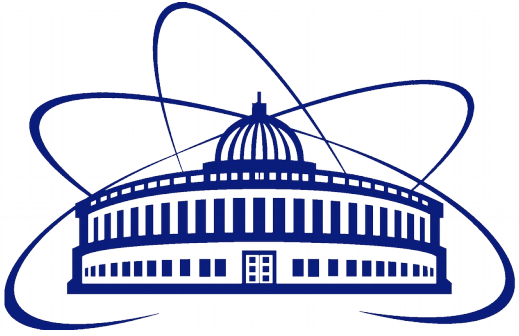
Comparison of centrality parametrizations for Request 30

Elizaveta Nazarova[1]

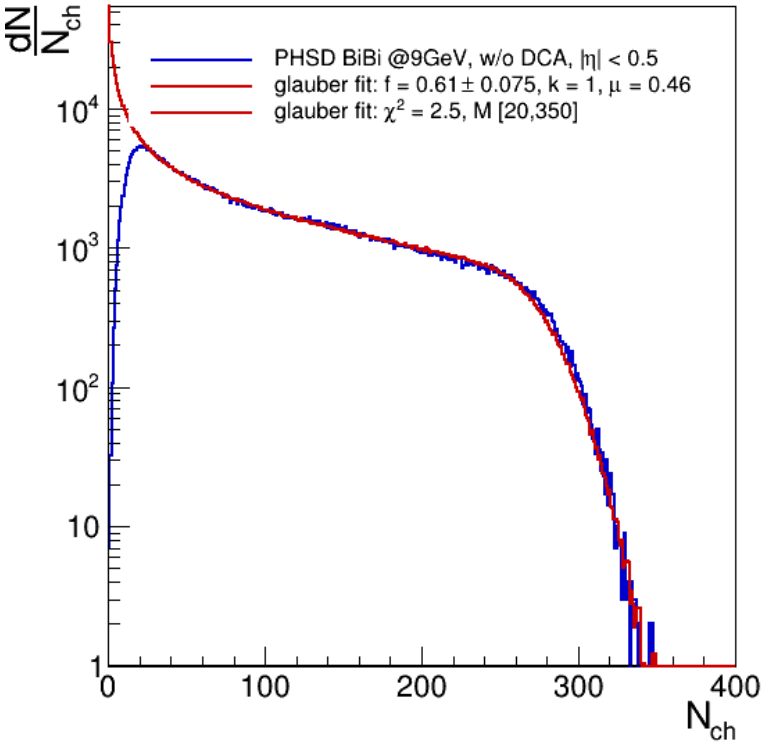


31.01.2023

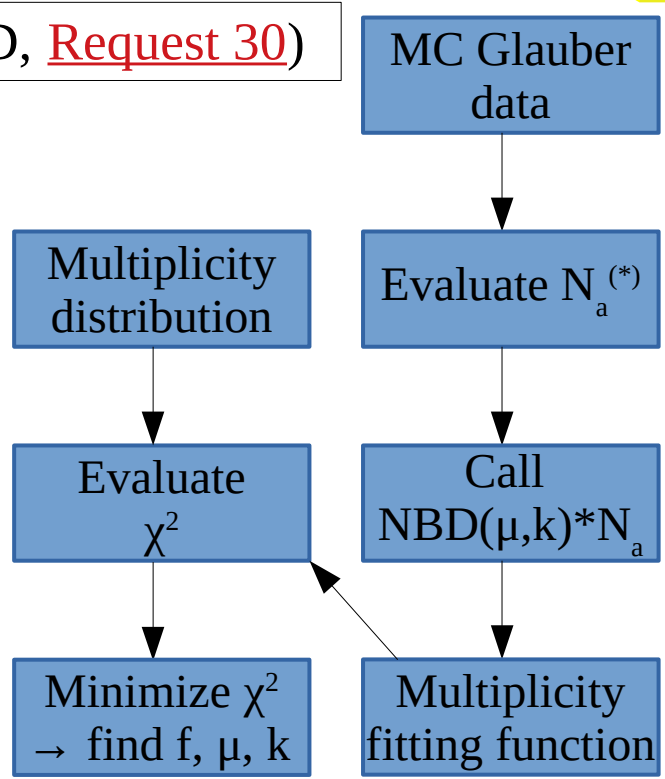
[1] Joint Institute of Nuclear Research, Dubna, Russia

Centrality determination for Request 30

- Dataset: Bi-Bi @ 9.2GeV, 15M MB events, b [0,12]fm (PHSD, Request 30)



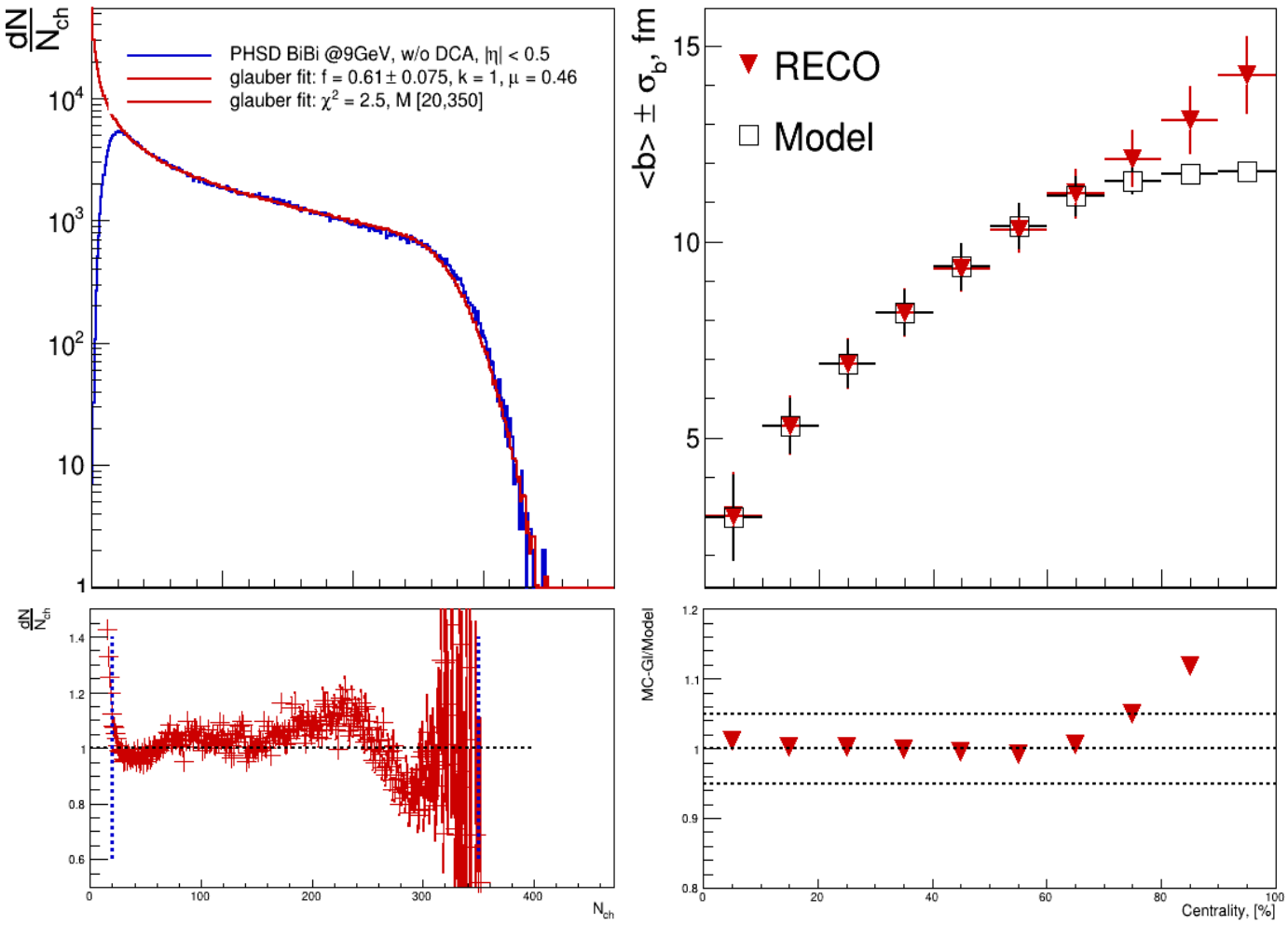
- MC-Glauber based centrality framework[1]
- TPC multiplicity for centrality calibration



$$N_a = f N_{\text{part}} + (1-f) N_{coll}$$

[1] Implementation for the MPD experiment (https://github.com/FlowNICA/CentralityFramework)
P. Parfenov, et al., Particles. 2021; 4(2):275-287

Original centrality parametrization



- Selection criteria:
  - 500k events
  - $|\eta| < 0.5$
  - $|p_T| > 0.15$ GeV
  - $N_{hits} > 16$
  - w/o DCA
  - 10%-centrality bins

Centrality tests overview

- Dataset: Bi-Bi @ 9.2GeV, 15M MB events, b [0,12]fm (PHSD, Request 30)
- + Private Dataset of 500000 events with b [0,16]fm for centrality tests

	Selections criteria
set1	b[0,12]fm; |DCA| < 1cm, |η| < 0.5
set2	b[0,12]fm; |DCA| < 3cm, |η| < 0.5
set3	b[0,12]fm; |DCA| < 1cm, |η| < 1.0
set4	b[0,12]fm; |DCA| < 3cm, |η| < 1.0
set5	b[0,16]fm; |DCA| < 1cm, |η| < 0.5
set6	b[0,16]fm; |DCA| < 3cm, |η| < 0.5
set7	b[0,16]fm; |DCA| < 1cm, |η| < 1.0
set8	b[0,16]fm; |DCA| < 3cm, |η| < 1.0

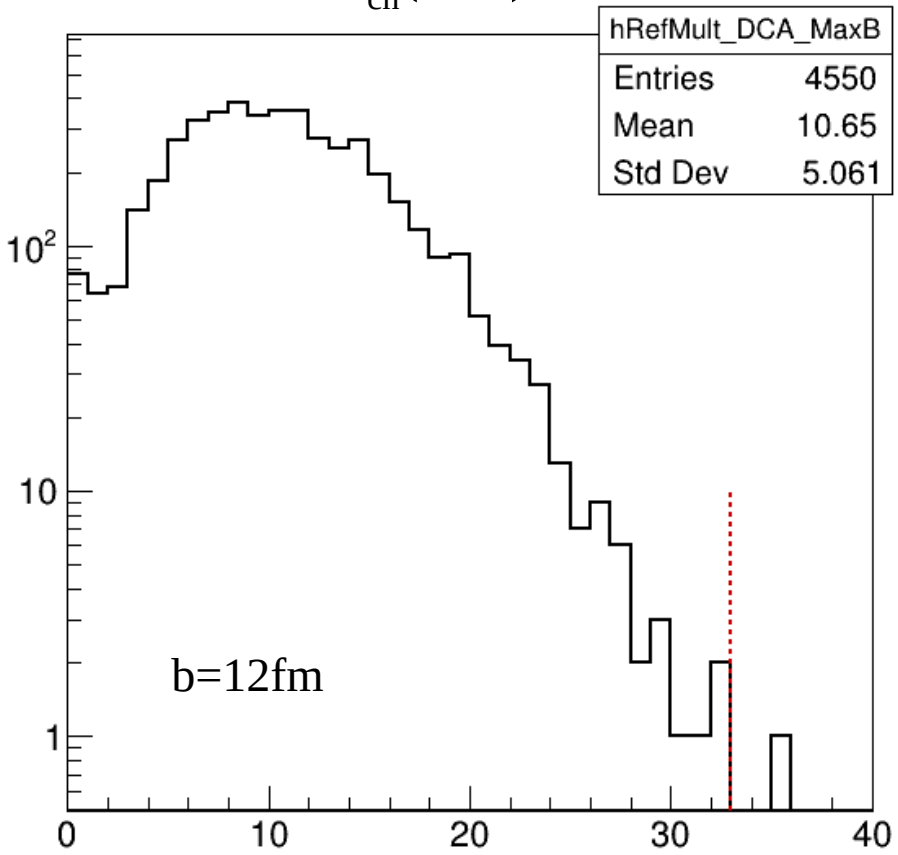
default

- Selection criteria:
  - 500k events
  - $|\eta| < 0.5$ or $|\eta| < 1.0$
  - $|p_T| > 0.15$ GeV
  - $N_{hits} > 16$
  - $|DCA| < 1$ or $|DCA| < 3$
  - 10%-centrality bins

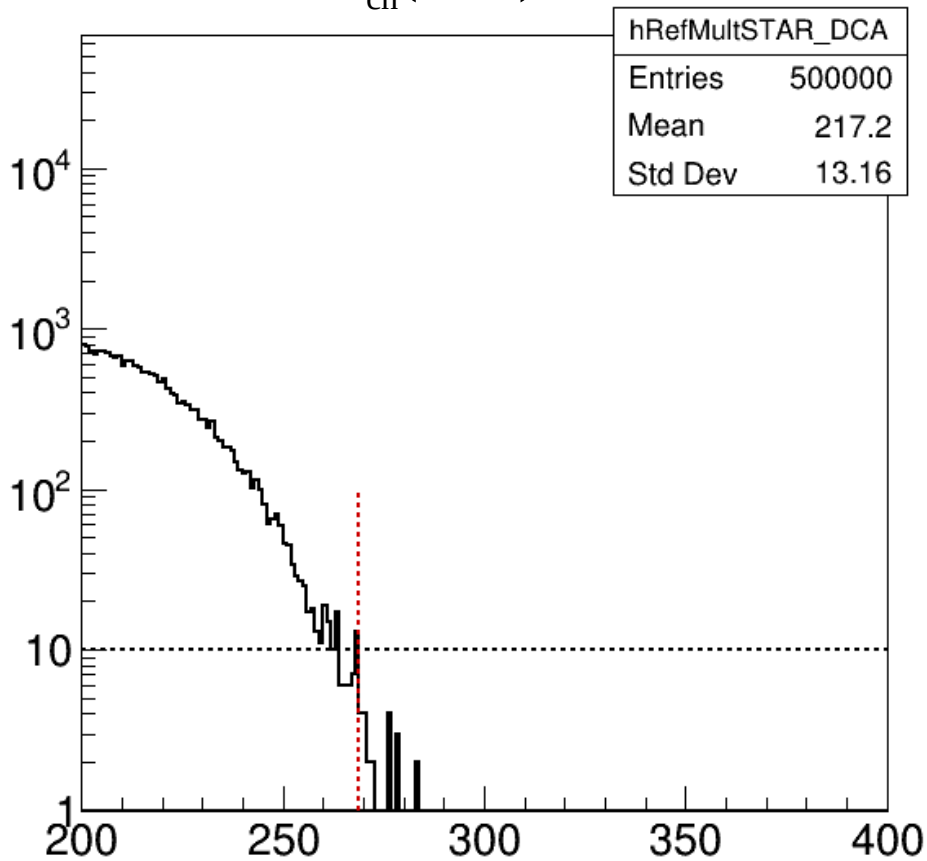
- Compare results for sets with same selections with b[0,12] and b[0,16]
- Compare all sets → choose the final parametrization

Multiplicity cut range for fitting (set1)

$N_{ch}(min) = 33$



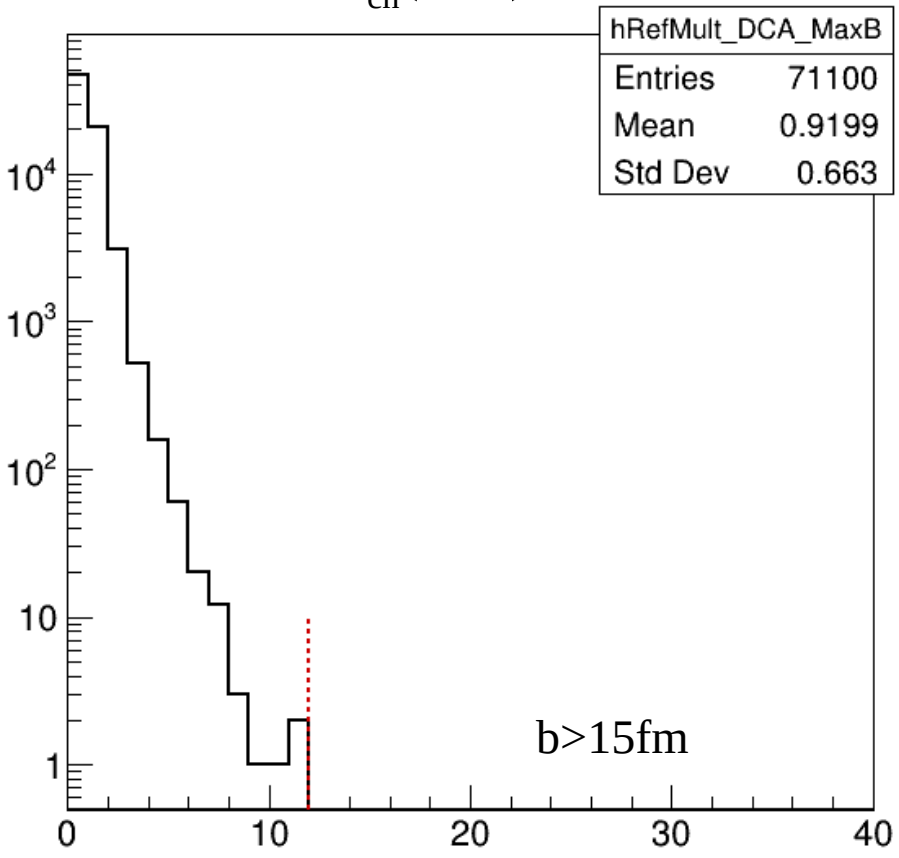
$N_{ch}(max) = 269$



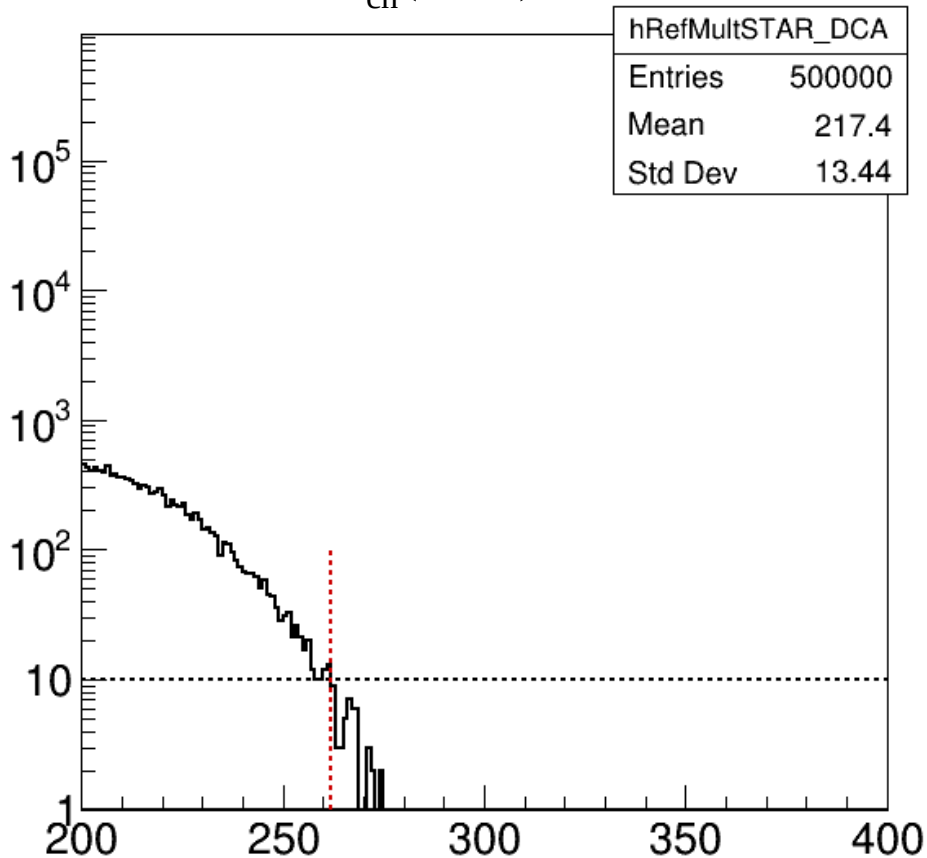
Correspondingly, last bin to have 1 (10) events is taken as $N_{ch}(min)$ and $N_{ch}(max)$

Multiplicity cut range for fitting (set5)

$N_{ch}(min) = 12$

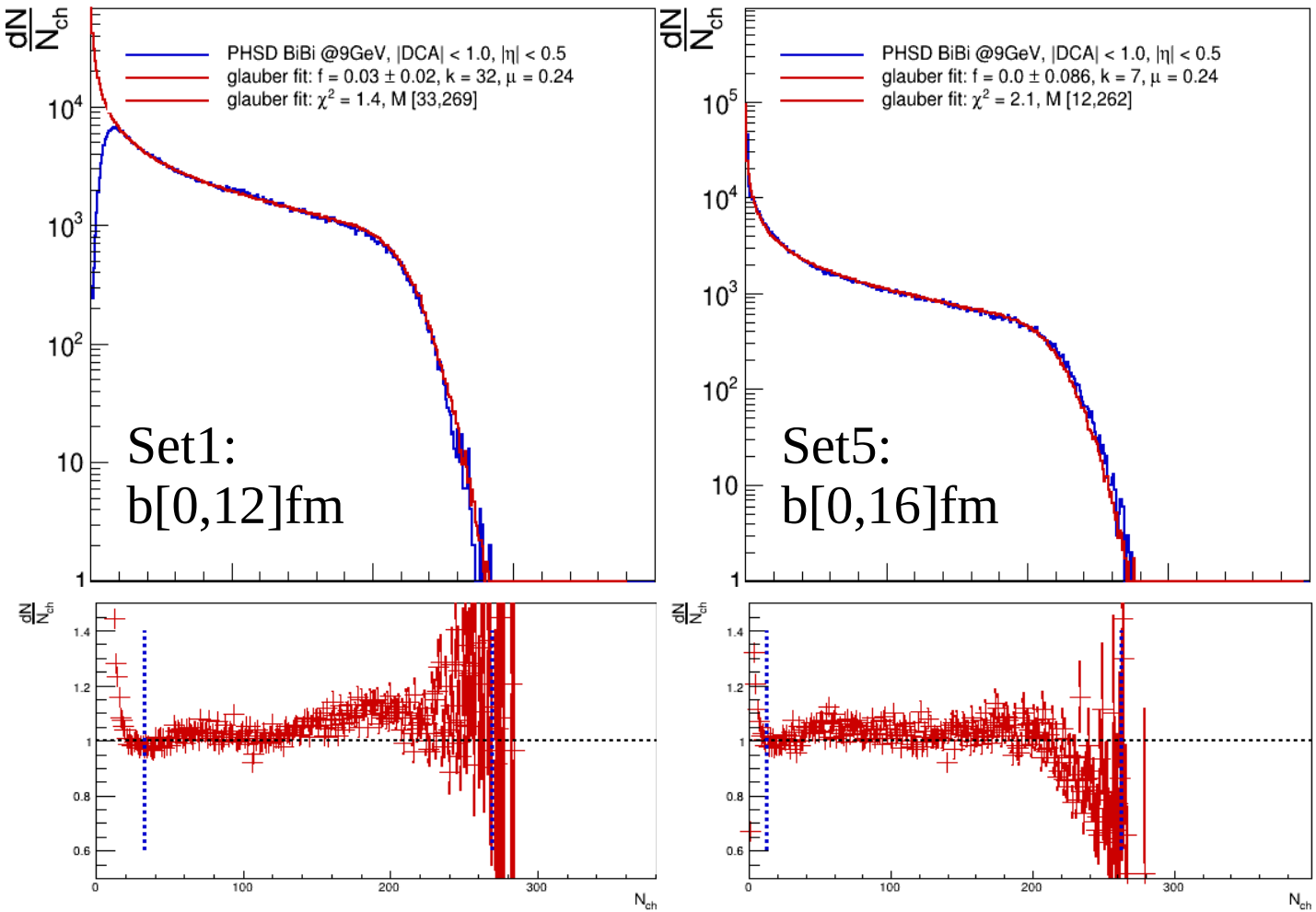


$N_{ch}(max) = 262$



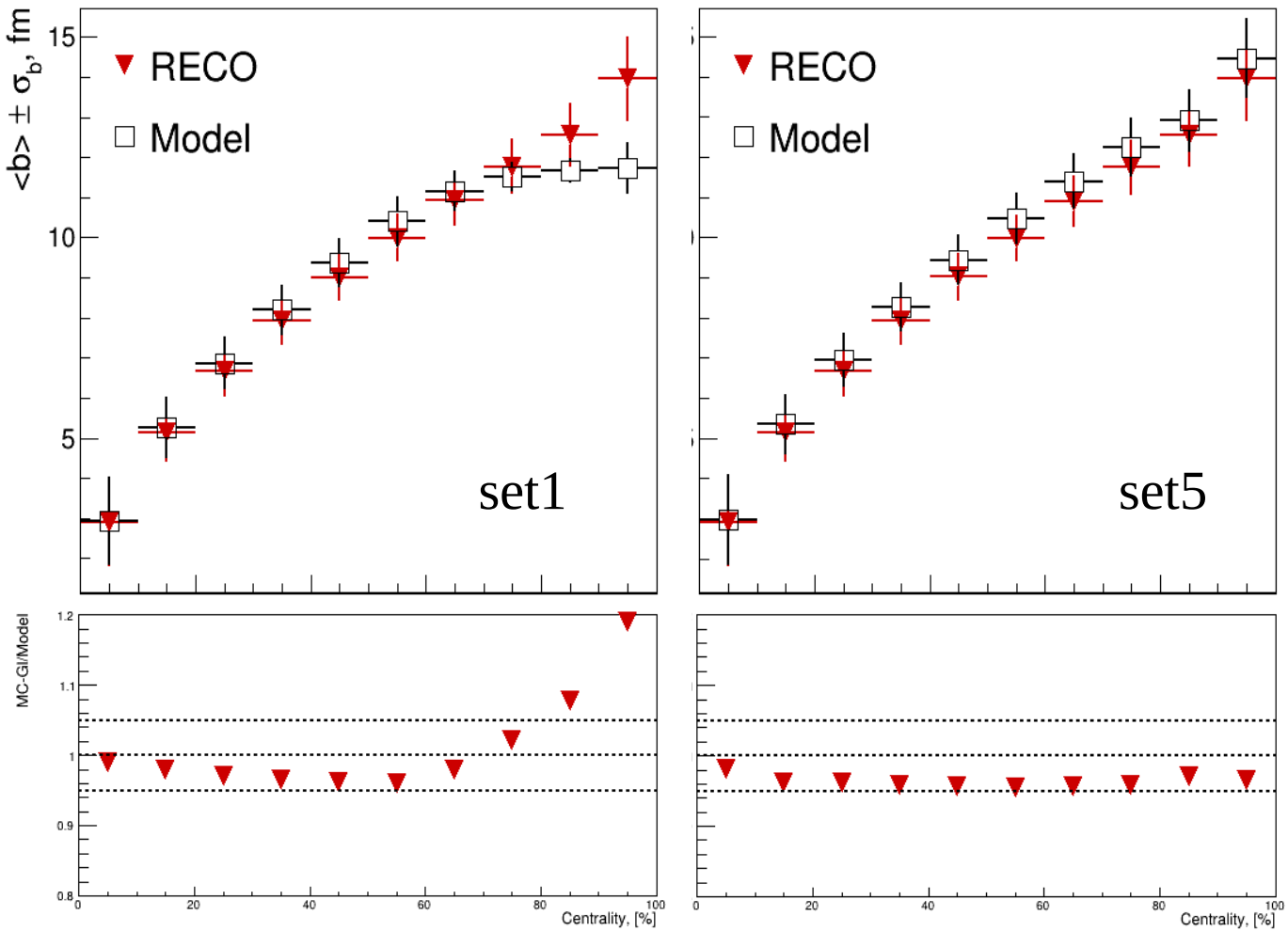
For b[0,16] taking the last imp. param. bin gave very small value of $N_{ch}(min)$ → using b>15fm

Multiplicity fitting (set1 vs set5)



- Using optimal values for the multiplicity fitting range improves the fit performance
- For sets 1 and 5 the obtained value of parameter f is basically 0 (within errors)

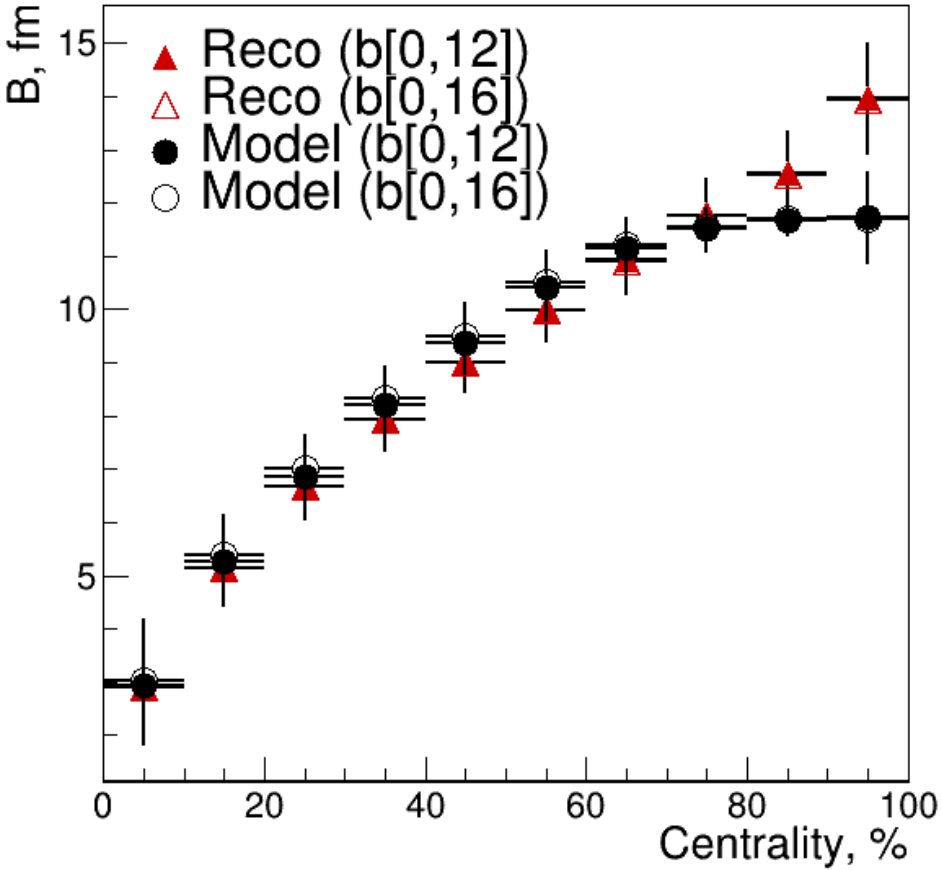
Reconstructed impact parameter (set1 vs set5)

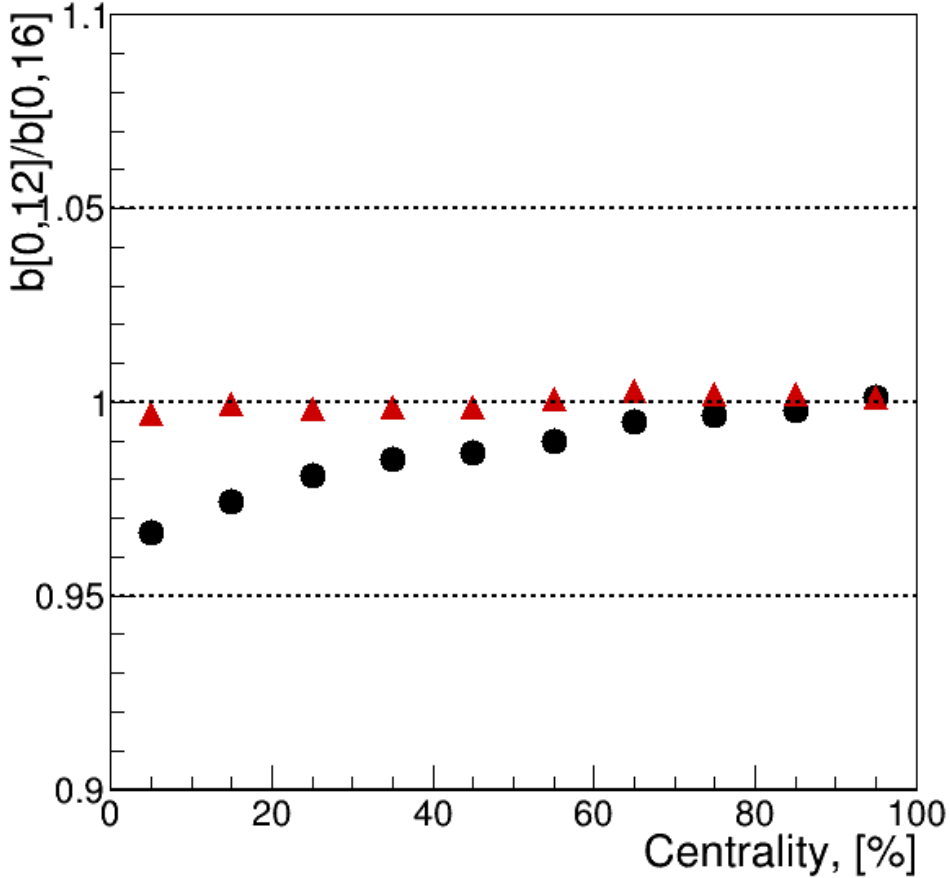


- For both sets 1 and 5 the reconstructed value of impact parameter is within 5% agreement with the model value of the corresponding dataset

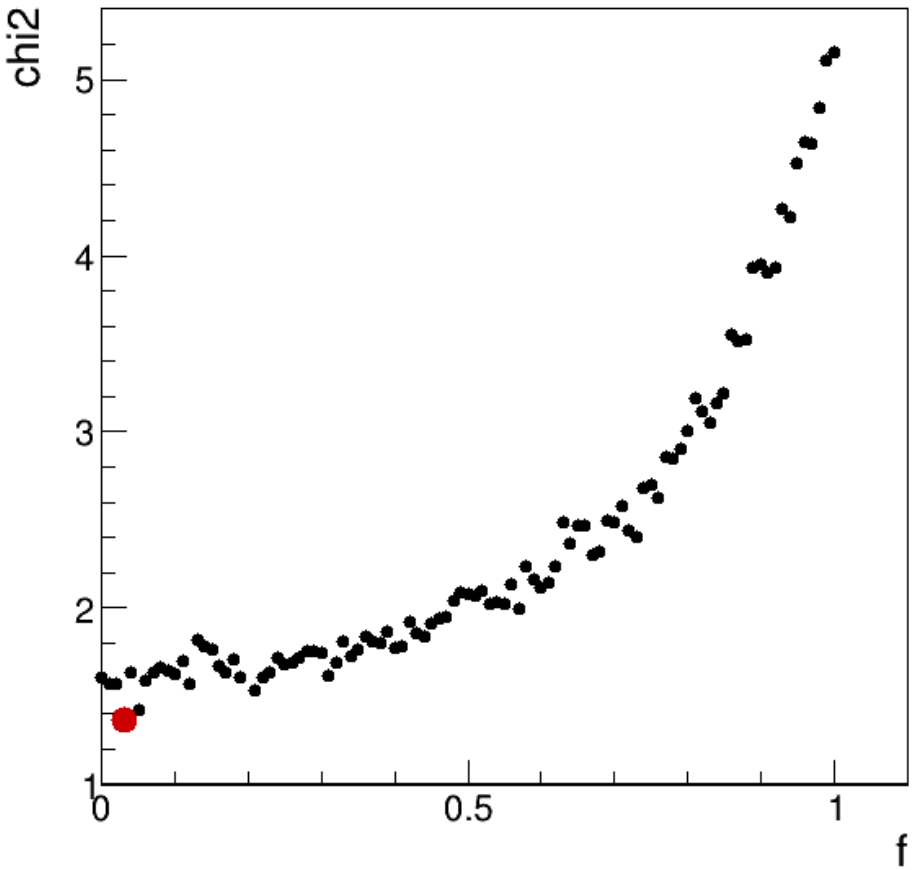
Impact parameter (set1 vs set5)

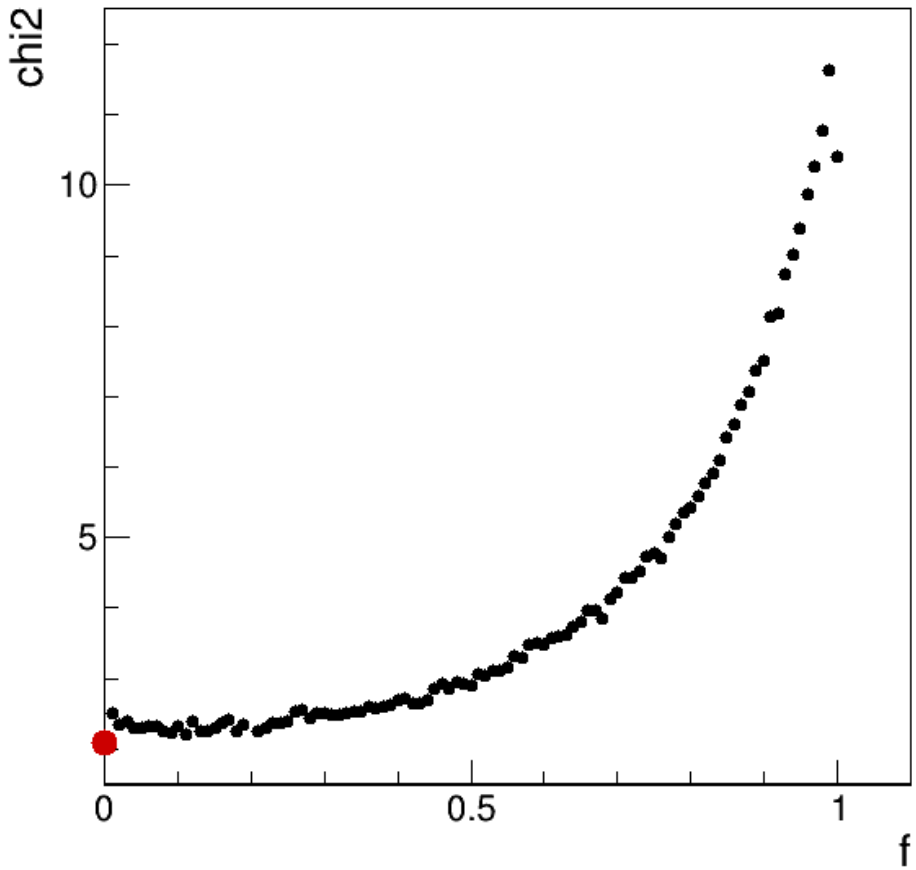
- Comparison of reconstructed impact parameter from the two parametrizations
- Calculated value of model b from the main dataset using either parametrization





Parameter f (set1 vs set5)





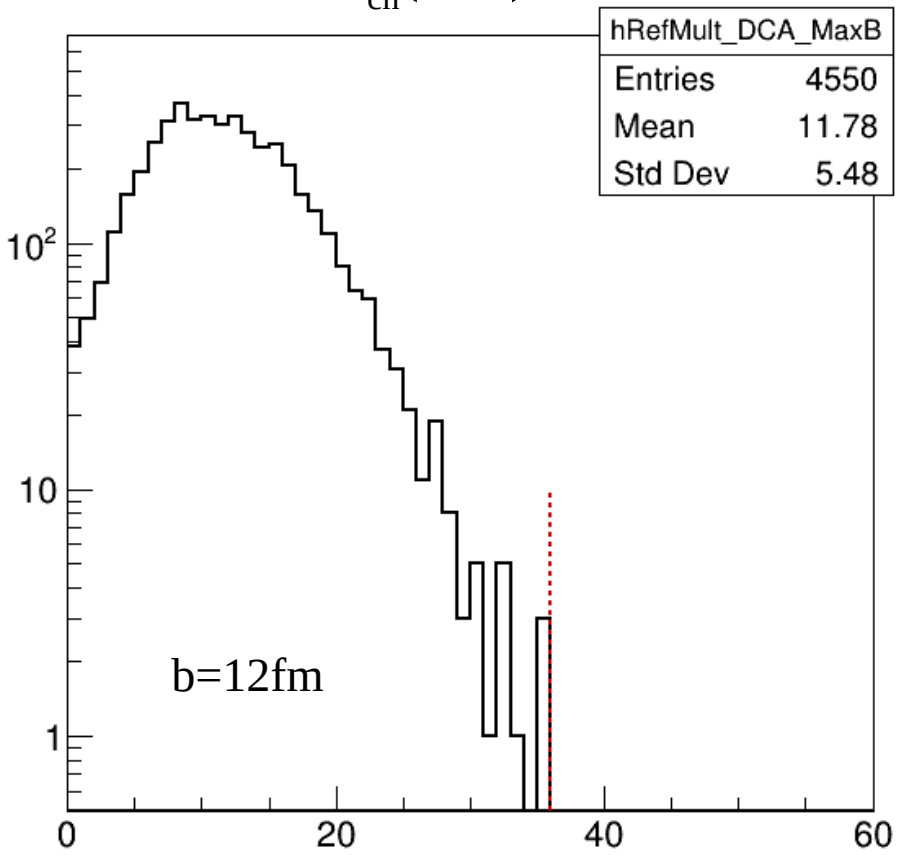
Multiplicity borders (set1 vs set5)

- Comparison of obtained borders on multiplicity for centrality bins

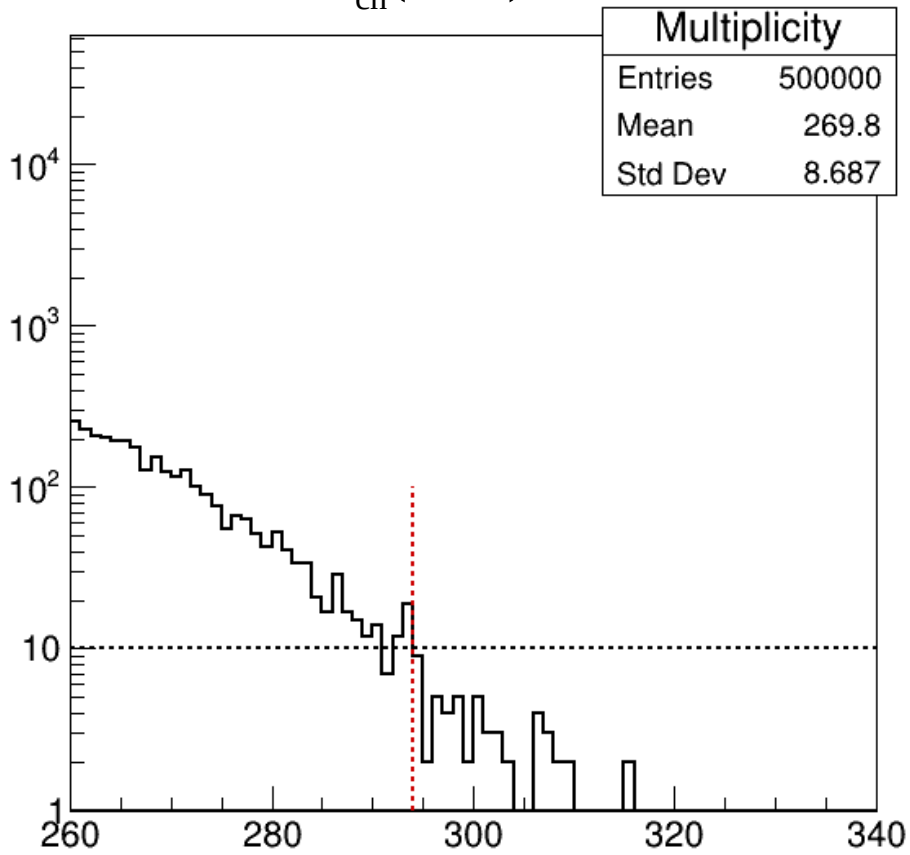
	N_{ch}(min)	N_{ch}(min)	N_{ch}(max)	N_{ch}(max)
	Set1 (b[0,12]fm; |DCA| < 1cm, |η| < 0.5)	Set5 (b[0,16]fm; |DCA| < 1cm, |η| < 0.5)	Set1 (b[0,12]fm; |DCA| < 1cm, |η| < 0.5)	Set5 (b[0,16]fm; |DCA| < 1cm, |η| < 0.5)
0-10%	155	152	282	279
10-20%	109	107	155	152
20-30%	76	74	109	107
30-40%	51	50	76	74
40-50%	33	32	51	50
50-60%	20	20	33	32
60-70%	11	11	20	20
70-80%	6	6	11	11
80-90%	**3**	**3**	6	6
90-100%	1	1	**2**	**2**

Multiplicity cut range for fitting (set2)

$N_{ch}(min) = 36$



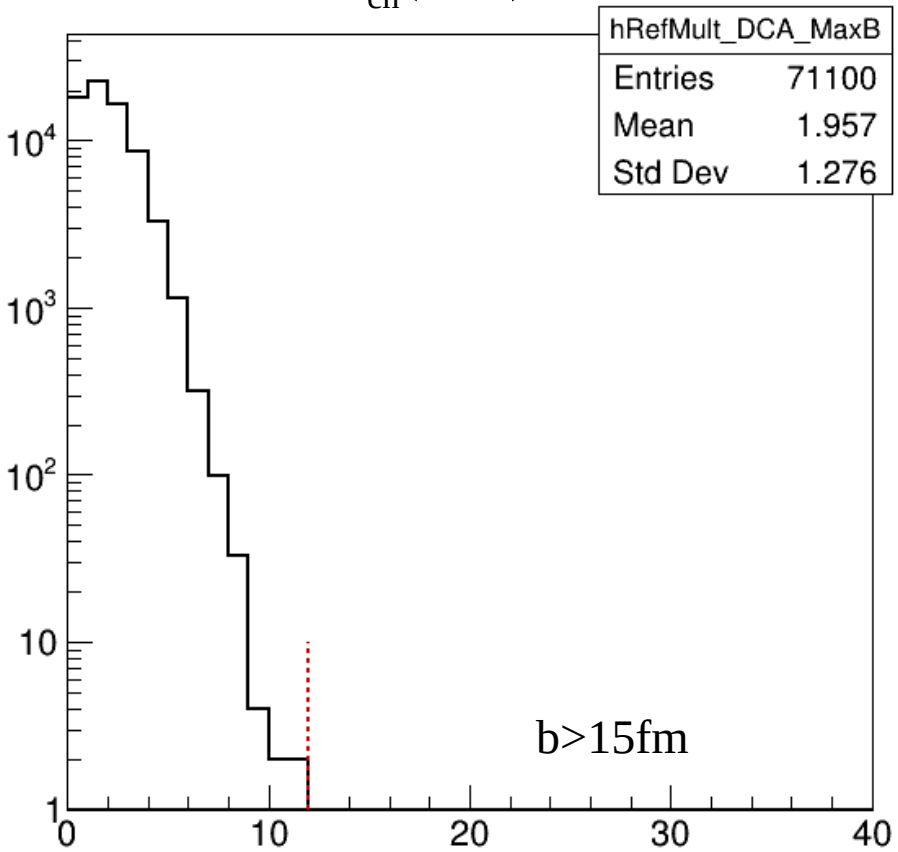
$N_{ch}(max) = 294$



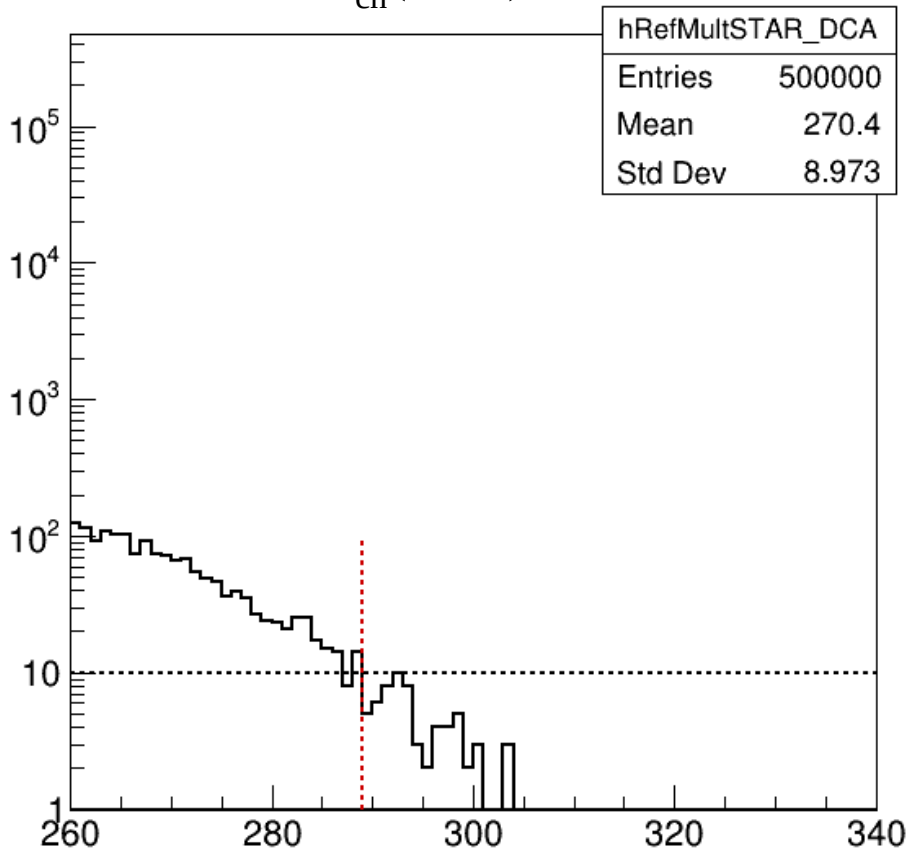
Correspondingly, last bin to have 1 (10) events is taken as $N_{ch}(min)$ and $N_{ch}(max)$

Multiplicity cut range for fitting (set6)

$N_{ch}(min) = 12$

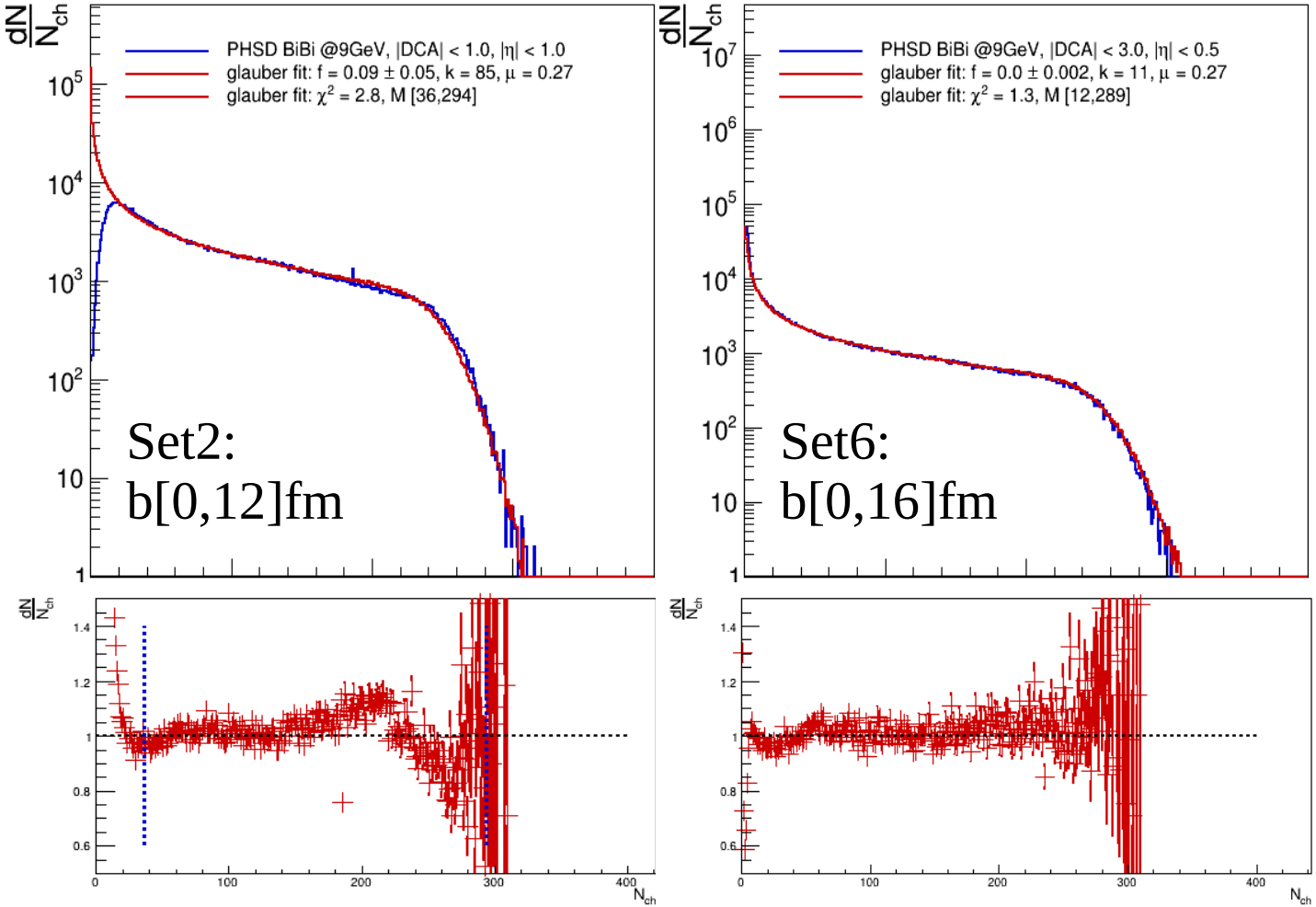


$N_{ch}(max) = 289$



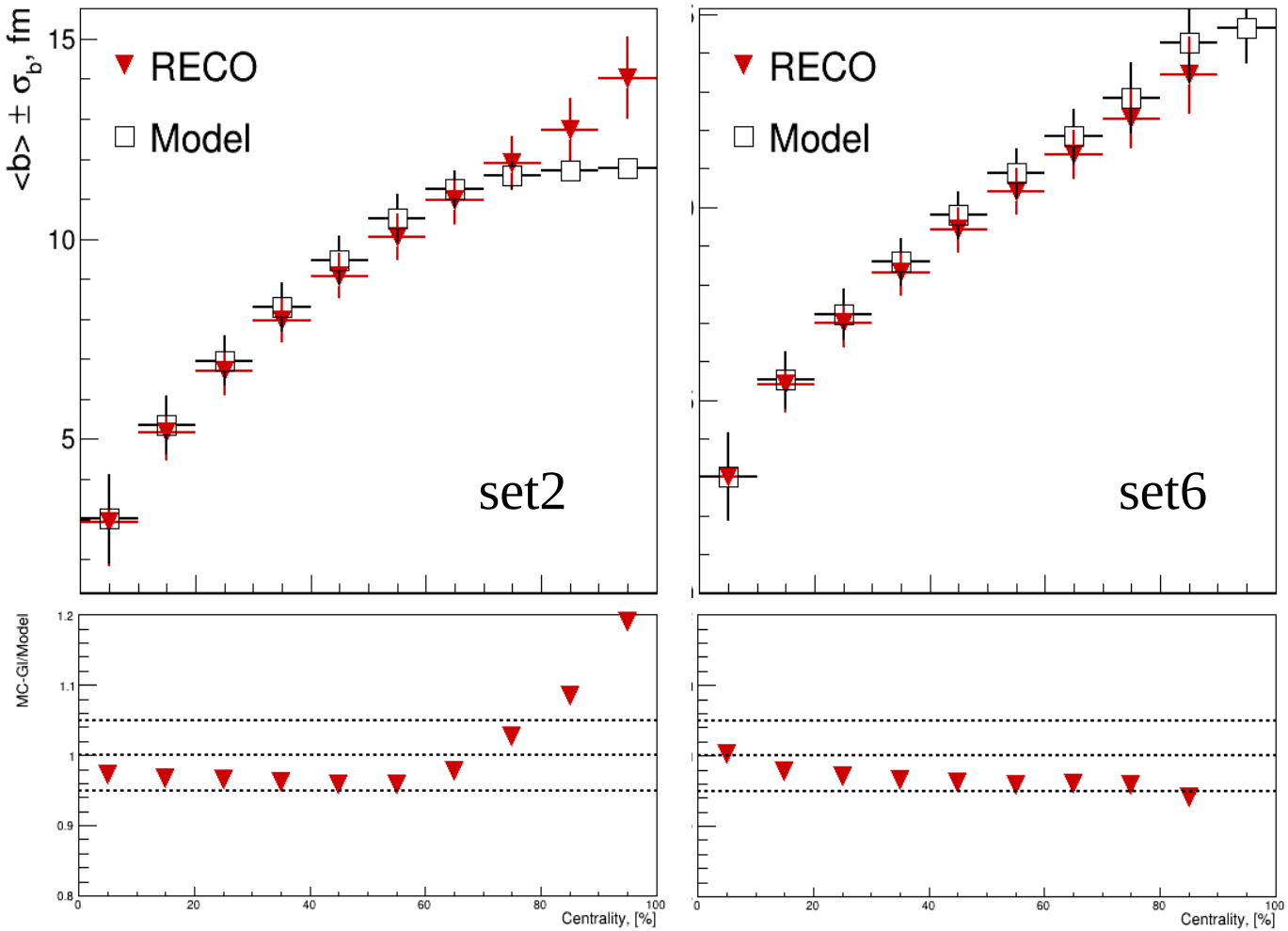
For b[0,16] taking the last imp. param. bin gave very small value of $N_{ch}(min)$ → using b>15fm

Multiplicity fitting (set2 vs set6)



- Using optimal values for the multiplicity fitting range improves the fit performance
- For sets 2 and 6 the obtained value of parameter f is basically 0 (within errors)

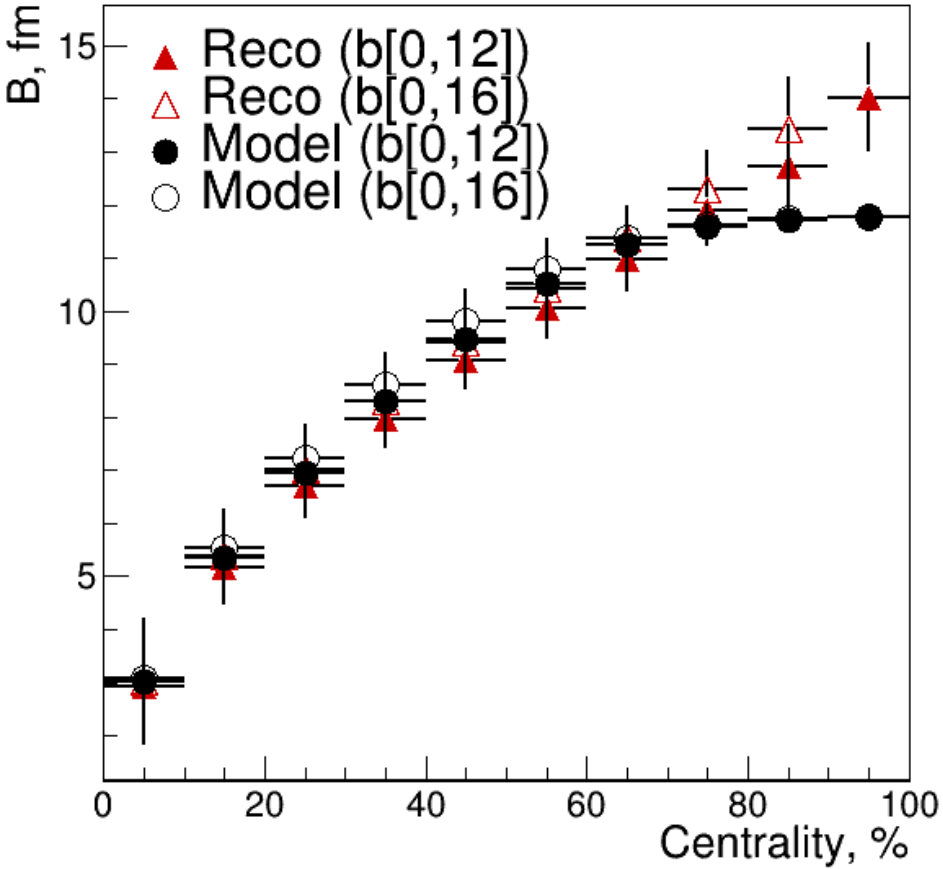
Reconstructed impact parameter (set2 vs set6)

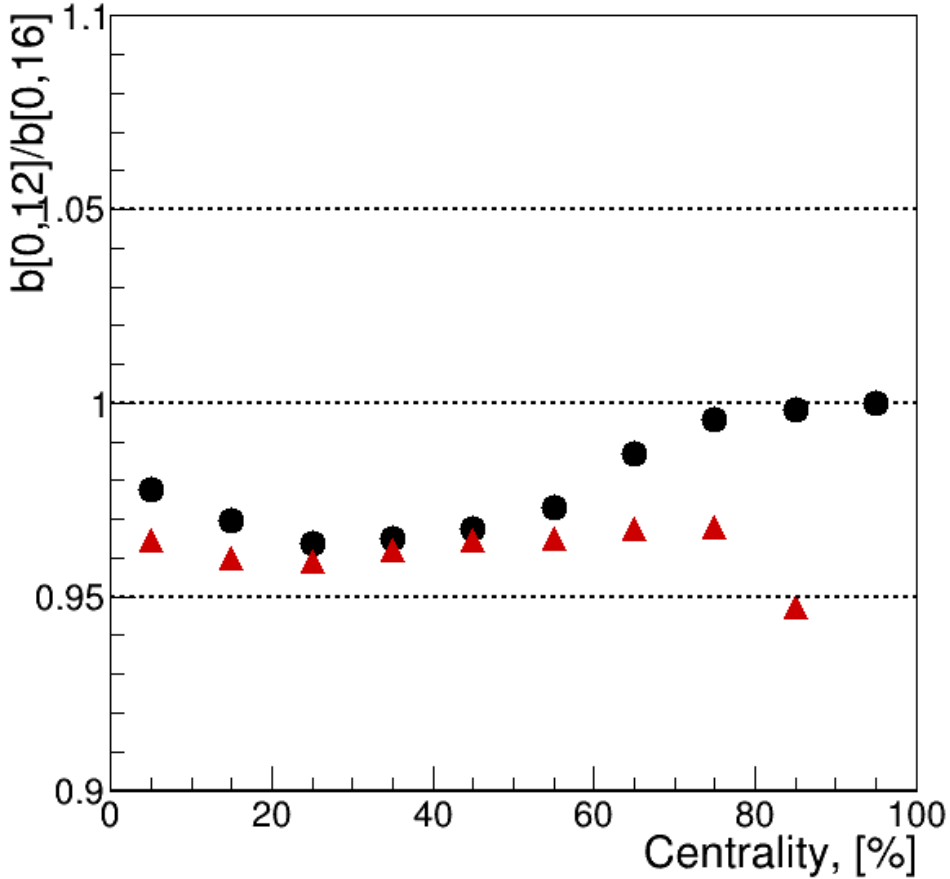


- For both sets 1 and 5 the reconstructed value of impact parameter is within 5% agreement with the model value of the corresponding dataset
- Set6 seems to have problems in the peripheral region

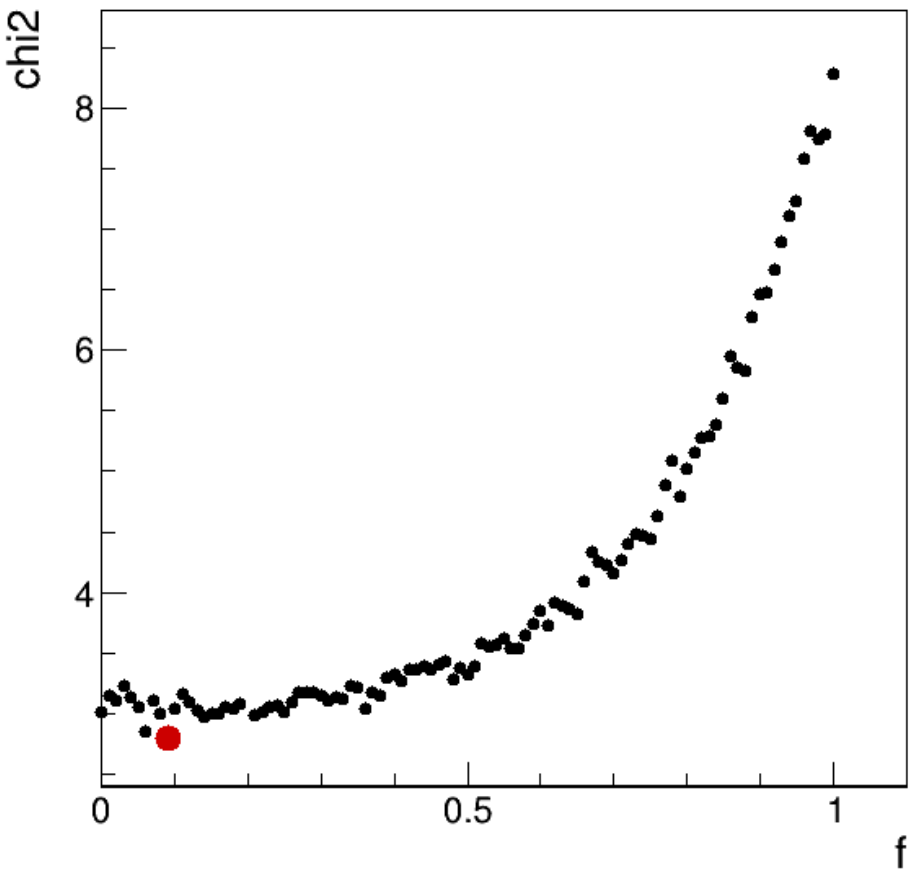
Impact parameter (set2 vs set6)

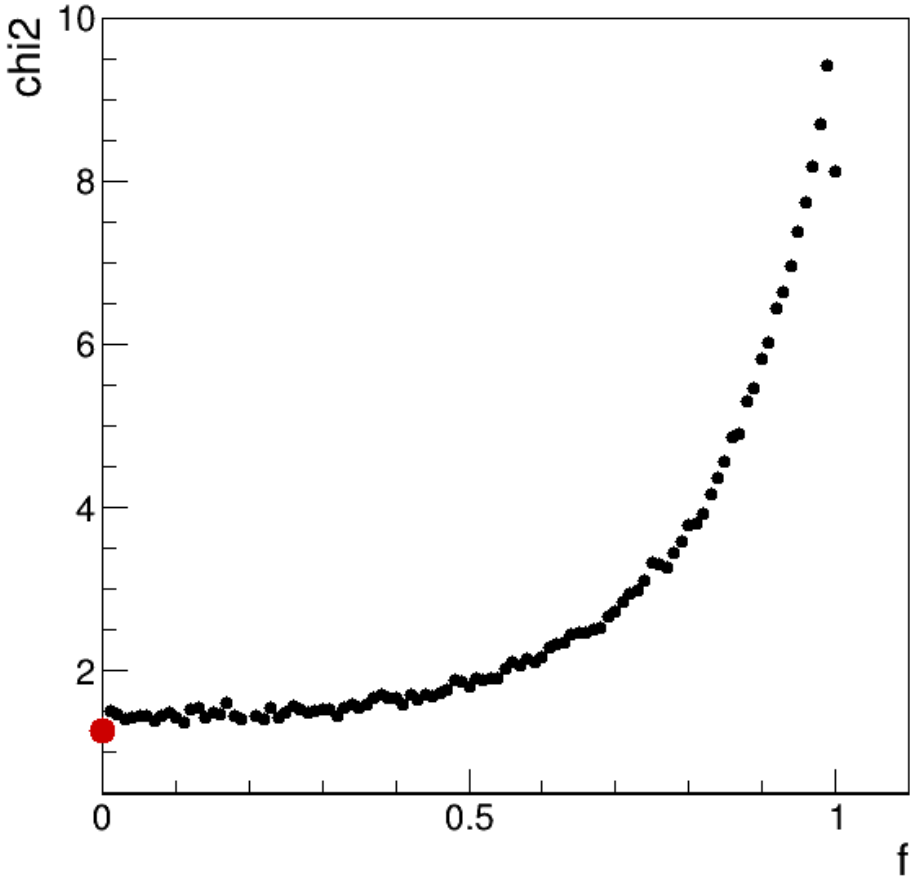
- Comparison of reconstructed impact parameter from the two parametrizations
- Calculated value of model b from the dataset using either parametrization





Parameter f (set2 vs set6)





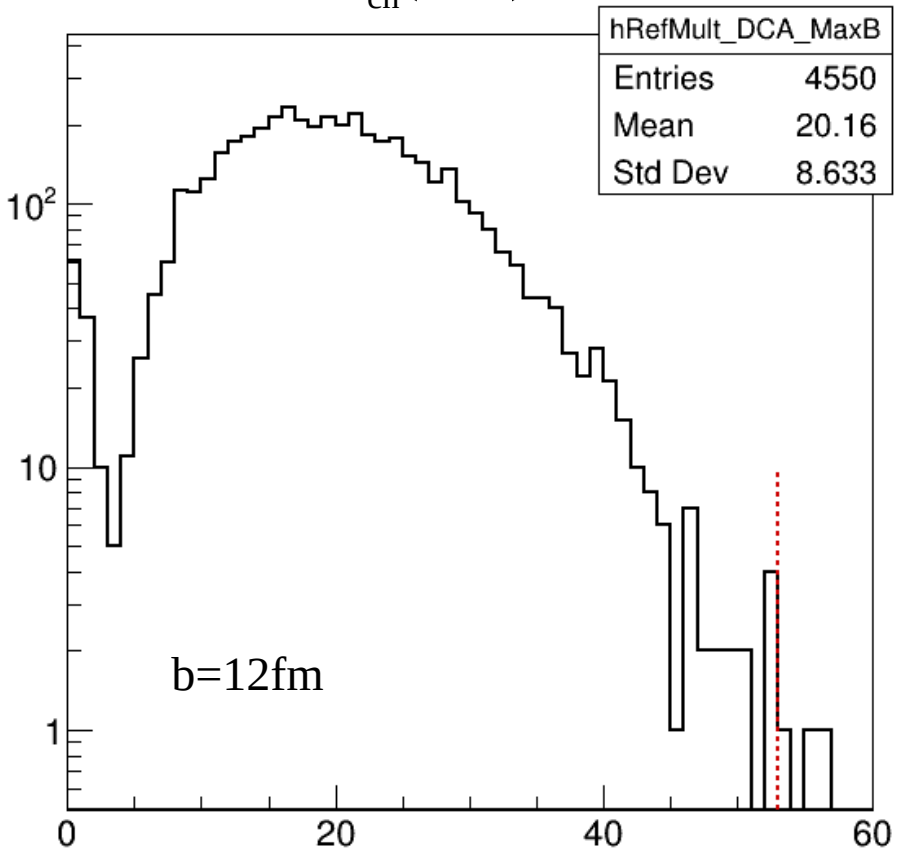
Multiplicity borders (set2 vs set6)

- Comparison of obtained borders on multiplicity for centrality bins

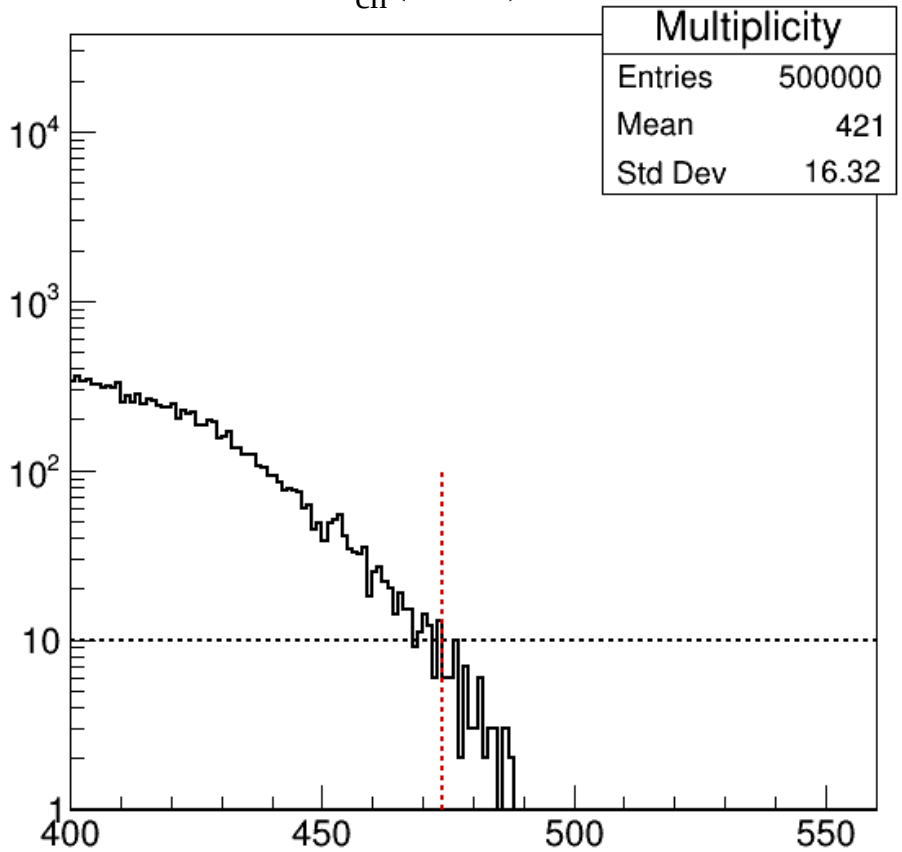
	N_{ch}(min)	N_{ch}(min)	N_{ch}(max)	N_{ch}(max)
	Set2 (b[0,12]fm; |DCA| < 3cm, |η| < 0.5)	Set6 (b[0,16]fm; |DCA| < 3cm, |η| < 0.5)	Set2 (b[0,12]fm; |DCA| < 3cm, |η| < 0.5)	Set6 (b[0,16]fm; |DCA| < 3cm, |η| < 0.5)
0-10%	172	169	315	320
10-20%	121	115	172	169
20-30%	84	77	121	115
30-40%	56	50	84	77
40-50%	36	31	56	50
50-60%	22	18	36	31
60-70%	12	10	22	18
70-80%	6	5	12	10
80-90%	3	2	6	5
90-100%	1	-	2	-

Multiplicity cut range for fitting (set3)

$N_{ch}(min) = 53$



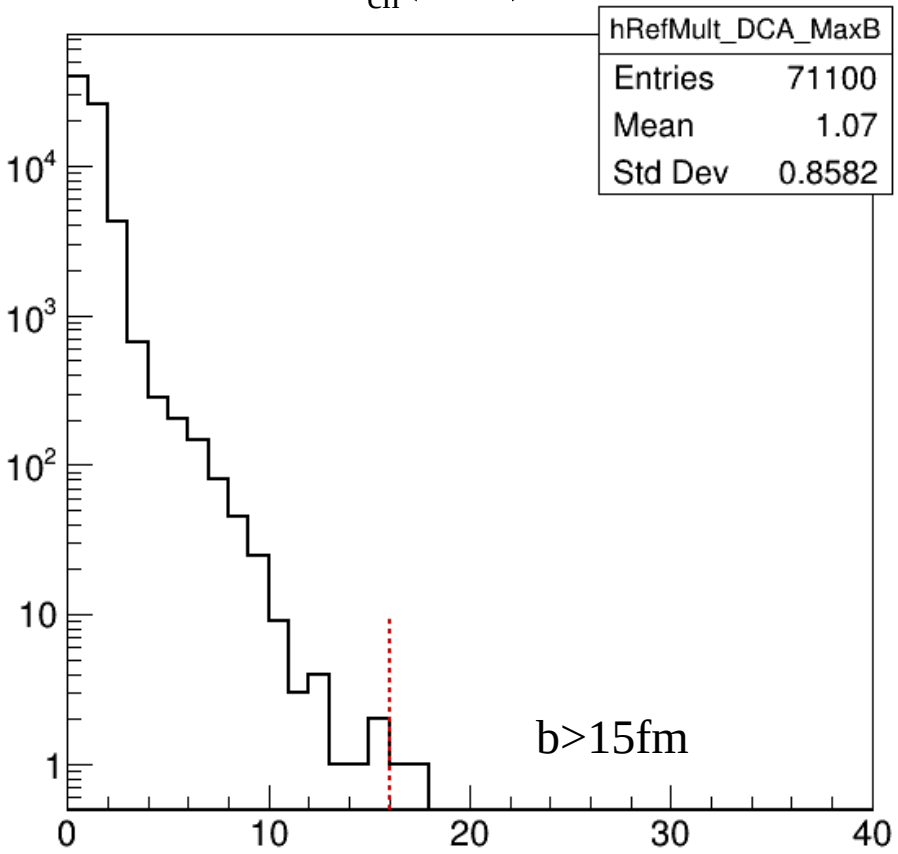
$N_{ch}(max) = 474$



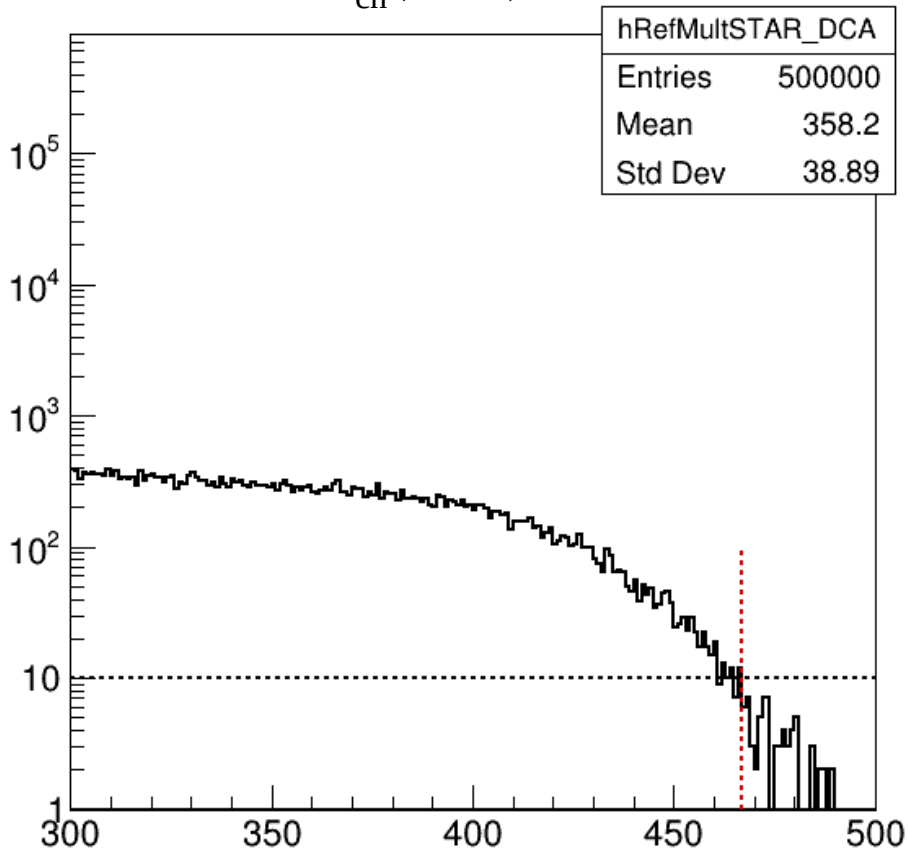
Correspondingly, last bin to have 1 (10) events is taken as $N_{ch}(min)$ and $N_{ch}(max)$

Multiplicity cut range for fitting (set7)

$N_{ch}(min) = 16$

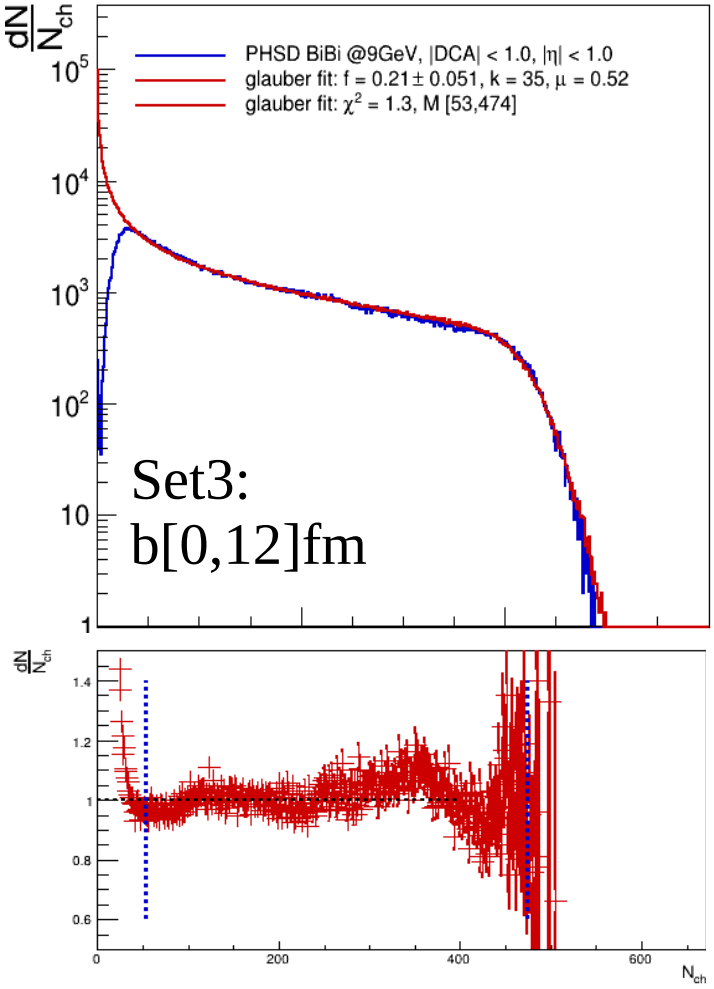


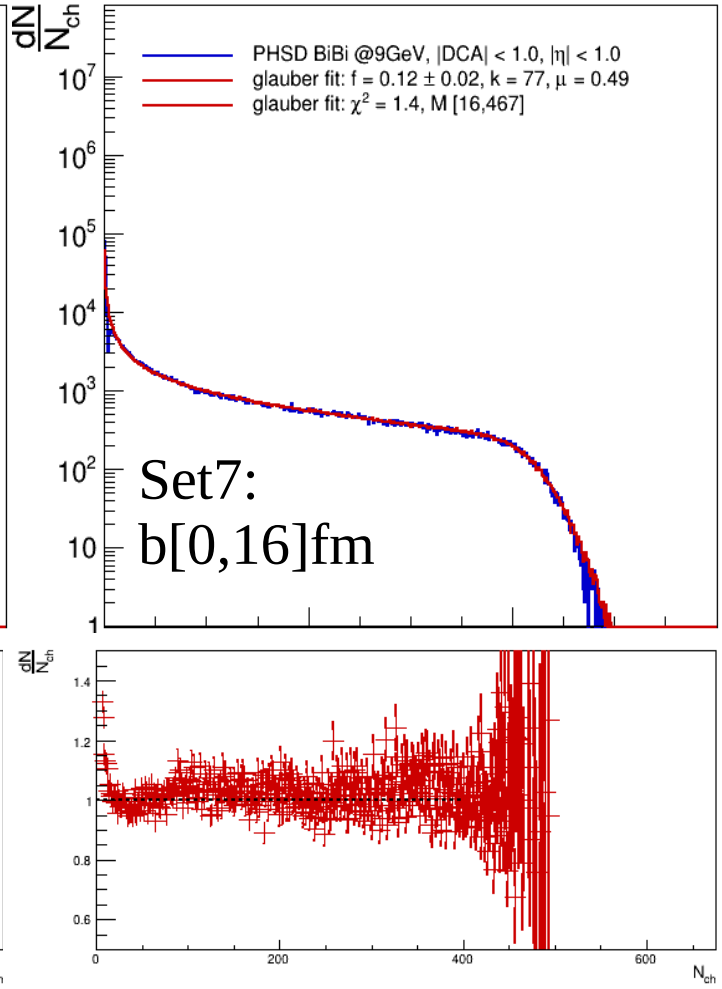
$N_{ch}(max) = 467$



For b[0,16] taking the last imp. param. bin gave very small value of $N_{ch}(min)$ → using b>15fm

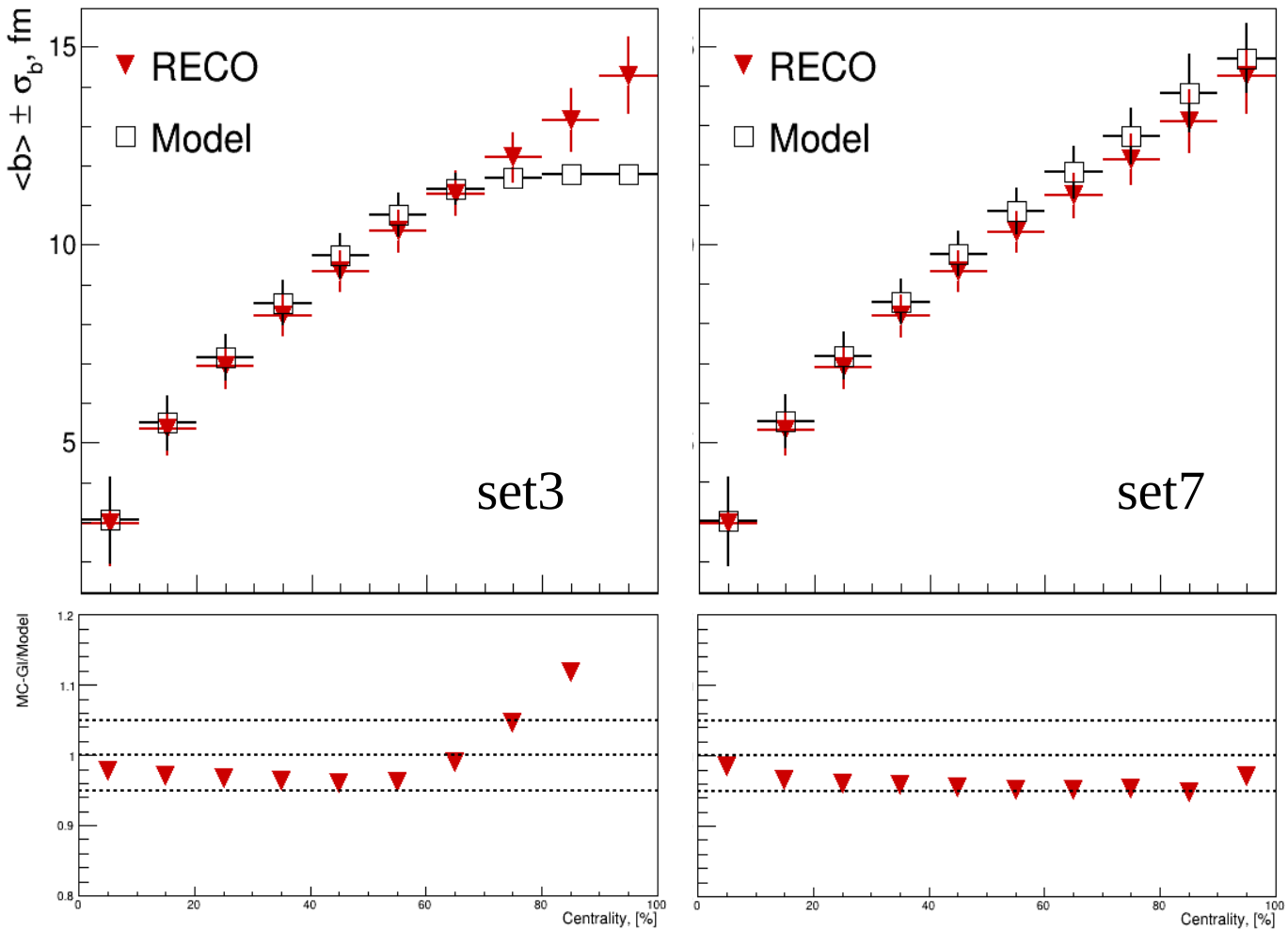
Multiplicity fitting (set3 vs set7)





- Using optimal values for the multiplicity fitting range improves the fit performance
- For sets 3 and 7 the obtained value of parameter f are no longer consistent with 0

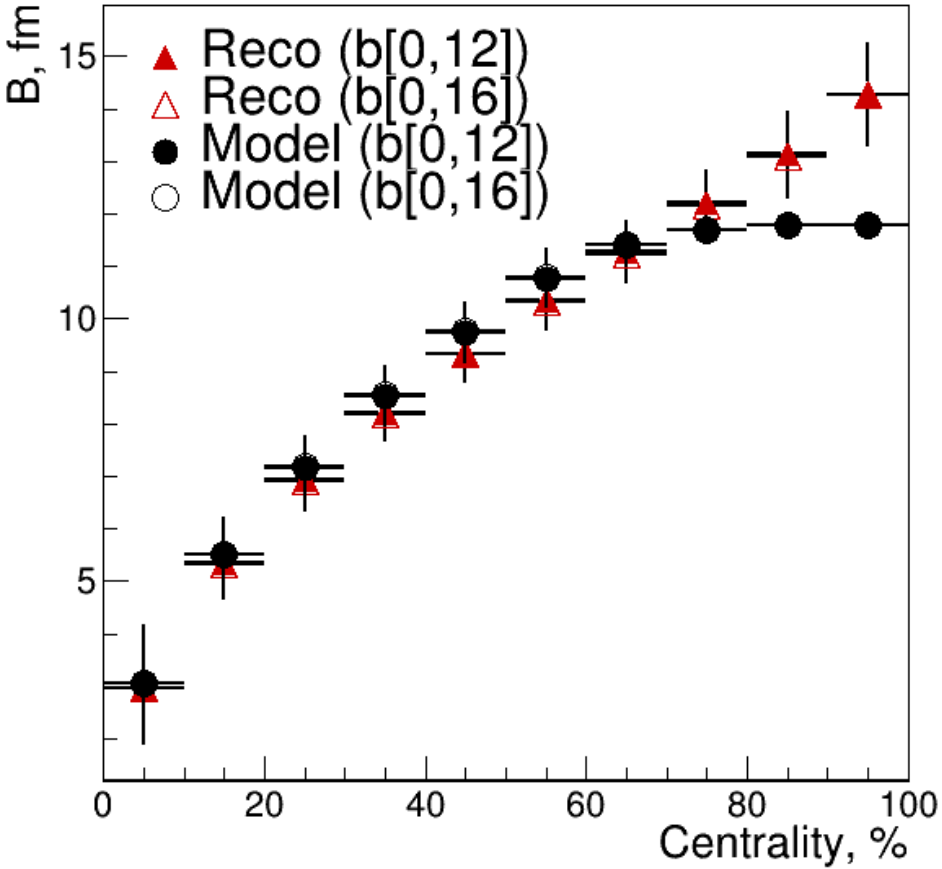
Reconstructed impact parameter (set3 vs set7)

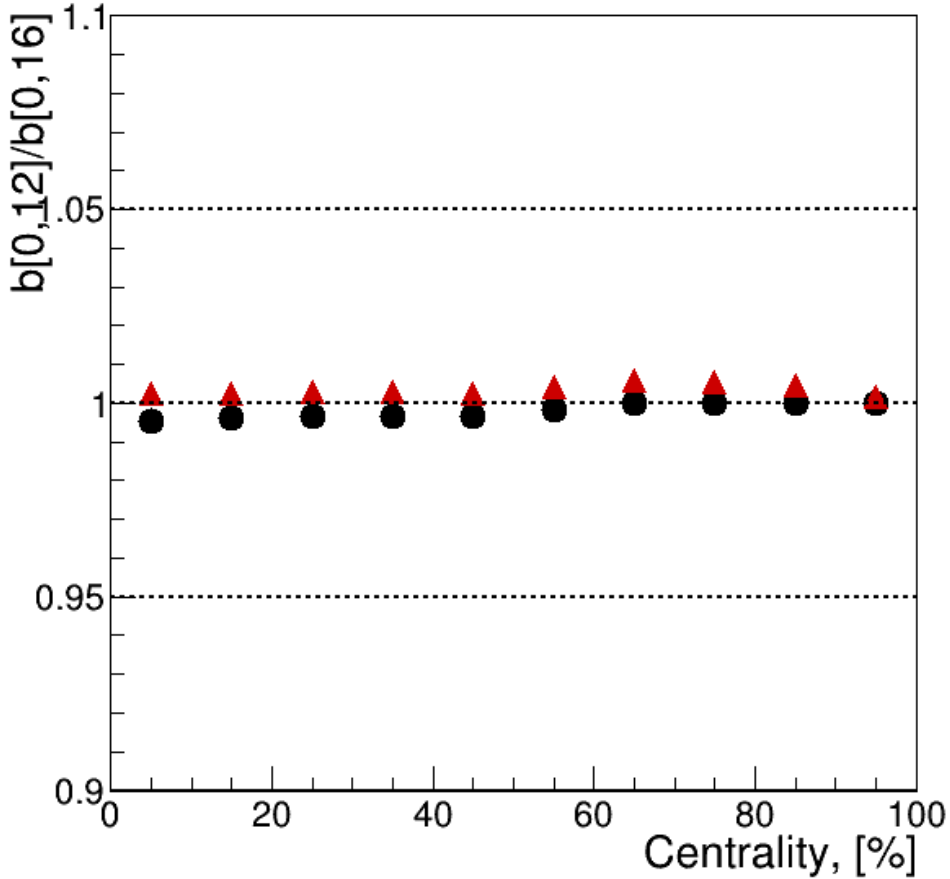


- For both sets 1 and 5 the reconstructed value of impact parameter is within 5% agreement with the model value of the corresponding dataset

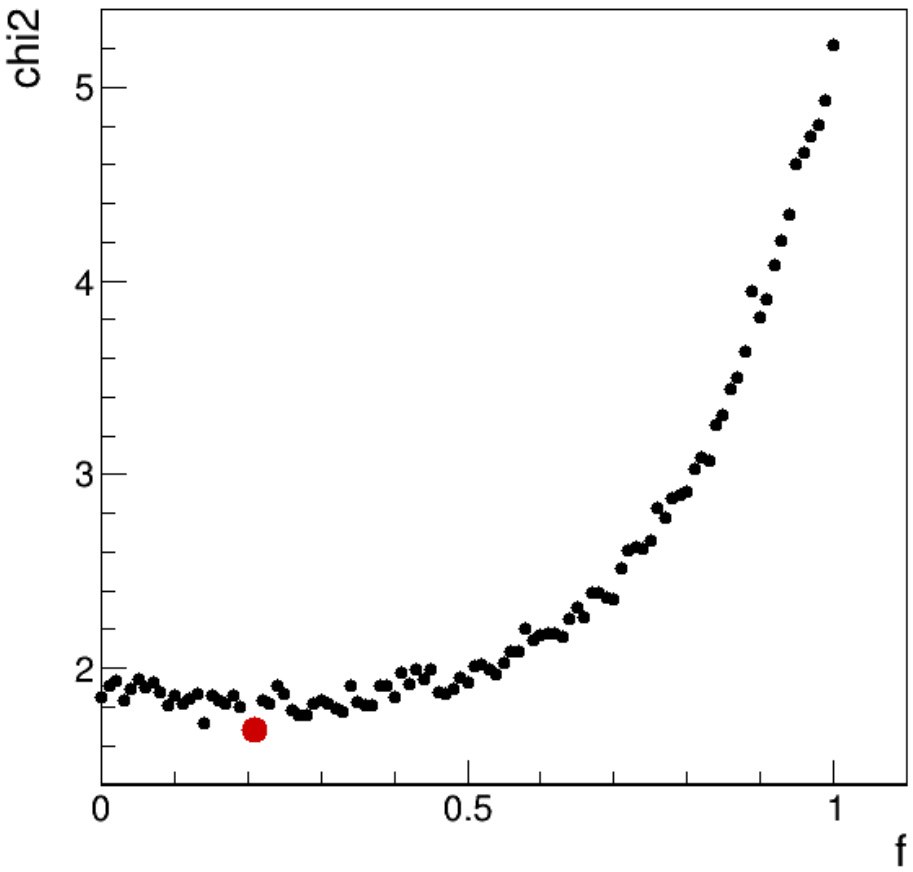
Impact parameter (set3 vs set7)

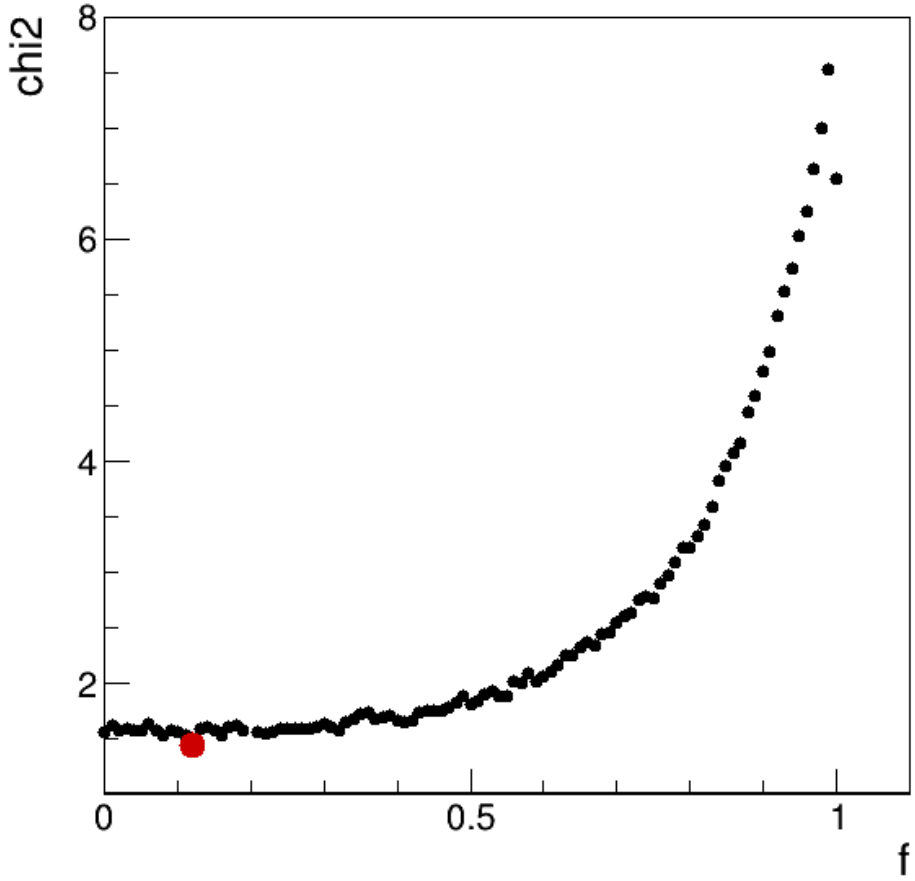
- Comparison of reconstructed impact parameter from the two parametrizations
- Calculated value of model b from the dataset using either parametrization





Parameter f (set3 vs set7)





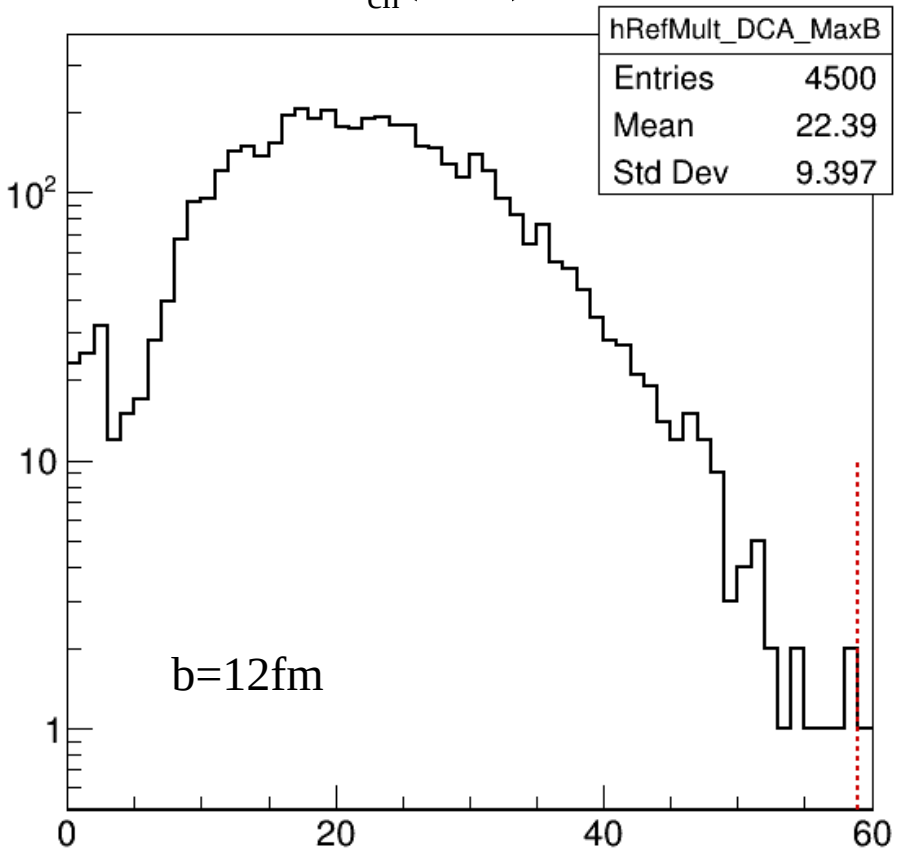
Multiplicity borders (set3 vs set7)

- Comparison of obtained borders on multiplicity for centrality bins

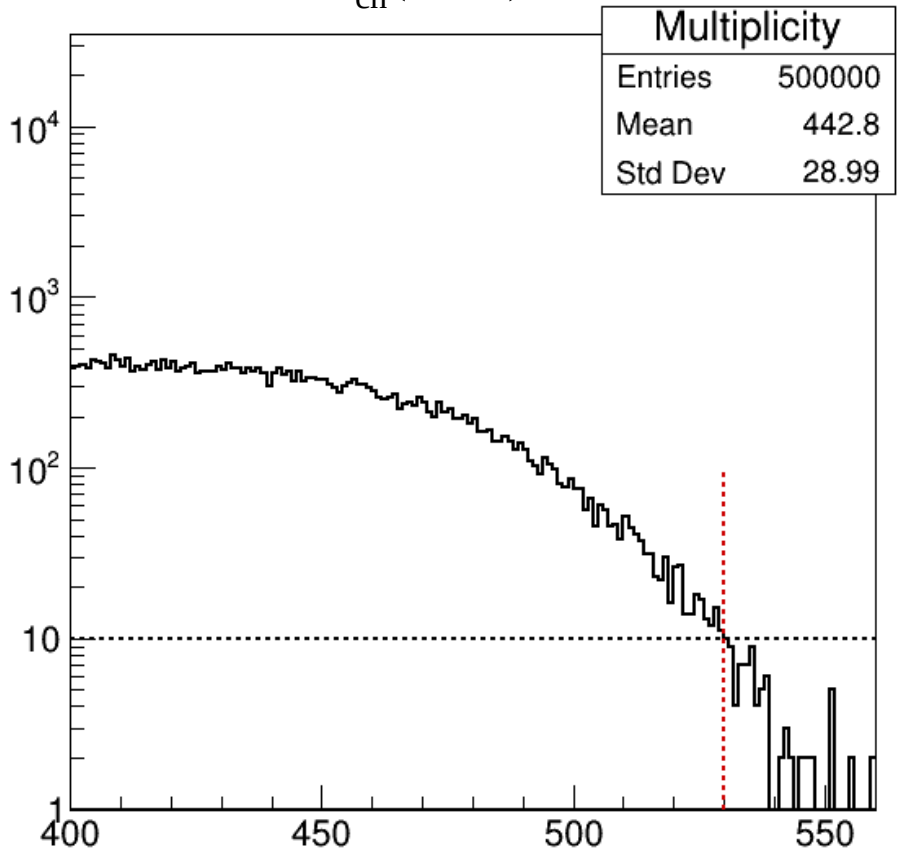
	N_{ch}(min)	N_{ch}(min)	N_{ch}(max)	N_{ch}(max)
	Set3 (b[0,12]fm; |DCA| < 1cm, |η| < 1.0)	Set7 (b[0,16]fm; |DCA| < 1cm, |η| < 1.0)	Set3 (b[0,12]fm; |DCA| < 1cm, |η| < 1.0)	Set7 (b[0,16]fm; |DCA| < 1cm, |η| < 1.0)
0-10%	285	284	513	504
10-20%	197	196	285	284
20-30%	134	133	197	196
30-40%	88	87	134	133
40-50%	55	54	88	87
50-60%	32	32	55	54
60-70%	17	17	32	32
70-80%	8	8	17	17
80-90%	3	3	8	8
90-100%	1	1	2	2

Multiplicity cut range for fitting (set4)

$N_{ch}(min) = 59$



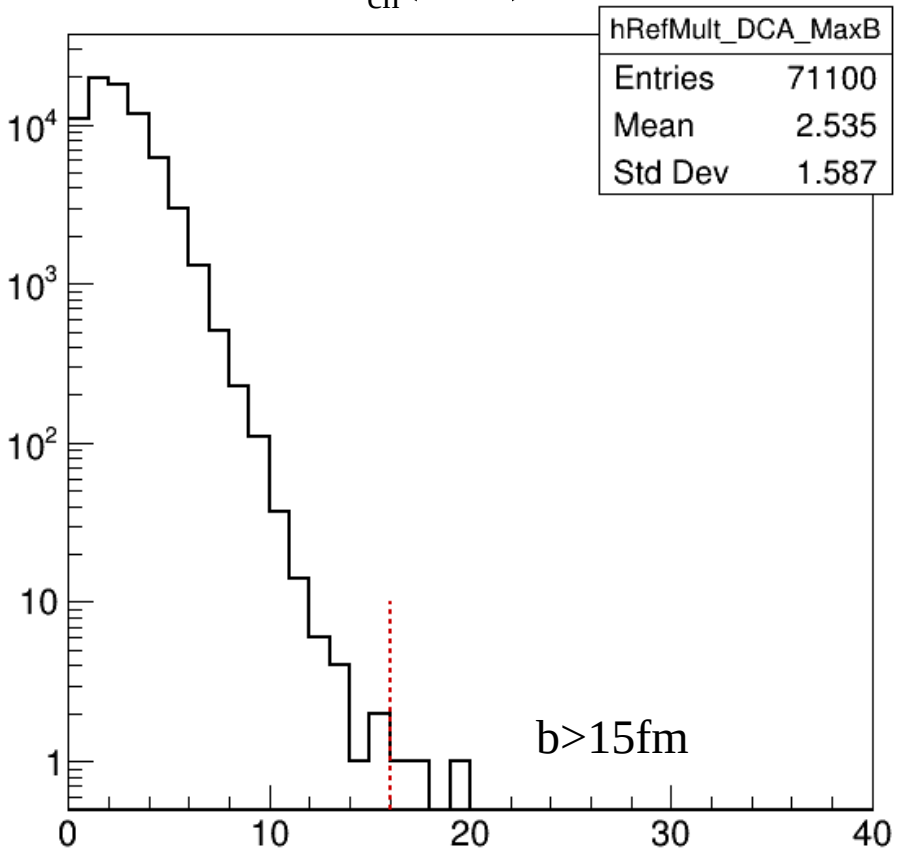
$N_{ch}(max) = 530$



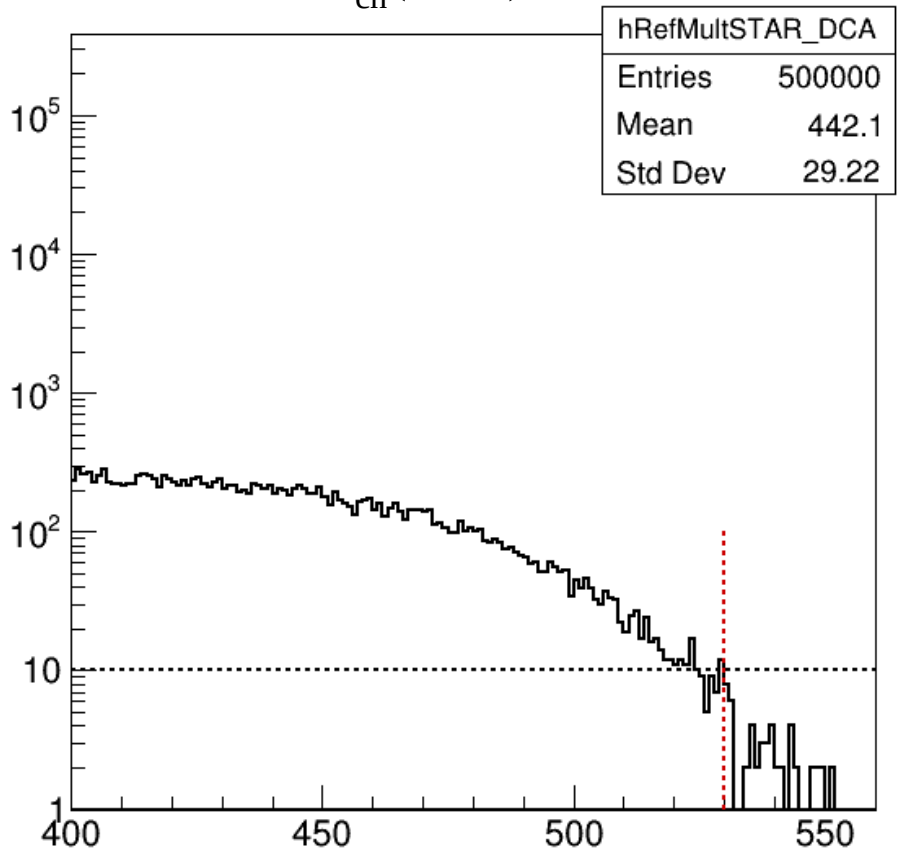
Correspondingly, last bin to have 1 (10) events is taken as $N_{ch}(min)$ and $N_{ch}(max)$

Multiplicity cut range for fitting (set8)

$N_{ch}(min) = 16$



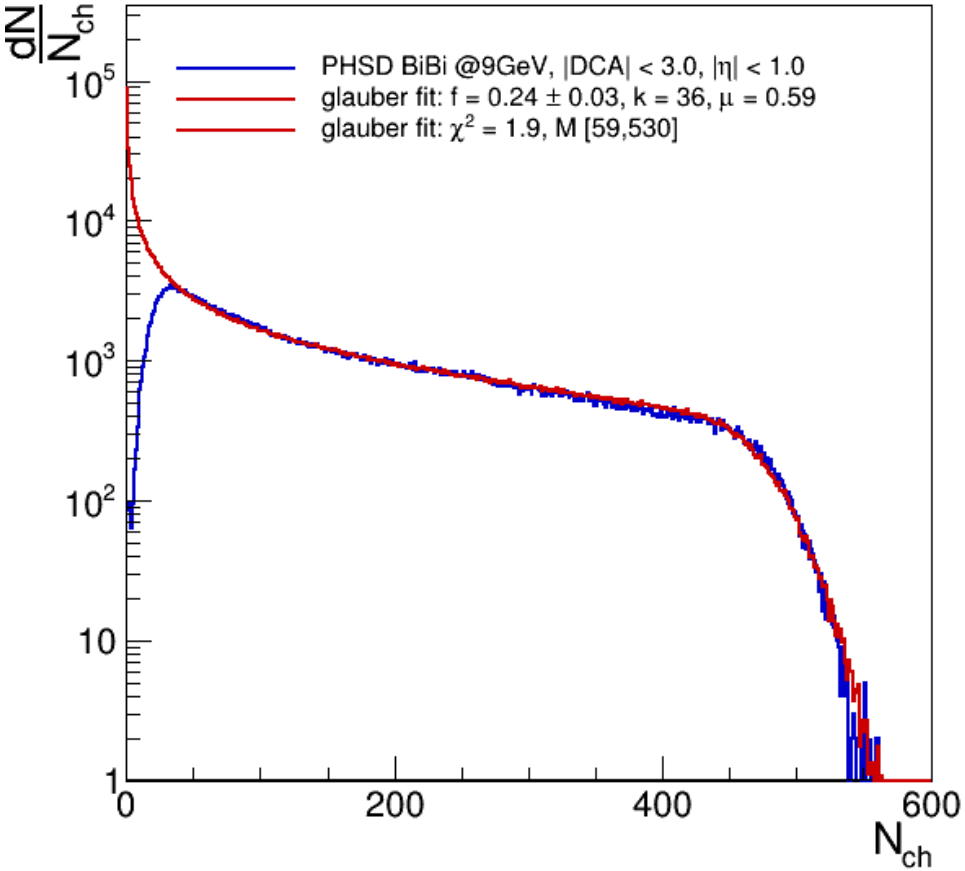
$N_{ch}(max) = 530$



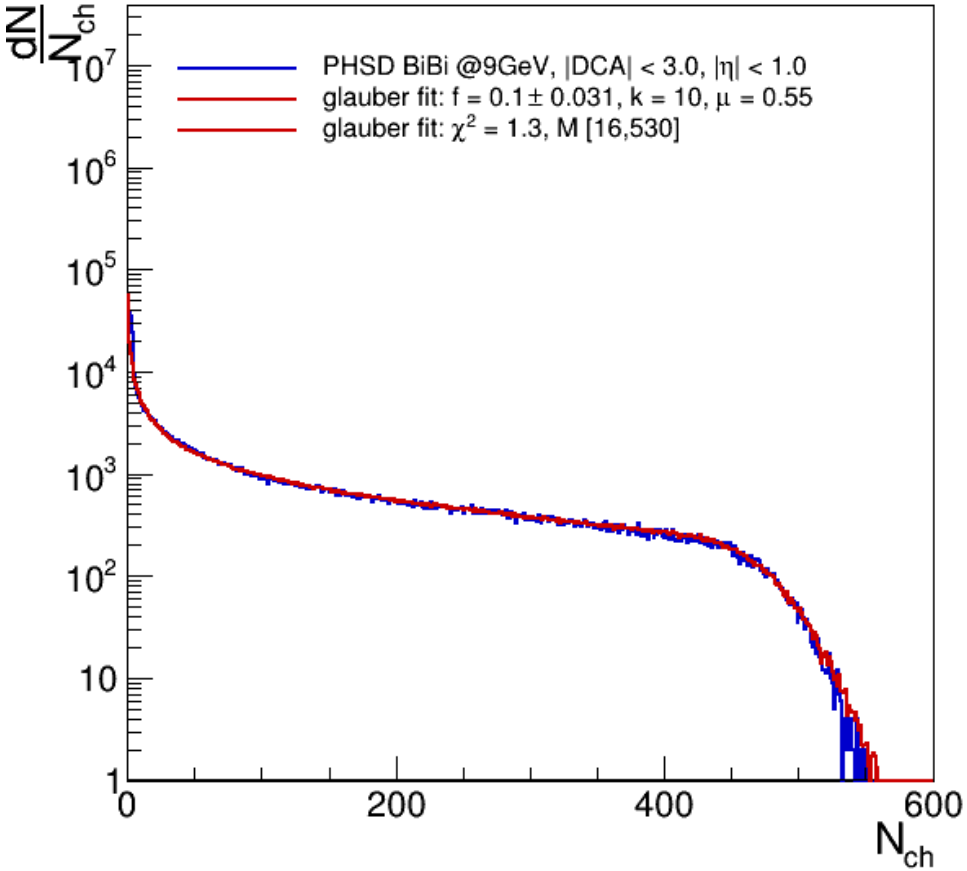
For b[0,16] taking the last imp. param. bin gave very small value of $N_{ch}(min)$ → using b>15fm

Multiplicity fitting (set4 vs set8)

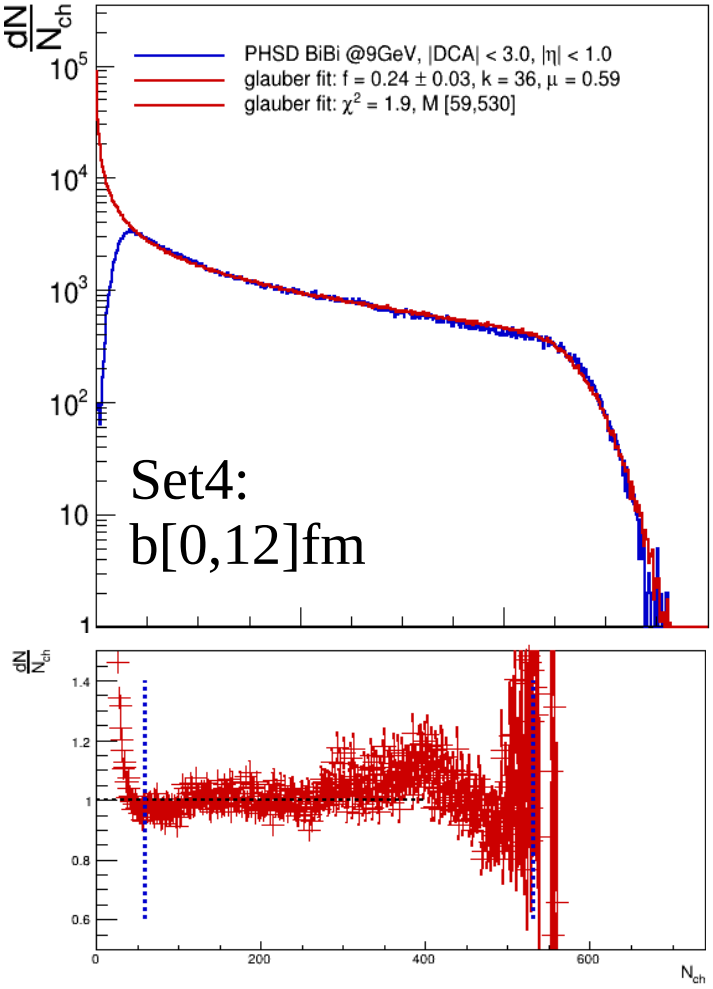
Set4: b[0,12]fm

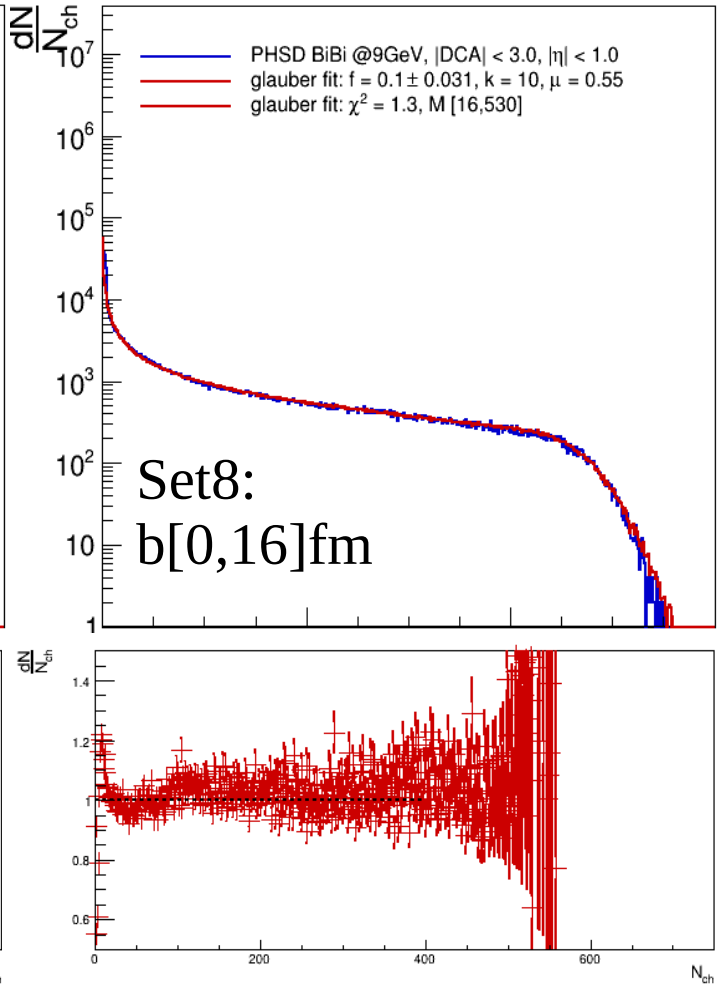


Set8: b[0,16]fm



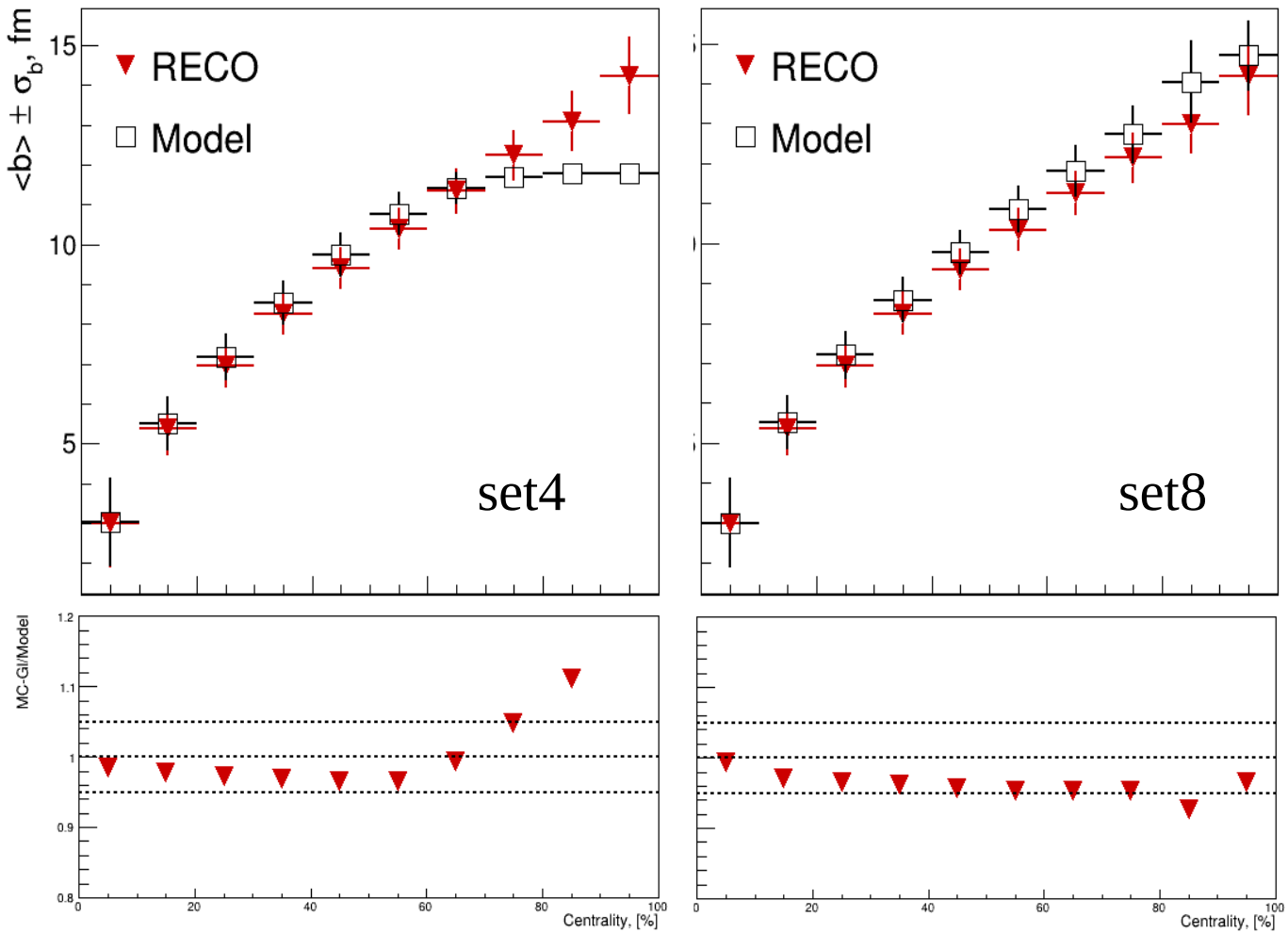
Multiplicity fitting (set4 vs set8)





- Using optimal values for the multiplicity fitting range improves the fit performance
- For sets 4 and 8 the obtained value of parameter f are no longer consistent with 0

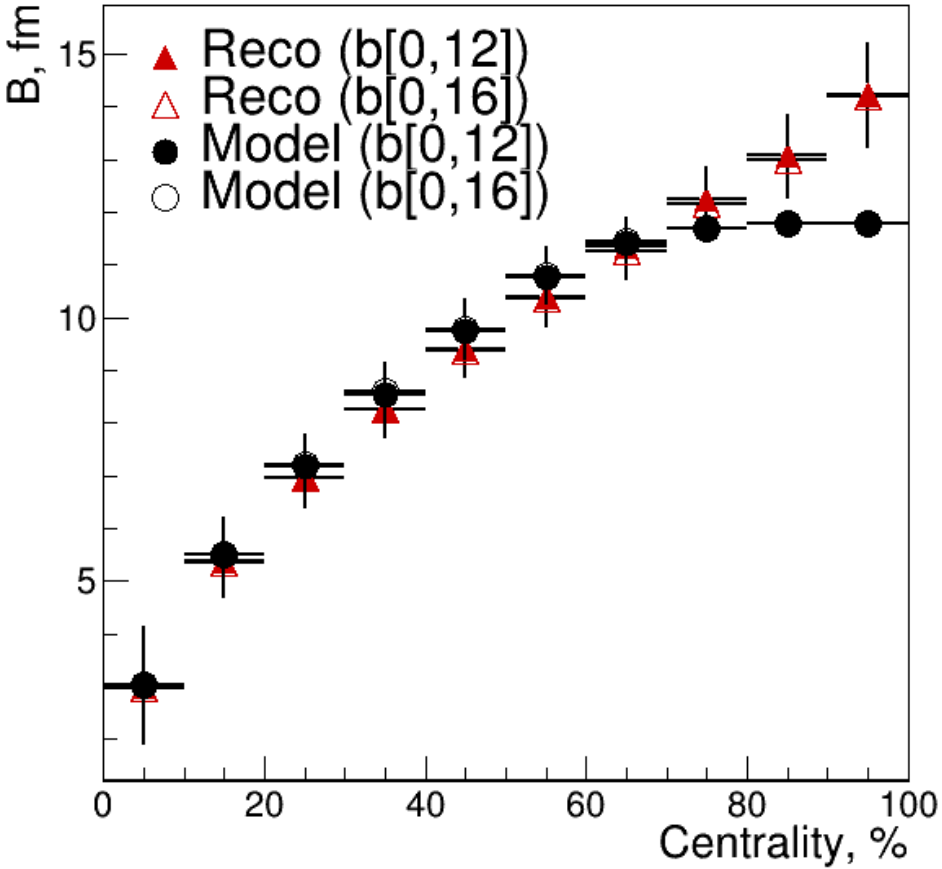
Reconstructed impact parameter (set4 vs set8)

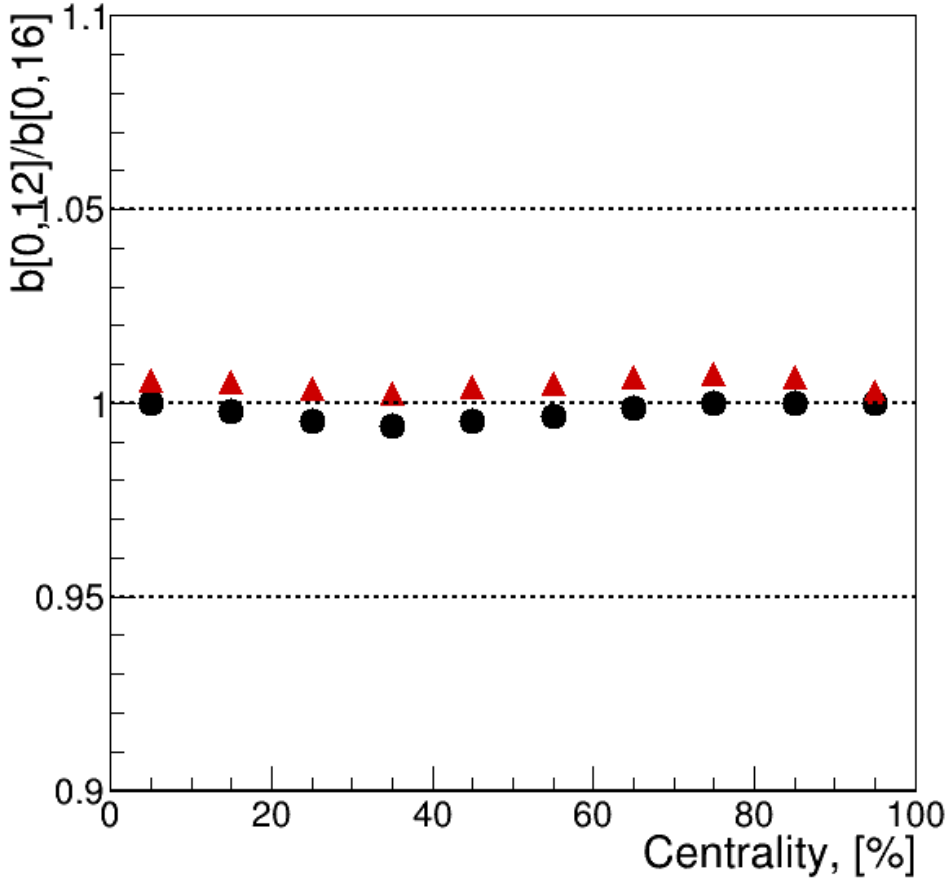


- For both sets 4 and 8 the reconstructed value of impact parameter is within 5% agreement with the model value of the corresponding dataset
- Set8 seems to have problems in the peripheral region

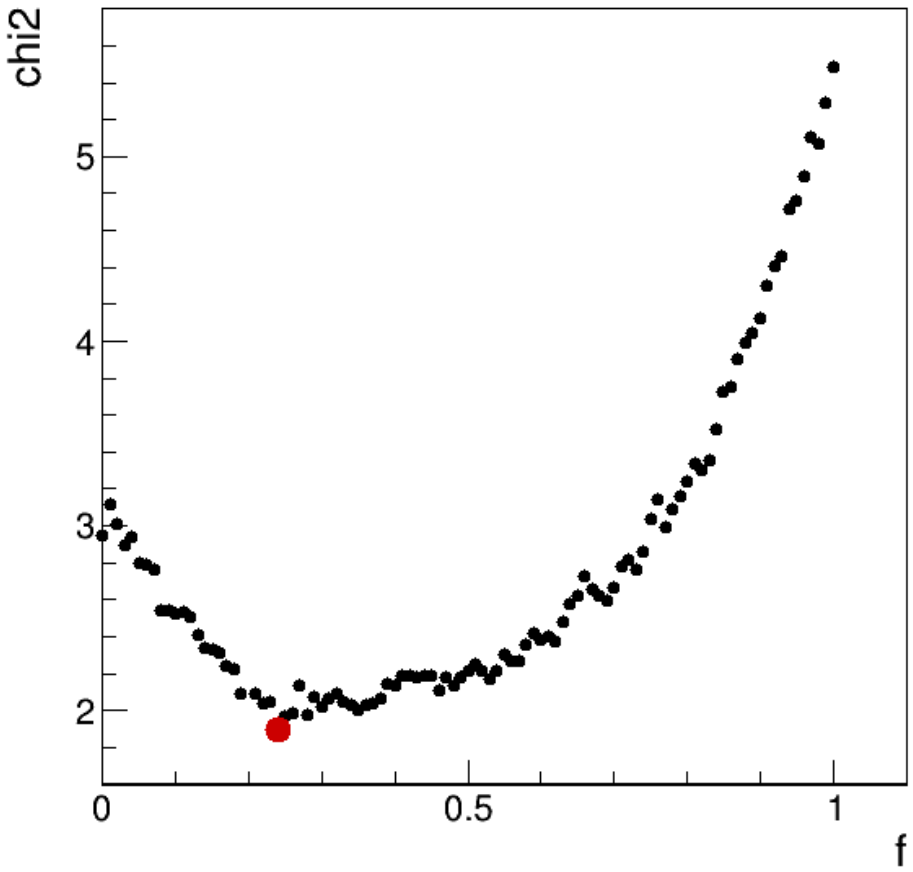
Impact parameter (set4 vs set8)

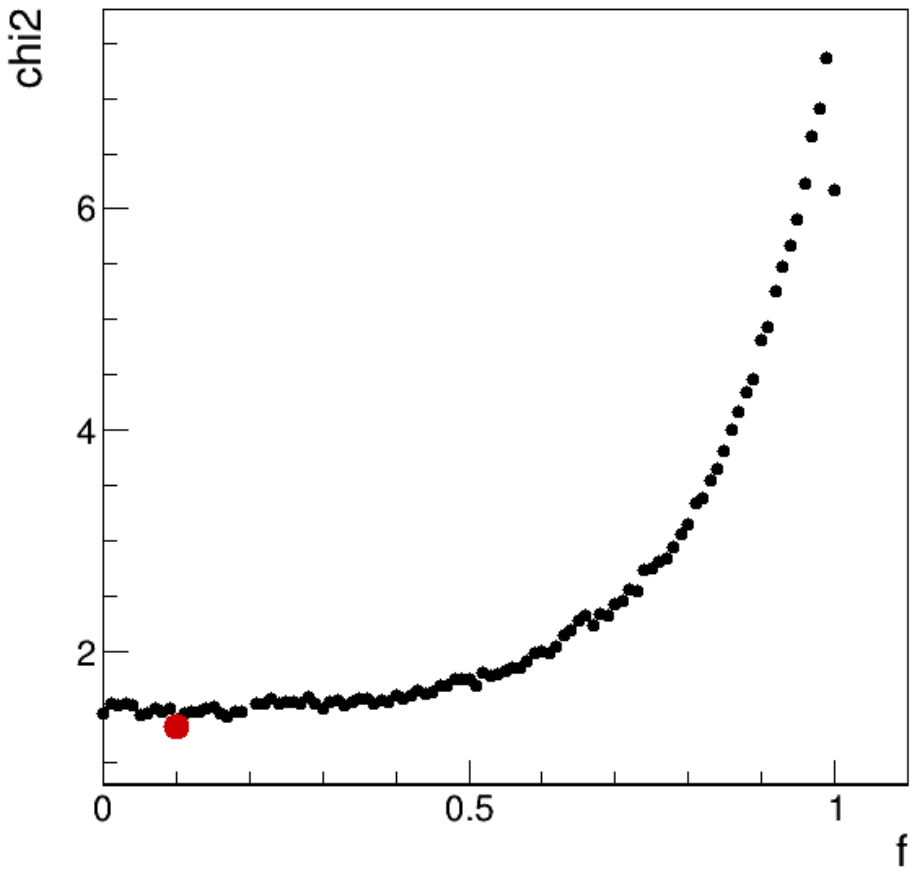
- Comparison of reconstructed impact parameter from the two parametrizations
- Calculated value of model b from the dataset using either parametrization





Parameter f (set4 vs set8)





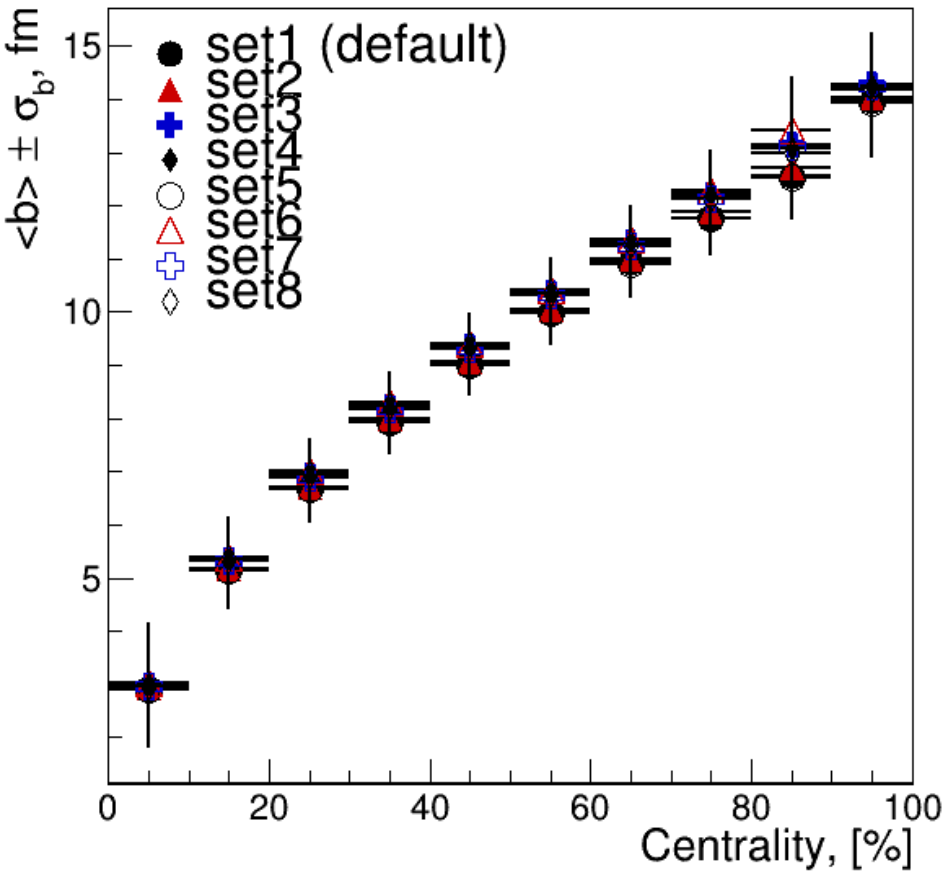
Multiplicity borders (set4 vs set8)

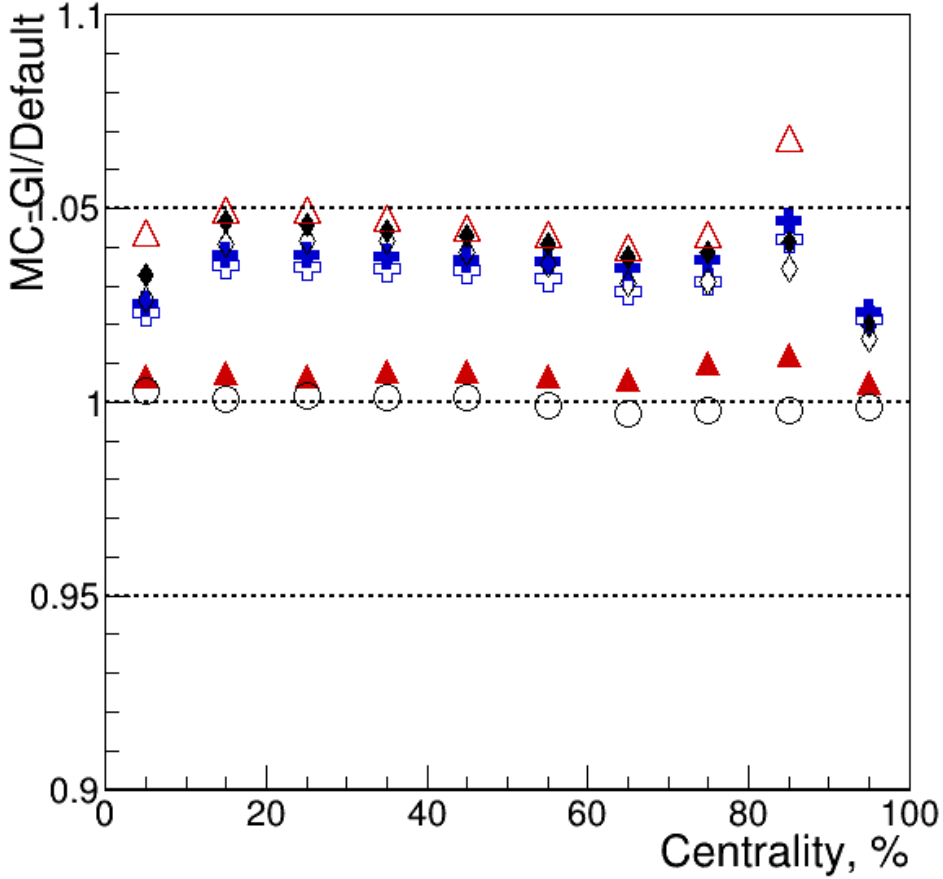
- Comparison of obtained borders on multiplicity for centrality bins

	N_{ch}(min)	N_{ch}(min)	N_{ch}(max)	N_{ch}(max)
	Set4 (b[0,12]fm; |DCA| < 3cm, |η| < 1.0)	Set8 (b[0,16]fm; |DCA| < 3cm, |η| < 1.0)	Set4 (b[0,12]fm; |DCA| < 3cm, |η| < 1.0)	Set8 (b[0,16]fm; |DCA| < 3cm, |η| < 1.0)
0-10%	321	321	567	568
10-20%	221	220	321	321
20-30%	150	148	221	220
30-40%	98	96	150	148
40-50%	61	60	98	96
50-60%	36	35	61	60
60-70%	19	19	36	35
70-80%	9	9	19	19
80-90%	4	4	9	9
90-100%	1	1	3	3

Comparison of all sets

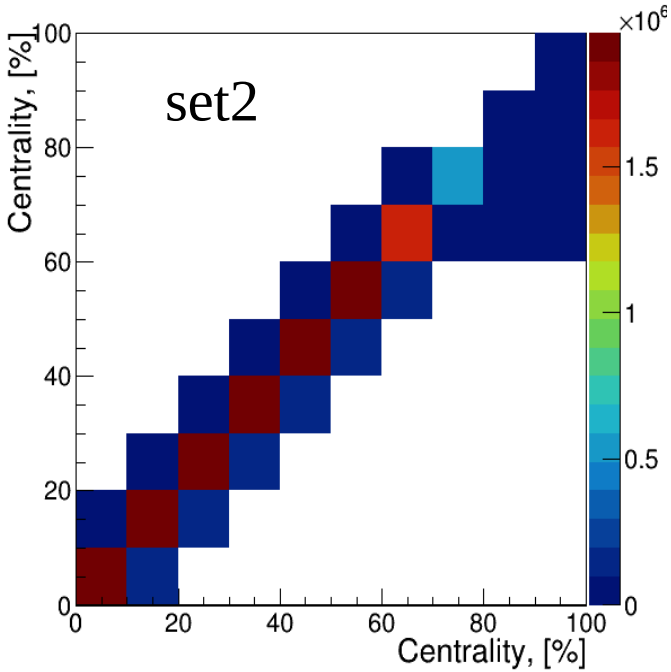
- Reconstructed impact parameter

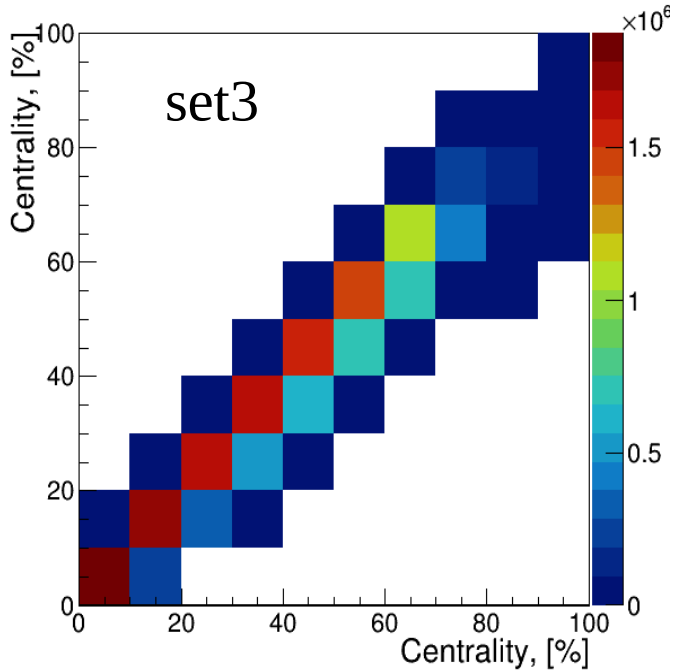


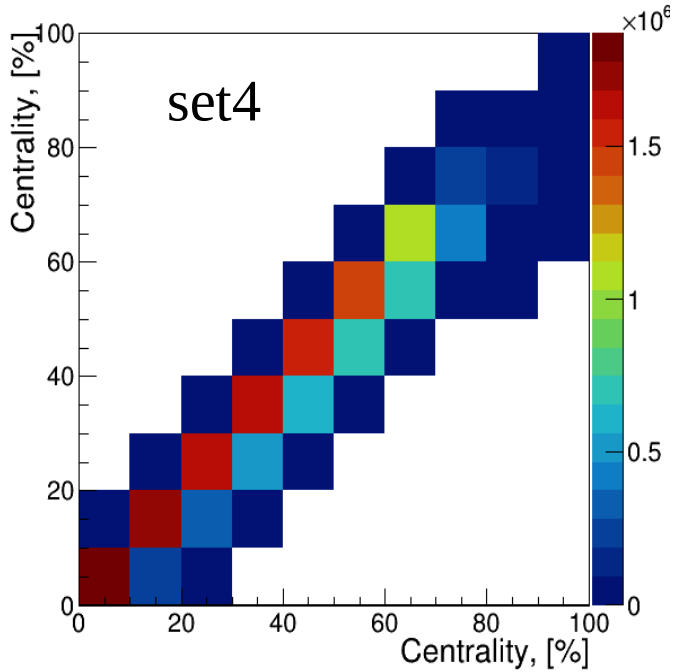


Comparison of all sets

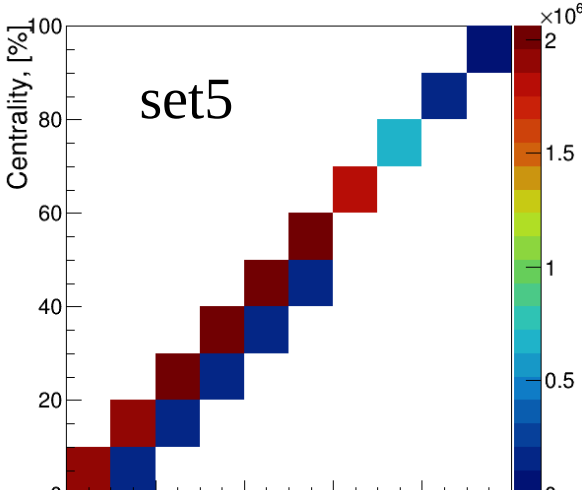
- Centrality, calculated from the dataset (Req.30) using one of sets w.r.t. default
- Default — set1 (X-axis)

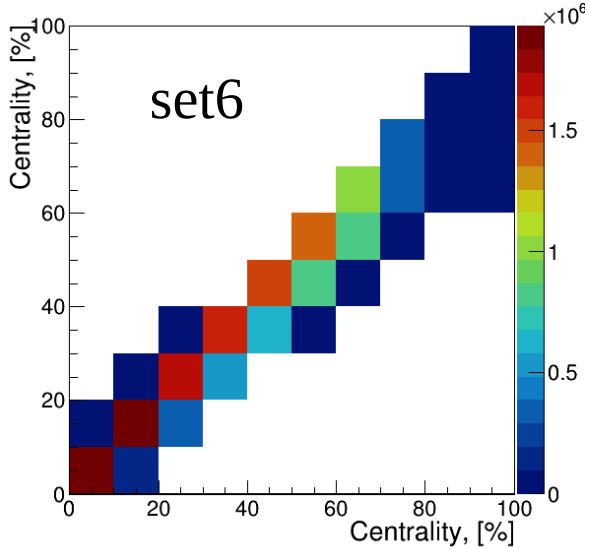


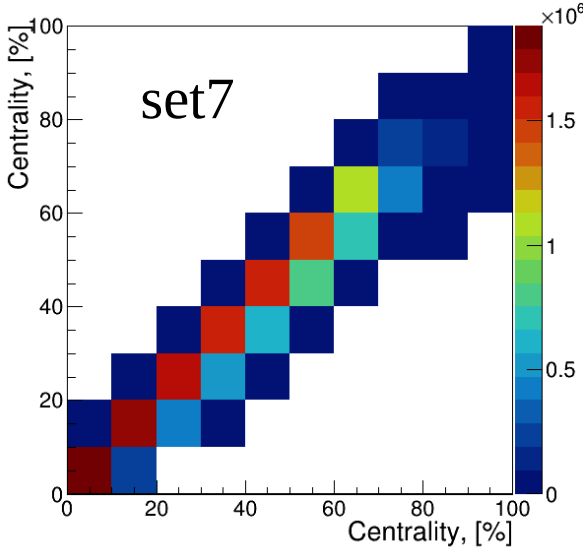


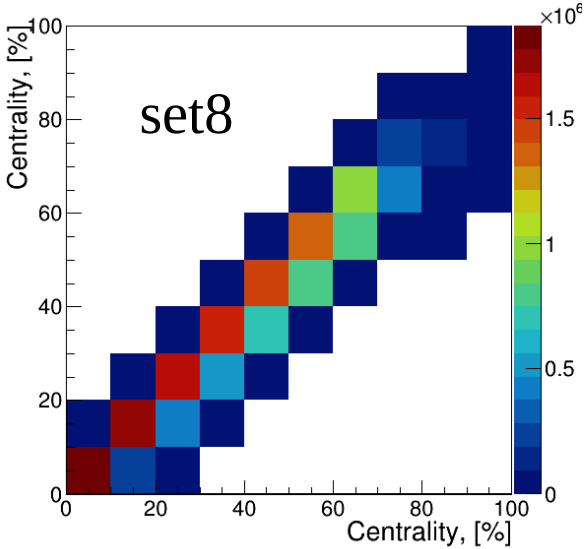


Comparison of all sets

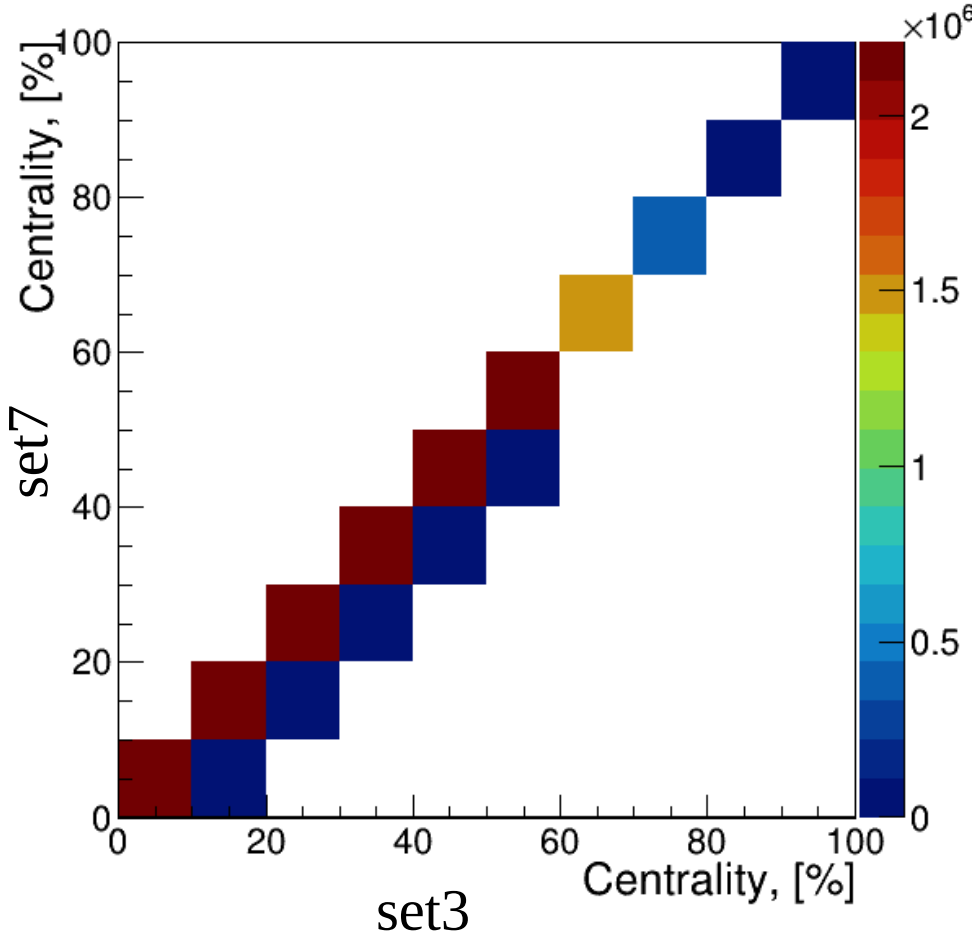








Set7 vs set3



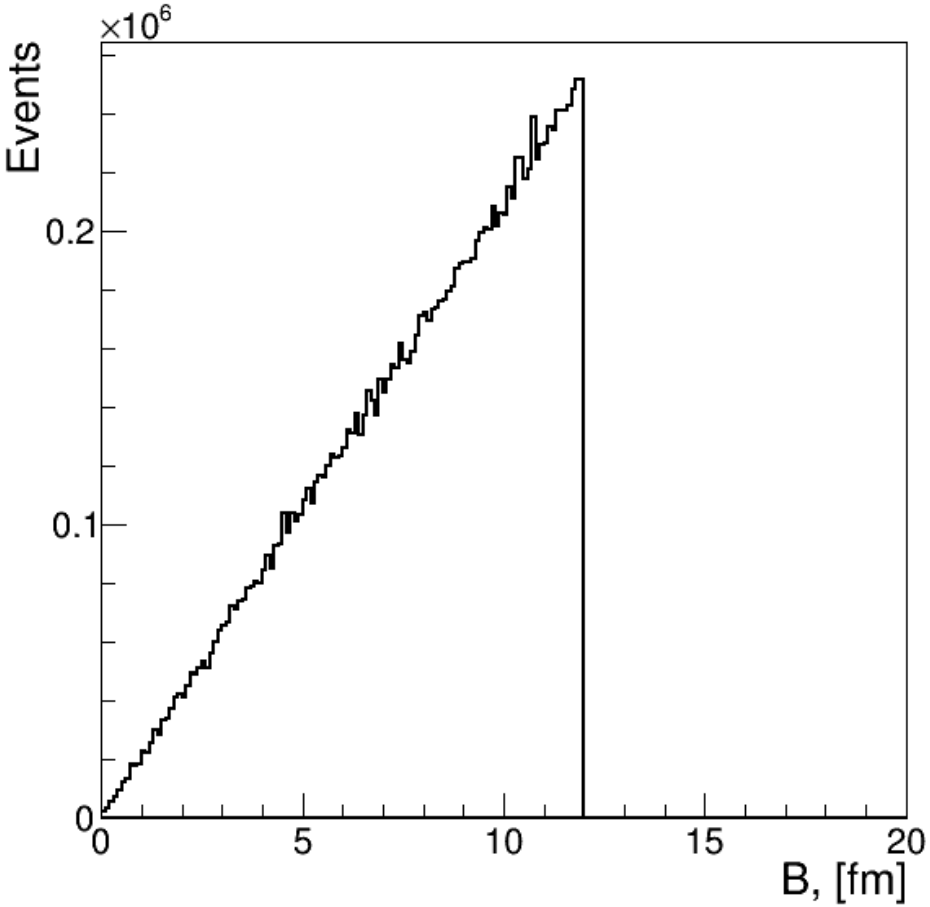
- Suggested best result: set3 or set7
- Selections: |DCA| < 1cm, |η| < 1.0
- Stable result using either b[0,12] or b[0,16]

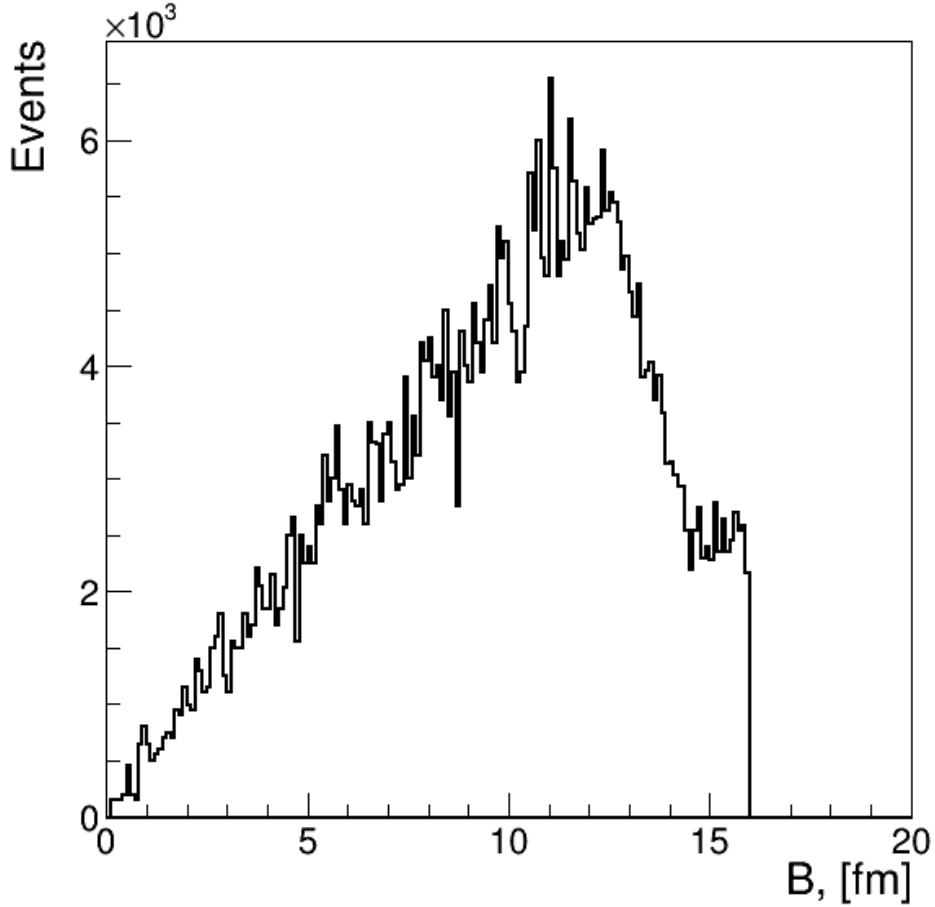
Conclusions

- Completed the centrality parametrizations study for Request 30
  - Implemented suggested optimal cuts for the multiplicity range for the fit
  - Studied the parametrizations with relaxed DCA and eta cuts
  - Compared to the parametrizations obtained from the private dataset with b[0,16]
- Out of the studied parametrization, the selection of $|DCA| < 1cm$, $|\eta| < 1.0$ (sets 3 and 7) seem to provide the best result

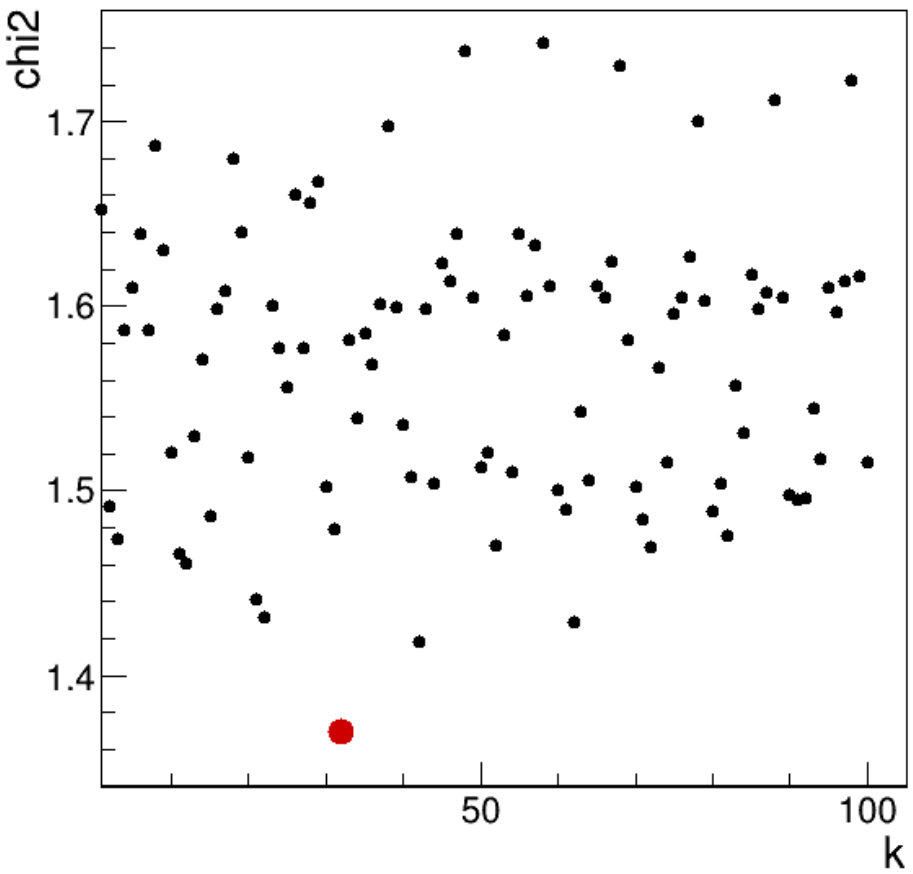
Thank you for your attention!

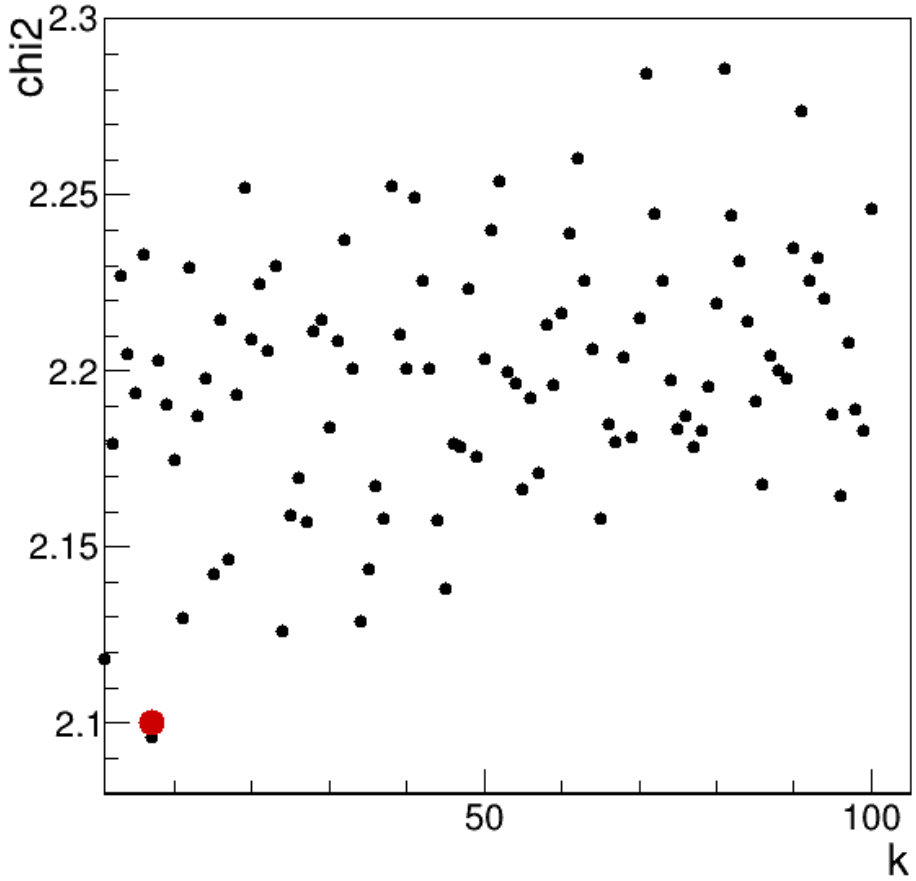
BackUp: Impact parameter



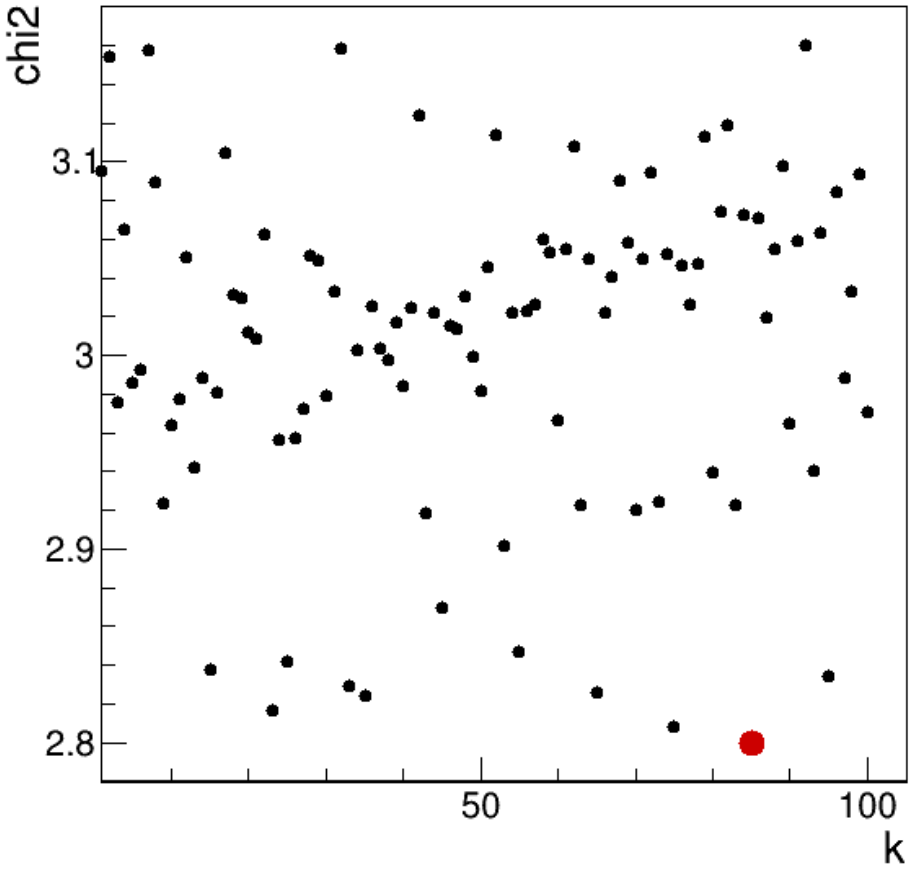


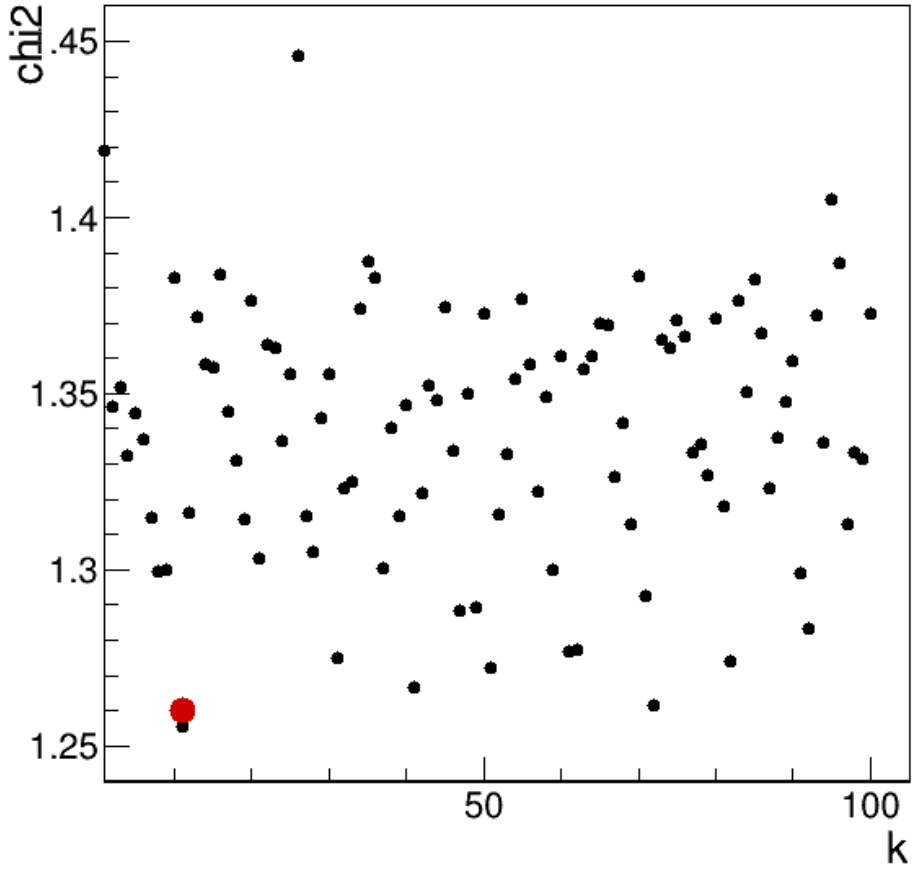
BackUp: Parameter k (set1 vs set5)



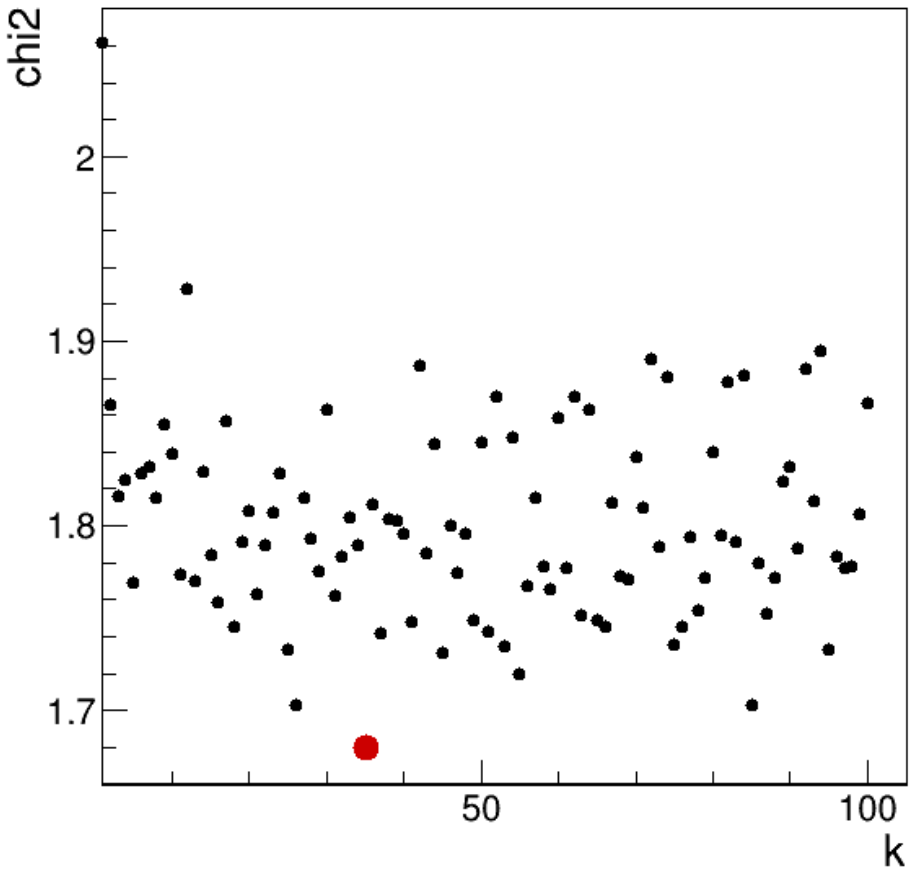


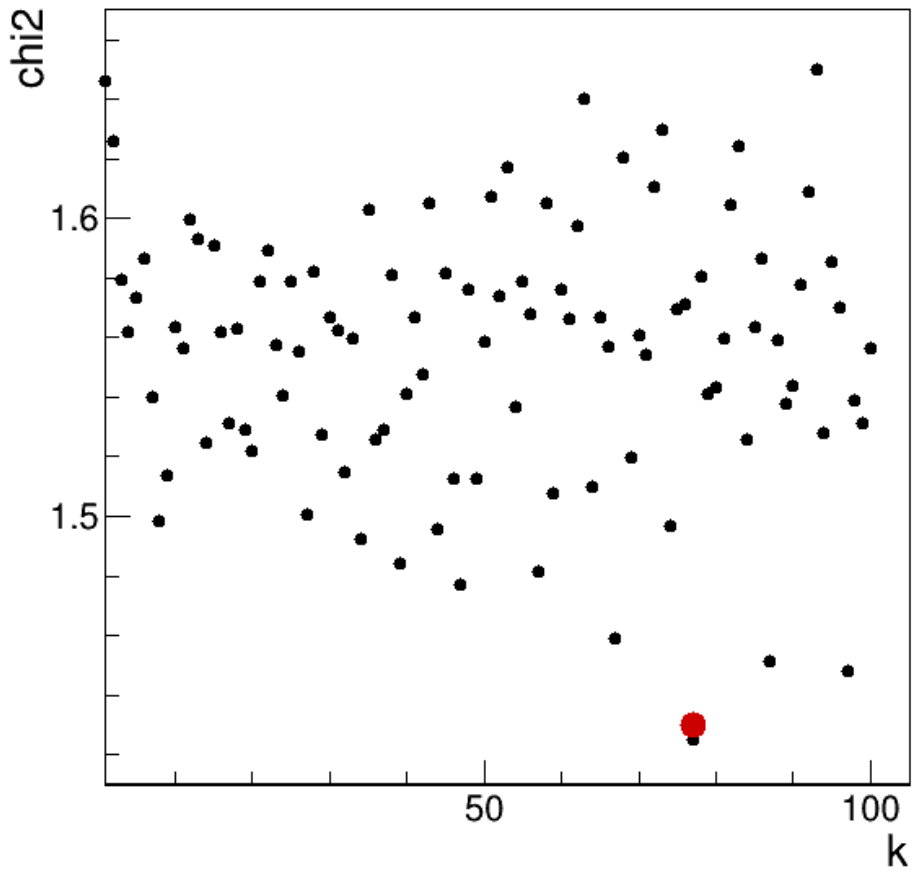
BackUp: Parameter k (set2 vs set6)





BackUp: Parameter k (set3 vs set7)





BackUp: Parameter k (set4 vs set8)