0.92	12.49	13.16	19.77	10.51	13.95	22.11	19.19	12.88	13.13	22.47
85 - 90	1	2	13.70	1.15	13.16	14.00	9.38	7.92	5.50	13.95	7.99	8.48	2.75	13.13



# Bi+Bi 7.7 GeV $|\eta| < 1.3$

**Best fit:**

$$f = 0.74 \pm 0.007, \mu = 0.358708 \pm 0.151799, k = 93 \pm 4.21,$$

$$\chi^2 = 1.1036 \pm 0.0898583$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	158	239	2.24	0.92	1.43	3.03	361.28	24.59	336.59	389.89	805.08	75.03	734.91	883.92
5 - 10	133	158	3.73	0.79	3.03	4.30	314.45	27.91	291.11	336.59	671.26	76.34	610.66	734.91
10 - 15	113	133	4.87	0.65	4.30	5.33	270.97	25.63	251.94	291.11	555.54	67.59	506.74	610.66
15 - 20	96	113	5.76	0.59	5.33	6.19	234.74	23.81	217.87	251.94	462.04	60.85	419.46	506.74
20 - 25	81	96	6.54	0.56	6.19	6.93	202.65	22.15	187.93	217.87	382.21	54.73	345.82	419.46
25 - 30	68	81	7.25	0.54	6.93	7.58	173.86	20.53	161.36	187.93	313.28	49.01	283.37	345.82
30 - 35	57	68	7.89	0.54	7.58	8.19	148.76	18.94	137.60	161.36	255.58	43.55	230.20	283.37
35 - 40	47	57	8.49	0.53	8.19	8.77	126.32	17.56	116.26	137.60	206.49	38.78	184.84	230.20
40 - 45	38	47	9.08	0.54	8.77	9.32	105.60	16.26	97.08	116.26	163.01	33.93	146.19	184.84
45 - 50	31	38	9.61	0.54	9.32	9.86	87.81	14.59	79.90	97.08	127.90	28.95	113.42	146.19
50 - 55	25	31	10.10	0.55	9.86	10.38	73.01	13.45	64.63	79.90	100.28	25.17	85.97	113.42
55 - 60	19	25	10.60	0.58	10.38	10.90	58.82	12.43	51.24	64.63	75.49	21.74	63.38	85.97
60 - 65	14	19	11.14	0.60	10.90	11.40	45.53	11.05	39.72	51.24	54.03	17.78	45.30	63.38
65 - 70	10	14	11.66	0.63	11.40	11.88	34.32	9.68	30.03	39.72	37.48	14.17	31.36	45.30
70 - 75	7	10	12.15	0.67	11.88	12.36	25.28	8.33	22.12	30.03	25.39	11.01	21.13	31.36
75 - 80	5	7	12.60	0.72	12.36	12.83	18.65	7.10	15.84	22.12	17.35	8.54	14.03	21.13
80 - 85	3	5	13.07	0.81	12.83	13.32	13.19	6.04	10.96	15.84	11.38	6.59	9.25	14.03
85 - 90	2	3	13.51	0.88	13.32	13.84	9.27	4.79	7.12	10.96	7.47	4.80	5.71	9.25
90 - 95	1	2	14.16	1.01	13.84	14.44	5.35	3.53	3.82	7.12	3.94	3.24	1.94	5.71

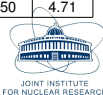
# Bi+Bi 9 GeV $|\eta| < 1.3$

**Best fit:**

$$f = 0.92 \pm 0.014, \mu = 0.494827 \pm 0.255544, k = 52 \pm 8.999,$$

$$\chi^2 = 1.13706 \pm 0.154046$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	183	271	2.27	0.93	1.45	3.07	362.30	24.42	337.16	390.21	826.98	80.42	754.22	904.88
5 - 10	156	183	3.78	0.78	3.07	4.35	314.40	27.12	291.32	337.16	688.78	82.80	626.59	754.22
10 - 15	133	156	4.92	0.65	4.35	5.39	270.51	25.07	251.46	291.32	568.19	74.27	518.46	626.59
15 - 20	114	133	5.83	0.59	5.39	6.26	233.24	22.77	216.56	251.46	469.53	65.66	426.84	518.46
20 - 25	97	114	6.62	0.56	6.26	7.01	200.80	21.08	185.80	216.56	386.86	58.94	349.19	426.84
25 - 30	82	97	7.34	0.53	7.01	7.68	171.68	19.34	158.52	185.80	315.39	52.07	283.41	349.19
30 - 35	69	82	8.00	0.52	7.68	8.30	146.07	17.83	134.23	158.52	255.25	45.89	227.74	283.41
35 - 40	57	69	8.61	0.53	8.30	8.89	123.03	16.49	112.58	134.23	203.69	40.39	180.75	227.74
40 - 45	47	57	9.20	0.52	8.89	9.46	102.48	14.87	93.30	112.58	160.00	34.41	141.28	180.75
45 - 50	38	47	9.74	0.53	9.46	10.01	84.65	13.59	76.21	93.30	124.29	29.56	108.40	141.28
50 - 55	30	38	10.28	0.54	10.01	10.55	68.54	12.32	61.20	76.21	94.03	24.92	81.34	108.40
55 - 60	23	30	10.81	0.56	10.55	11.06	54.14	11.00	48.19	61.20	68.89	20.46	59.46	81.34
60 - 65	18	23	11.29	0.57	11.06	11.55	42.50	9.53	37.10	48.19	50.16	16.24	42.20	59.46
65 - 70	13	18	11.76	0.61	11.55	12.02	32.70	8.52	27.87	37.10	35.73	13.16	29.02	42.20
70 - 75	9	13	12.26	0.64	12.02	12.48	23.84	7.24	20.37	27.87	23.86	9.98	19.38	29.02
75 - 80	6	9	12.75	0.69	12.48	12.95	16.90	5.97	14.43	20.37	15.50	7.31	12.63	19.38
80 - 85	4	6	13.19	0.76	12.95	13.45	12.01	4.85	9.79	14.43	10.19	5.34	8.04	12.63
85 - 90	2	4	13.70	0.88	13.45	14.01	7.96	3.92	6.11	9.79	6.26	3.87	4.71	8.04
90 - 95	1	2	14.34	0.98	14.01	14.70	4.47	2.54	2.90	6.11	3.17	2.27	1.50	4.71



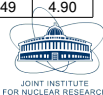
# Bi+Bi 9.46 GeV $|\eta| < 1.3$

**Best fit:**

$$f = 0.81 \pm 0.039, \mu = 0.464844 \pm 0.209926, k = 65 \pm 32.813,$$

$$\chi^2 = 1.24468 \pm 0.107304$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	196	285	2.25	0.91	1.44	3.06	362.79	23.98	337.54	391.48	833.08	77.30	758.77	914.84
5 - 10	166	196	3.79	0.74	3.06	4.34	314.37	26.15	291.32	337.54	690.71	76.20	628.38	758.77
10 - 15	141	166	4.92	0.61	4.34	5.39	270.92	23.96	251.44	291.32	570.62	67.55	519.28	628.38
15 - 20	120	141	5.82	0.55	5.39	6.26	234.03	21.95	216.76	251.44	472.65	60.14	427.79	519.28
20 - 25	101	120	6.62	0.53	6.26	7.00	201.19	20.46	186.36	216.76	388.52	54.04	350.85	427.79
25 - 30	85	101	7.34	0.51	7.00	7.67	172.08	18.76	159.49	186.36	316.75	47.70	285.94	350.85
30 - 35	71	85	7.98	0.50	7.67	8.28	146.83	17.29	135.61	159.49	257.12	42.23	231.06	285.94
35 - 40	59	71	8.58	0.50	8.28	8.85	124.38	15.89	114.30	135.61	206.69	37.15	184.61	231.06
40 - 45	48	59	9.15	0.51	8.85	9.41	104.23	14.67	95.26	114.30	163.59	32.51	145.36	184.61
45 - 50	39	48	9.69	0.51	9.41	9.94	86.40	13.29	78.29	95.26	127.63	27.85	112.35	145.36
50 - 55	31	39	10.20	0.53	9.94	10.47	70.92	12.12	63.26	78.29	98.25	23.83	84.89	112.35
55 - 60	24	31	10.70	0.54	10.47	10.97	56.98	10.98	50.11	63.26	73.53	20.06	62.42	84.89
60 - 65	18	24	11.21	0.57	10.97	11.47	44.50	9.80	38.77	50.11	53.14	16.41	44.47	62.42
65 - 70	13	18	11.71	0.60	11.47	11.95	33.77	8.60	29.21	38.77	37.13	13.08	30.62	44.47
70 - 75	9	13	12.21	0.64	11.95	12.43	24.75	7.39	21.33	29.21	24.93	10.08	20.40	30.62
75 - 80	6	9	12.69	0.69	12.43	12.91	17.62	6.20	15.03	21.33	16.28	7.55	13.24	20.40
80 - 85	4	6	13.15	0.76	12.91	13.42	12.50	5.07	10.10	15.03	10.70	5.60	8.40	13.24
85 - 90	2	4	13.67	0.88	13.42	13.99	8.27	4.11	6.26	10.10	6.56	4.07	4.90	8.40
90 - 95	1	2	14.32	0.98	13.99	14.65	4.58	2.67	3.11	6.26	3.28	2.40	1.49	4.90



# UrQMD Bi+Bi 7.7 GeV $|\eta| < 0.5$ $p_T > 0.15$

Best fit:

$$f = 0.6 \pm 0.003, \mu = 0.336361 \pm 0.173538, k = 96 \pm 8.216,$$

$$\chi^2 = 1.67286 \pm 0.0920108$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	168	255	2.23	0.91	1.38	3.01	361.56	24.35	336.89	389.92	807.68	72.56	736.64	884.96
5 - 10	141	168	3.72	0.77	3.01	4.30	314.74	27.40	291.52	336.89	672.45	71.61	612.46	736.64
10 - 15	119	141	4.85	0.63	4.30	5.33	271.73	25.40	252.37	291.52	557.36	63.64	508.25	612.46
15 - 20	100	119	5.76	0.58	5.33	6.18	234.81	23.59	218.25	252.37	462.39	57.08	420.53	508.25
20 - 25	84	100	6.55	0.54	6.18	6.91	202.48	21.78	188.22	218.25	381.69	50.95	346.40	420.53
25 - 30	70	84	7.25	0.53	6.91	7.57	173.93	20.26	161.56	188.22	313.30	45.76	283.54	346.40
30 - 35	58	70	7.90	0.52	7.57	8.18	148.66	18.74	137.72	161.56	255.25	40.65	230.09	283.54
35 - 40	48	58	8.48	0.52	8.18	8.76	126.66	17.24	116.34	137.72	206.82	35.89	184.60	230.09
40 - 45	39	48	9.03	0.52	8.76	9.32	107.07	16.00	97.17	116.34	165.72	31.84	145.97	184.60
45 - 50	31	39	9.58	0.53	9.32	9.86	88.91	14.72	80.04	97.17	129.75	27.91	113.36	145.97
50 - 55	24	31	10.12	0.55	9.86	10.38	72.44	13.42	64.88	80.04	99.03	24.04	86.14	113.36
55 - 60	18	24	10.65	0.57	10.38	10.89	57.47	12.18	51.64	64.88	73.05	20.35	63.83	86.14
60 - 65	14	18	11.13	0.58	10.89	11.37	45.66	10.75	40.28	51.64	53.99	16.71	46.02	63.83
65 - 70	10	14	11.59	0.62	11.37	11.84	35.57	9.78	30.76	40.28	39.09	14.05	32.28	46.02
70 - 75	7	10	12.08	0.66	11.84	12.29	26.48	8.51	22.97	30.76	26.80	11.13	22.13	32.28
75 - 80	5	7	12.52	0.72	12.29	12.75	19.72	7.33	16.73	22.97	18.54	8.78	14.98	22.13
80 - 85	3	5	13.01	0.81	12.75	13.24	13.93	6.35	11.74	16.73	12.14	6.90	9.99	14.98
85 - 90	2	3	13.46	0.88	13.24	13.79	9.77	5.08	7.59	11.74	7.94	5.09	6.10	9.99
90 - 95	1	2	14.12	1.01	13.79	14.45	5.60	3.77	3.66	7.59	4.15	3.45	1.88	6.10

# UrQMD Bi+Bi 9 GeV $|\eta| < 0.5$ $p_T > 0.15$

**Best fit:**

$$f = 0.08 \pm 0.03, \mu = 0.374141 \pm 0.463384, k = 58 \pm 19.697,$$

$$\chi^2 = 1.21253 \pm 0.0615514$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	274	409	2.16	0.86	1.32	2.98	364.57	22.98	339.85	390.89	843.40	66.55	766.82	918.18
5 - 10	227	274	3.70	0.68	2.98	4.26	317.22	25.39	295.24	339.85	697.90	59.02	638.83	766.82
10 - 15	189	227	4.82	0.56	4.26	5.29	274.49	23.63	256.11	295.24	579.43	51.52	530.66	638.83
15 - 20	157	189	5.72	0.51	5.29	6.14	237.98	22.00	221.70	256.11	481.67	45.63	439.25	530.66
20 - 25	130	157	6.50	0.49	6.14	6.87	205.99	20.47	191.35	221.70	399.41	40.79	362.01	439.25
25 - 30	107	130	7.19	0.47	6.87	7.52	177.77	19.03	164.49	191.35	329.39	36.36	296.71	362.01
30 - 35	87	107	7.83	0.47	7.52	8.12	152.58	17.64	140.69	164.49	269.34	32.45	241.53	296.71
35 - 40	70	87	8.43	0.47	8.12	8.69	129.86	16.30	119.57	140.69	217.67	28.74	194.92	241.53
40 - 45	56	70	8.98	0.47	8.69	9.24	109.94	14.97	100.84	119.57	174.51	25.34	155.65	194.92
45 - 50	44	56	9.50	0.48	9.24	9.76	92.39	13.79	84.26	100.84	138.45	22.37	122.69	155.65
50 - 55	34	44	10.00	0.49	9.76	10.26	76.66	12.55	69.63	84.26	107.92	19.48	95.21	122.69
55 - 60	26	34	10.48	0.51	10.26	10.72	62.98	11.40	56.78	69.63	83.04	16.86	72.53	95.21
60 - 65	19	26	10.95	0.53	10.72	11.17	50.70	10.37	45.56	56.78	62.26	14.63	54.06	72.53
65 - 70	14	19	11.40	0.55	11.17	11.60	40.17	9.19	35.83	45.56	45.72	12.21	39.30	54.06
70 - 75	10	14	11.82	0.59	11.60	12.03	31.53	8.28	27.42	35.83	33.35	10.36	27.72	39.30
75 - 80	7	10	12.24	0.64	12.03	12.50	24.22	7.38	20.16	27.42	23.79	8.63	18.81	27.72
80 - 85	4	7	12.76	0.73	12.50	13.05	17.01	6.62	13.83	20.16	15.36	7.12	11.96	18.81
85 - 90	2	4	13.40	0.88	13.05	13.74	10.53	5.35	8.16	13.83	8.62	5.16	6.47	11.96
90 - 95	1	2	14.15	1.00	13.74	14.67	5.54	3.63	2.81	8.16	4.05	3.18	1.47	6.47

# UrQMD Bi+Bi 9.46 GeV $|\eta| < 0.5$ $p_T > 0.15$

**Best fit:**

$$f = 0.01 \pm 0.178, \mu = 0.365591 \pm 0.490669, k = 59 \pm 9.511,$$

$$\chi^2 = 1.2062 \pm 0.688291$$

Centrality, %	$N_{ch}^{min}$	$N_{ch}^{max}$	$\langle b \rangle$ , fm	RMS	$b_{min}$ , fm	$b_{max}$ , fm	$\langle N_{part} \rangle$	RMS	$N_{part}^{min}$	$N_{part}^{max}$	$\langle N_{coll} \rangle$	RMS	$N_{coll}^{min}$	$N_{coll}^{max}$
0 - 5	281	423	2.17	0.86	1.33	2.98	364.60	23.04	339.98	391.22	846.18	66.55	769.57	922.36
5 - 10	233	281	3.70	0.68	2.98	4.26	317.36	25.31	295.37	339.98	700.16	58.02	640.94	769.57
10 - 15	194	233	4.81	0.56	4.26	5.29	275.01	23.58	256.37	295.37	582.27	50.76	532.62	640.94
15 - 20	161	194	5.71	0.51	5.29	6.13	238.61	22.05	222.14	256.37	484.61	45.16	441.32	532.62
20 - 25	133	161	6.49	0.48	6.13	6.86	206.50	20.59	191.96	222.14	401.58	40.33	364.25	441.32
25 - 30	109	133	7.19	0.47	6.86	7.50	178.04	19.10	165.26	191.96	330.71	35.98	299.11	364.25
30 - 35	89	109	7.82	0.46	7.50	8.10	153.04	17.65	141.56	165.26	270.91	31.85	243.97	299.11
35 - 40	72	89	8.40	0.47	8.10	8.67	130.93	16.40	120.49	141.56	220.53	28.48	197.29	243.97
40 - 45	57	72	8.96	0.47	8.67	9.22	110.94	15.16	101.74	120.49	176.92	25.30	157.81	197.29
45 - 50	45	57	9.48	0.48	9.22	9.74	93.13	13.82	85.10	101.74	140.18	21.98	124.54	157.81
50 - 55	35	45	9.96	0.49	9.74	10.23	77.94	12.68	70.36	85.10	110.47	19.34	96.70	124.54
55 - 60	26	35	10.45	0.51	10.23	10.70	63.76	11.62	57.39	70.36	84.51	16.99	73.64	96.70
60 - 65	19	26	10.94	0.53	10.70	11.15	50.95	10.39	46.05	57.39	62.62	14.50	54.83	73.64
65 - 70	14	19	11.38	0.56	11.15	11.58	40.53	9.25	36.20	46.05	46.27	12.23	39.80	54.83
70 - 75	10	14	11.81	0.59	11.58	12.02	31.86	8.34	27.70	36.20	33.82	10.45	28.04	39.80
75 - 80	7	10	12.23	0.64	12.02	12.49	24.47	7.47	20.37	27.70	24.14	8.78	19.04	28.04
80 - 85	4	7	12.75	0.74	12.49	13.04	17.21	6.70	13.98	20.37	15.60	7.23	12.16	19.04
85 - 90	2	4	13.39	0.88	13.04	13.74	10.66	5.42	8.25	13.98	8.76	5.25	6.60	12.16
90 - 95	1	2	14.15	1.01	13.74	14.66	5.59	3.68	2.82	8.25	4.09	3.24	1.37	6.60



# Number of ancestors parametrization

- "Default":  $N_a(f) = fN_{part} + (1 - f)N_{coll}$
- "PSD":  $N_a(f) = f - N_{part}$
- "Npart":  $N_a(f) = (N_{part})^f$
- "Ncoll":  $N_a(f) = (N_{coll})^f$
- "STAR":  $N_a(f) = \frac{(1-f)}{2} N_{part} + fN_{coll}$

Back to slide 3

