

Beam test of the ALICE ALPIDE sensor at the LNF Beam Test Facility

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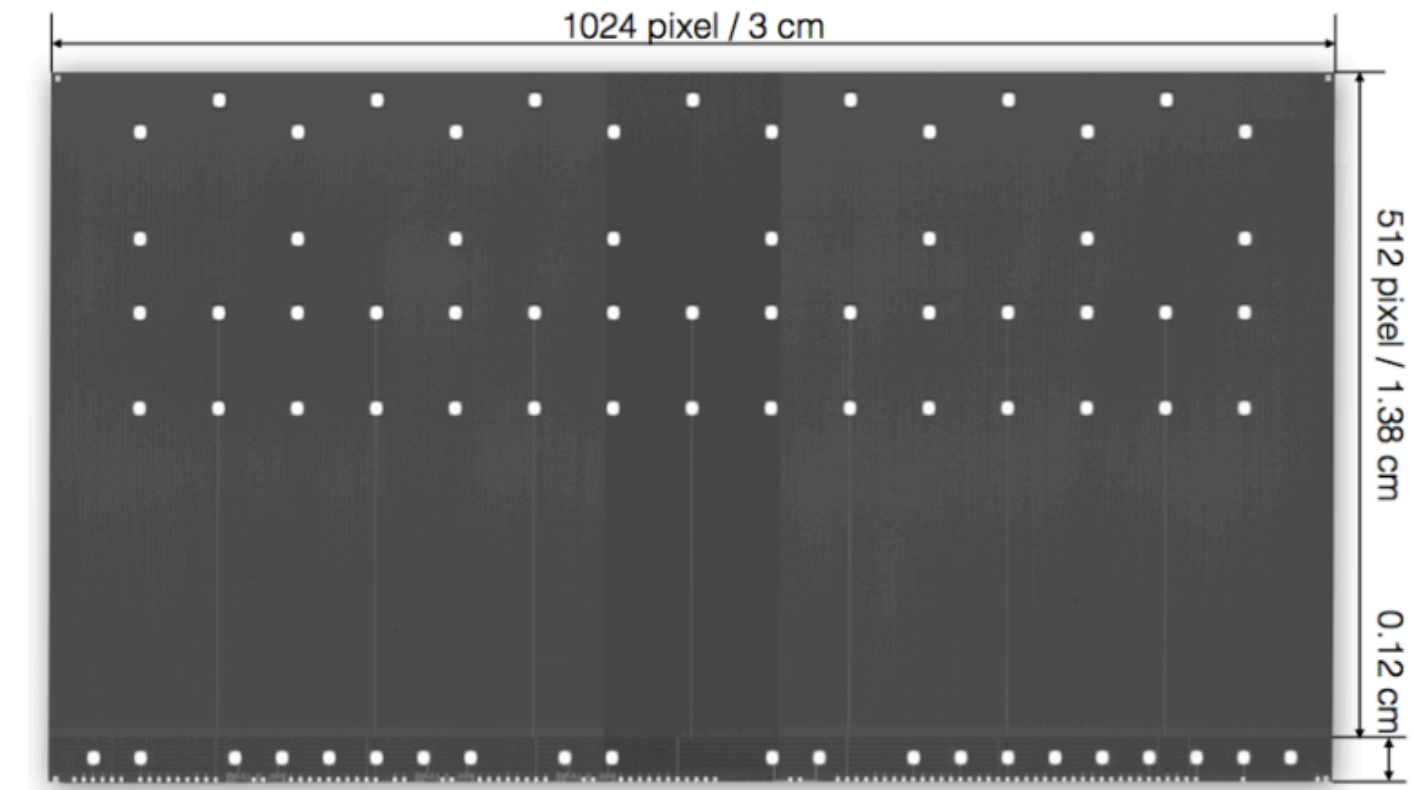
Beam test of the ALICE ALPIDE sensor @ LNF BTF, April 2017

Goal: performance of the ALICE ALPIDE chip in beam:

- Cluster size distribution;
- Correlations;
- Tracking / Detection efficiency.

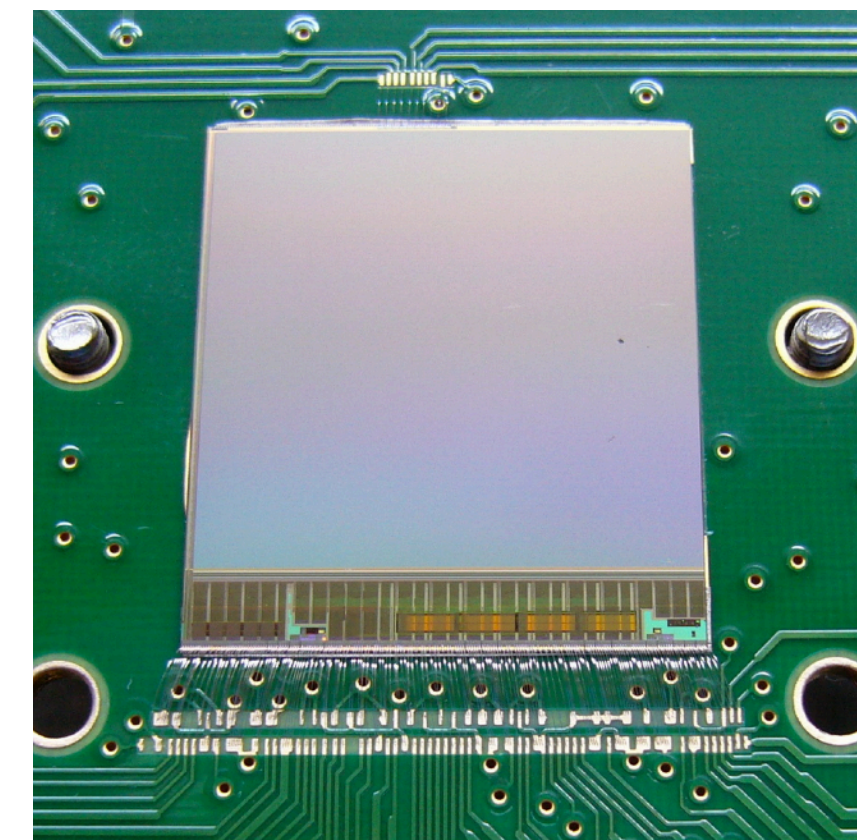
Devices used in the beam test

- 1× ALPIDE sensor:
 - 3 cm × 1.5 cm size;
 - 1024×512 pixels;
 - 29 μm × 27 μm per pixel;
 - Fake hit rate $\sim 10^{-12}$ hits/pixel/event with 3 hot pixels masked (@ strobe length of 500 ns);
 - Readout: MOSAIC board;



ALPIDE

- 1× MIMOSA-28 sensor:
 - 2 cm × 2 cm size;
 - 960 × 928 pixels;
 - 20.7 μm × 20.7 μm per pixel;
 - Readout: SoCKit-based system.

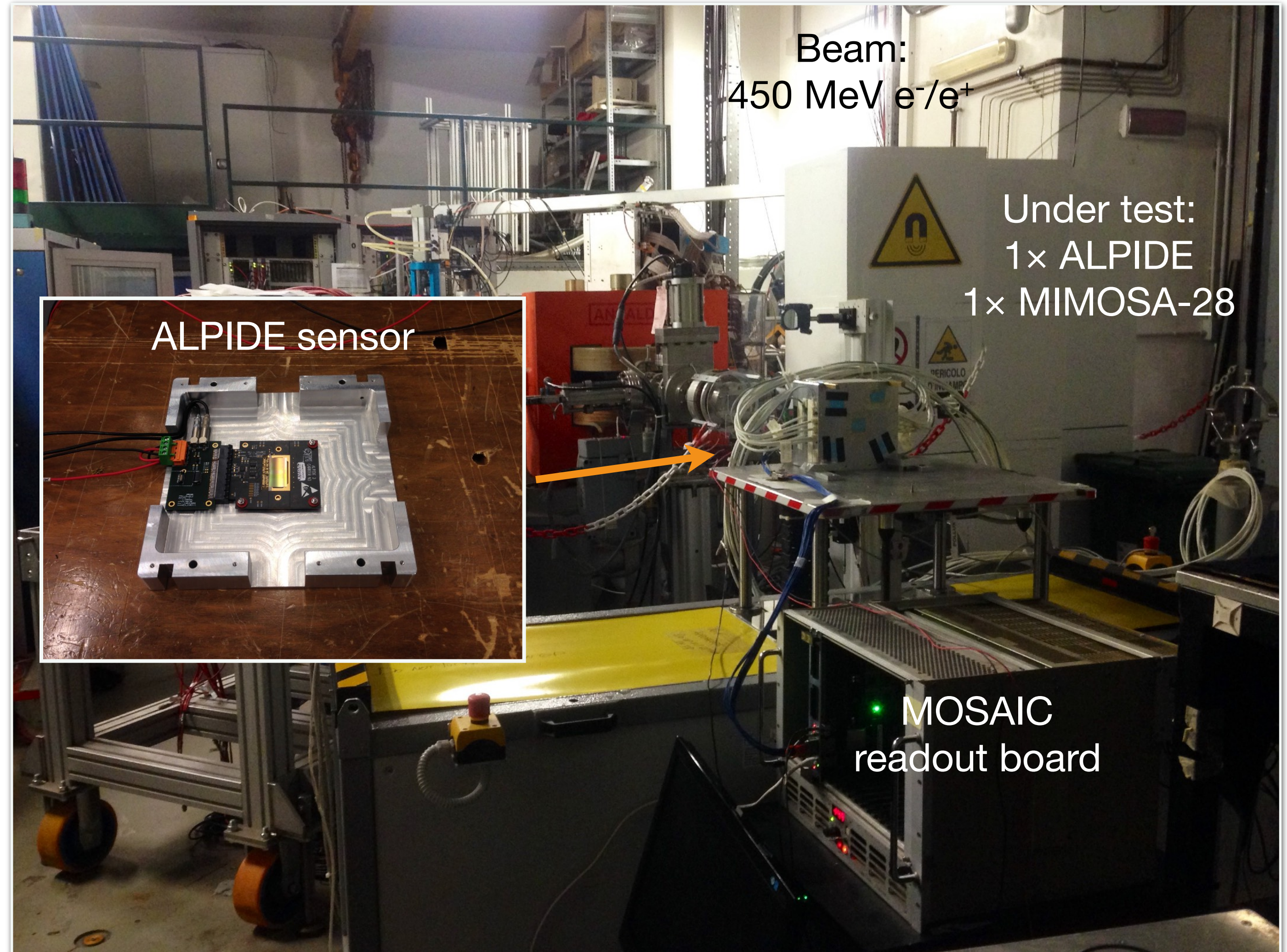


MIMOSA-28

Fig: <http://www.iphc.cnrs.fr/>

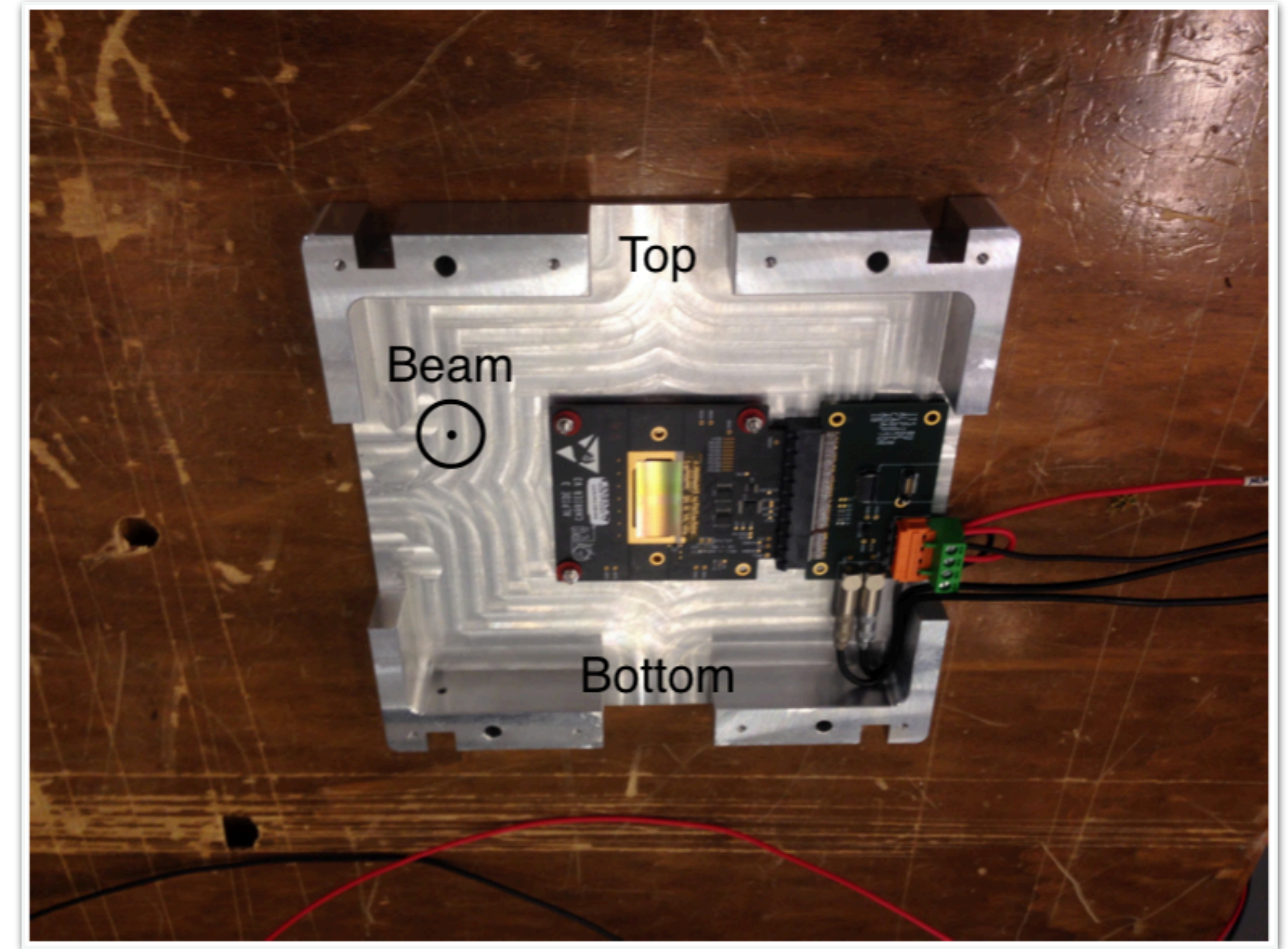
Setup

- Beam: 450 MeV e^-/e^+ ;
- Sensors assembled in stations: ALPIDE closest to the beam;
- ALPIDE default settings used (fixed for all runs);
- DAQ: MIMOSA data acquisition triggered by the MOSAIC board (which receives the trigger from the accelerator);
- DAQ frequency: 50 Hz;
- BTF Medipix sensor used in several runs to control the beam spot size;
- Bunch multiplicity: e^- : ~ 10 , e^+ : ~ 2 .



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Beam
→



Medipix
sensor (BTF)
*used in runs
2000-2002,
2006-2008



Acquired data

- 13 runs with data acquired;
- ALPIDE and MIMOSA raw data saved in separate files;
- During the same run both the positron and electron data present;
- No data is acquired when switching b/w beams: events with data are less than total number of events.

Run number	# of events	# of events with hits (ALPIDE)
2000	5k	721
2001	10k	9638
2002	10k	9869
2003	10k	9882
2004	100k	63921
2005	100k	47137
2006	100k	55764
2007	100k	46467
2008	10k	4717
2009	100k + 1	55603
2010	101k	22670
2011	101k	68098
2012	51k	26549

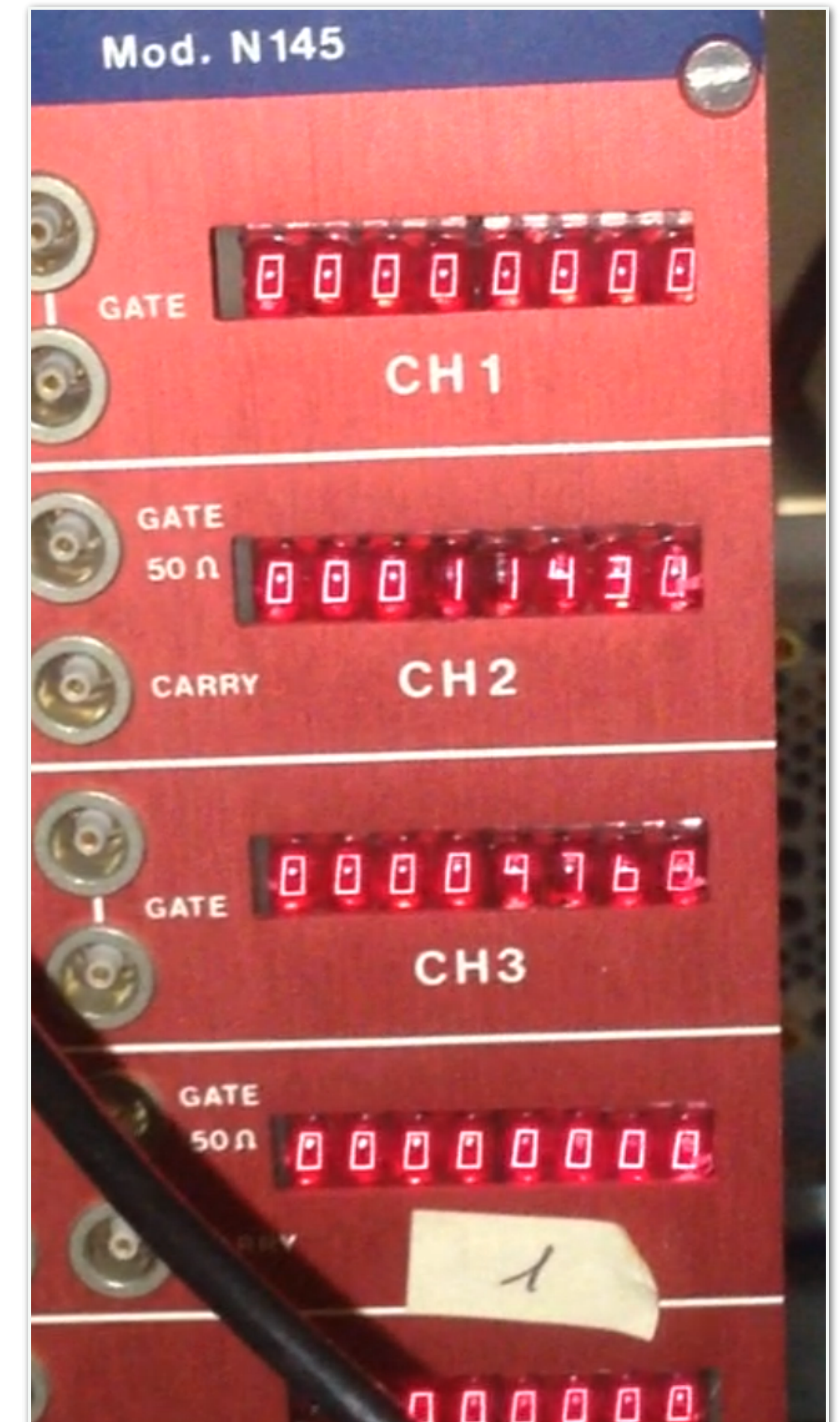
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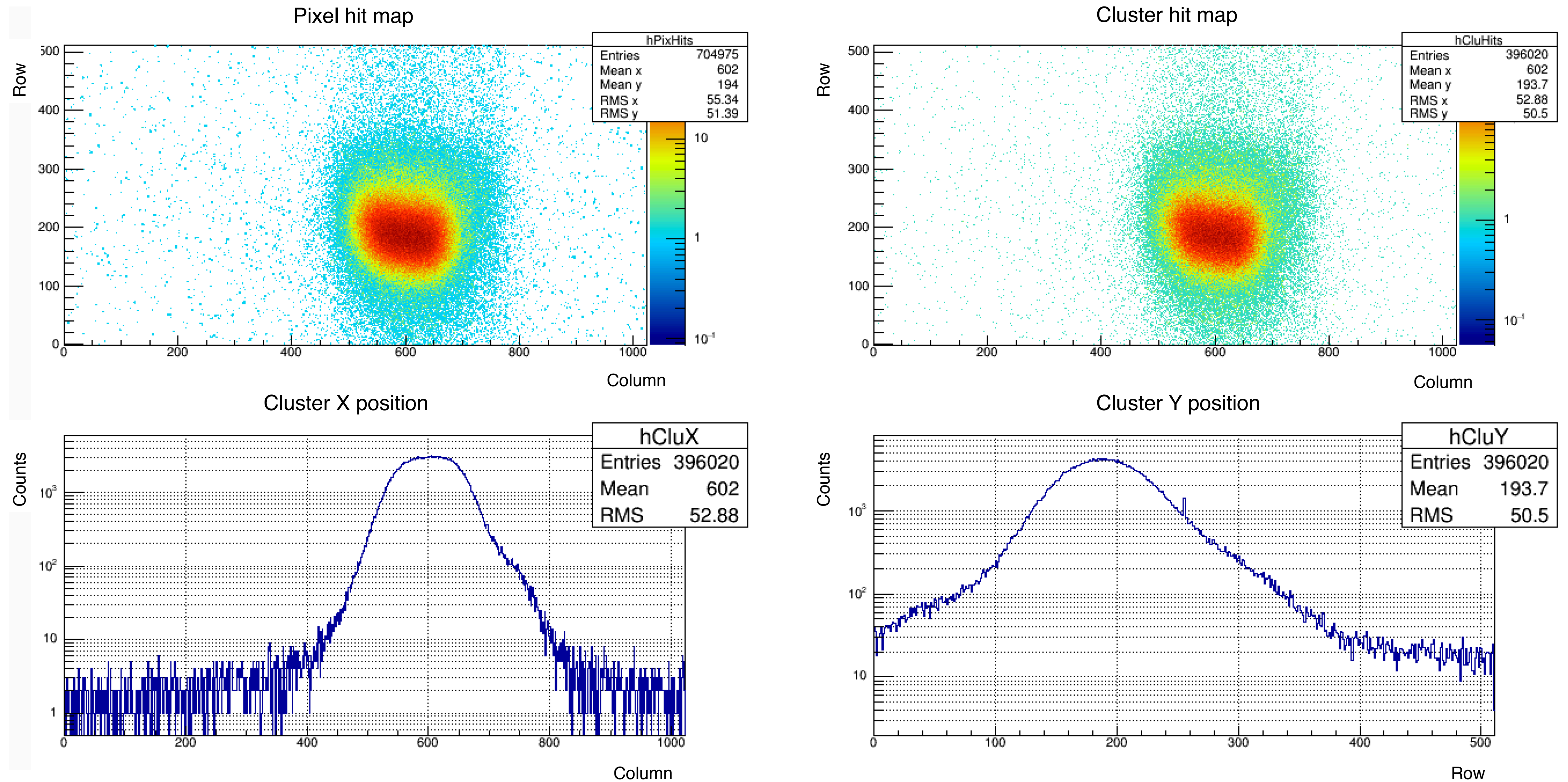
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Problems during the beam test

- Second MIMOSA sensor did not produce any data;
- Up to run 2010: MOSAIC not taking all the triggers at a 50 Hz frequency; acquired data longer than expected;
- CH2: number of triggers received by the MOSAIC;
- CH3: number of triggers counted by the MOSAIC and sent to the MIMOSA;
- Reason: trigger pulse length too short (40 ns);
- For runs 2010-2012: increased to 150 ns: all triggers are acquired;
- Previously (before the run 2010) acquired data is not bad, just the acquisition takes ~ 15% longer.



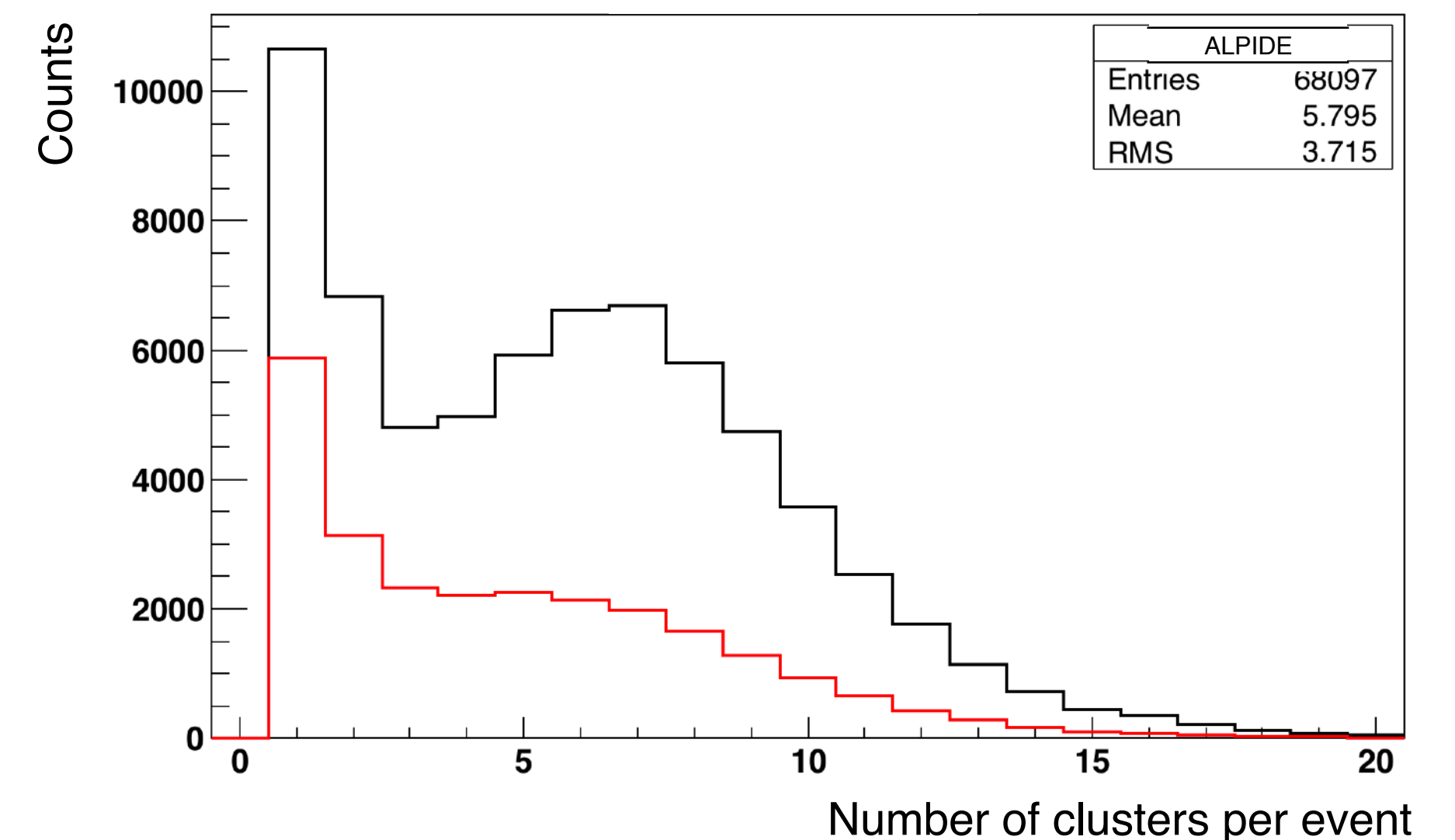
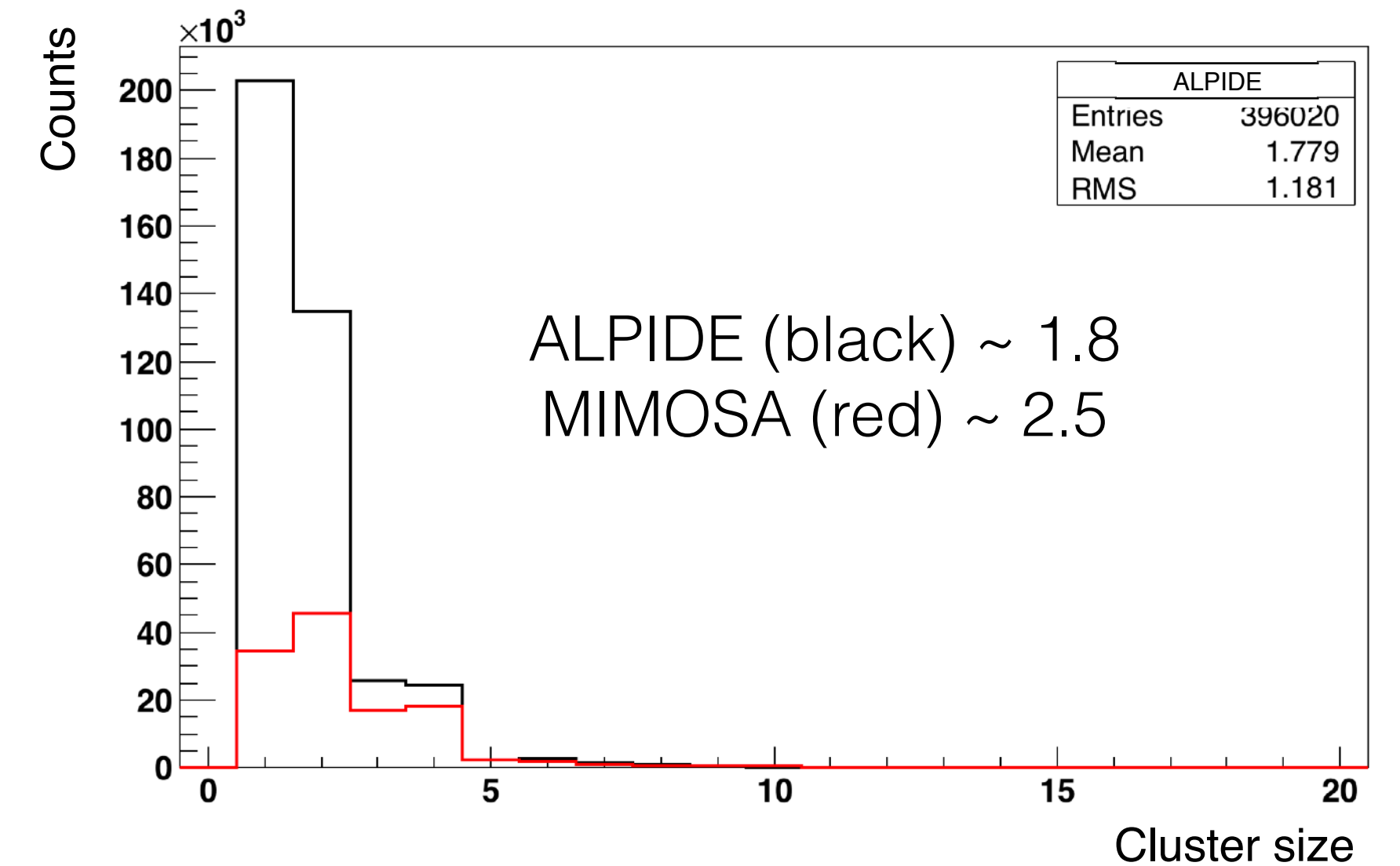
ALPIDE analysis: beam profile



Run 2011: pixel and cluster hit maps (top), cluster X and Y center-of-gravity positions (bottom).

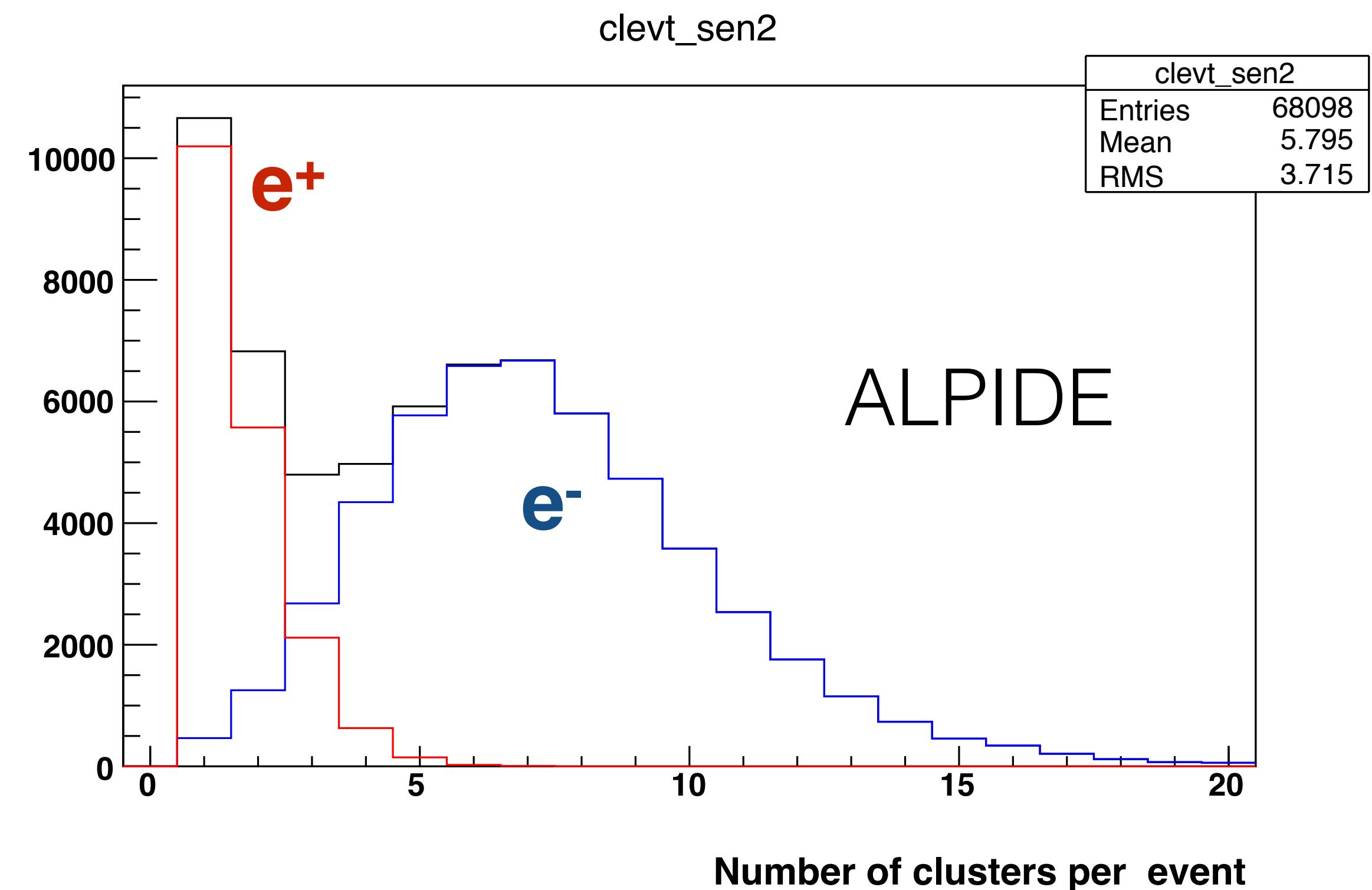
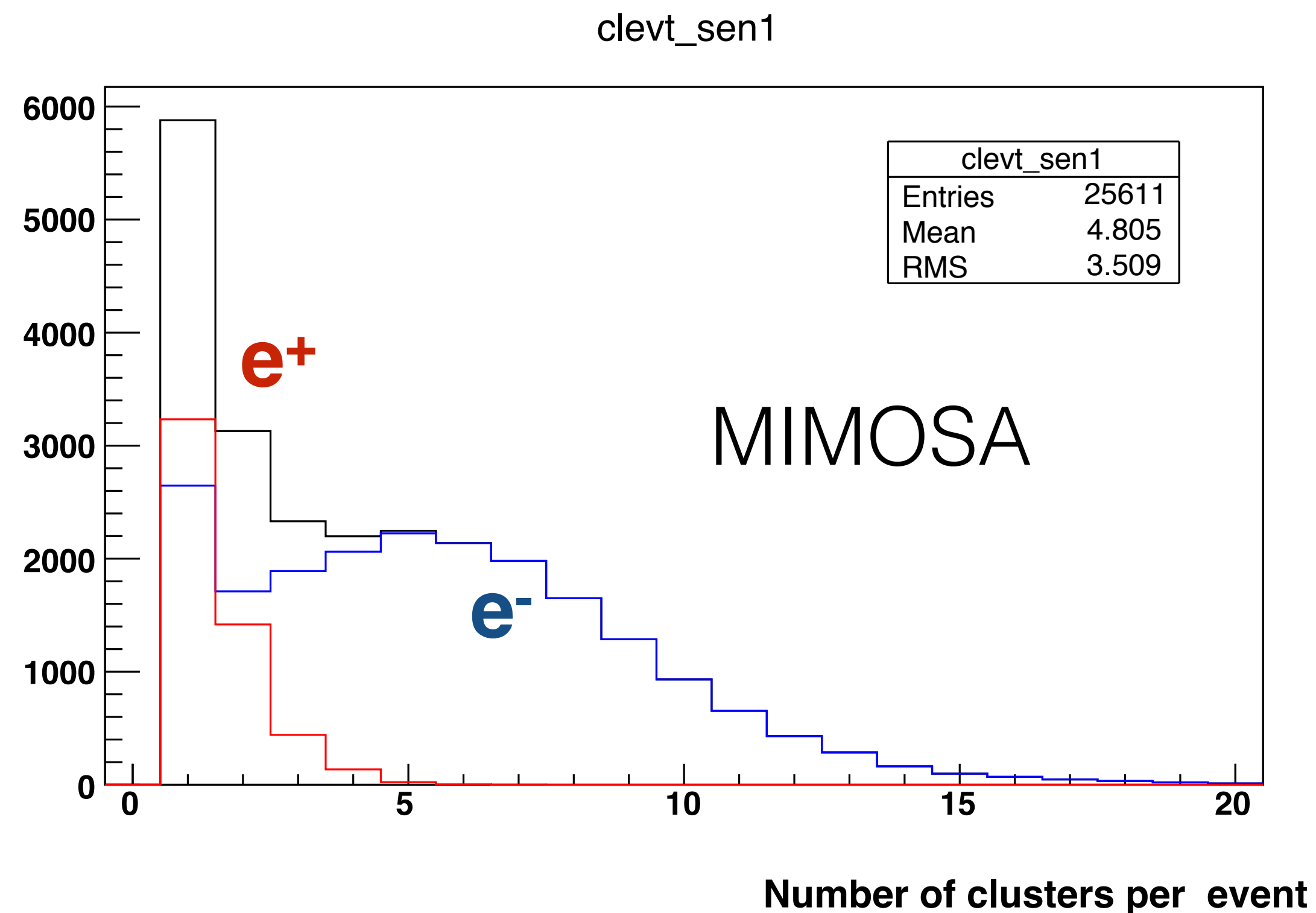
Analysis: clustering (Run 2011)

- Mean cluster size of the ALPIDE is ~ 1.8 , which is less than in the source test (~ 2.5) and previous beam tests (>2); for the moment, the reason is not clear;
- Mean cluster size of MIMOSA is ~ 2.5 ;
- MIMOSA: total number of clusters ~ 3 times less than those of ALPIDE;
- Number of clusters per event depend on the bunch multiplicity: 1-3 for the positron beam, 5-15 for the electron one;
- MIMOSA: less clusters per event.



Analysis: clustering (Run 2011)

- Number of clusters per event depend on the bunch multiplicity:
1-3 for the positron beam, 5-15 for the electron one;



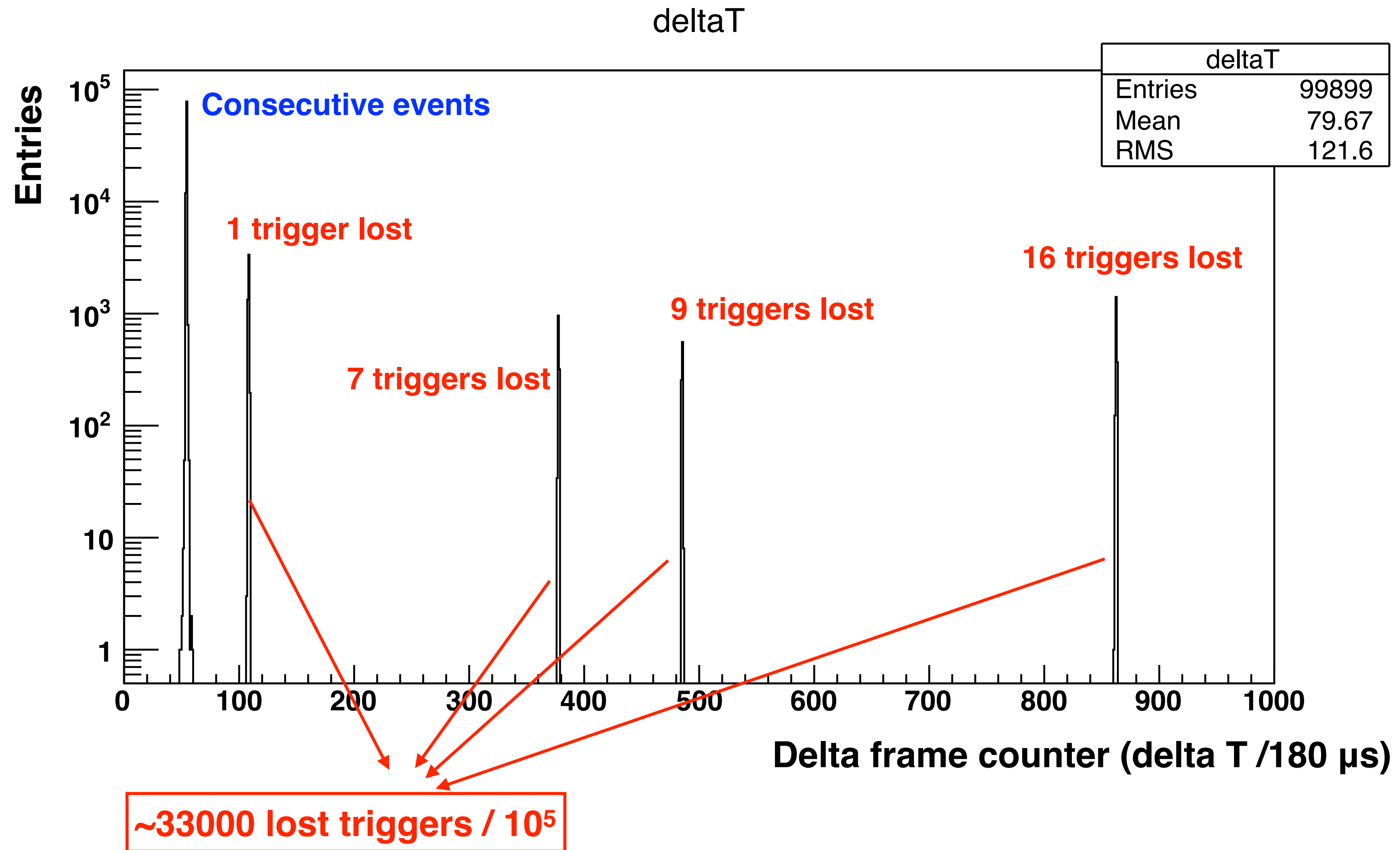
Analysis: clustering (Run 2011)

- At the beginning we were convinced that MIMOSA is loosing some data due to task switching of the operating system;
- To handle this, MIMOSA frame counter was used;
- According to frame counter, MIMOSA was supposed to lose 1/3 of events;
- However, MIMOSA DAQ registered > 99 % of events;
- Frame counter became non-trustable.

220551	220552	220553
220605	220606	220607
220658	220659	220660
220712	220713	220714
220766	220767	220768
220820	220821	220822
220874	220875	220876
220928	220929	220930
220982	220983	220984
221036	221037	221038
221090	221091	221092
221144	221145	221146

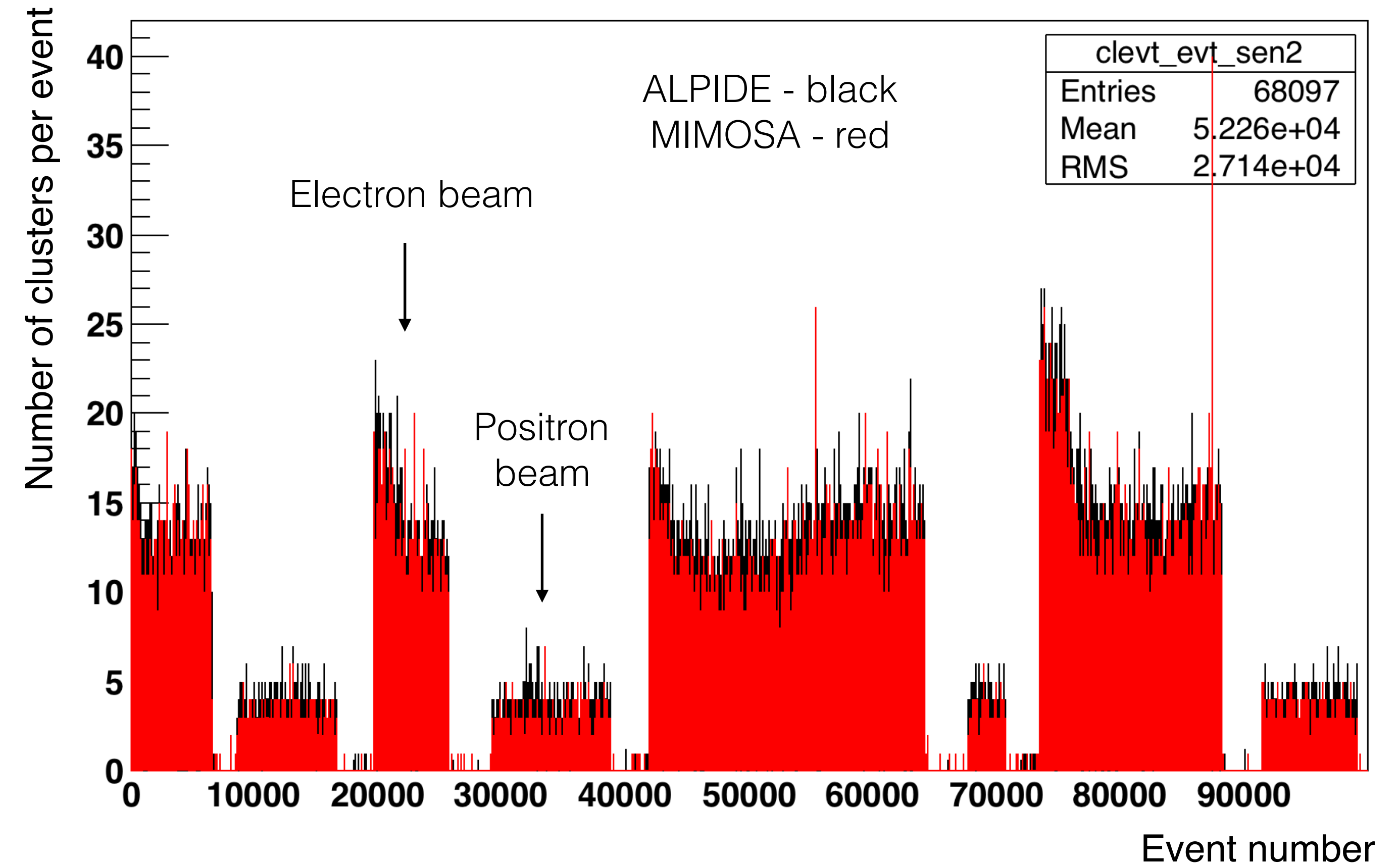
MIMOSA frame counter (in 180 μ s units)

Analysis: clustering (Run 2011)



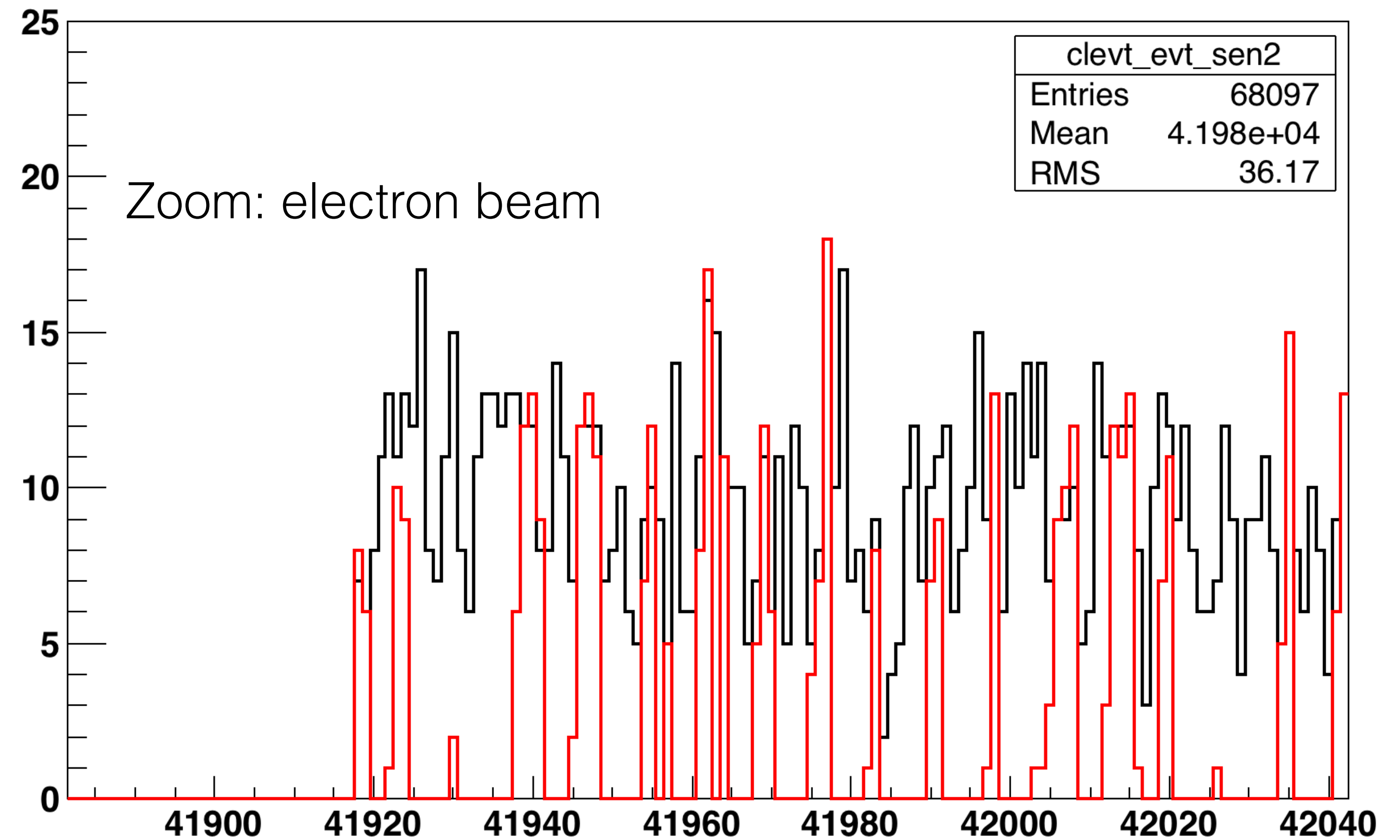
Correlations: number of clusters as a function of the event

- Run 2011;
- Number of clusters as a function of the event → seems that data collected properly;
- Electron and positron beams easily recognizable;



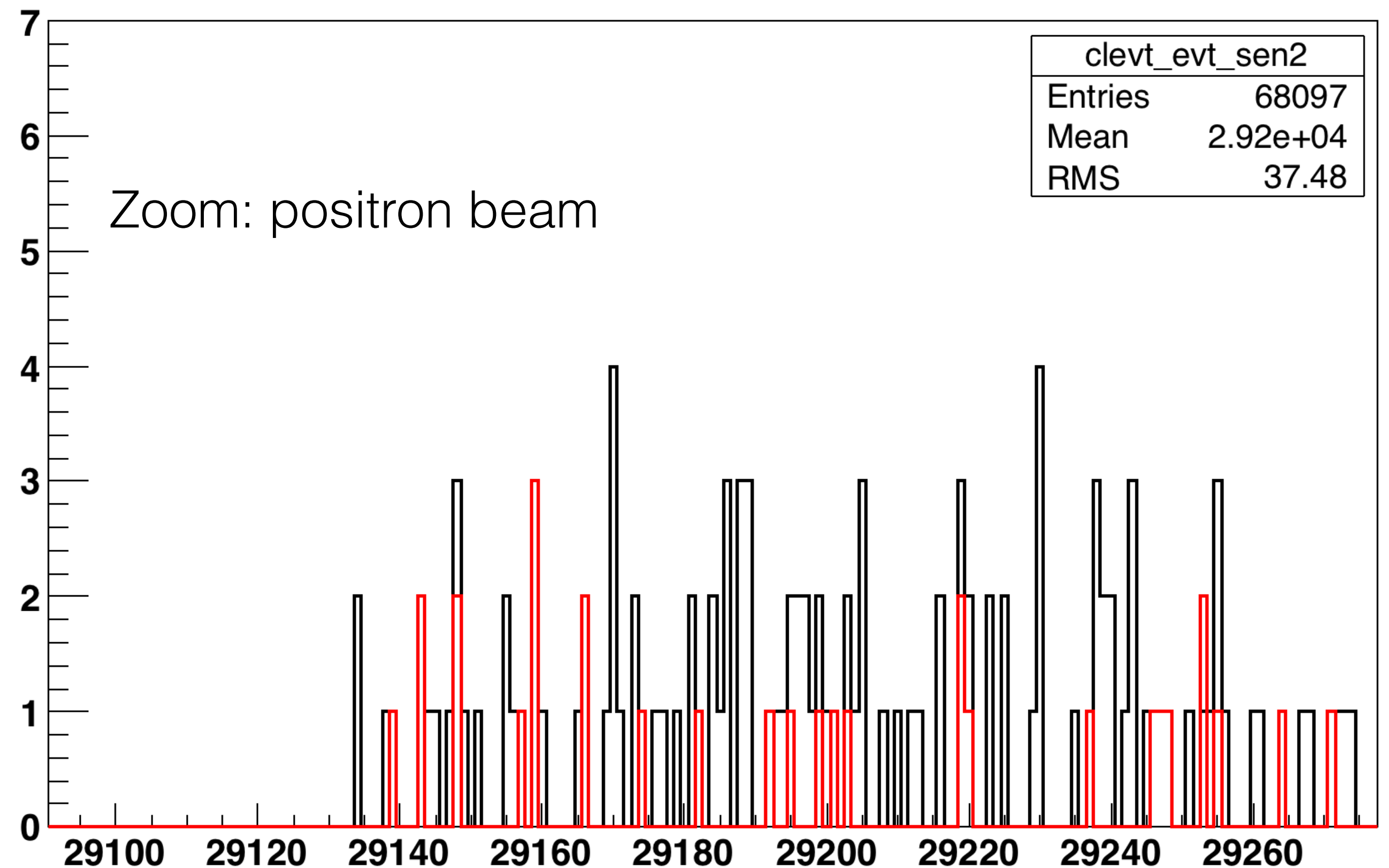
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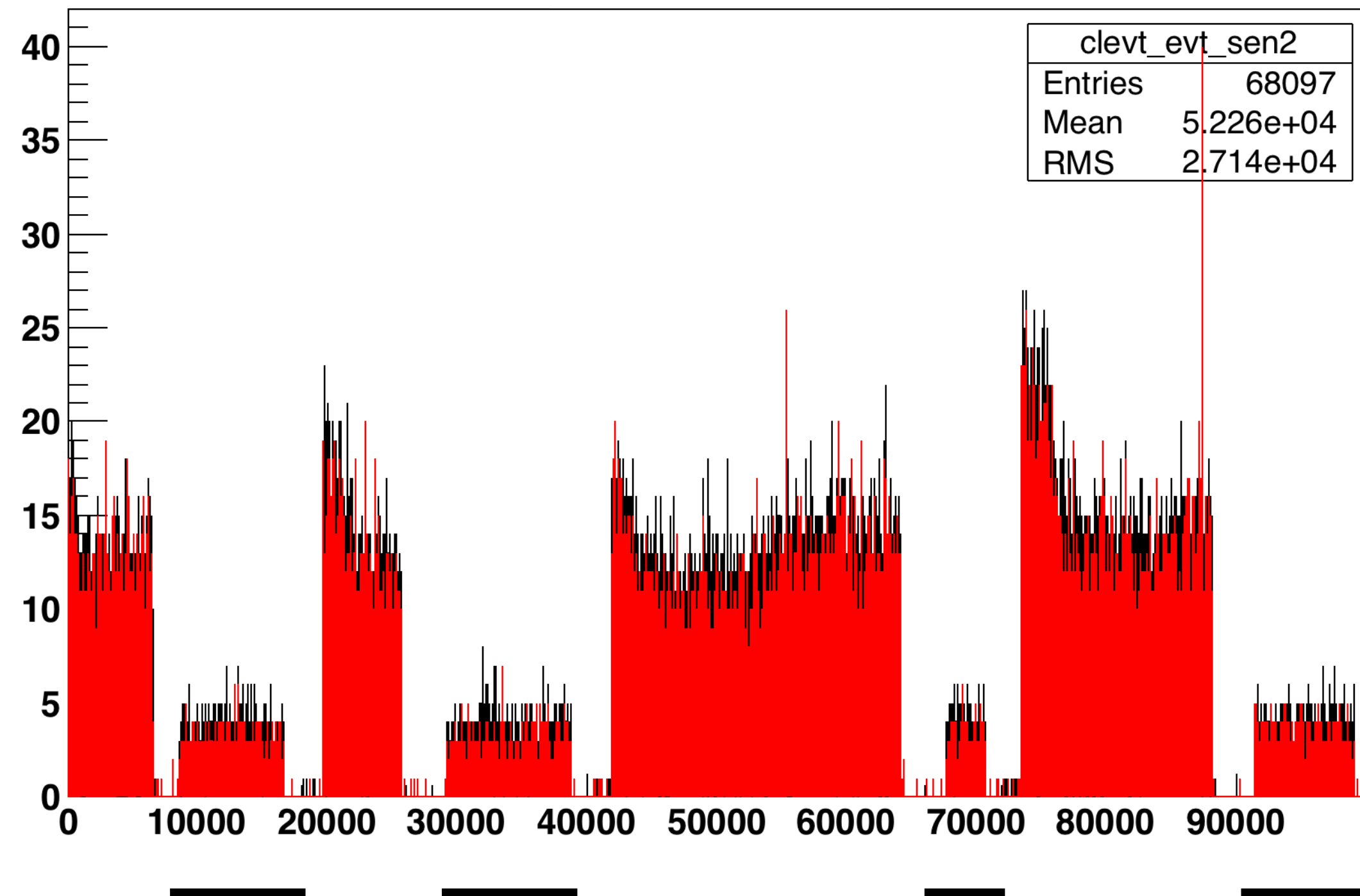


Correlations: number of clusters as a function of the event

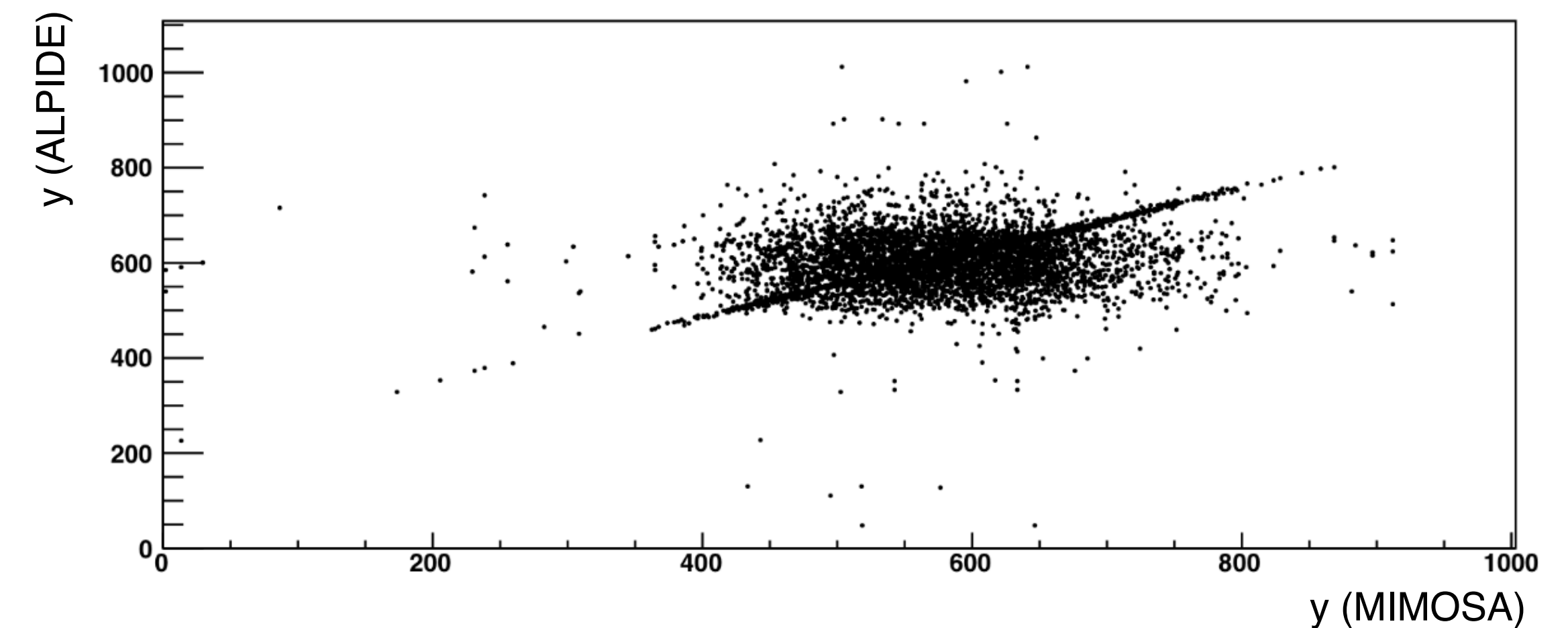
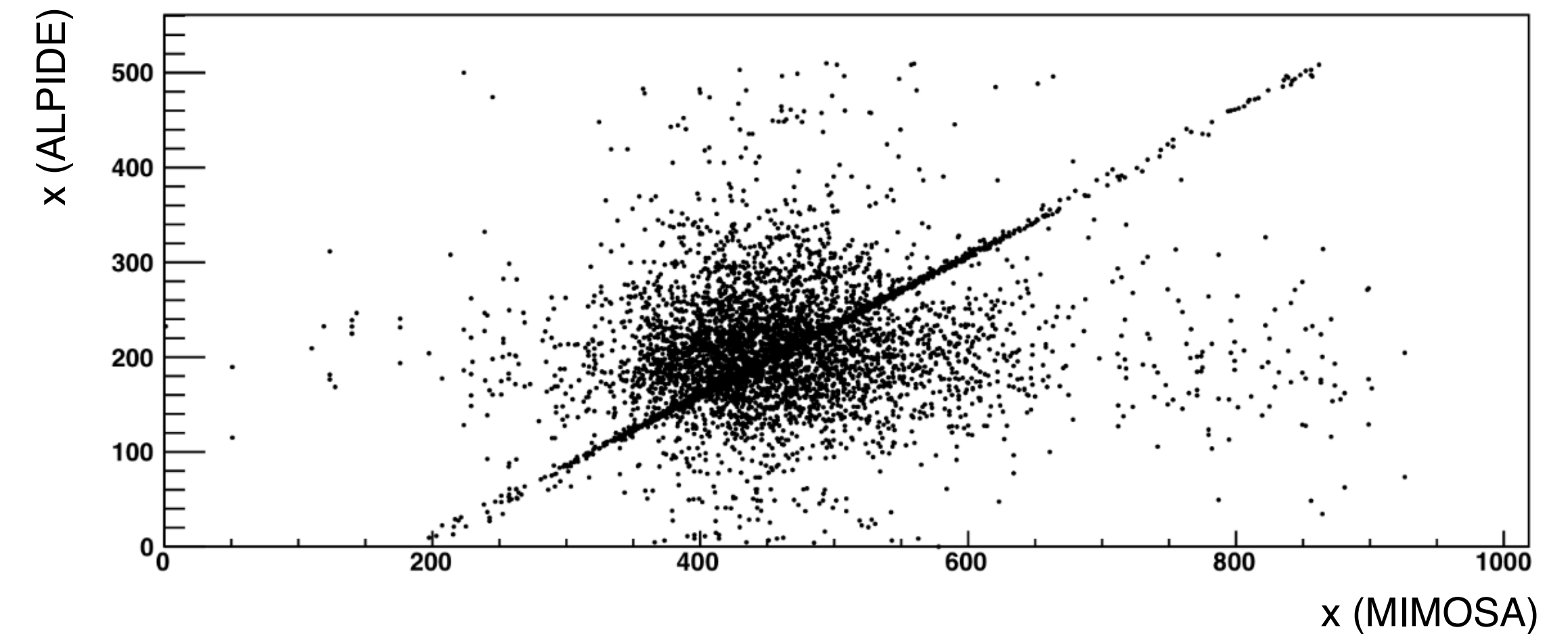
- Run 2011;
- Number of clusters as a function of the event → seems that data collected properly;
- Electron and positron beams easily recognizable;
- Eleuterio suggested to select the events with positrons having cluster size > 1 to minimize the number of clusters in the event;



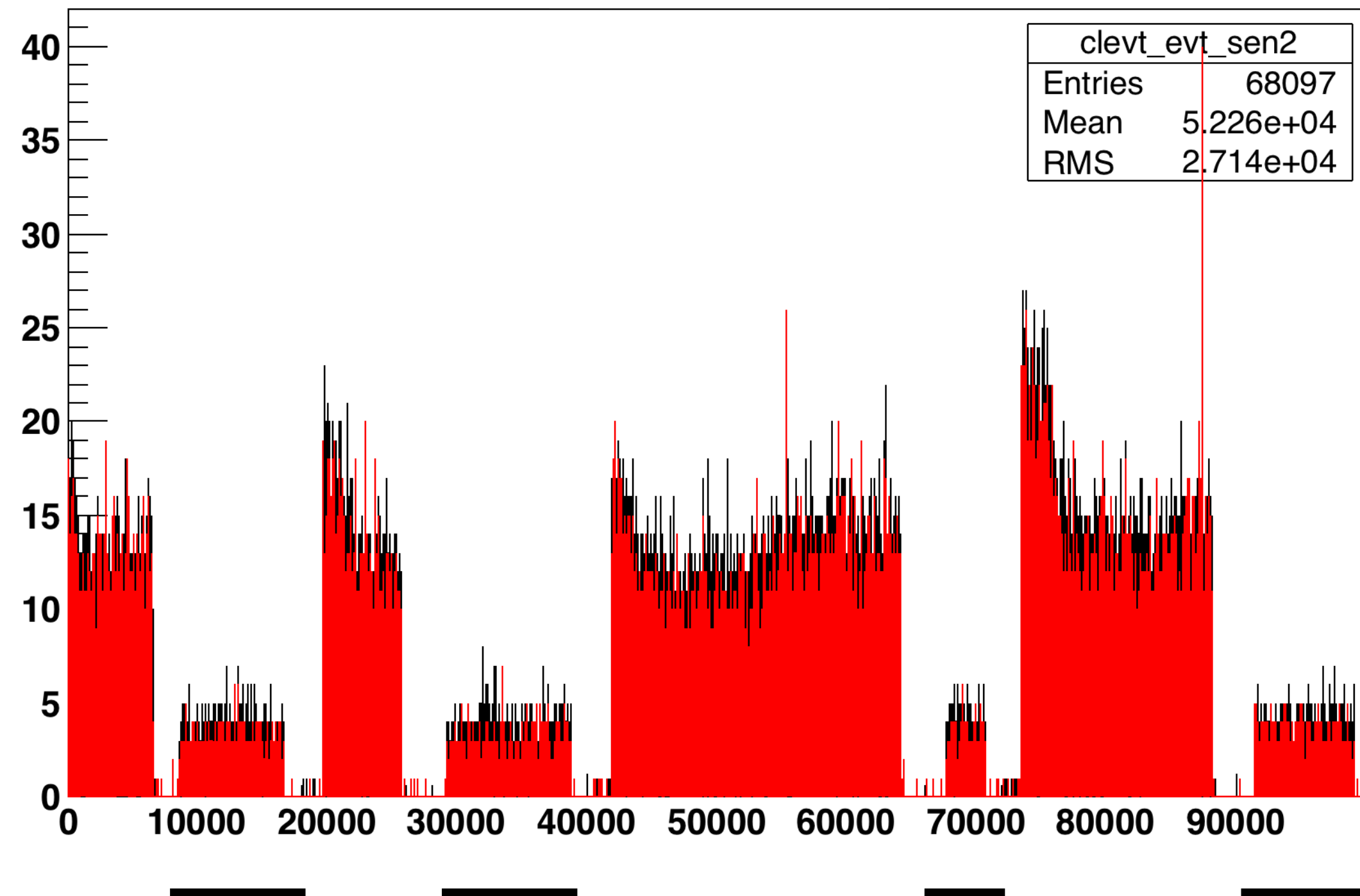
Correlation analysis: positron data



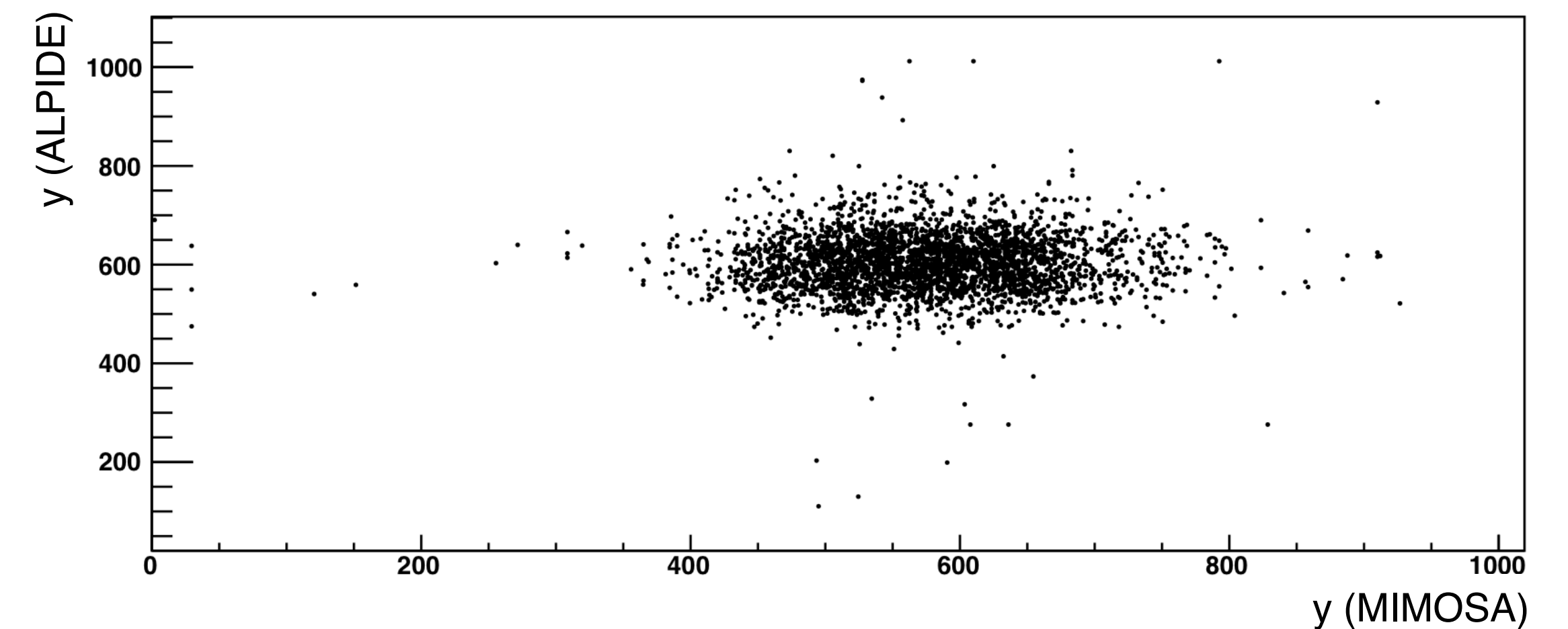
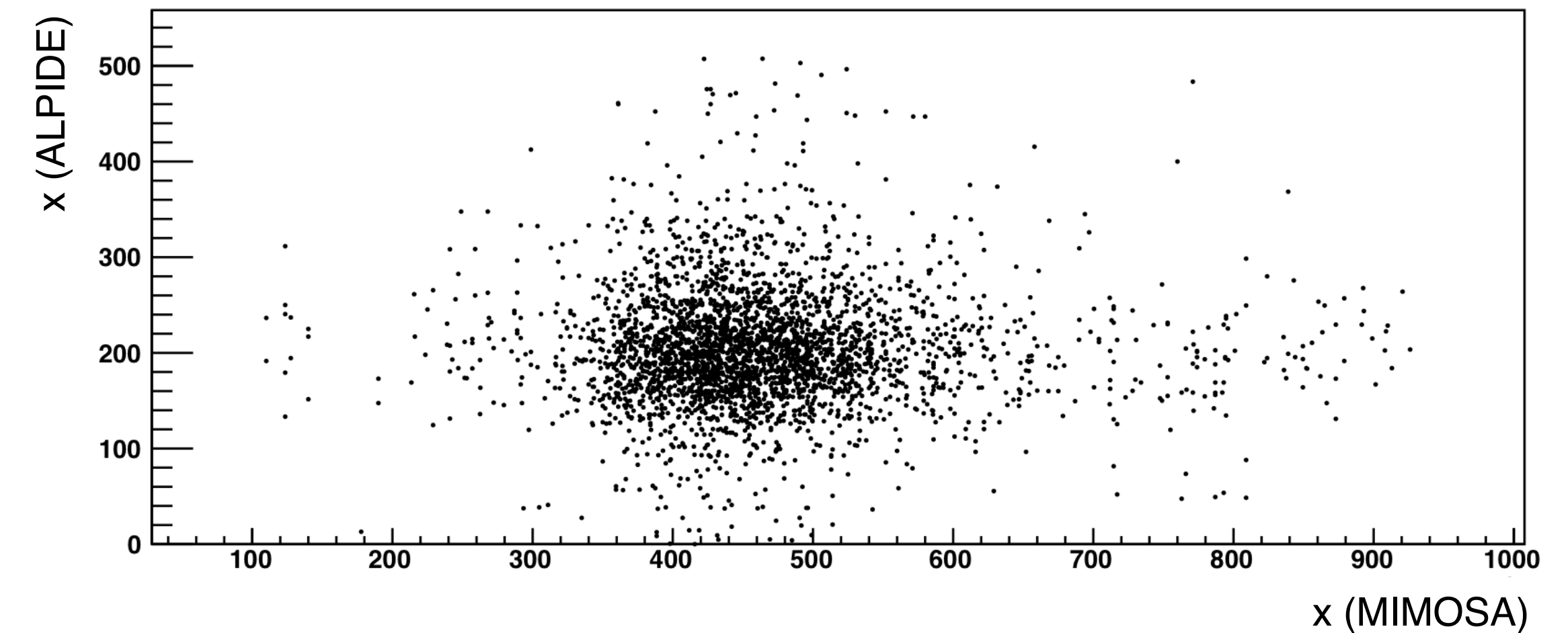
- Data selected: all regions with positron beam;
- Events with cluster size > 1 ;
- Correlated cluster positions along the straight line.



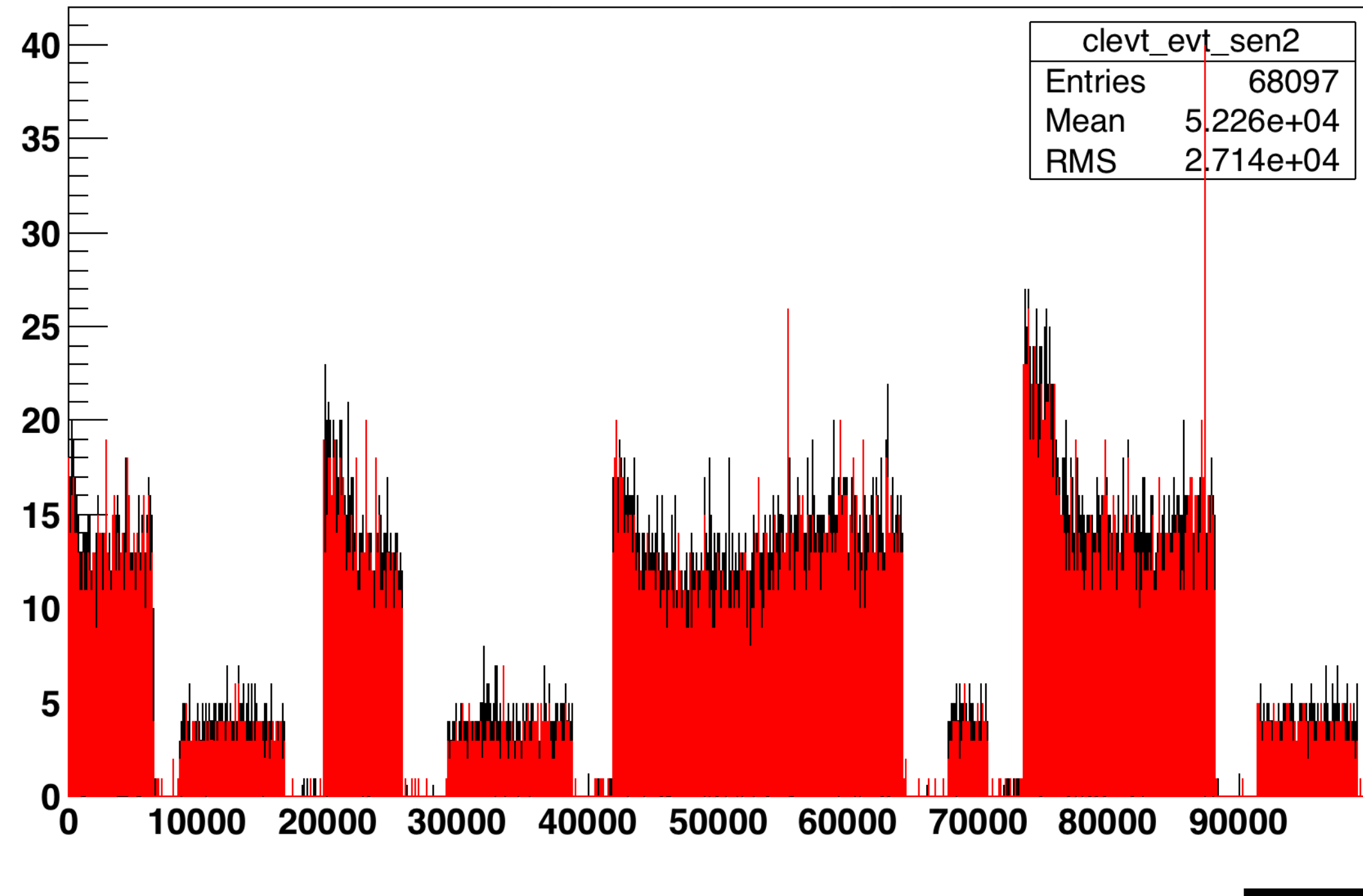
Correlation analysis: positron data



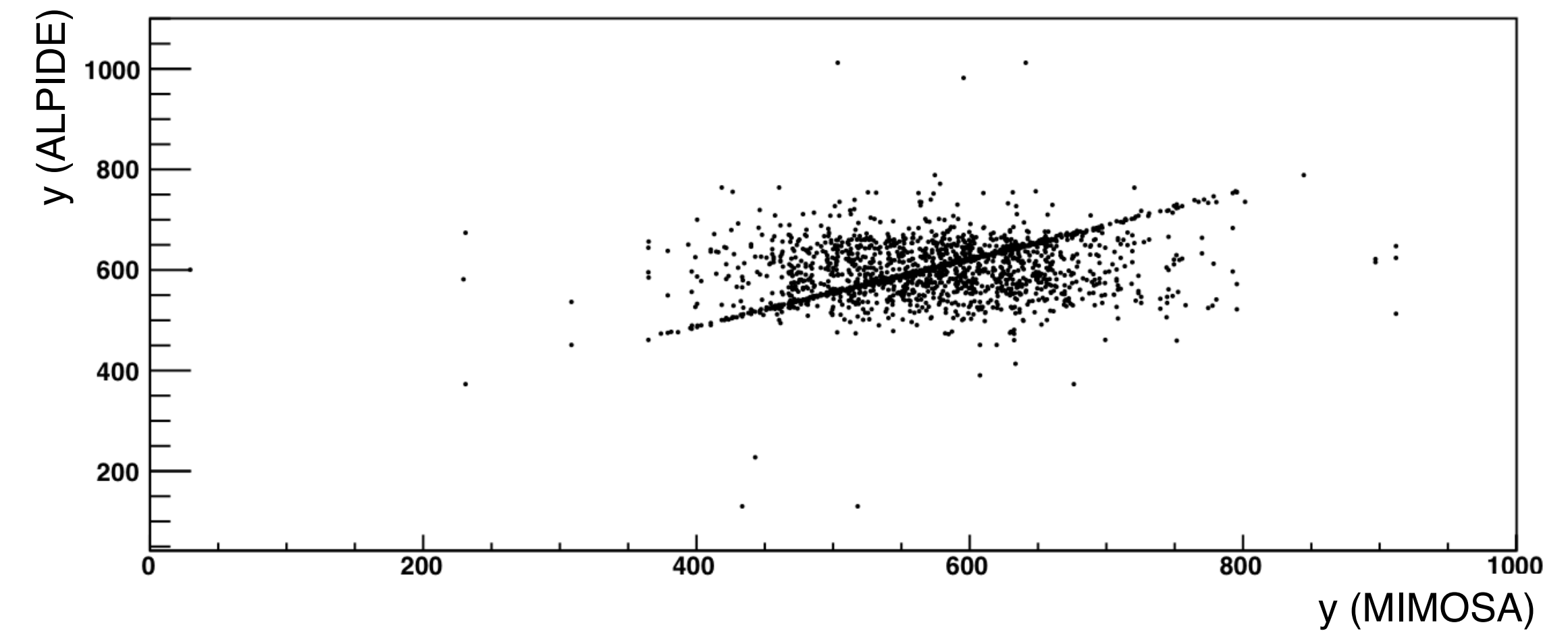
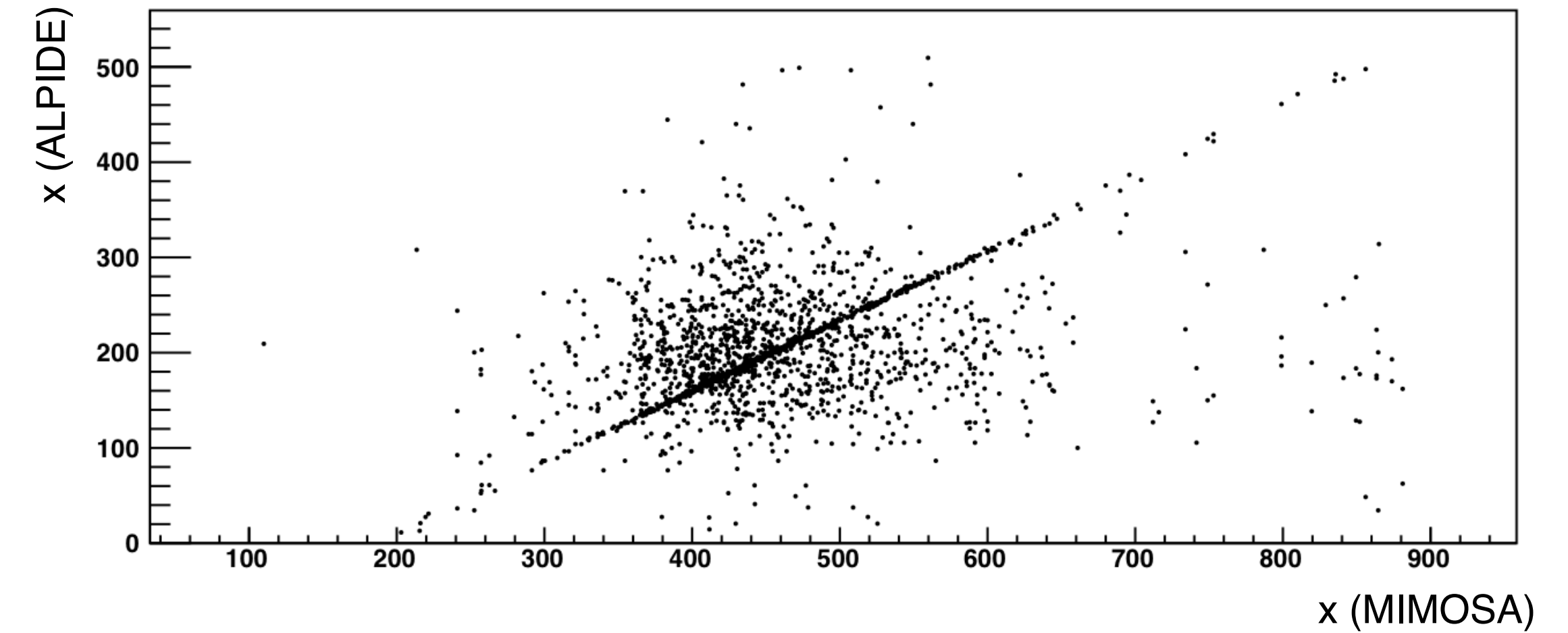
- Data selected: all regions with positron beam;
- Events with cluster size > 1 ;
- One data set (MIMOSA) is shifted by 1 event artificially from the beginning \rightarrow correlation lost completely.



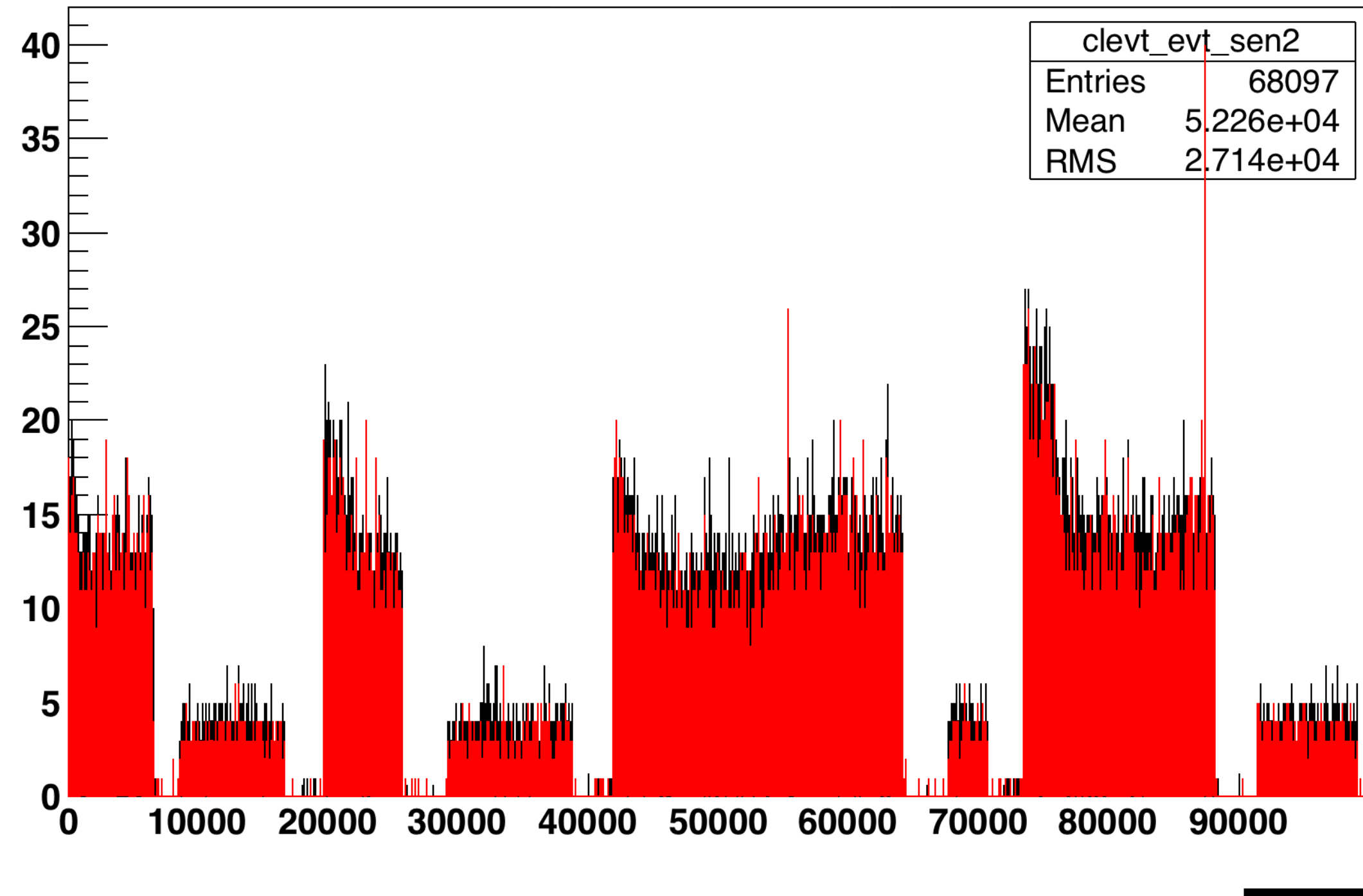
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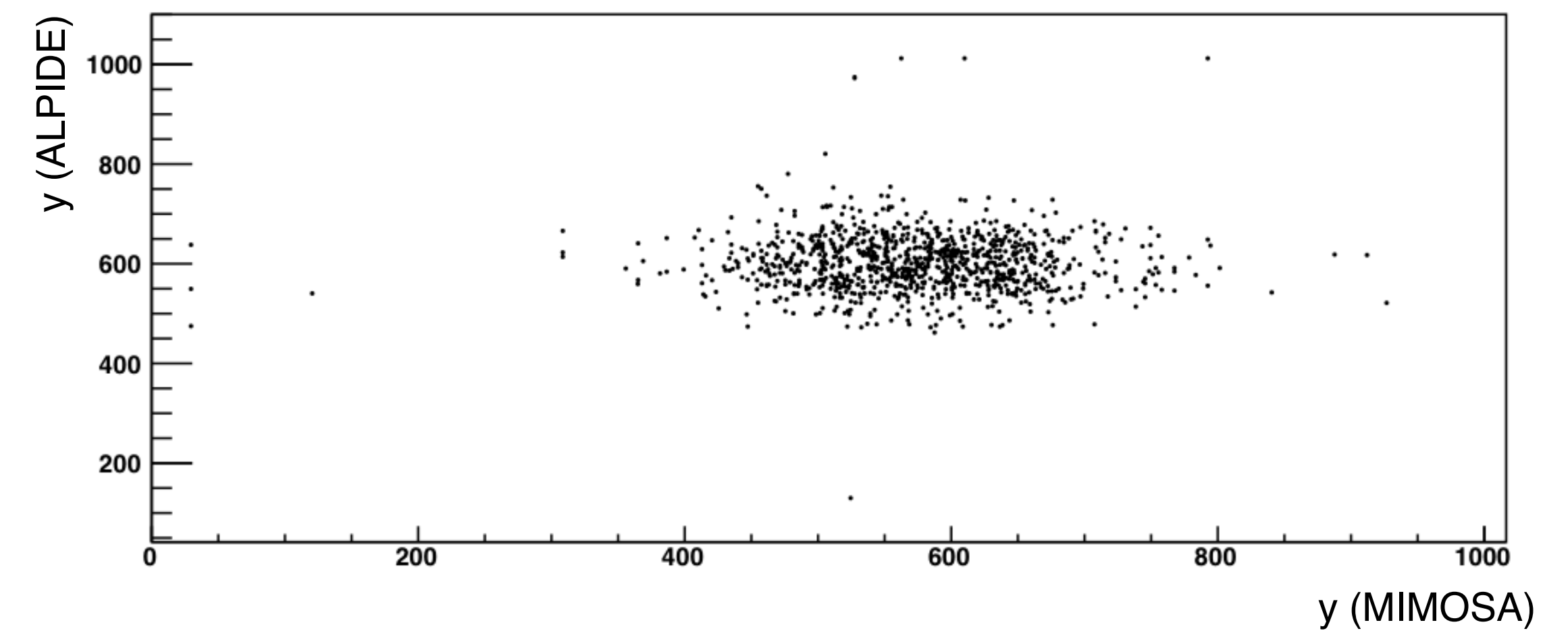
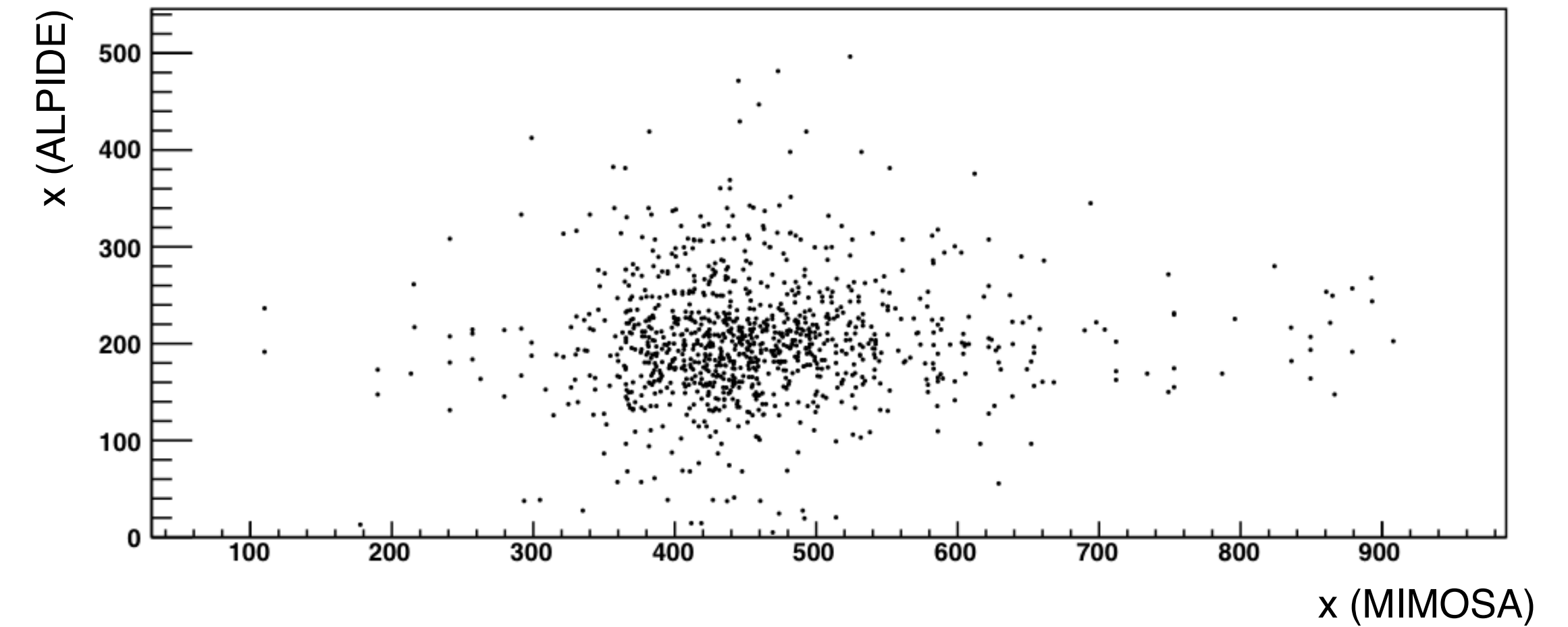
- Latest positron region selected;
- Events with cluster size > 1 ;
- Correlations are present until the end of the run.



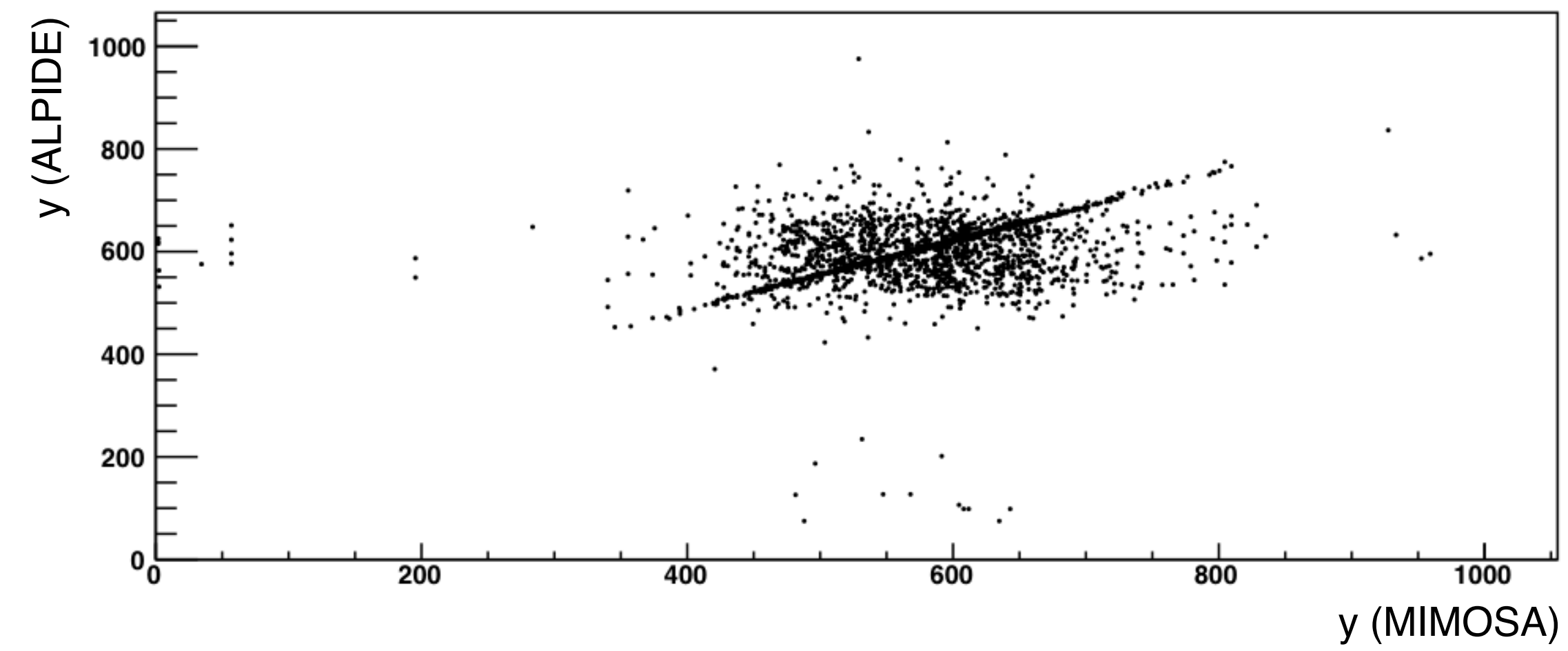
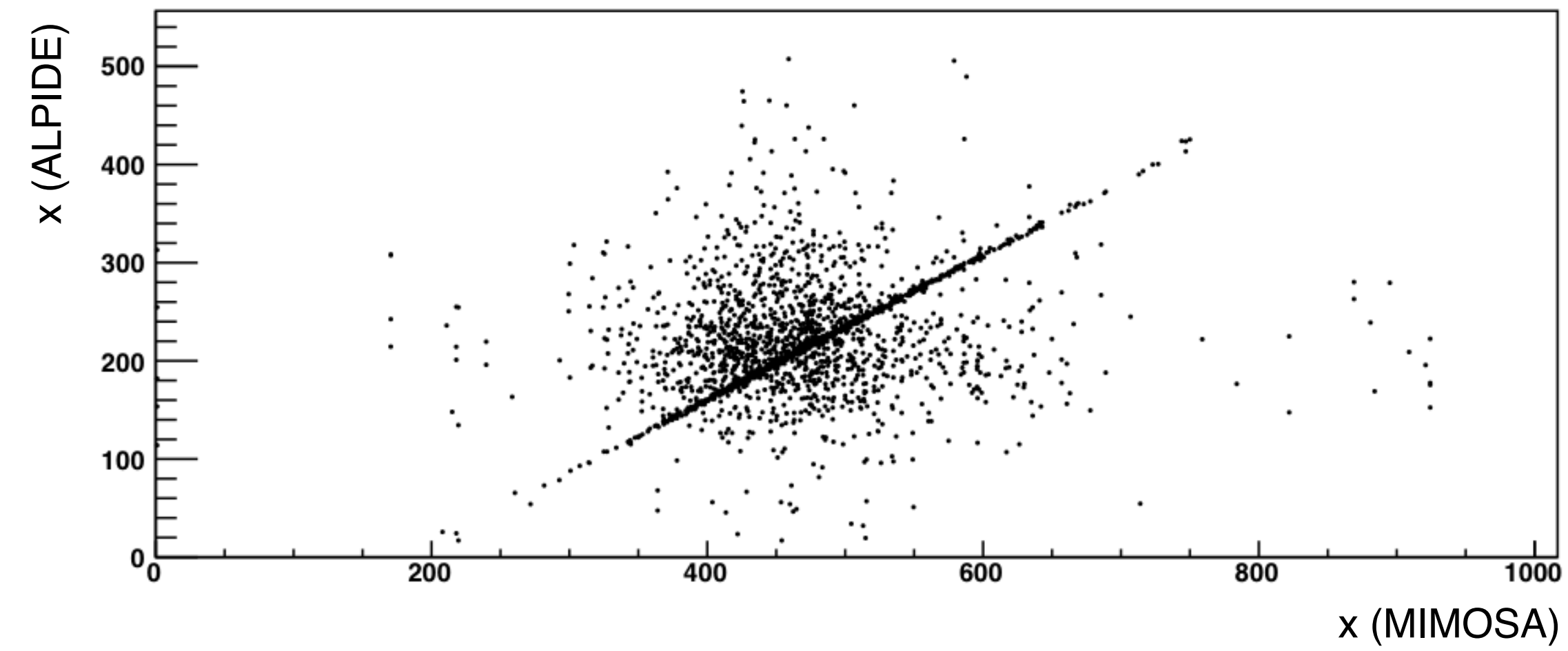
Correlation analysis: positron data



- Latest positron region selected;
- Events with cluster size > 1 ;
- Data set shifted \rightarrow no correlation.

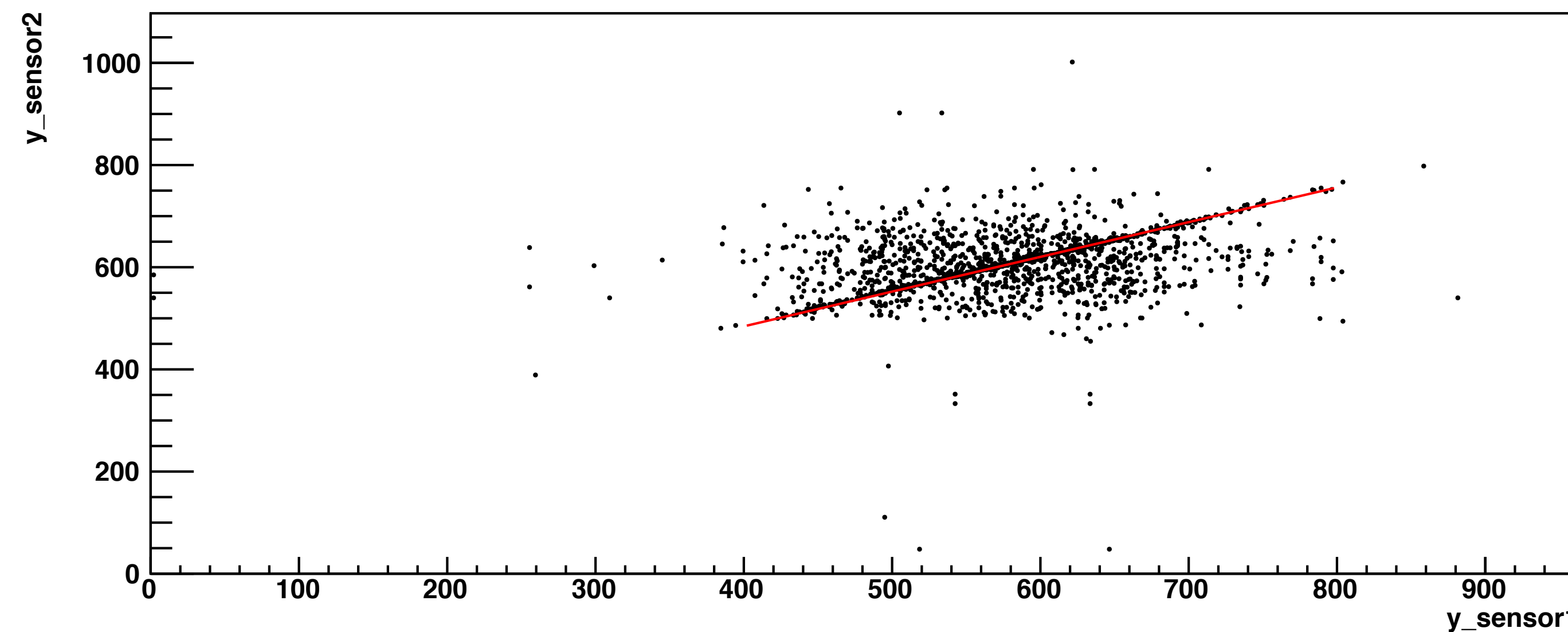
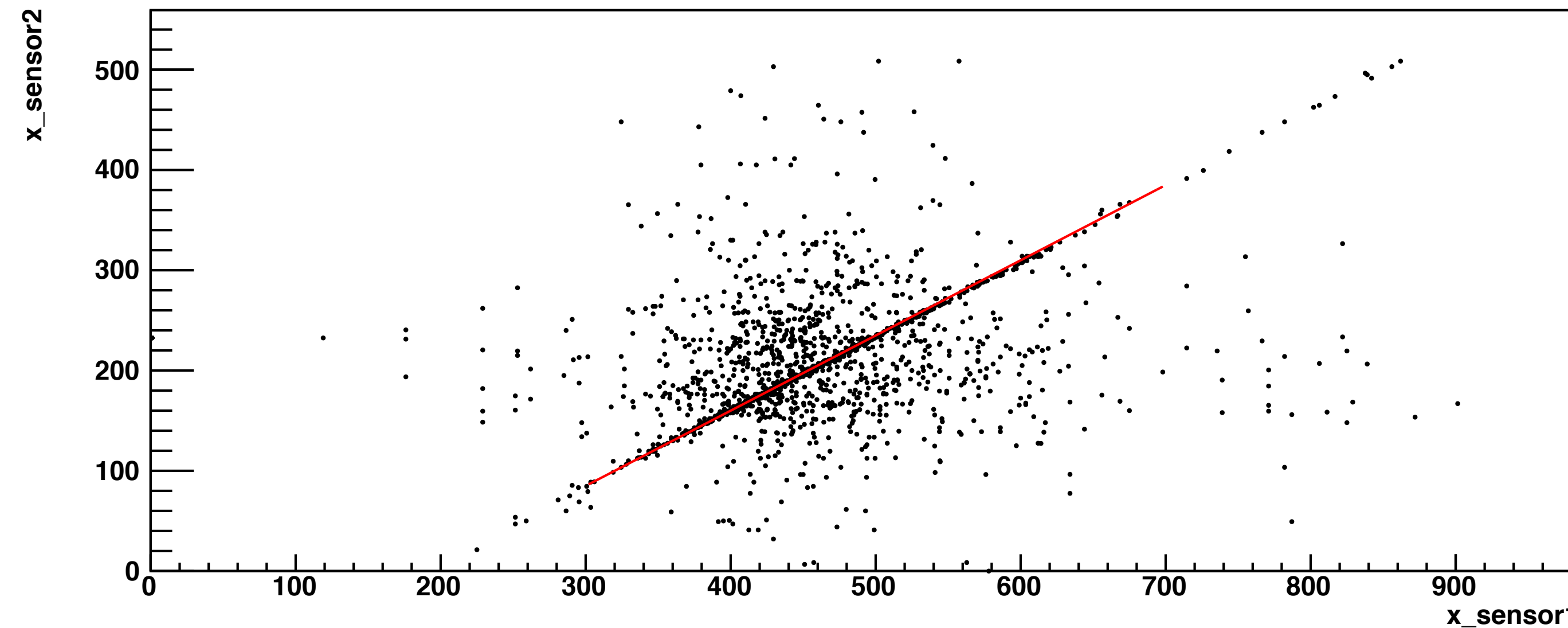


Cross check: run 2004 data

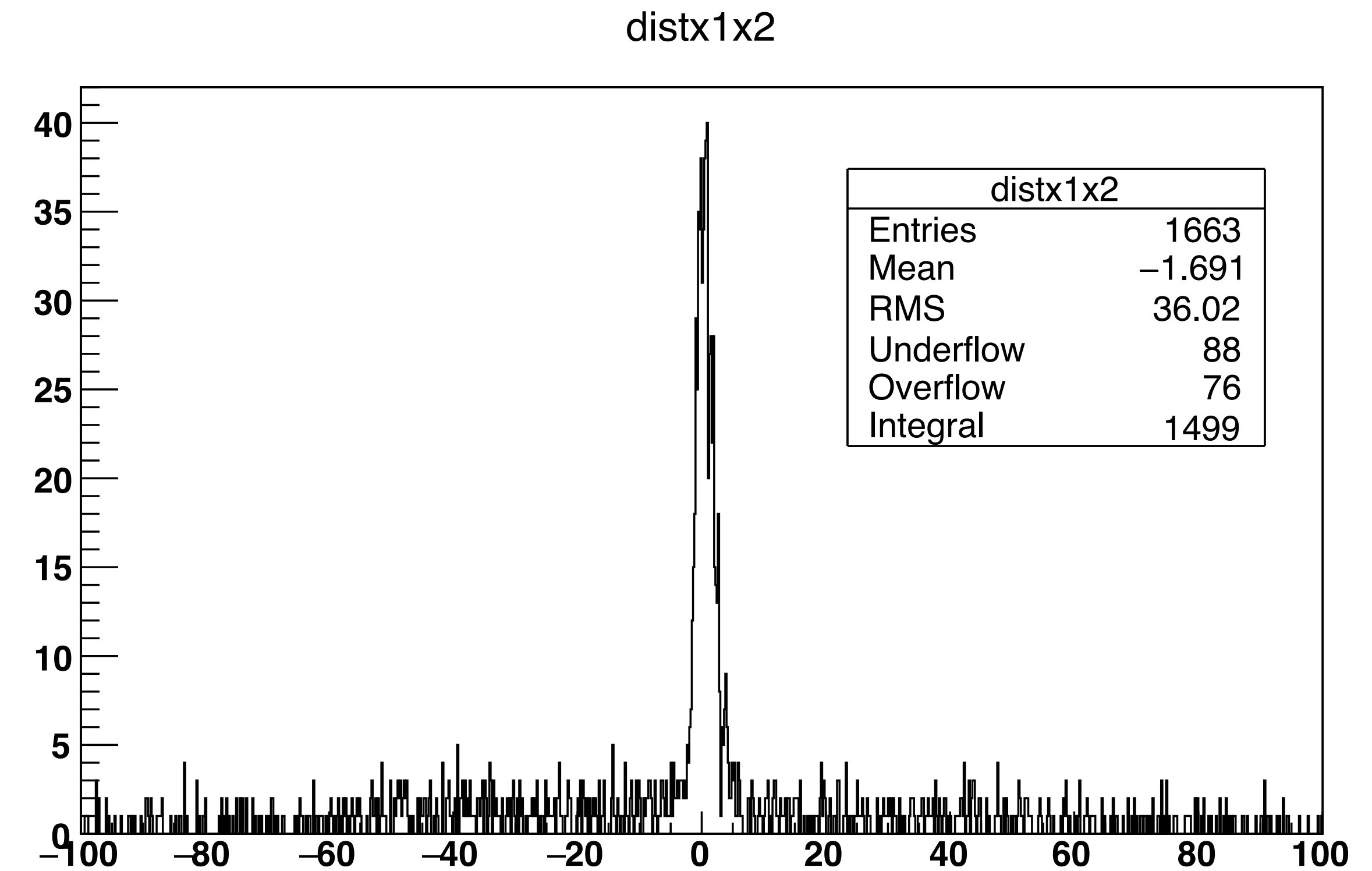
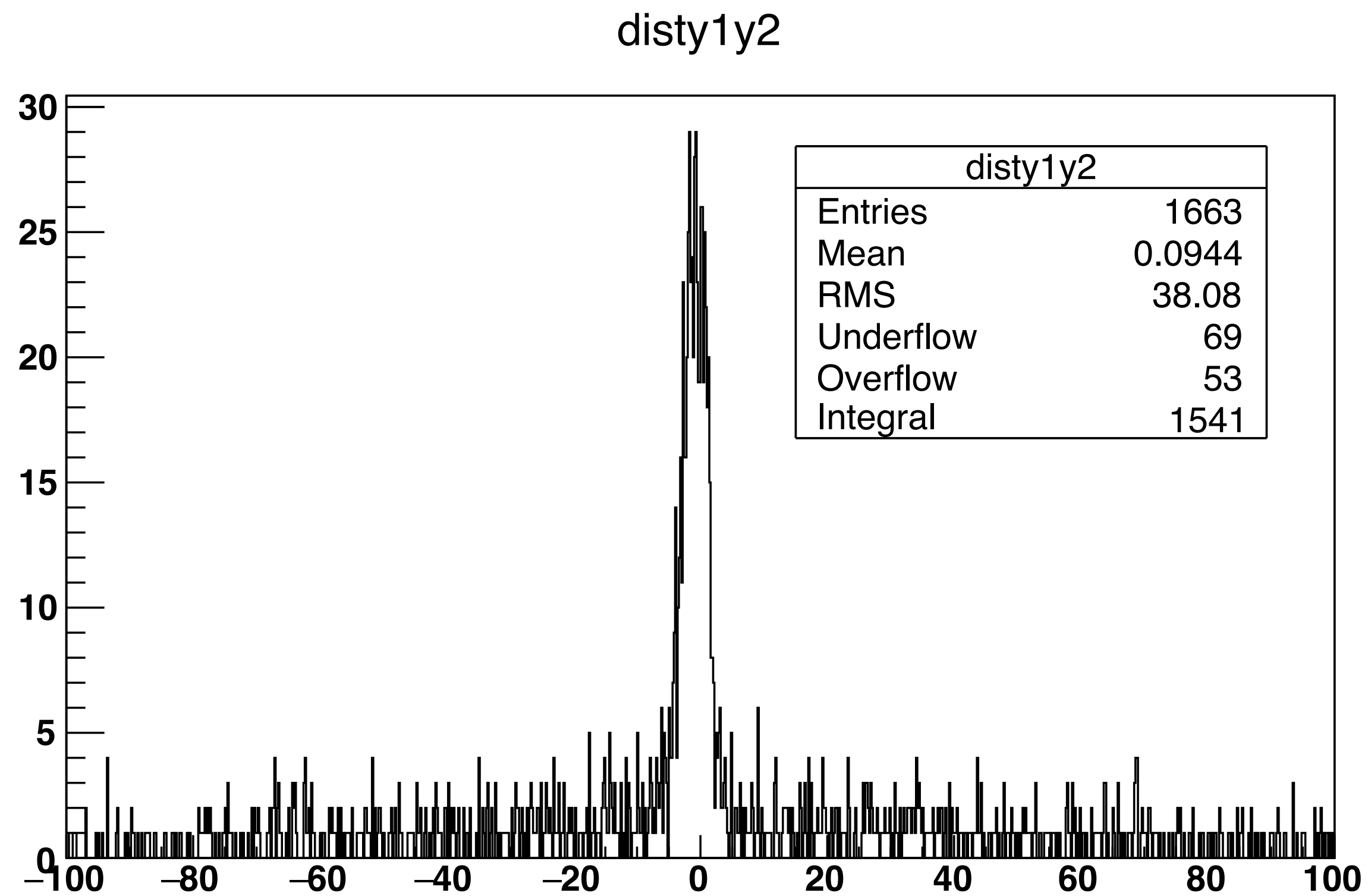


Selecting correlated events (Run 2011), first region e^+

A fit to the correlated events has been done in order to select and count them



Selecting correlated events (Run 2011): first region e^+



Distributions of the distances of all the points in the correlation plots with respect to the fitted line

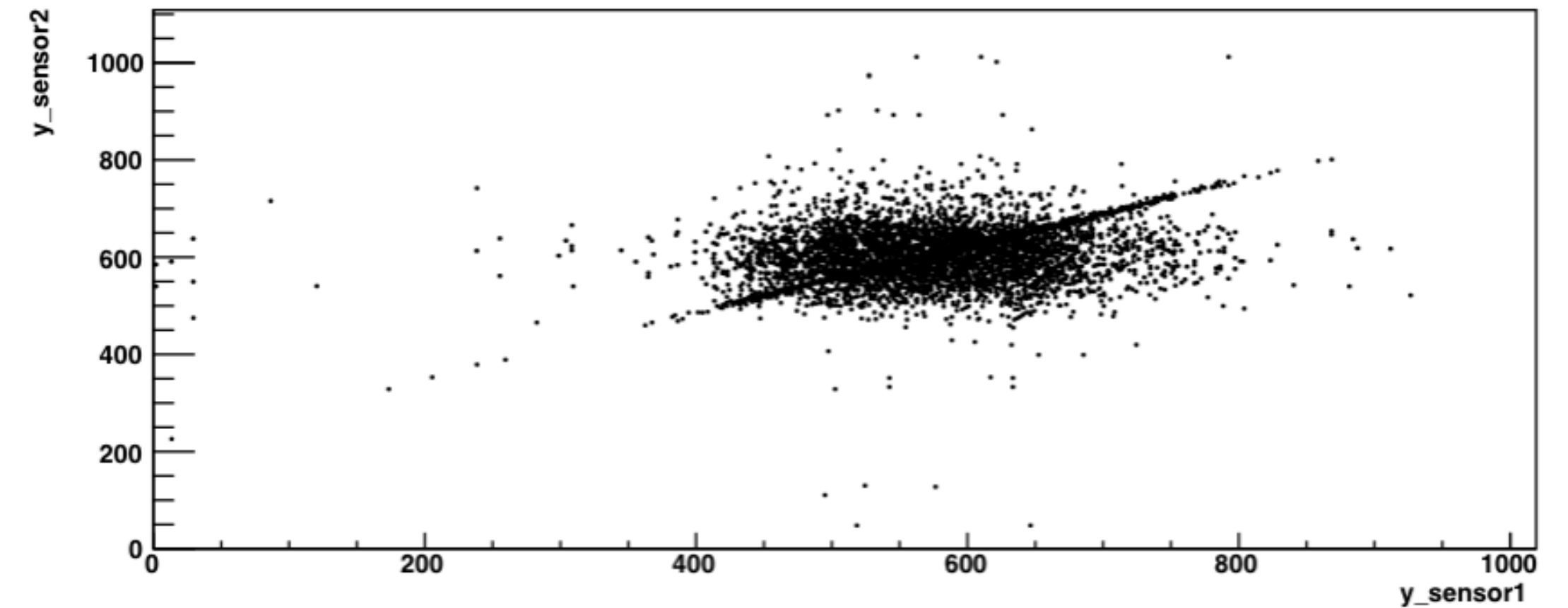
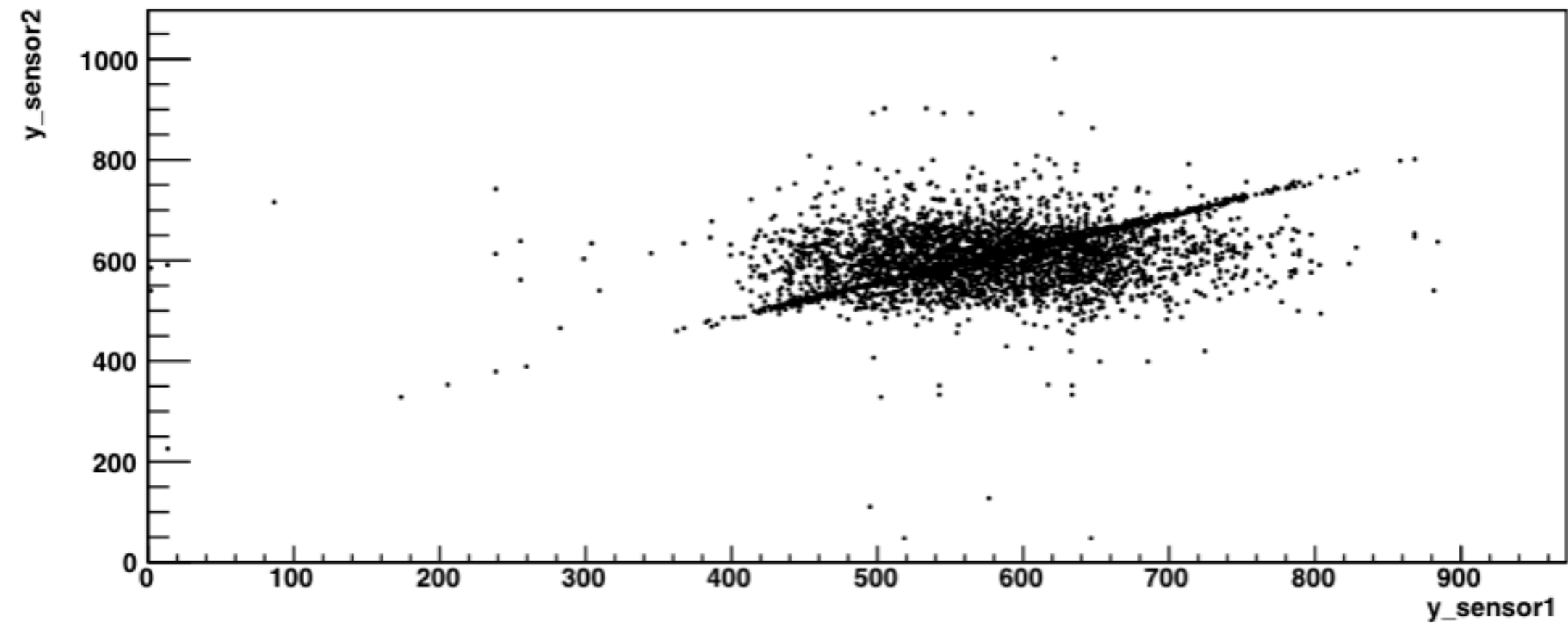
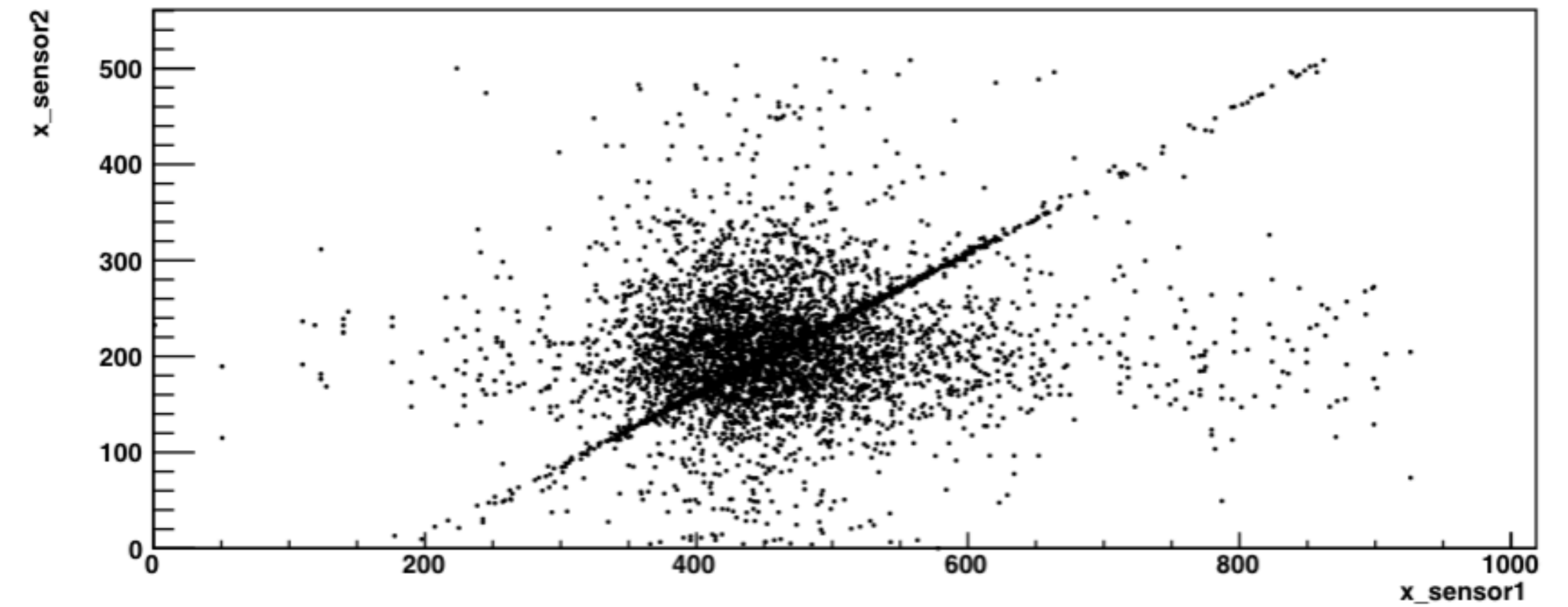
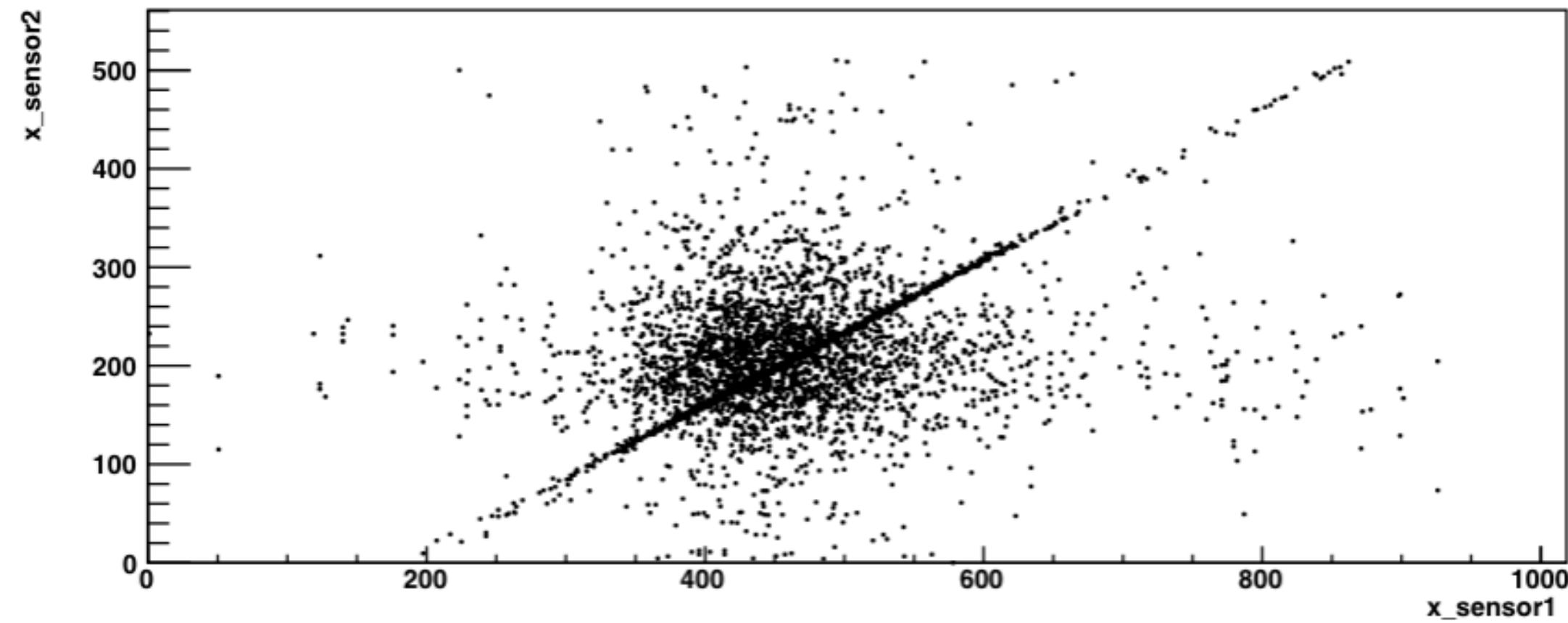
Summary

- Beam test performed with an ALPIDE and a MIMOSA sensors;
- Collected data seems to be good and useful;
- Beam spot well centered, amount of data collected well enough;
- Synchronization of the DAQ worked well: events are synchronized (in time) without the timing information;
- Correlated cluster positions are observed: perpendicular tracks;
- Further analysis can be done: tracking (search of the non-perpendicular tracks);
- Detection efficiency: too small system, also the detection efficiency of MIMOSA is unknown.

Backup: run stats (ALPIDE)

Run number	Cluster X RMS	Cluster Y RMS	Mean cluster size	# of events with hits
2000	62.17	86.37	1.729	721
2001	61.03	51.56	1.697	9638
2002	58.69	51.56	1.686	9869
2003	52.02	43.94	1.685	9882
2004	52.22	46.34	1.684	63921
2005	52.64	45.77	1.697	47137
2006	57.67	55.54	1.706	55764
2007	56.98	54.18	1.702	46467
2008	58.22	55.99	1.743	4717
2009	53.01	49.82	1.759	55603
2010	59.36	61.88	1.773	22670
2011	52.88	50.5	1.78	68098
2012	53.13	50.58	1.789	26549

Correlations with and without shift in the last events



first 3 positron regions

first 3 positron regions + last shifted