VMM3 test beam results

RD51 mini week 14.12.2017

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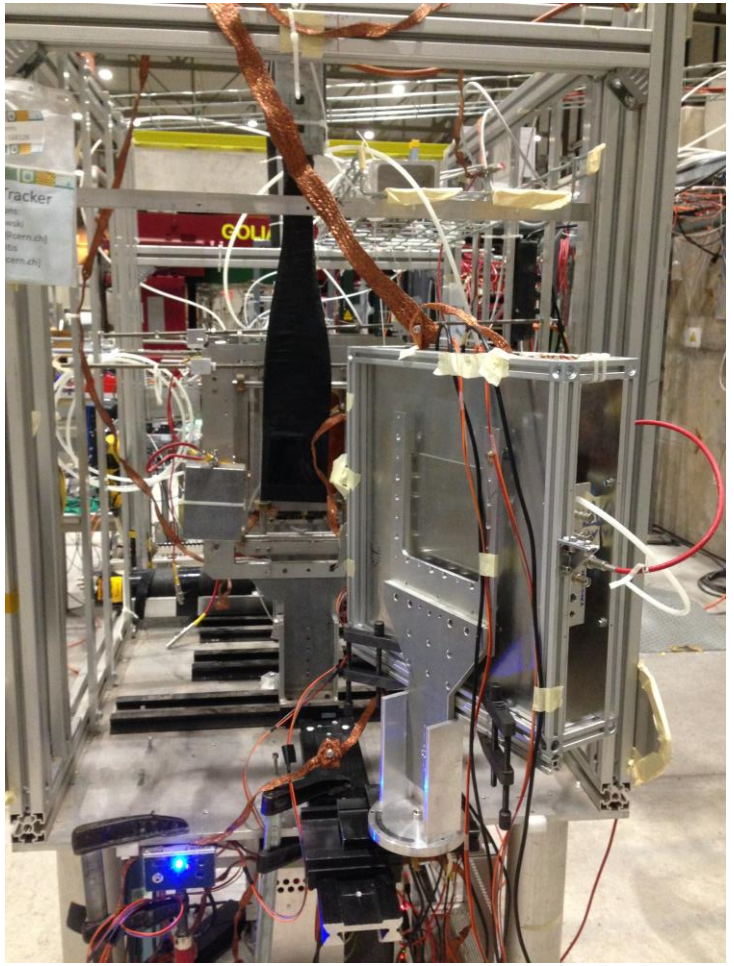
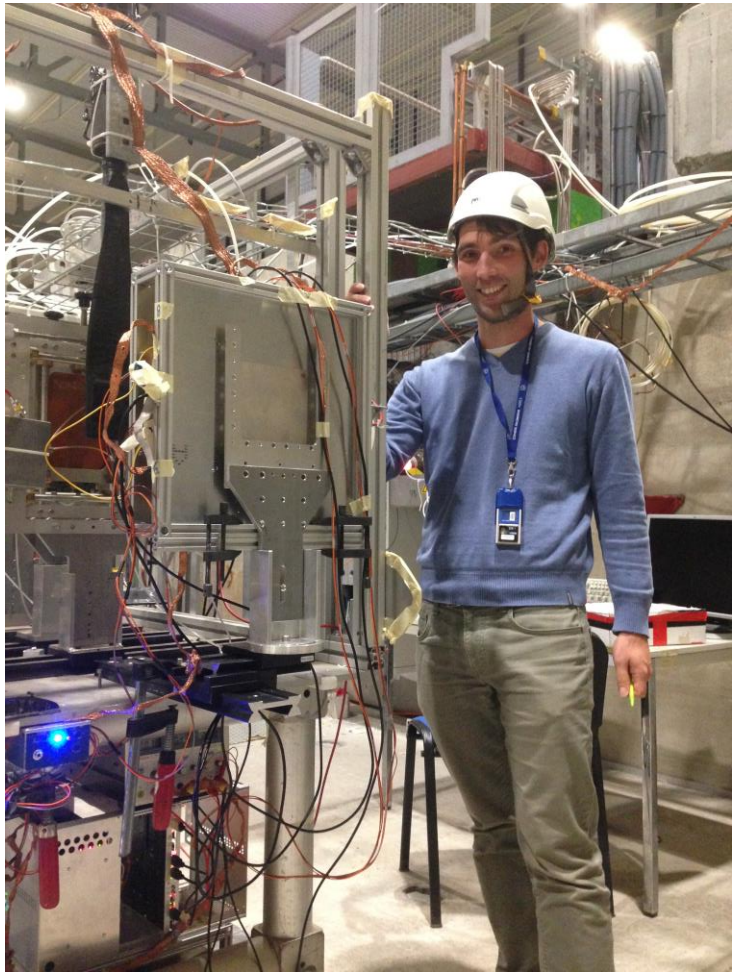
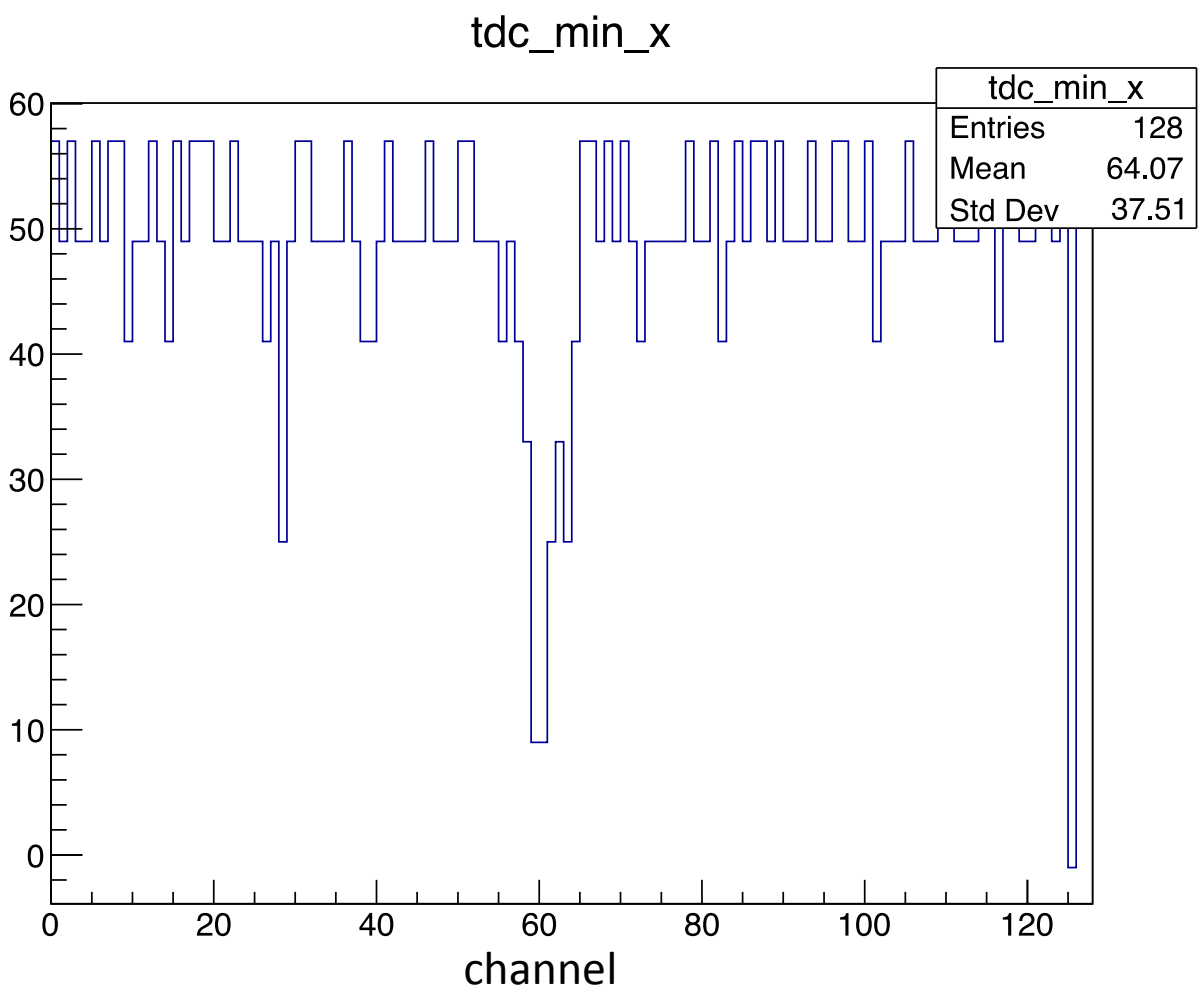
Testbeam at H4 in the North Area (August and October 2017)

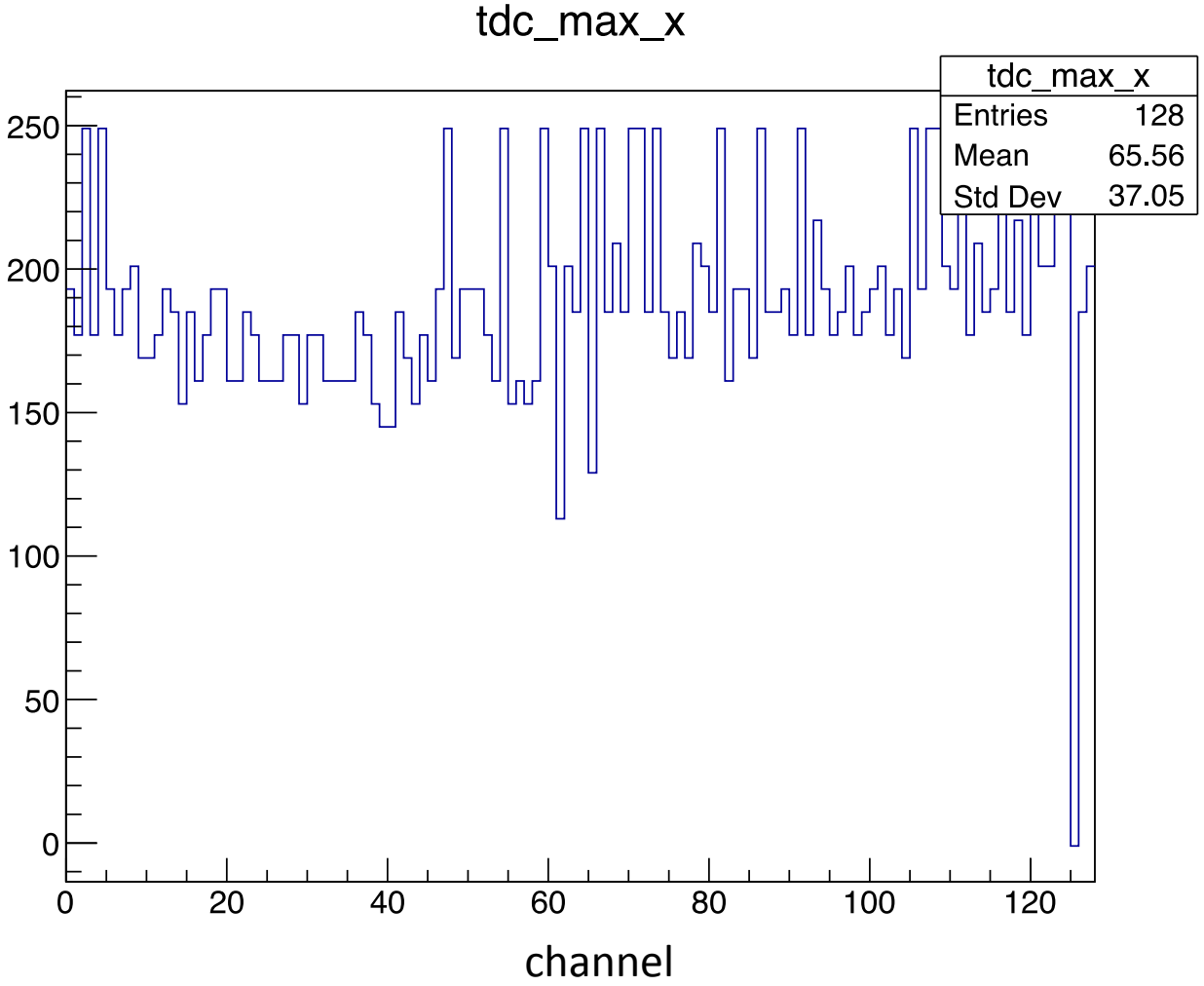
- Standard Triple-GEM detector with 3mm drift
- Normal copper cathode
- 2 VMM3 in August
- 4 VMM3 in October
- Muon and pion beam





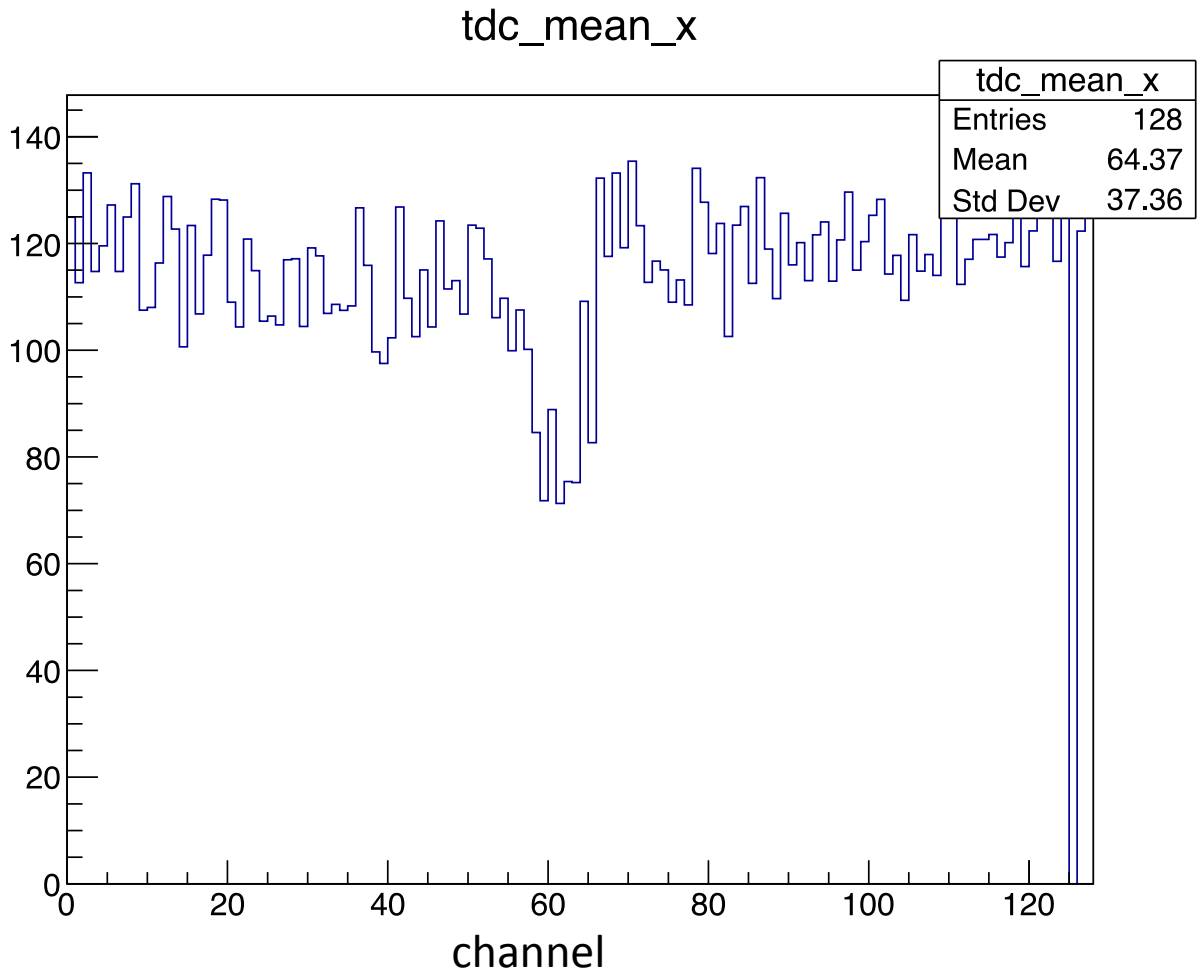
Run19: Minimum and maximum TDC values Uncalibrated TDC (August 2017)

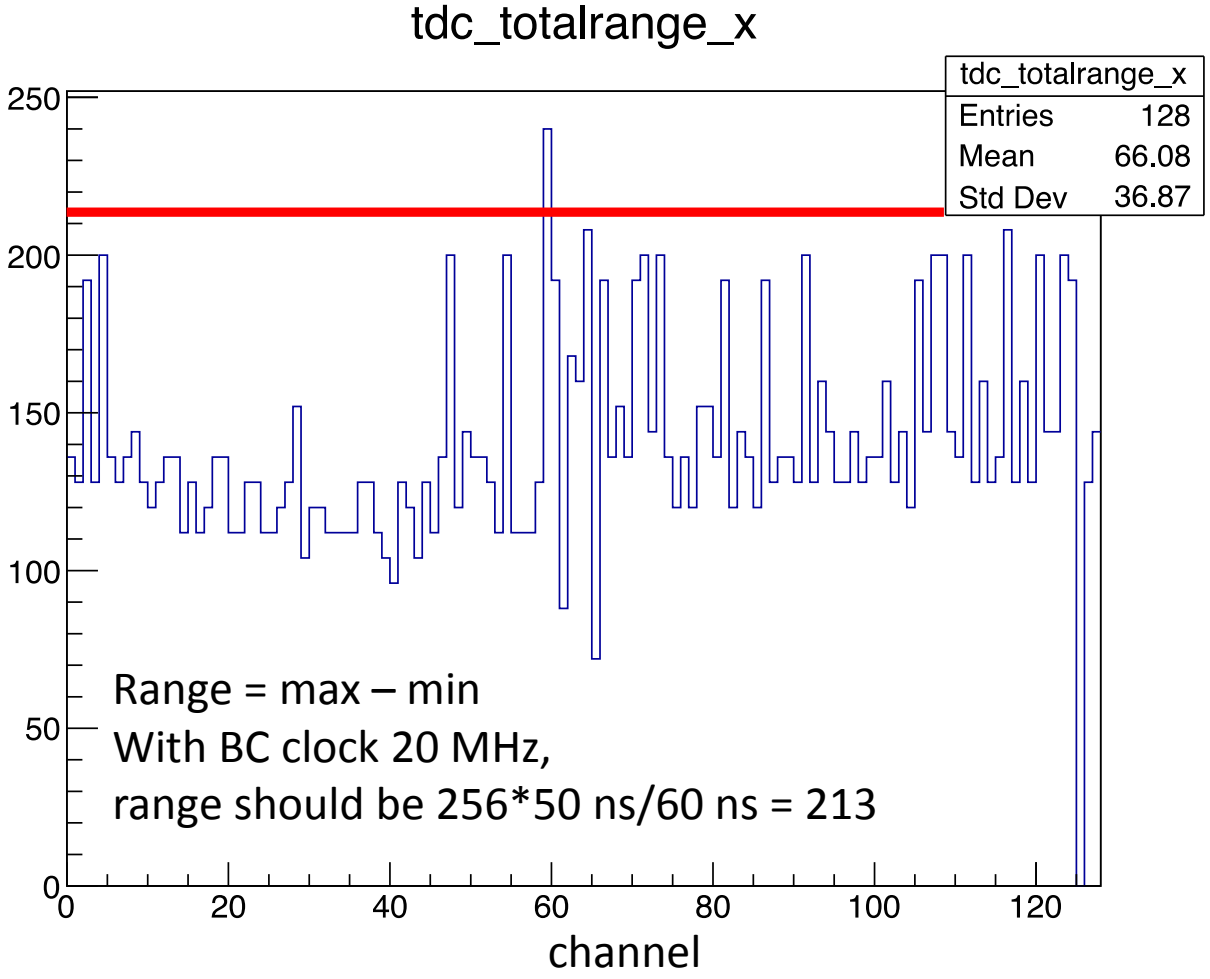




Run19, muons, BC clock 20 MHz, TAC slope 60 ns

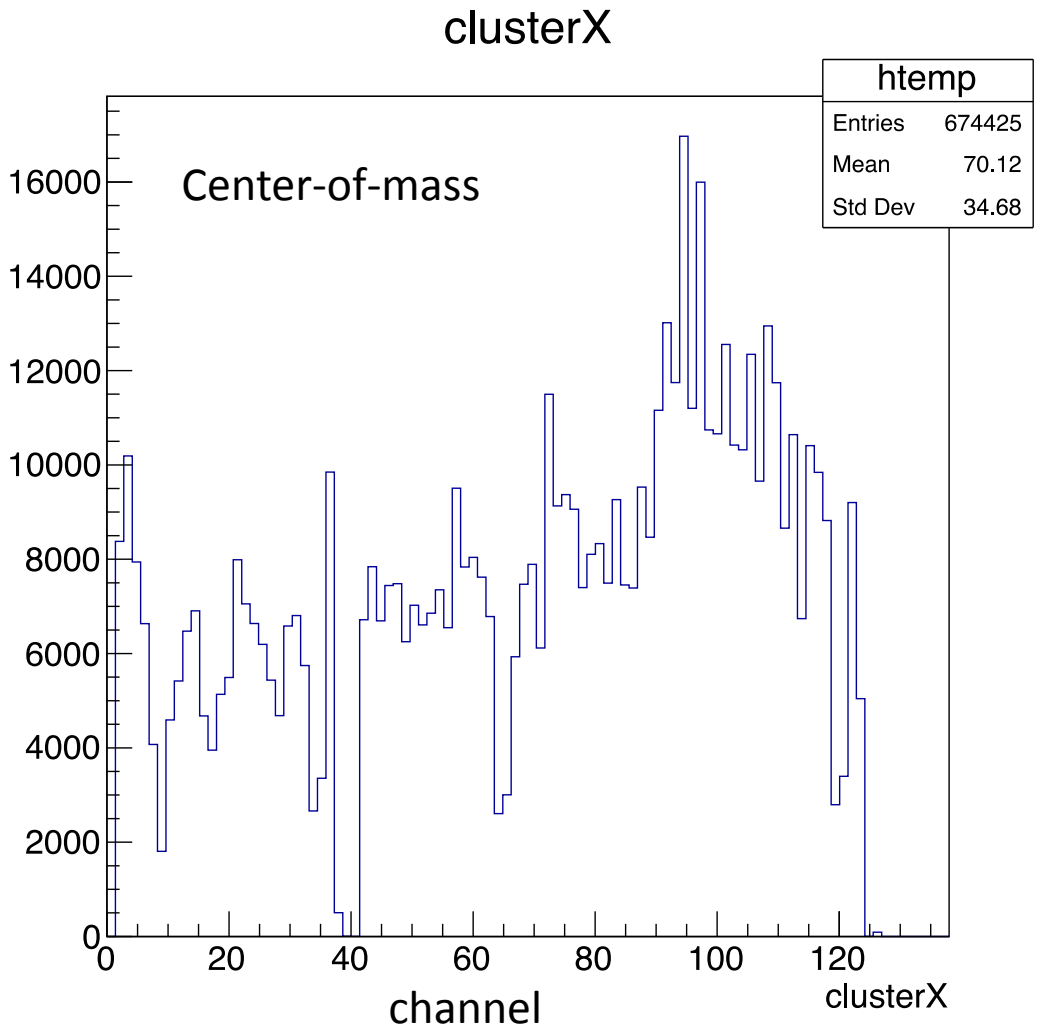
Run19: TDC mean and range
Uncalibrated TDC (August 2017)

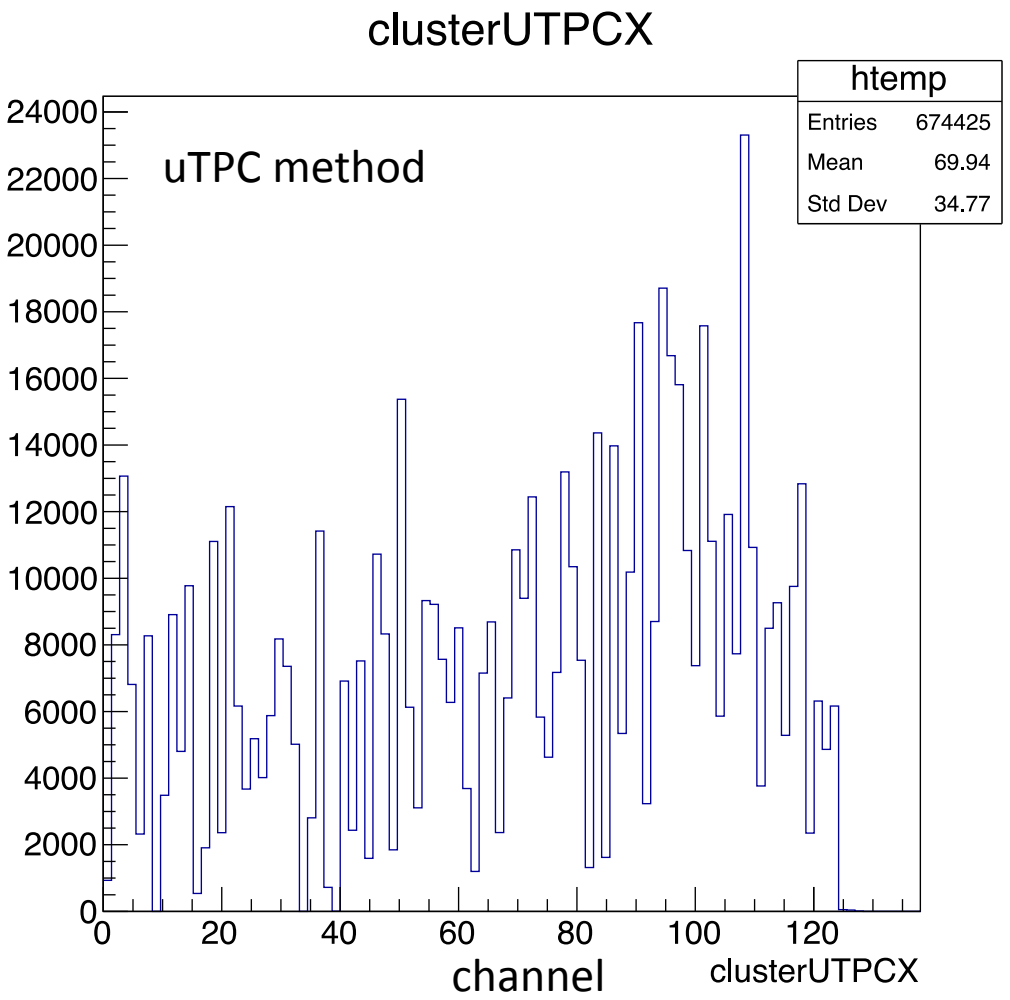




Run19, muons, BC clock 20 MHz, TAC slope 60 ns

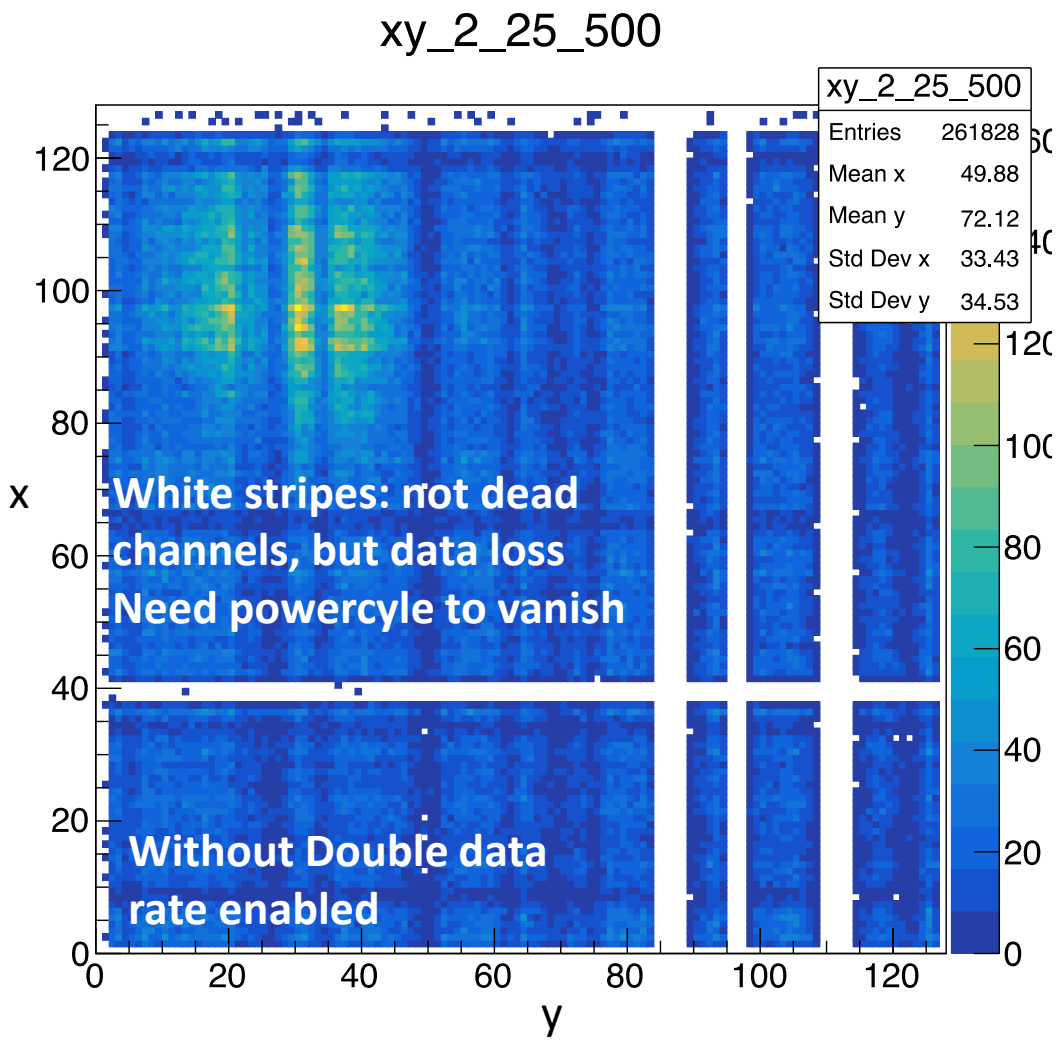
Run73: Clustering: center of mass and uTPC Uncalibrated TDC (August 2017)

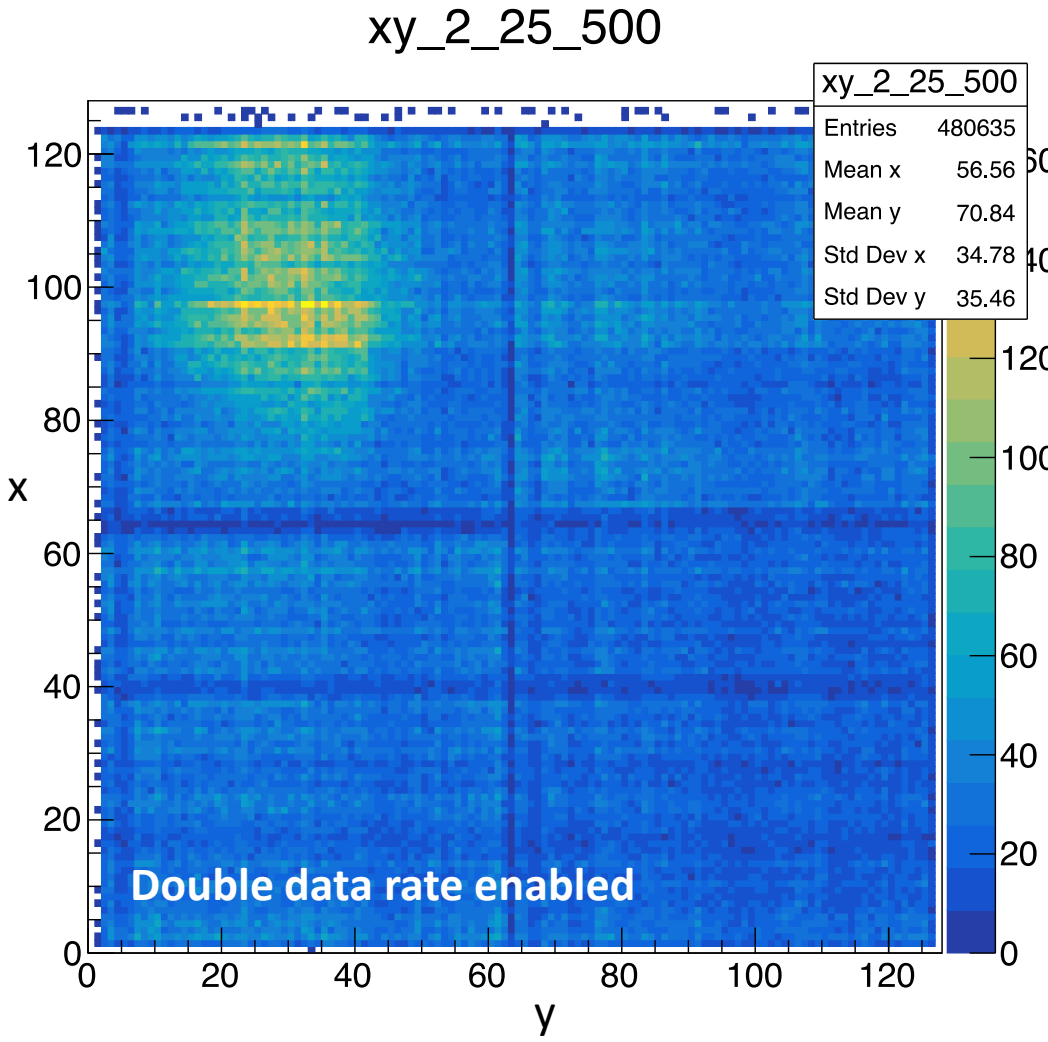




Run73, pions, BC clock 20 MHz, TAC slope 60 ns

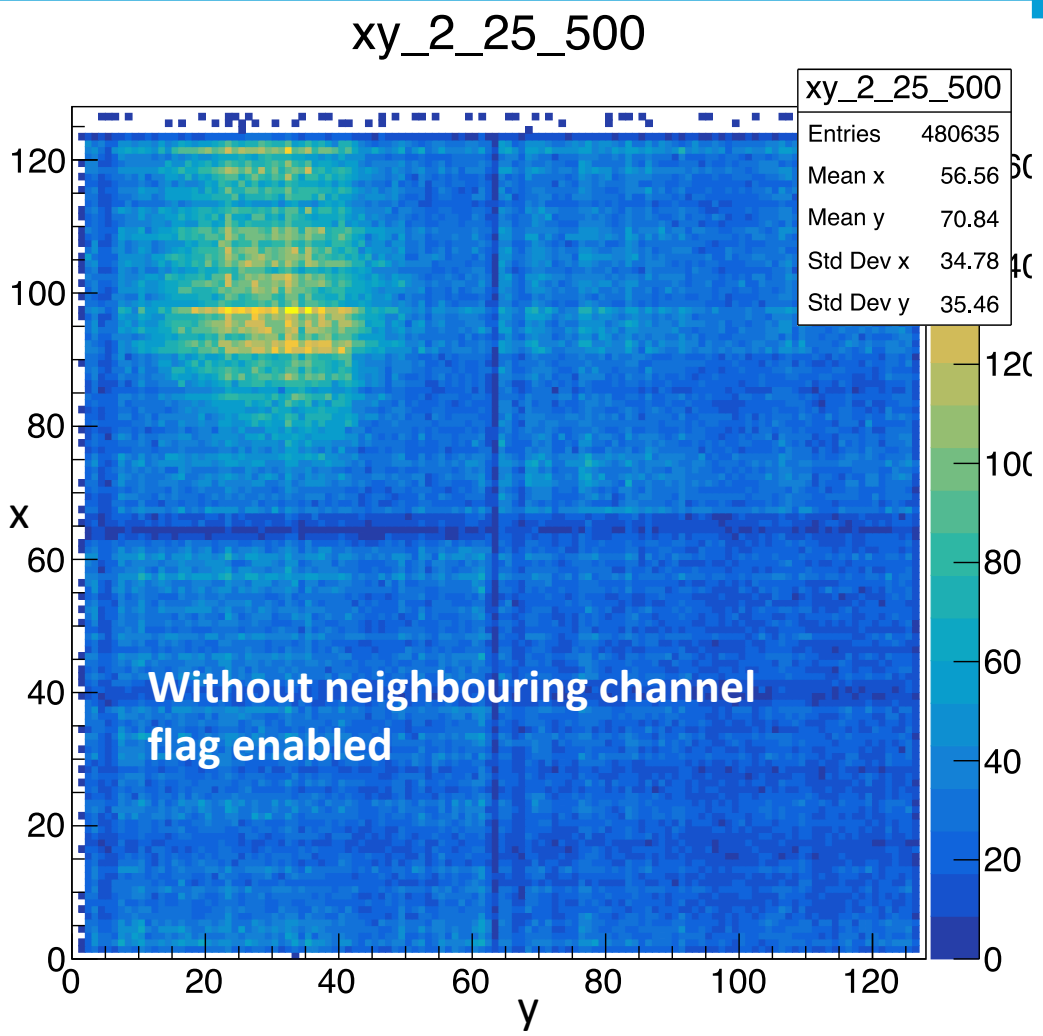
Run73 and 76: Center-of-mass clustering Data loss (August 2017)

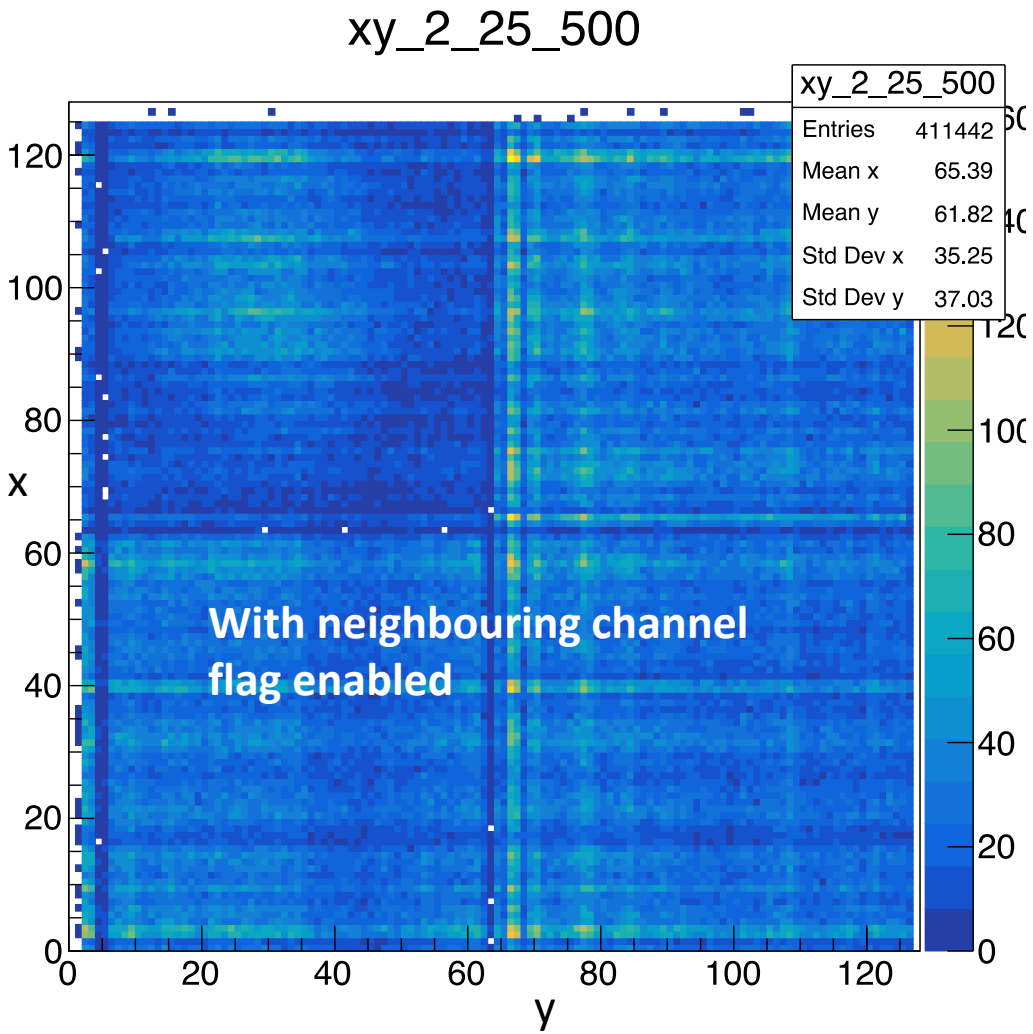




Run73 and Run76, pions, BC clock 20 MHz, TAC slope 60 ns, acquisition window 7060, Run76 with Double Data Rate enabled

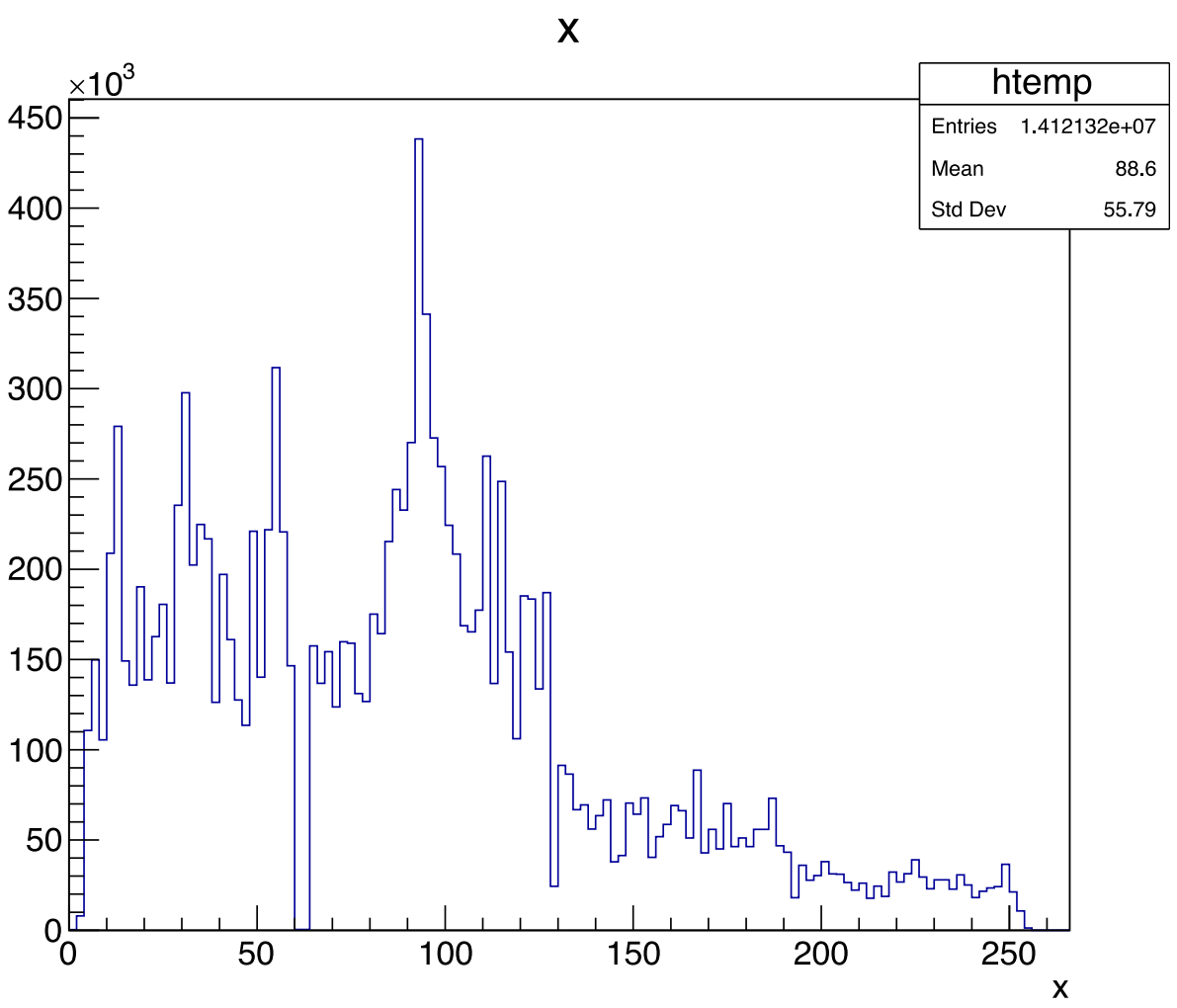
Run76 and 77: Center-of-mass clustering and neighbouring flag (August 2017)

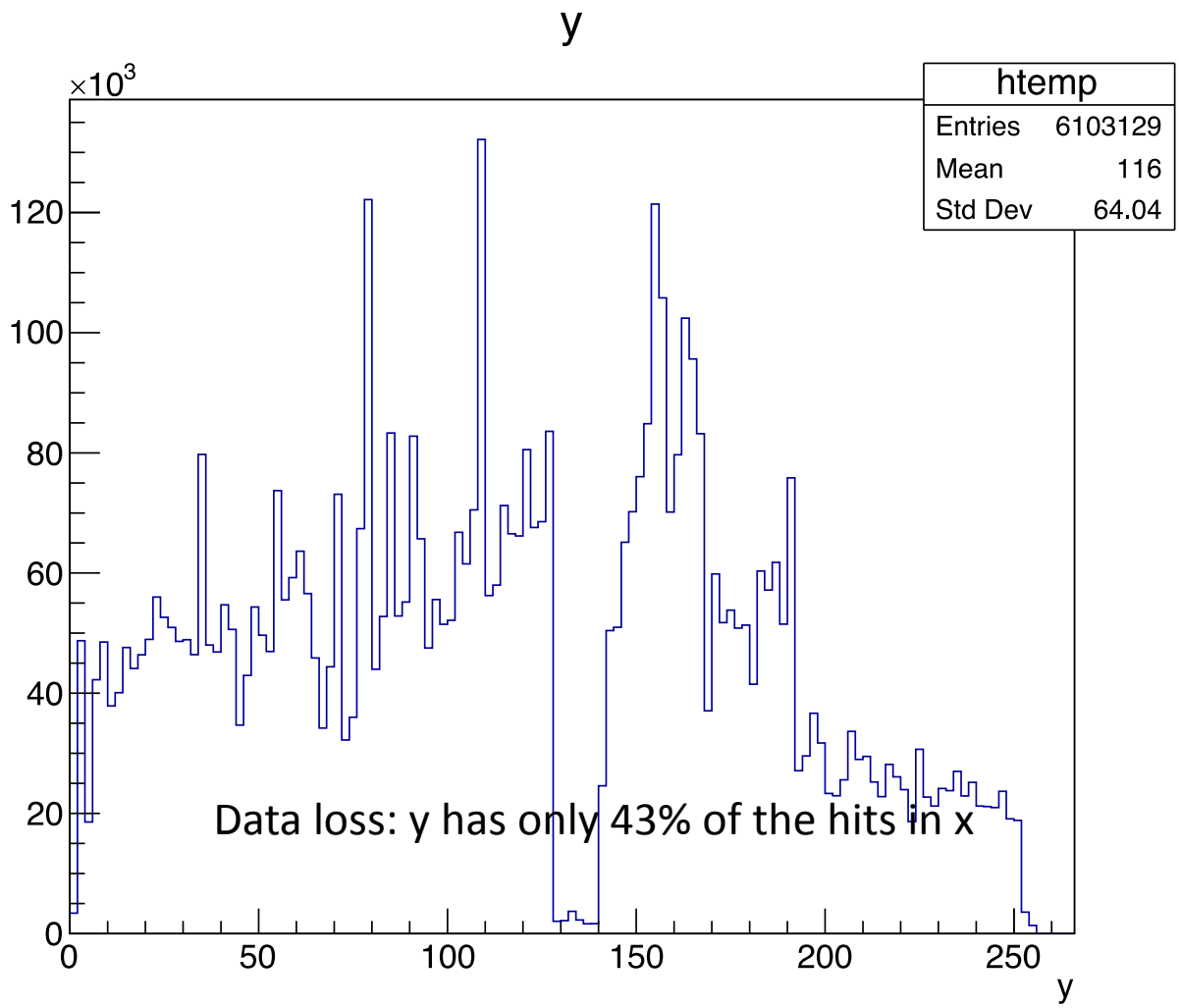




Run76 and Run77, pions, BC clock 20 MHz, TAC slope 60 ns, acquisition window 7060, double data rate, Run77 with neighbouring channel flag enabled

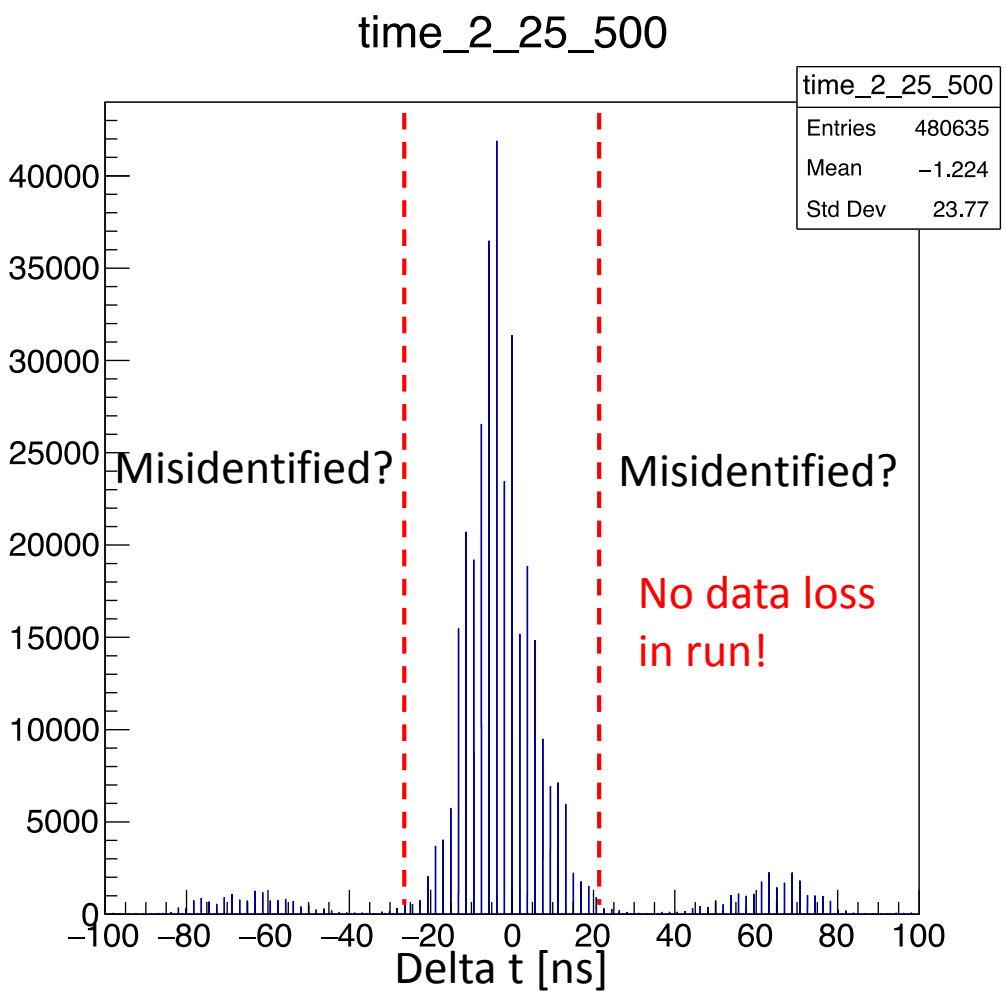
Run152: Data loss at high particle rates and 10 kHz trigger rate (October 2017)



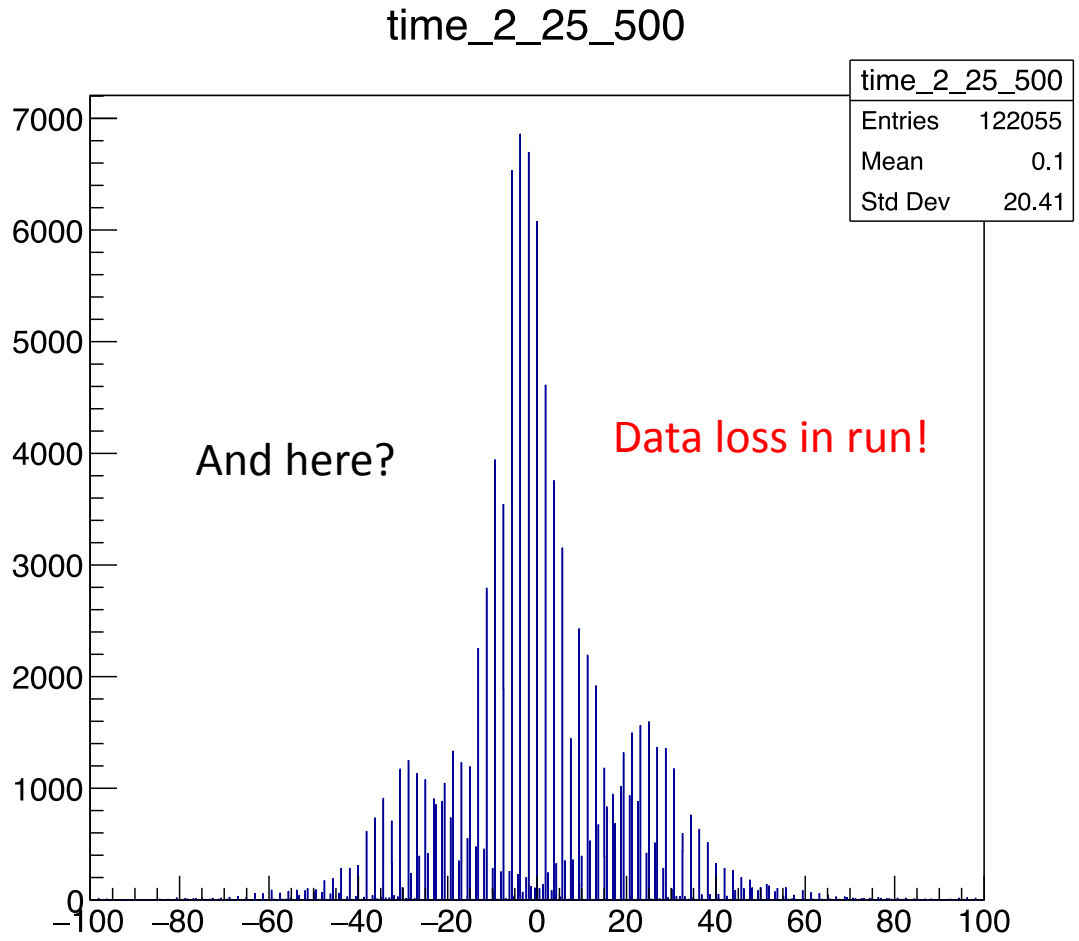


Run152, pions, BC clock 40 MHz, TAC slope 60 ns, acquisition window 3100

Run76 and 152: Delta t between clusters in x and y



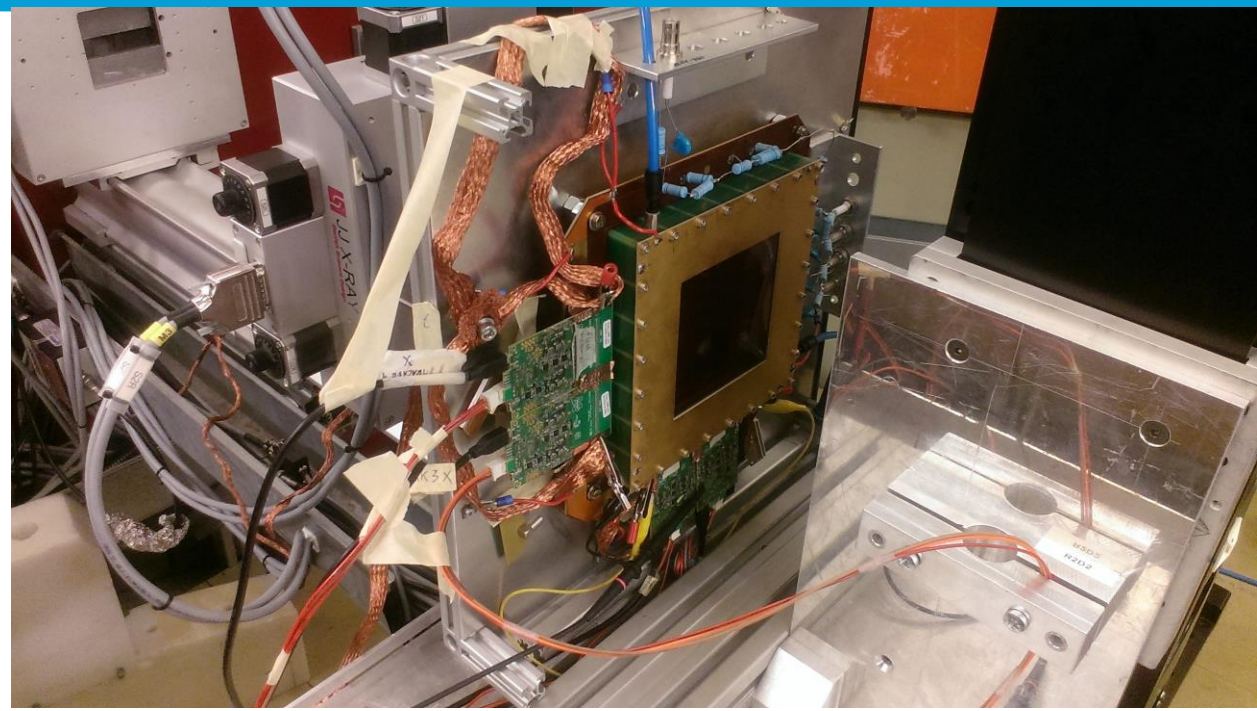
Run76, pions, BC clock 20 MHz, TAC slope 60 ns, acquisition window 7060, double data rate

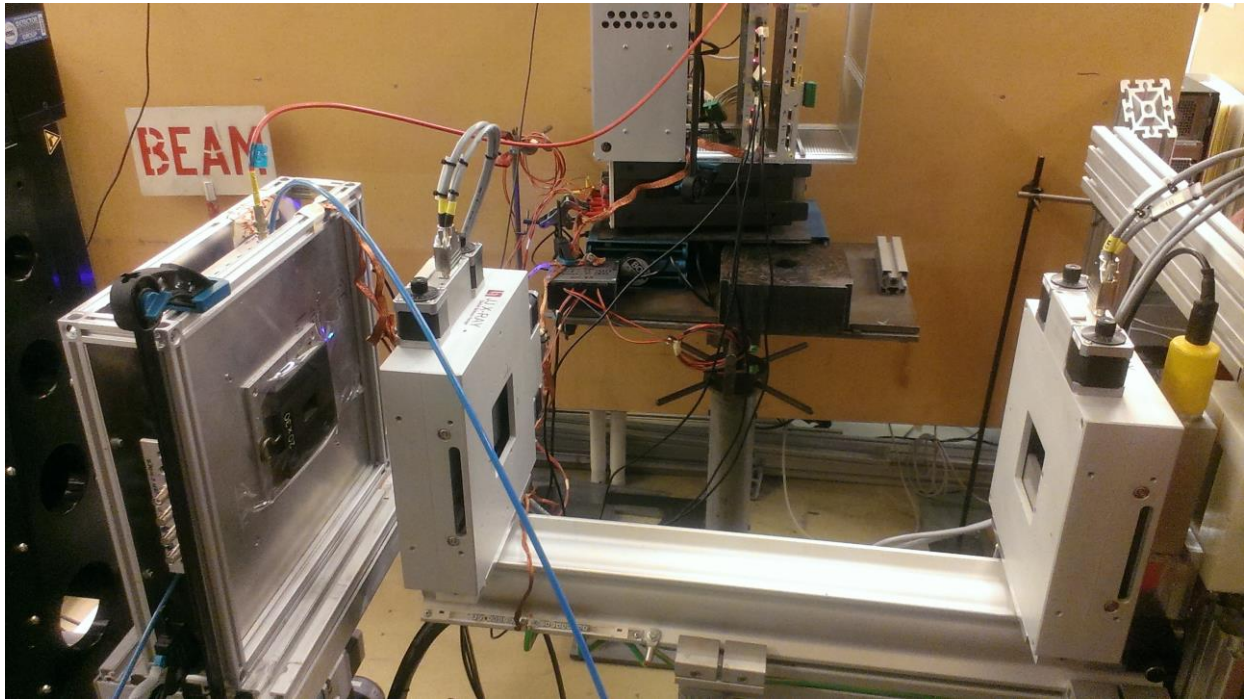


Run152, pions, BC clock 40 MHz, TAC slope 60 ns, acquisition window 3100

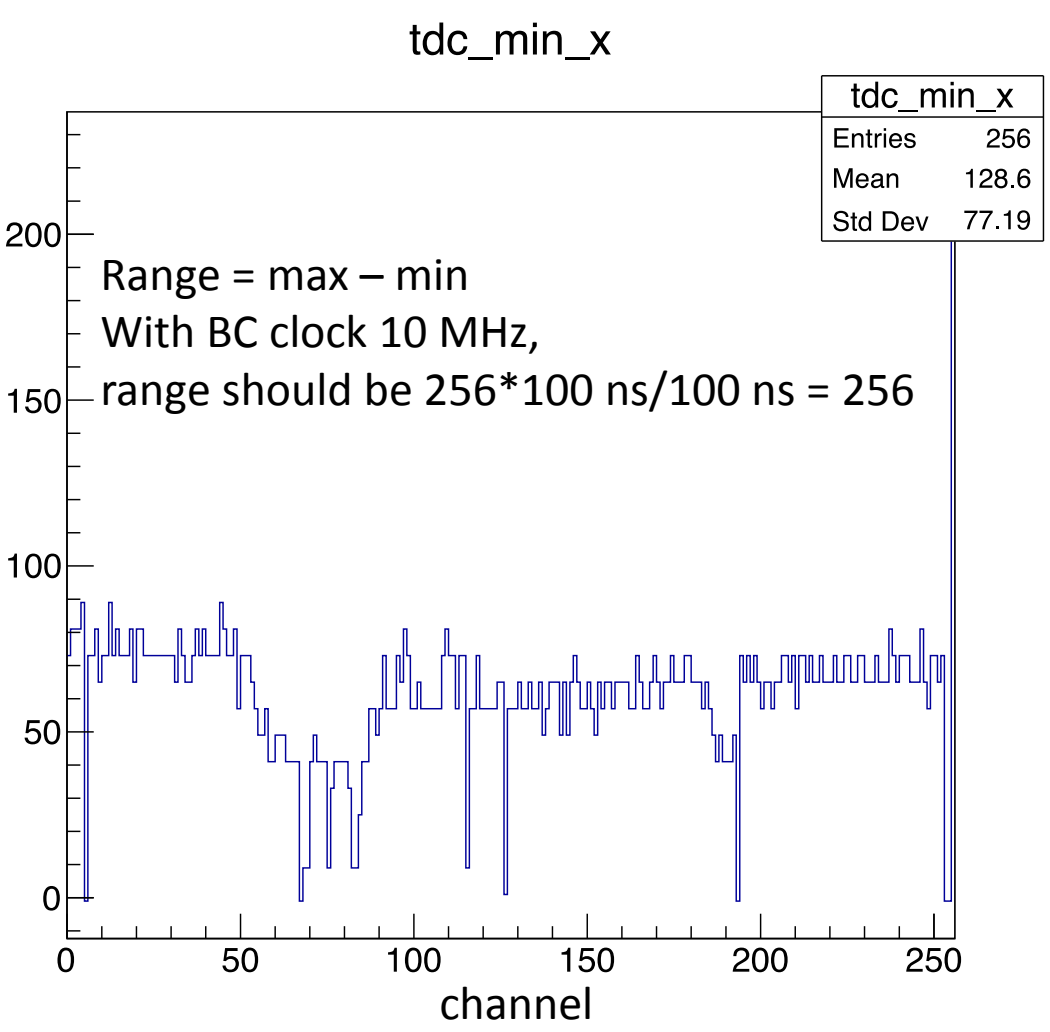
Testbeam at IFE in Kjeller/Norway (December 2017)

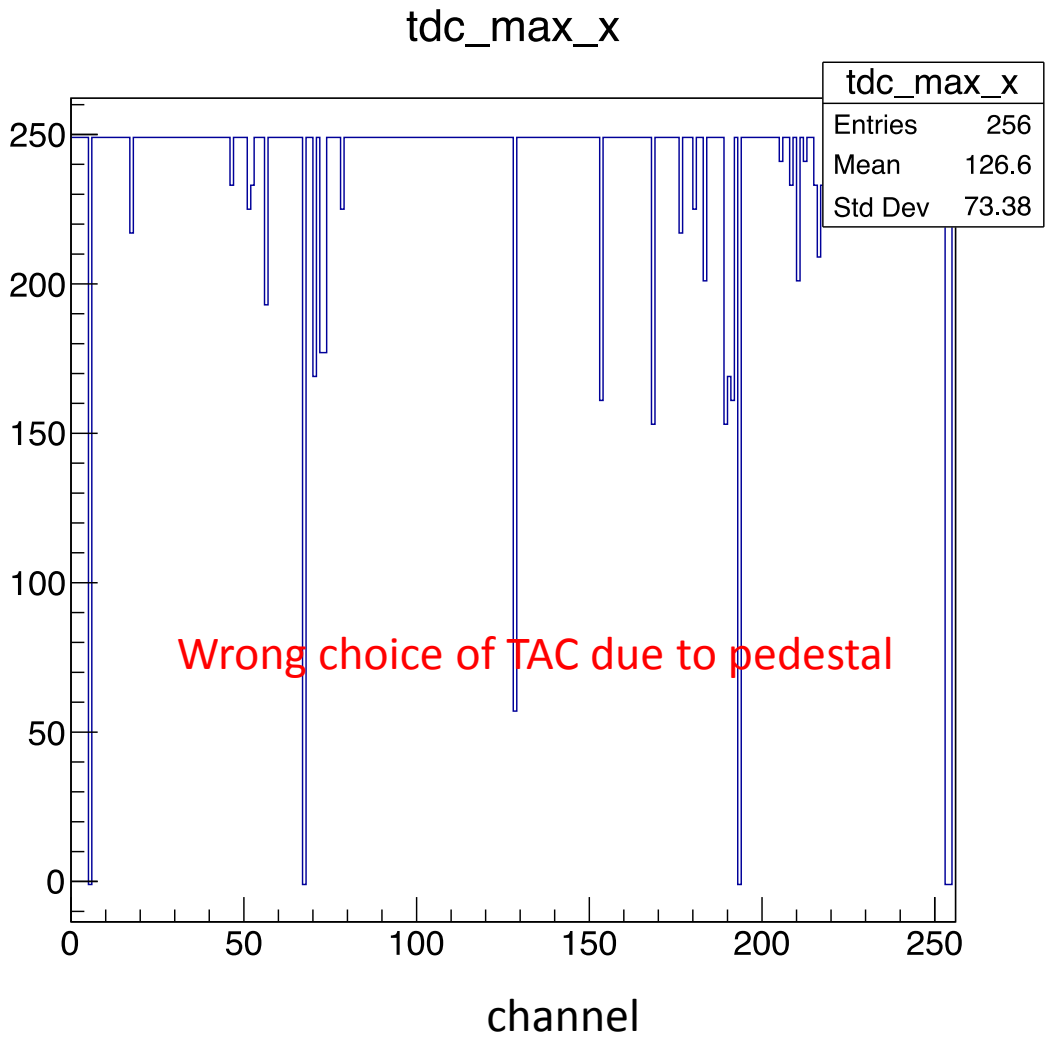
- Standard Triple-GEM detector with 10 mm drift
- Gd cathode with copper tape
- 4 VMM3
- Neutron beam of 1.54 – 2.4 A





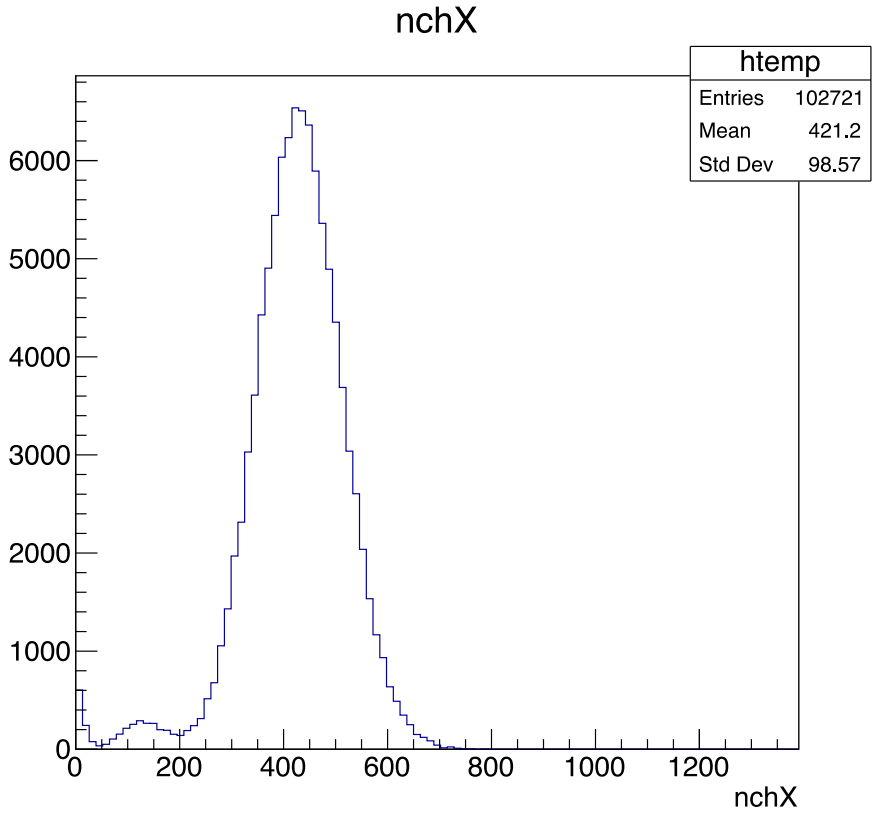
Run14: Minimum and maximum TDC values Equalized TDC (December2017

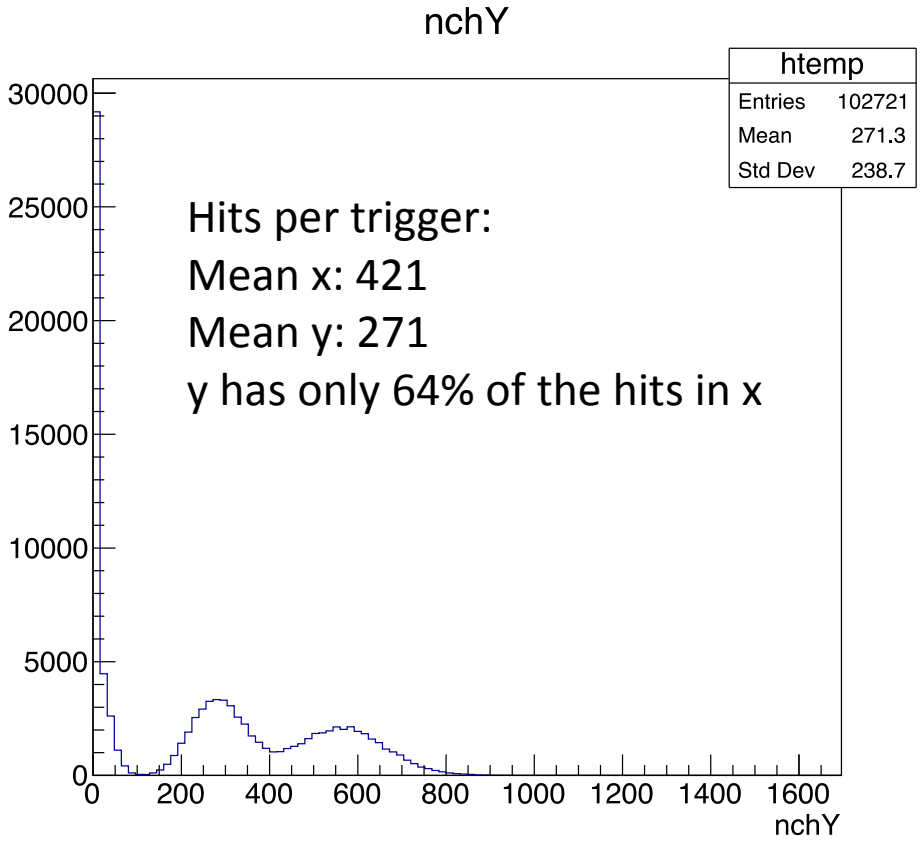




Run14, neutrons, BC clock 10 MHz, TAC slope 100 ns, acquisition window 4000

Run14: Data loss of hits at high neutron rates (December 2017)





Hits per trigger:
Mean x: 421
Mean y: 271
y has only 64% of the hits in x

Hit rate per VMM3 in x:
2.5 kHz trigger rate * 105 hits
= 263 kHits/s

Hit rate per channel in x:
263 kHits/s/64 channels
= 4.1 kHits/s/channel
But most hits occur on 1 VMM3 in 20 channels: 52.6 kHits/s per channel

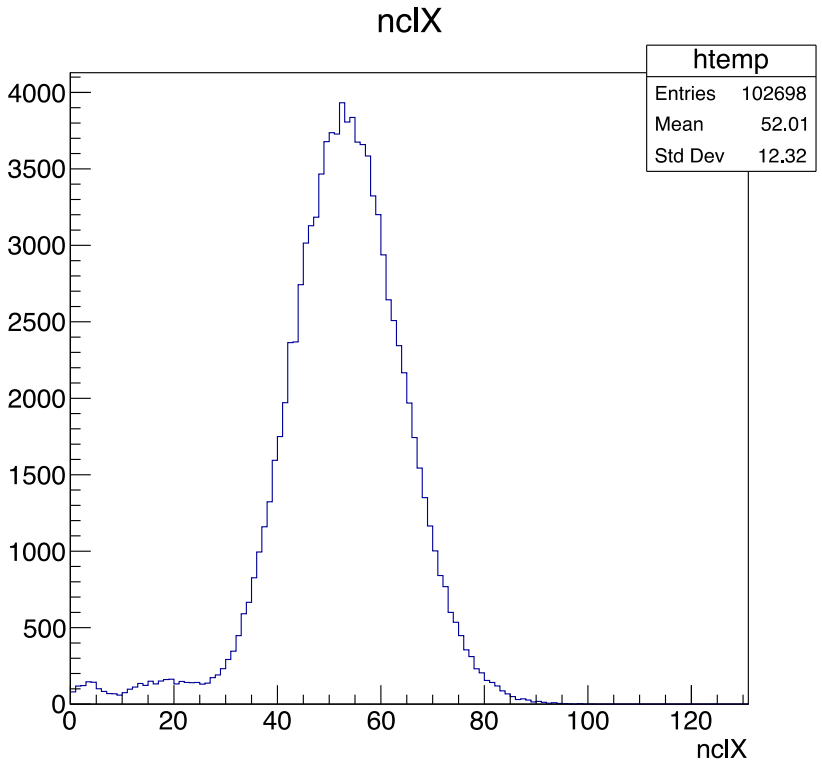
SRS FEC incoming bit rate:
2.5 kHz * 692 * 38 bit
= 65.7 Mbit/s

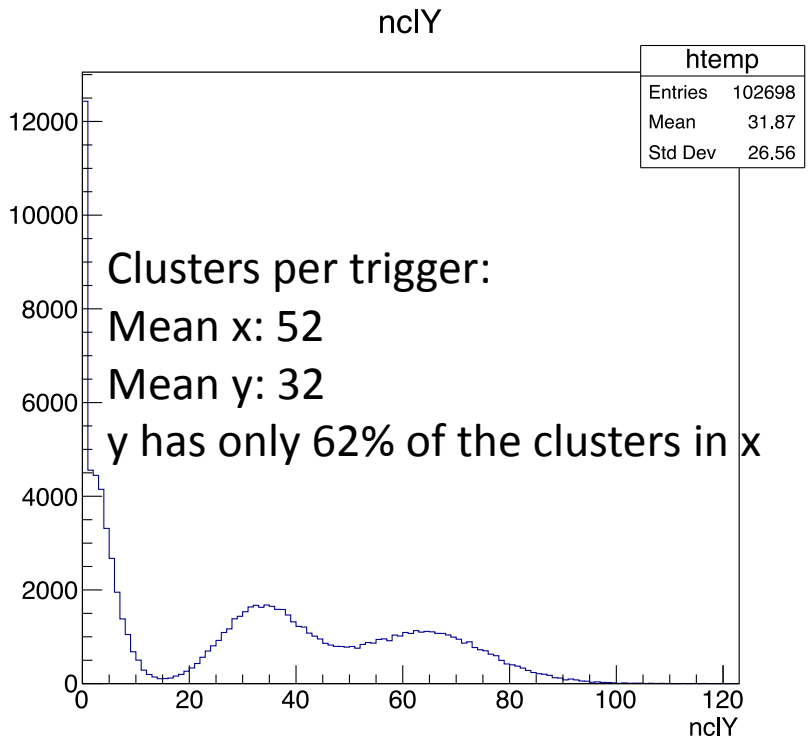
SRS FEC outgoing bit rate:
2.5 kHz * 692 * 64 bit * 1.1 overhead
= 122 Mbit/s

Where does data loss occur?
FEC ?, VMM3 (cf white gaps) ?, in the EFU and while writing to file.

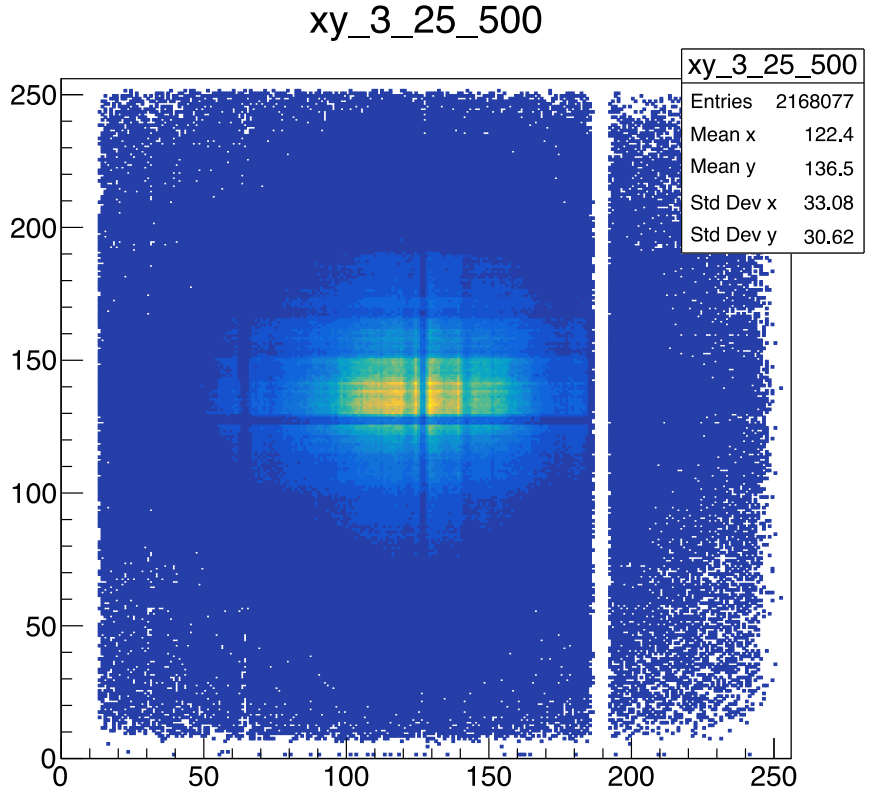
Run14, neutrons, BC clock 10 MHz, TAC slope 100 ns, acquisition window 4000

Run14: Data loss of clusters at high neutron rates (December 2017)





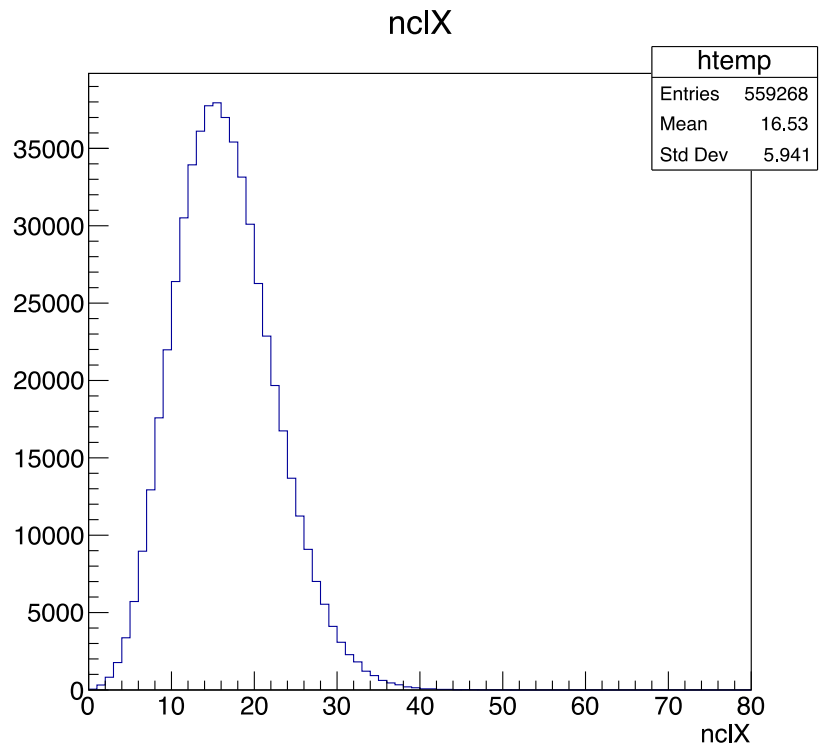
Clusters per trigger:
Mean x: 52
Mean y: 32
y has only 62% of the clusters in x

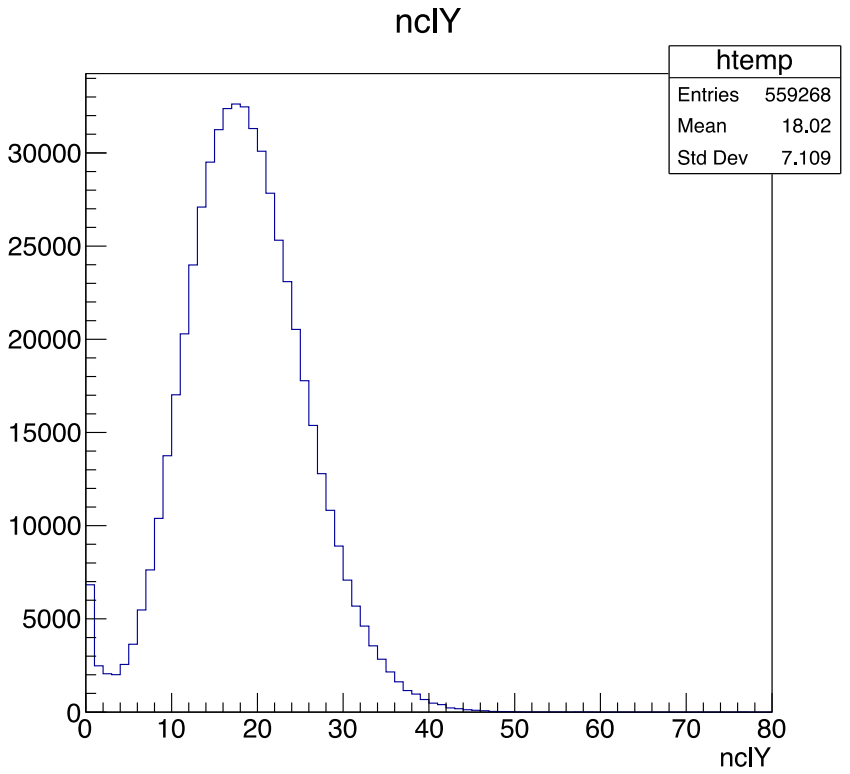


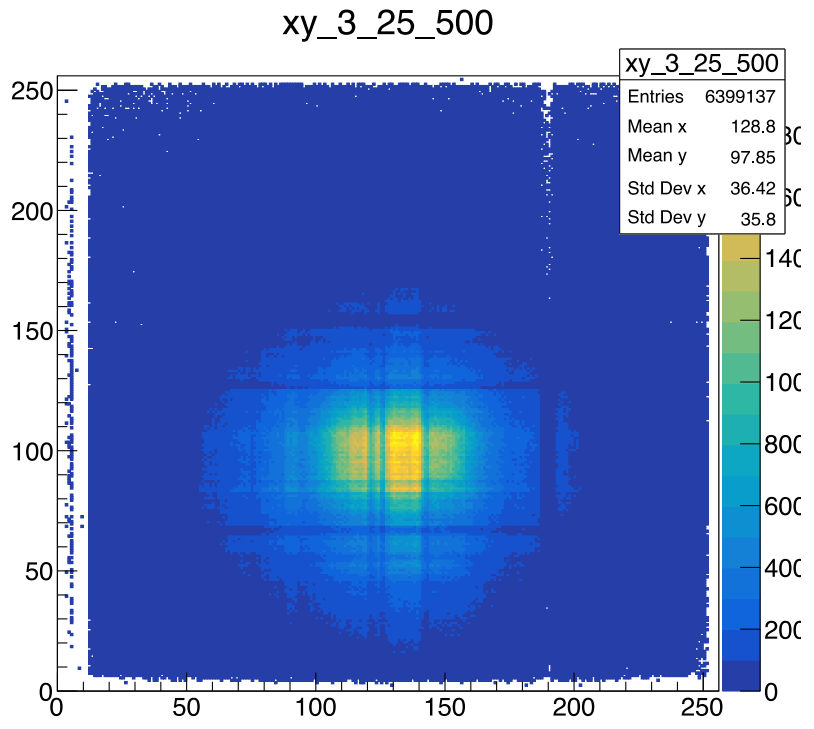
Total clusters in x: 5341117
Total clusters in y: 3272885
Common in x and y: 2168077
=> 66% of clusters in y have “partner” in x

Run14, neutrons, BC clock 10 MHz, TAC slope 100 ns, acquisition window 4000

Run31: No data loss of clusters at high neutron rates (December 2017)





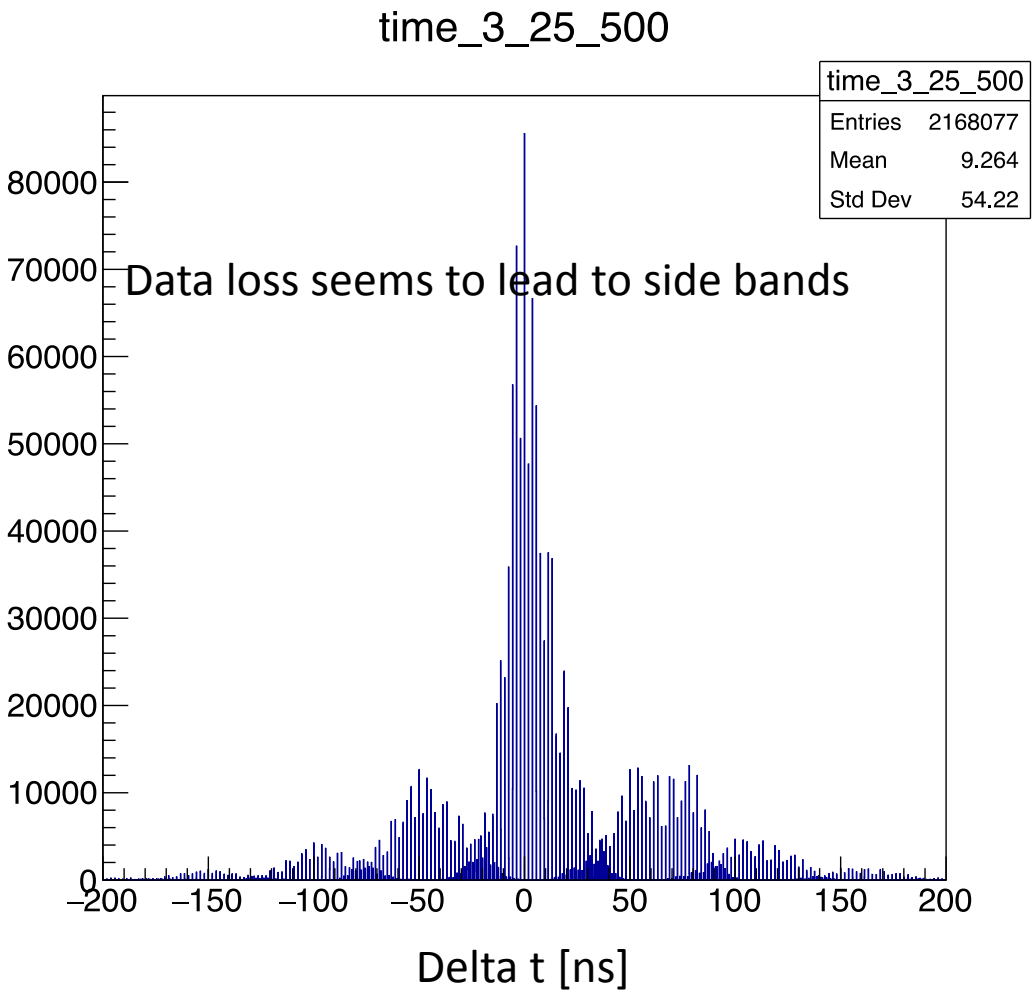


Clusters per trigger:
Mean x: 16
Mean y: 18
x has 89% of the clusters in y

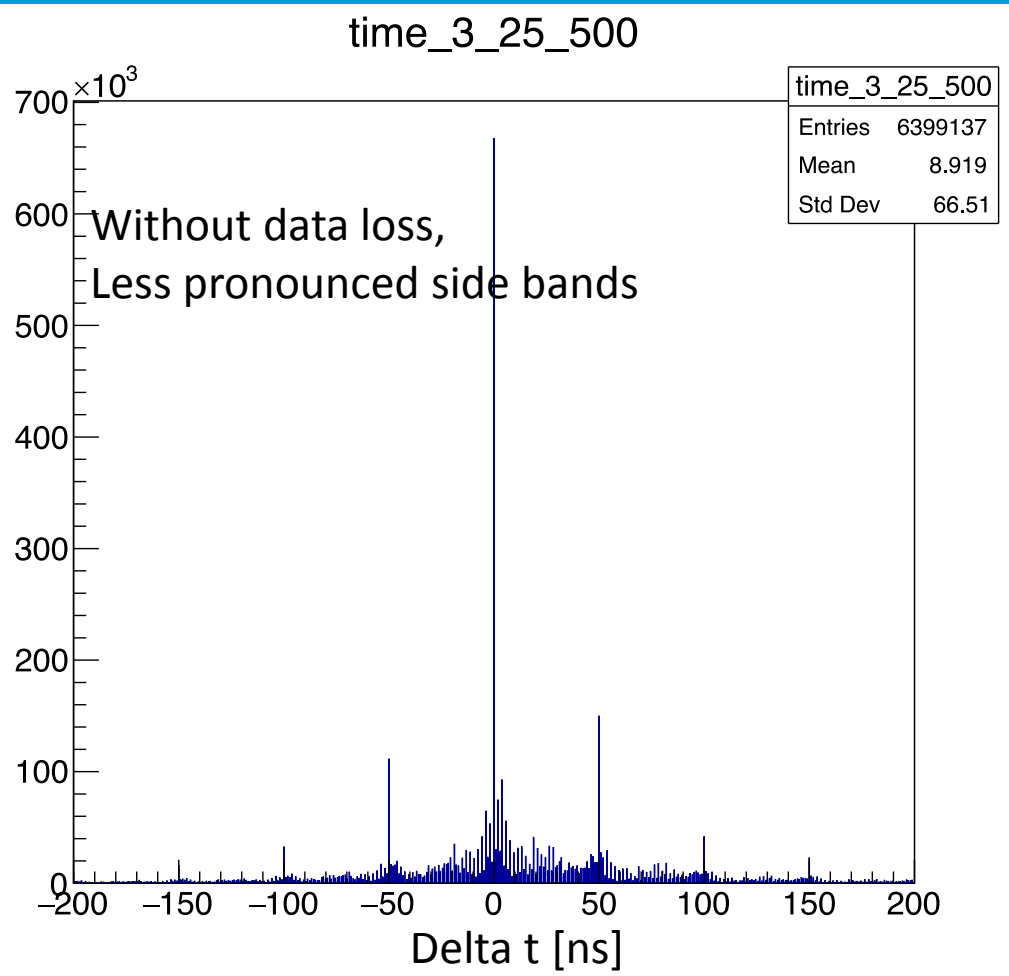
Total clusters in x: 8.9 e+6
Total clusters in y: 1.0 e+7
Common in x and y: 6.4e+6
=> 72 % of clusters in x have “partner” in y

Run31, neutrons, BC clock 20 MHz, TAC slope 60 ns, acquisition window 4000

Run14 and 31: Delta t between clusters in x and y



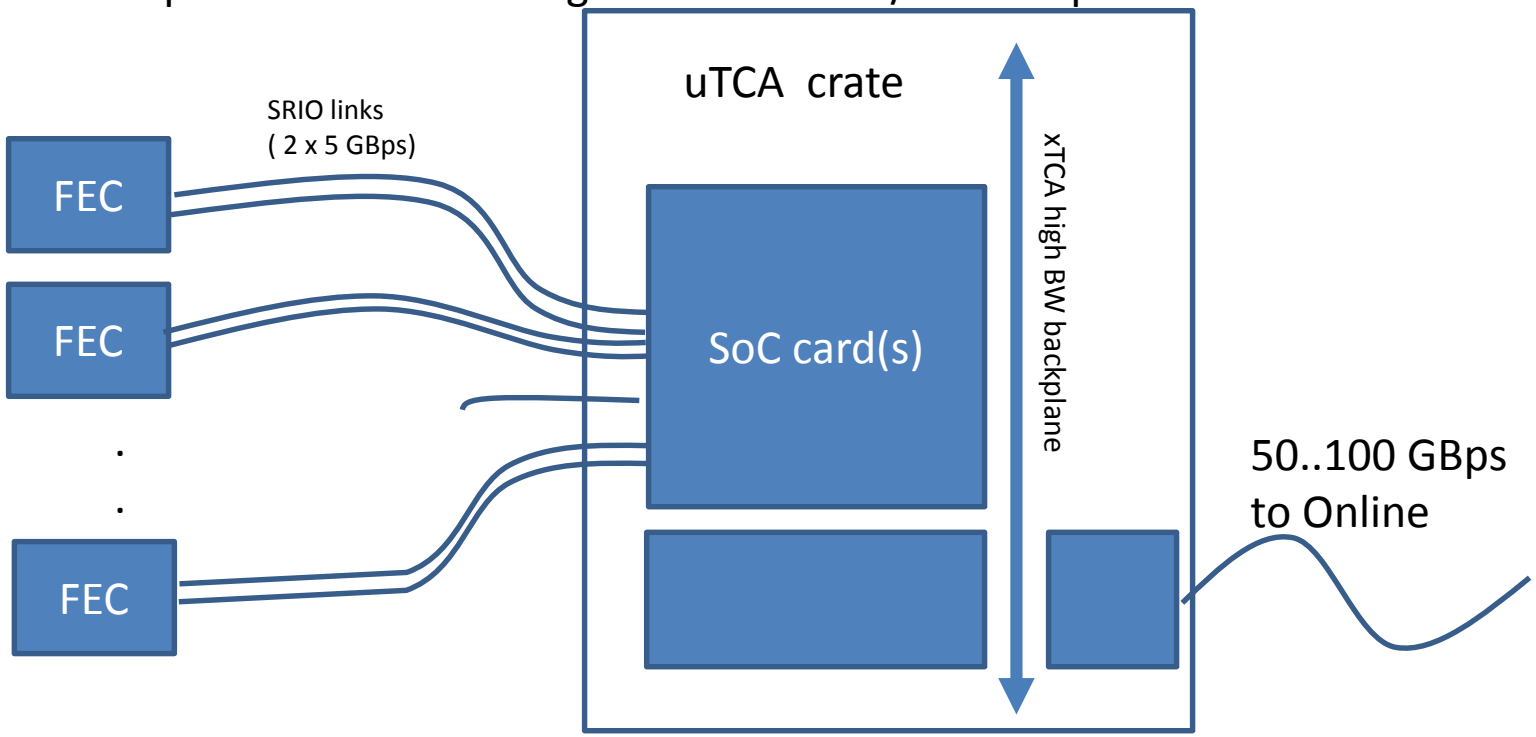
Run14, neutrons, BC clock 10 MHz,
TAC slope 100 ns, acquisition window 4000



Run31, neutrons, BC clock 20 MHz,
TAC slope 60 ns, acquisition window 4000

SRU future: from FPGA to SoC

Beyond 1 Gbit bandwidth limit
use SoC processors with integrated SRIO and / 10 GBE ports



- implement SRIO IP in V6 FPGA on FECs
- identify optimal SoC board for uTCA crate
- Implement RO and eventbuilding in C++
- coordinate with similar efforts at CERN

* project conducted by D.Pfeiffer /ESS
students M. Machiels, Yan Huang