Study of D^0 reconstruction in the CBM experiment

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Motivation

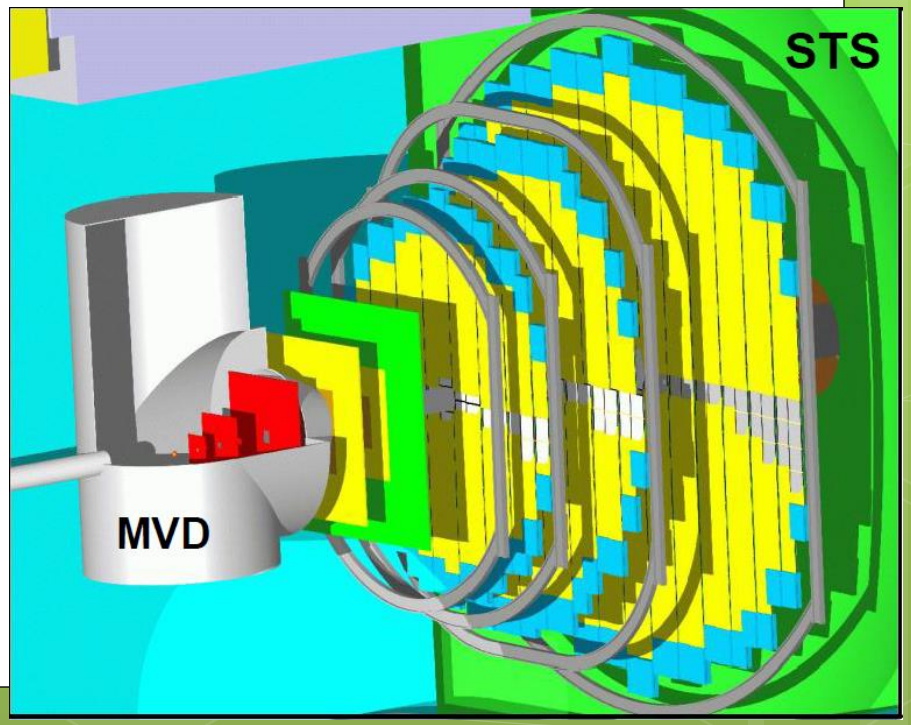
One of the major experimental challenges of the CBM experiment is to trigger on the displaced vertex of the D-meson or Λ_c decay via hadronic modes in the environment of a heavy ion collision.

Problems:

- *Short lifetime of the open charm;*
- *rarity of the open charm decays;*
- *high density of the beam.*

We examined the influence of the following factors on the quality of D^0 reconstruction :

- Clustering algorithm;
- Delta electrons.



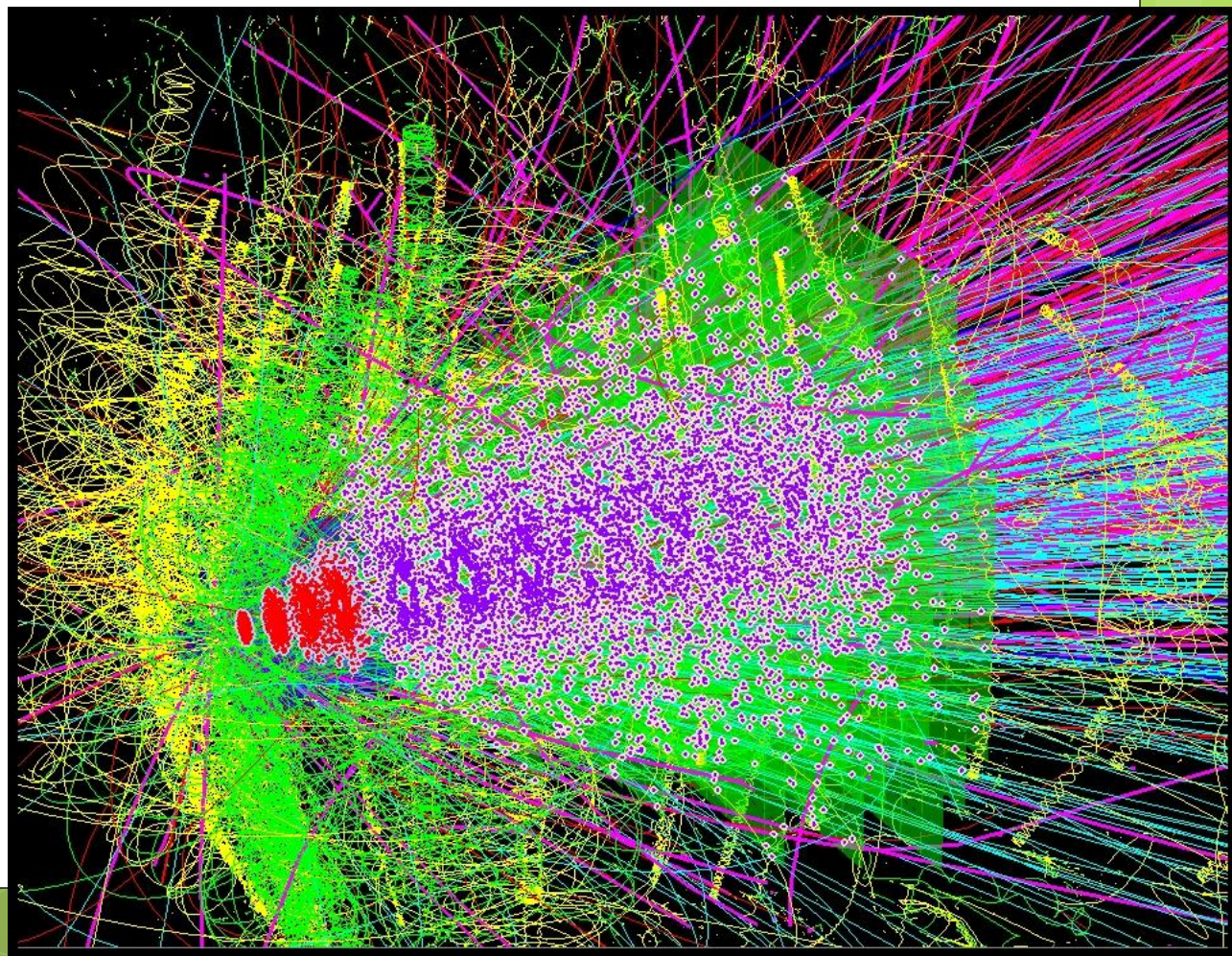
Outline

- Interaction Rate problem;
- Clustering algorithms;
- D^0 + deltas at 10-100 kHz Interaction Rate;
- D^0 + UrQMD + deltas at 10-50 kHz Interaction Rate;
- Conclusions

Detector configuration

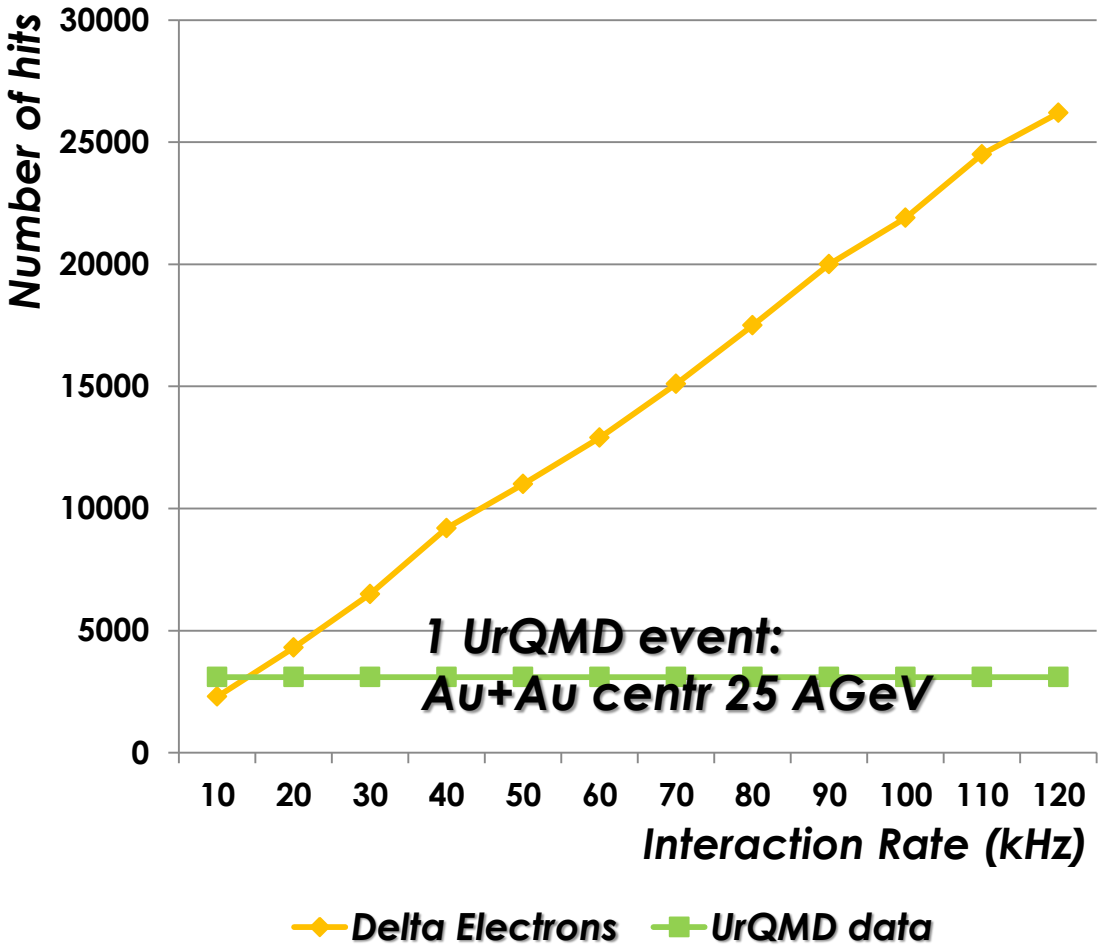
Variant of the MVD detector, which we consider, has the following configuration:

- **Geometry version:** *v10b;*
- **Detecting stations:** *4 MVD MAPS;*
- **Pad size:** *18,4x18,4 μm MIMOSA26;*
- **Readout time:** *30 μs.*

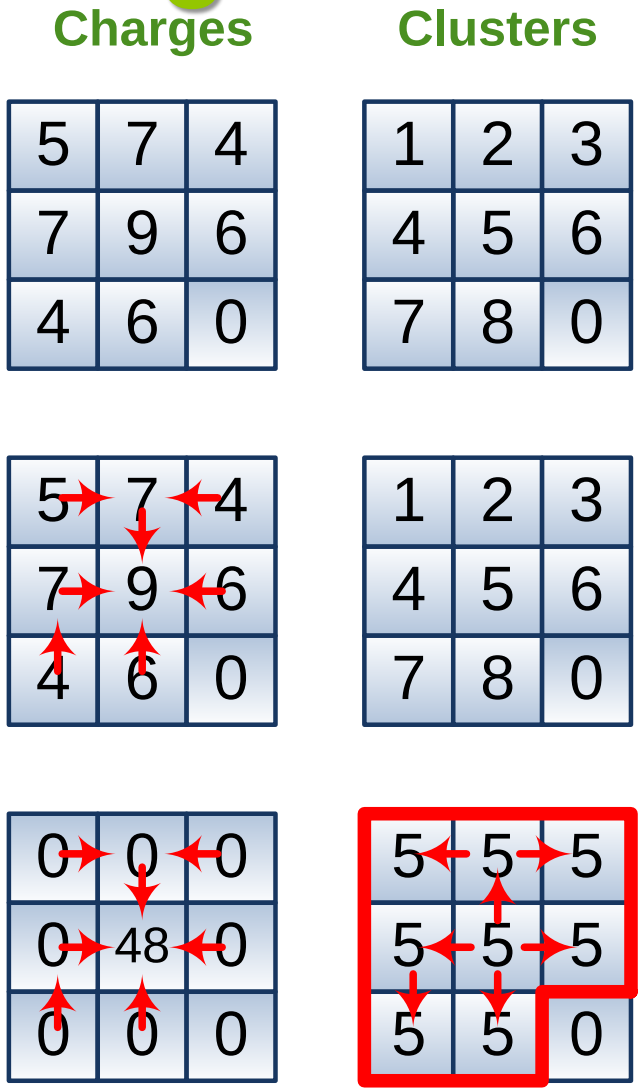


Amount of clusters from delta electrons in all MAPS of detector

Interaction Rate (kHz)	Amount of clusters
10	**2300**
20	**4300**
30	**6500**
40	**9200**
50	**11000**
60	**12900**
70	**15100**
80	**17500**
90	**20000**
100	**21900**
110	**24500**
120	**26200**



Clustering algorithm with charges



Every pad with local maximum of charge creates a single cluster.

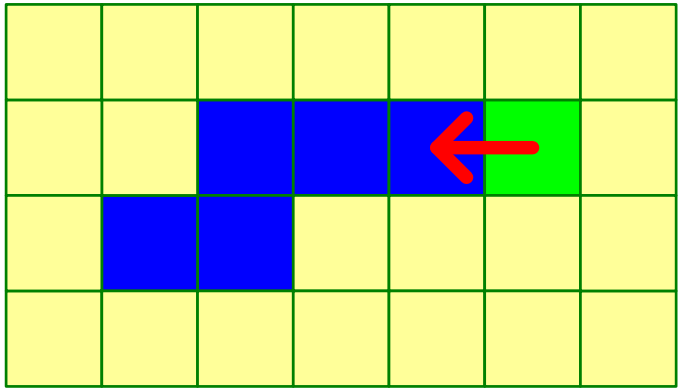
Every cluster has only one local maximum of charge.

Algorithm:

- each pad with a non-zero charge is considered as a separate cluster;
- if the pad is not a local maximum, then it is joined the neighbor with the largest charge, else it is a separate object;
- algorithm is executed until all pads are added to clusters.

Clustering algorithm without charges

Algorithm adds the object to the cluster, if this object is close to one of the objects already included in this cluster.



Pads were merged on the basis of their neighborhood.

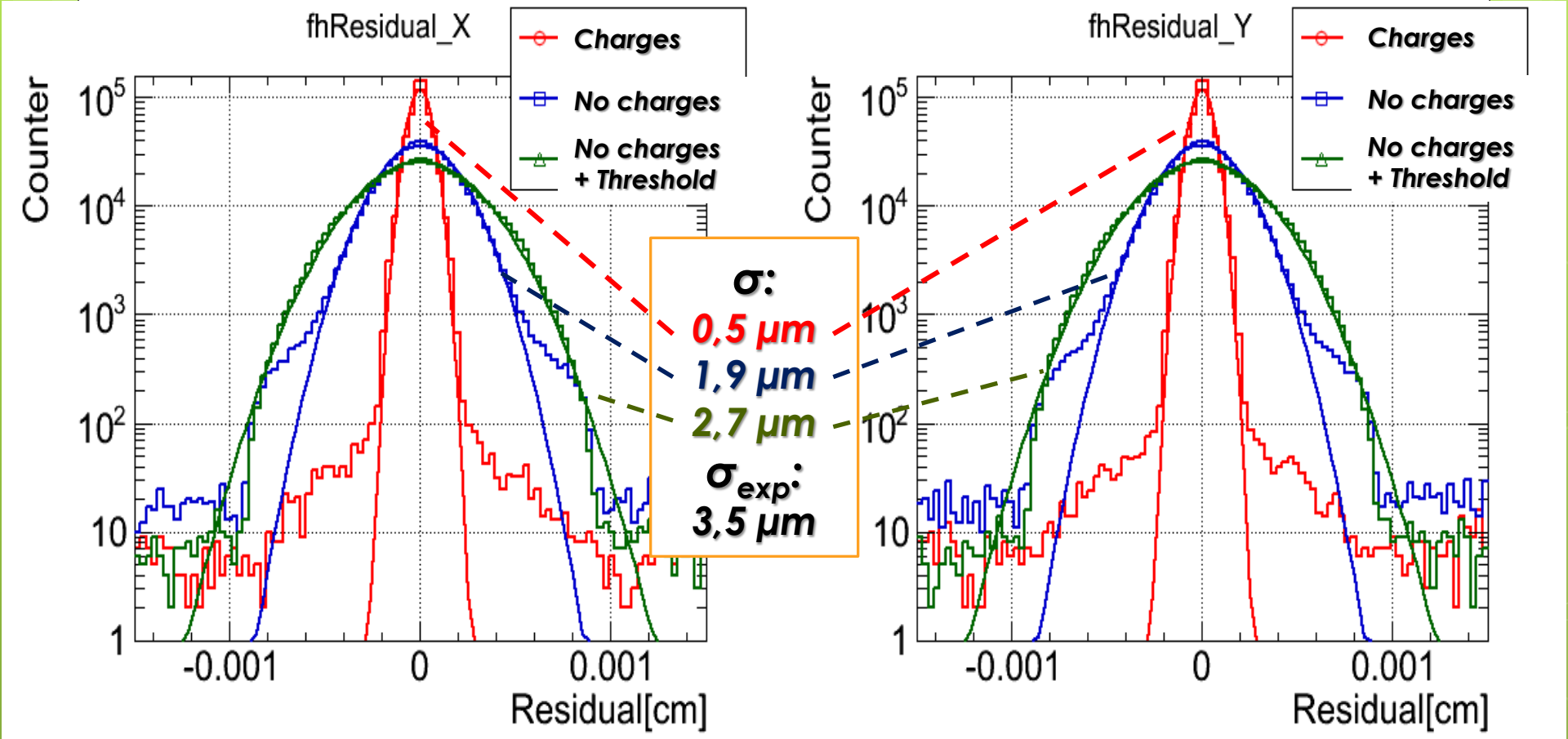
Advantages:

- high calculation speed;
- does not require information about the charges.

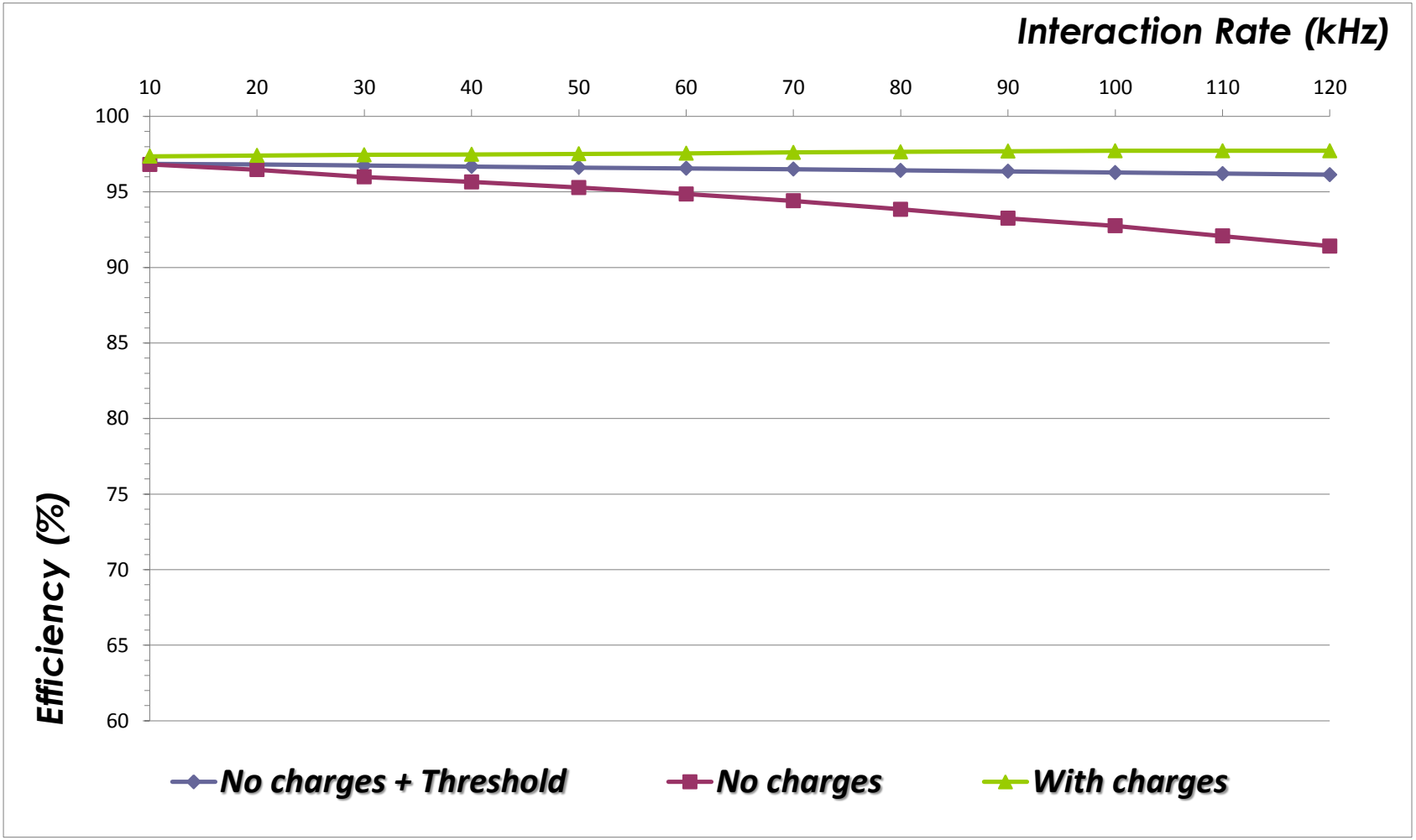
Disadvantages:

- no separation of overlapping clusters.

Accuracy of hits finding

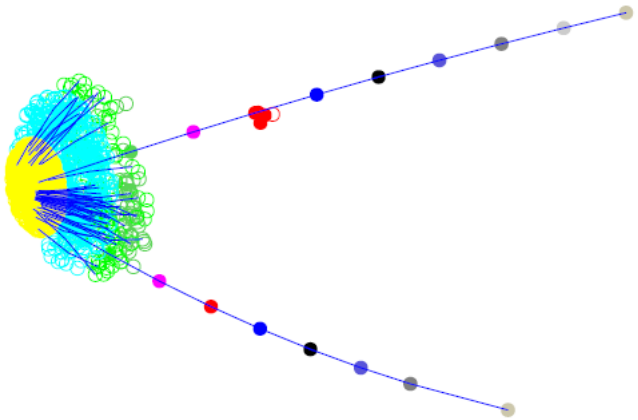


Efficiency of MVD clustering

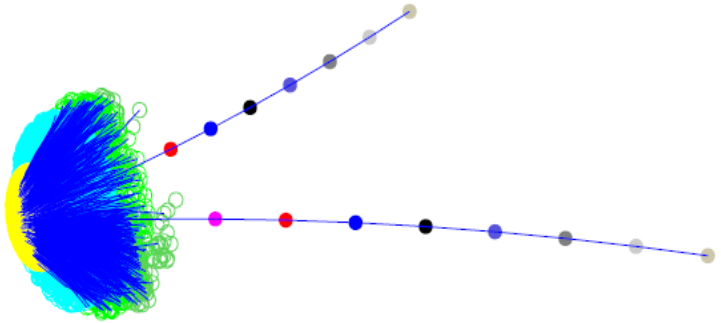


Reconstructed tracks

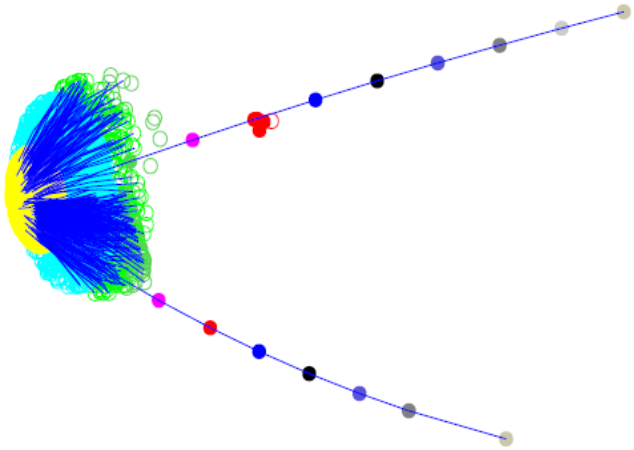
10 kHz



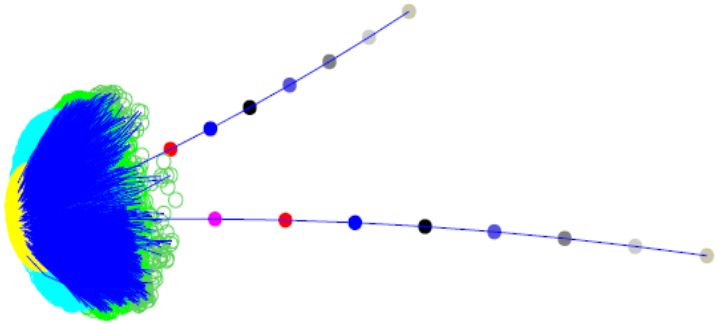
50 kHz



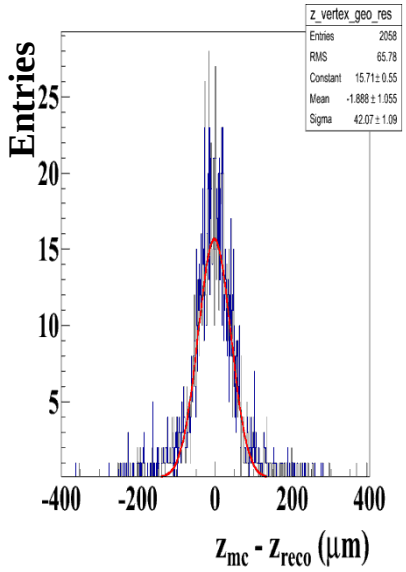
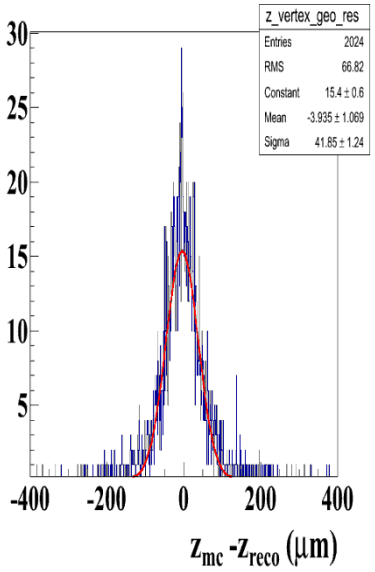
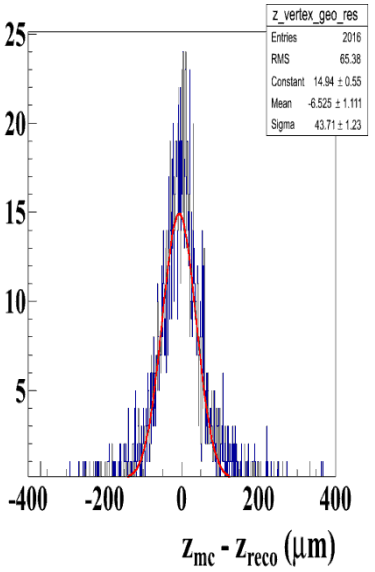
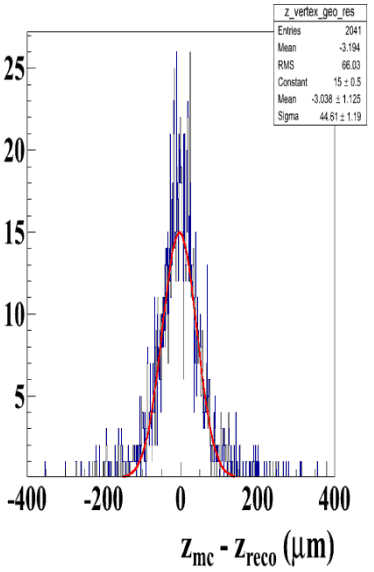
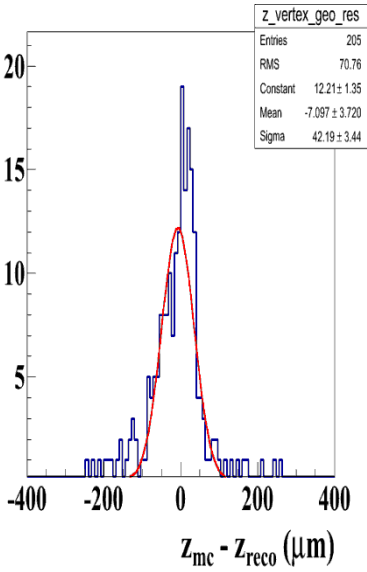
30 kHz



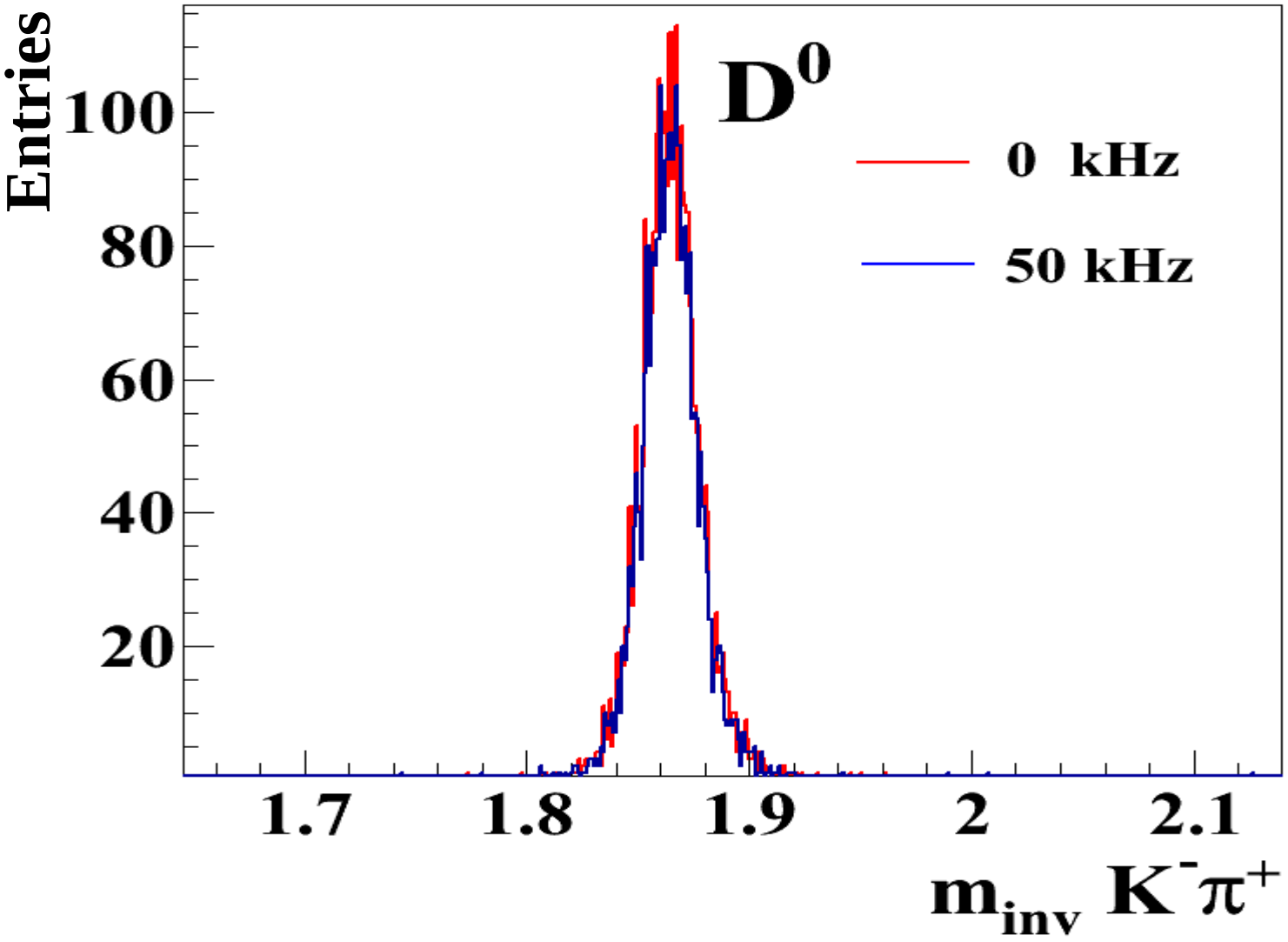
100 kHz



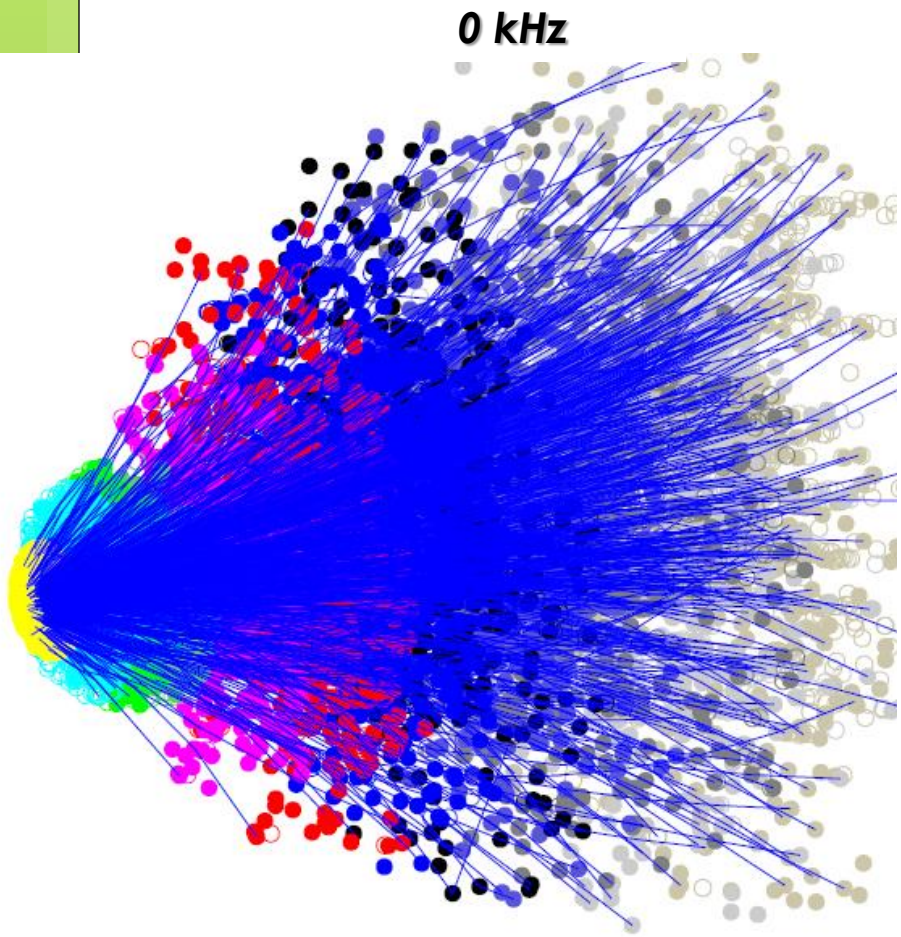
D^0 Z vertex resolution – D^0+deltas

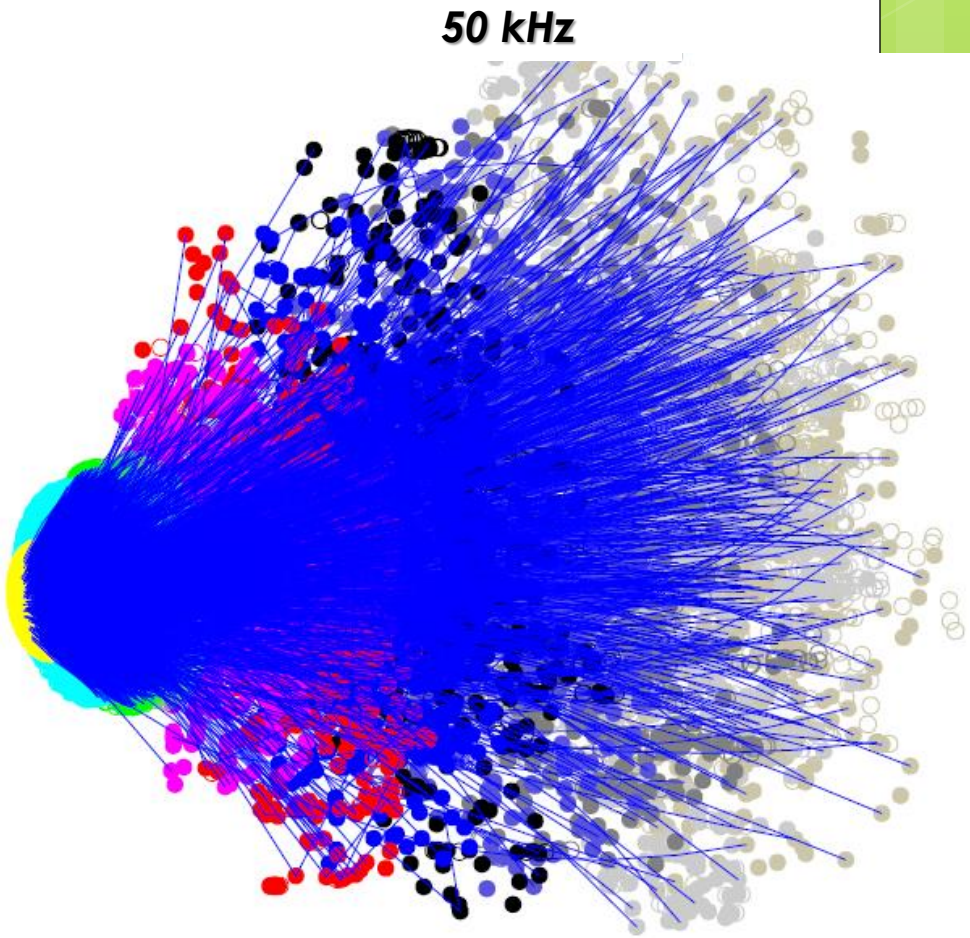
0 kHz	10 kHz	30 kHz	50 kHz	100 kHz
				
Events: 10000 Entries: 2058 Sigma: 42,07 ±1,09 μm Tracking time: 0,003 s/ev	Events: 10000 Entries: 2041 Sigma: 44,61 ±1,24 μm Tracking time: 0,110 s/ev	Events: 10000 Entries: 2016 Sigma: 42,07 ±1,23 μm Tracking time: 0,255 s/ev	Events: 10000 Entries: 2024 Sigma: 41,85 ±1,19 μm Tracking time: 0,760 s/ev	Events: 1000 Entries: 205 Sigma: 42,19 ±3,44 μm Tracking time: 3,700 s/ev

D^0 invariant mass resolution – D^0+deltas



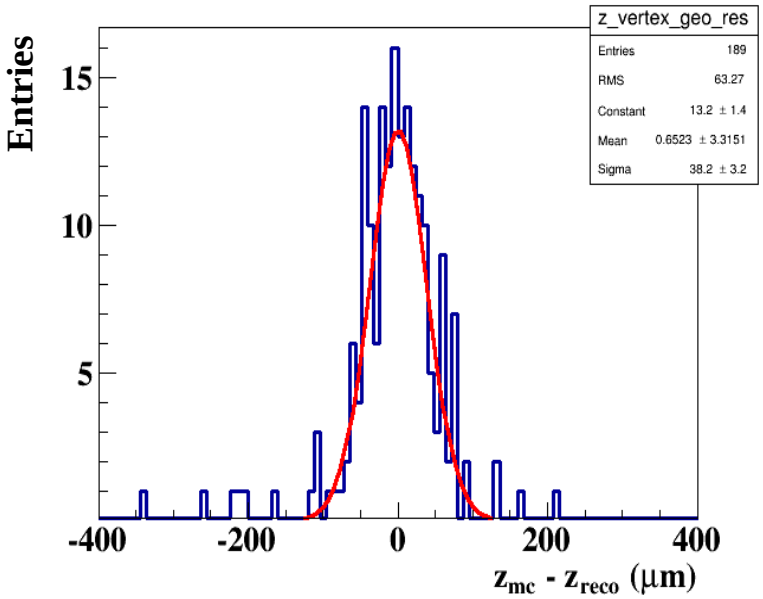
Reconstructed tracks with UrQMD





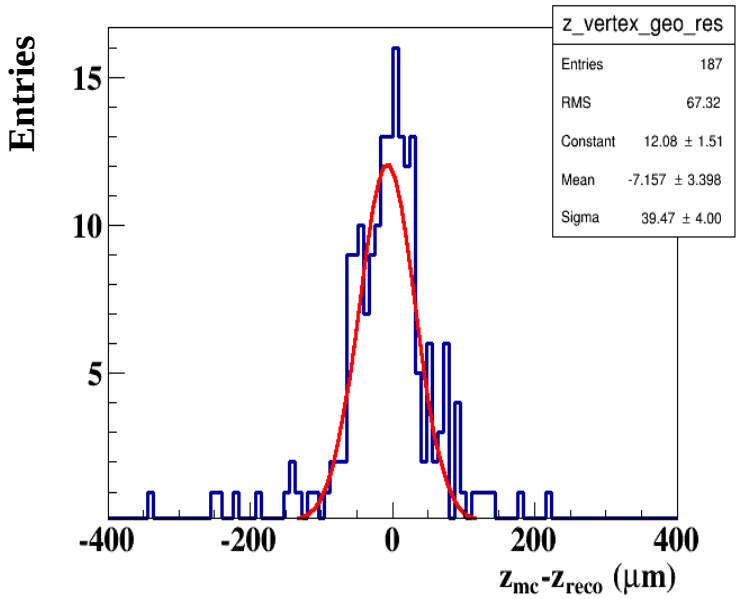
D^0 Z vertex resolution – D^0+deltas+UrQMD

0 kHz



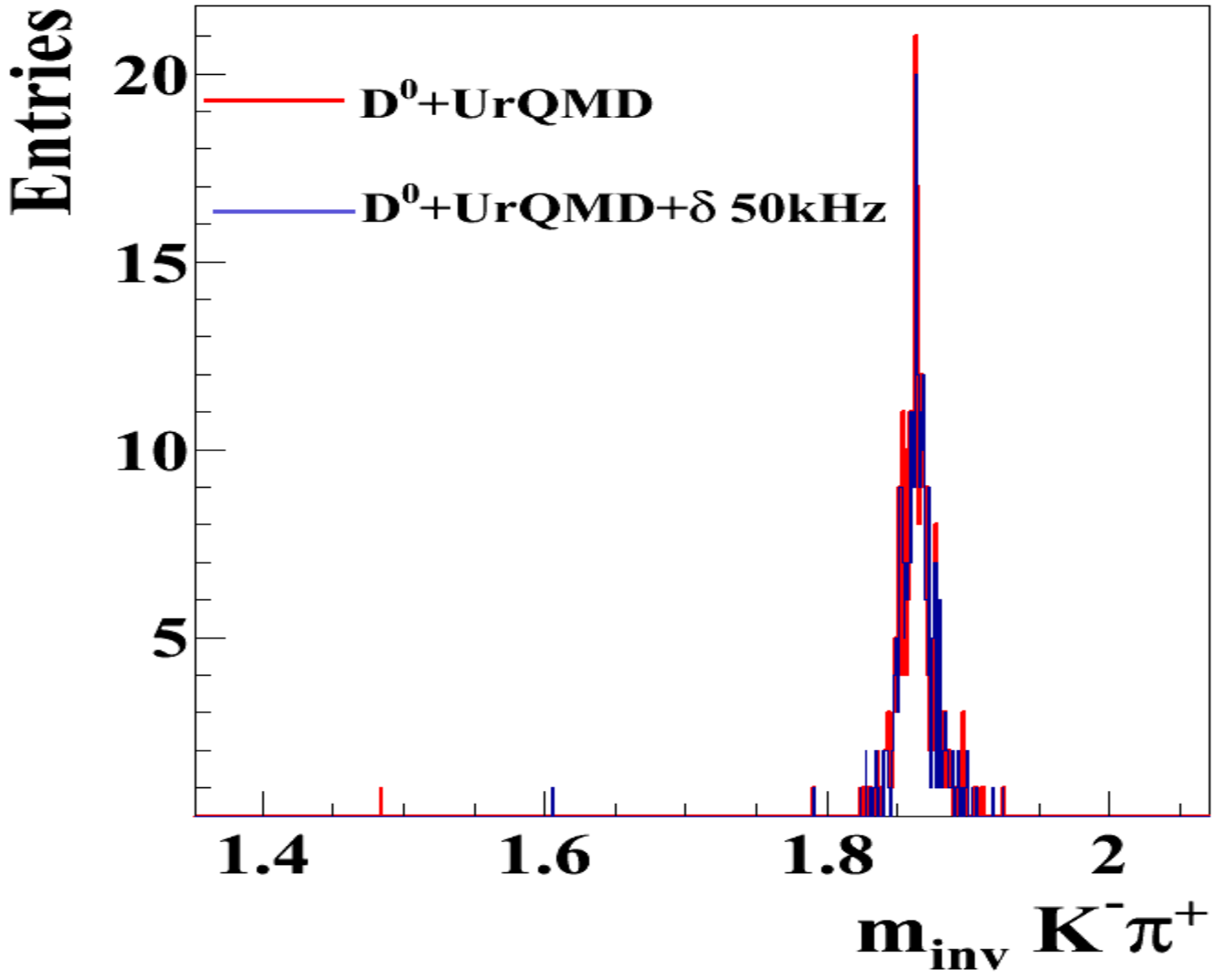
Events: 1000
Entries: 189
Sigma:
38,2 ±3,20 μm
Tracking time:
0,211 s/ev

30 kHz



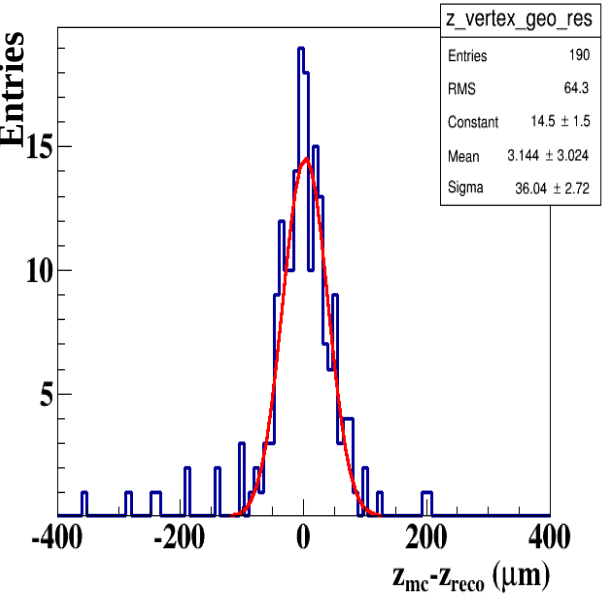
Events: 1000
Entries: 187
Sigma:
39,47 ±4,00 μm
Tracking time:
0,879 s/ev

D^0 invariant mass resolution – D^0+deltas+UrQMD



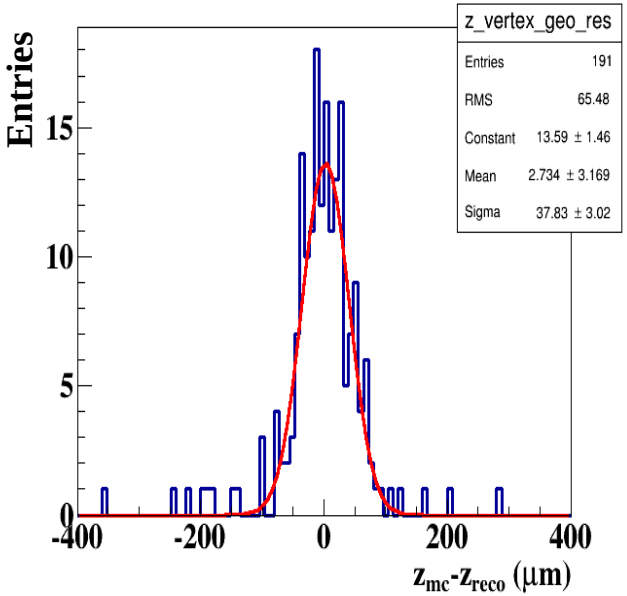
D^0 Z vertex resolution – D^0+deltas+UrQMD
Clustering with charges

0 kHz



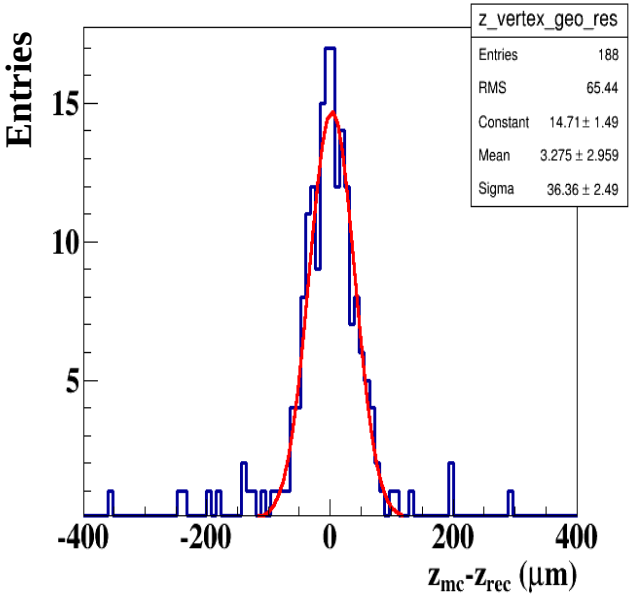
Events: 1000
Entries: 190
Sigma: 36,04 ±3,72 μm
Tracking time: 0,227 s/ev

30 kHz



Events: 1000
Entries: 191
Sigma: 37,83 ±3,02 μm
Tracking time: 0,961 s/ev

50 kHz



Events: 1000
Entries: 188
Sigma: 36,36 ±2,49 μm
Tracking time: 1,935 s/ev

All results

		0 kHz	10 kHz	30 kHz	50 kHz	100 kHz
D^0 + delta	Sigma(μm)	42,07 ±1,09	44,61 ±1,24	43,71 ±1,23	41,85 ±1,19	42,19 ±3,44
	Time (s/ev)	0,003	0,110	0,255	0,760	3,700
D^0 + UrQMD + delta	Sigma(μm)	38,2 ±3,20	42,79 ±3,62	39,47 ±4,00	47,01 ±3,77	-
	Time (s/ev)	0,211	0,346	0,879	1,722	-
D^0 + UrQMD + delta with charges	Sigma(μm)	36,04 ±3,72	37,15 ±3,27	37,83 ±3,02	36,36 ±2,49	-
	Time (s/ev)	0,227	0,371	0,961	1,935	-

Summary

- Using charge provides a slight increase in efficiency and accuracy of clustering and tracking. Absence of charges does not lead to loss of important information.
- Interaction rate up to 100 kHz does not lead to a significant drop in the efficiency of D^0 determining:
  - Graphs of the invariant mass remain practically unchanged;
  - Number of found D^0 and Z vertex resolution remains at one level;
  - Z vertex reconstruction graphs have a similar shape.
- Increasing of the interaction rate leads to a decrease in speed of events reconstruction.

Thank you for your attention!