Correlations and CM Correction in TB2015 Data

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Correlation Coefficient Estimation

$$P_i = \frac{\sum_{t=1}^{N} S_{it}}{N}$$ Pedestal

S_{it} – signal in channel i in time bin t;
i = 1..128 are channel number.

$$\sigma_i = \sqrt{\frac{\sum_{t=1}^{N} (S_{it} - P_i)^2}{(N-1)}}$$

Data contain 21 time bins for each channel.

The particle signal starts at around bin 10, so the upper limit was N=9.

$$R_{ij} = \frac{\sum_{t=1}^{N} (S_{it} - P_i) \cdot (S_{jt} - P_j)}{\sigma_i \sigma_j (N-1)}$$

Correlation coefficient;
for APV with 128 channels it is 8128 values.

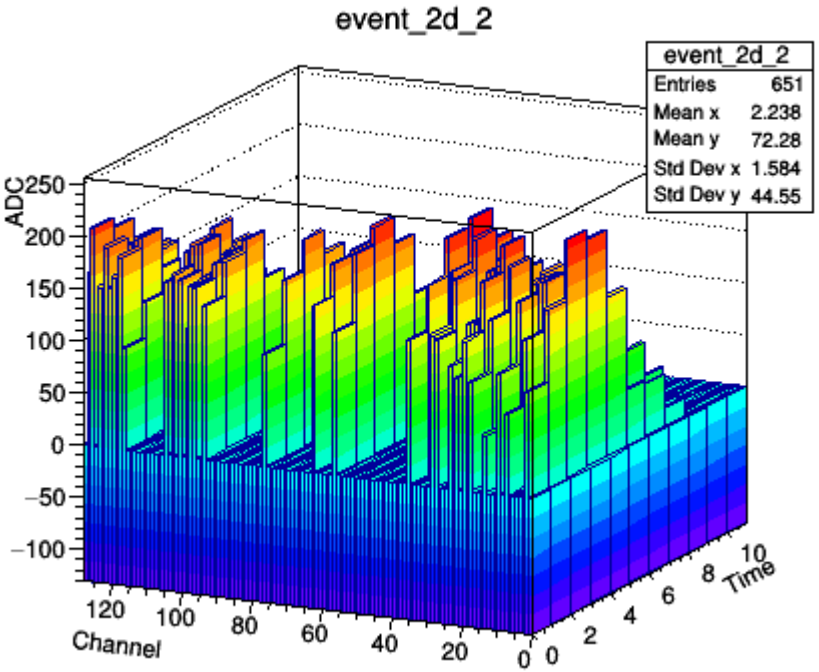
$R_{ij} = R_{ji}$ - correlation coefficient is symmetric.

It was used to display R_{ij} on the histograms

CM Correction

Three steps for each time bin:

1. Calculate average signal and its standard deviation (σ) using all available channels;
2. Calculate average signal using only those channels where signal deviates from the previous avarage on less than $A\sigma$. This is to exclude the channels which might contain signal from the particle.
3. The CM is subtracted if the number of channels used for the second pass greater than N and if its ratio to the number all available channels is more than B.



A = 1, 2.5, 3;

N = 5;

B = 50%.

Noise < 30

Sum_9_15 > 50.0

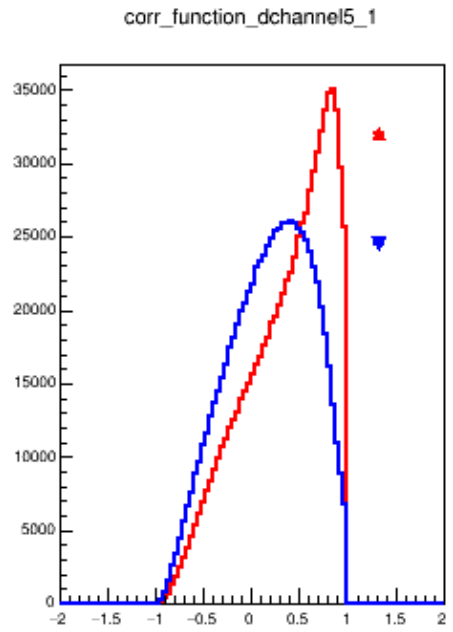
chi2 < 100.0

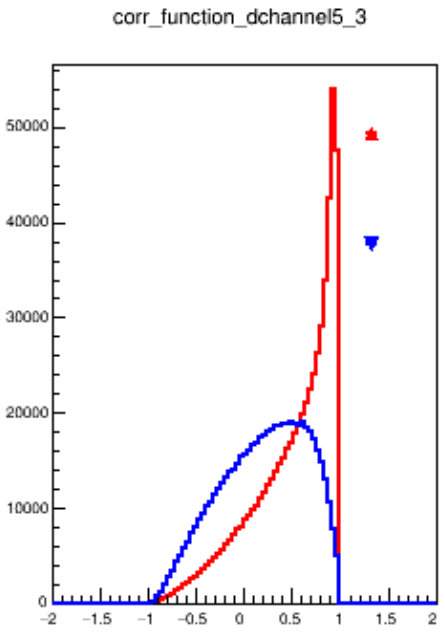
9 < t0 < 11

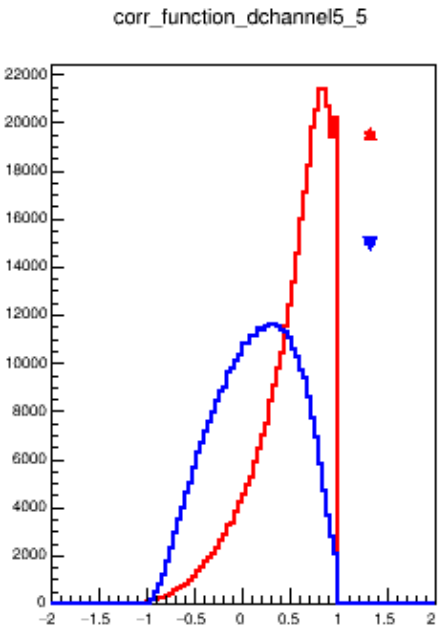
chi2/signl_max > 1.1

$$CM_t = \frac{\sum_{i=1}^{N_c} \left(S_{it} - P_i \right)}{N_c}$$

Correlation Coefficient, Run 122 at TAU

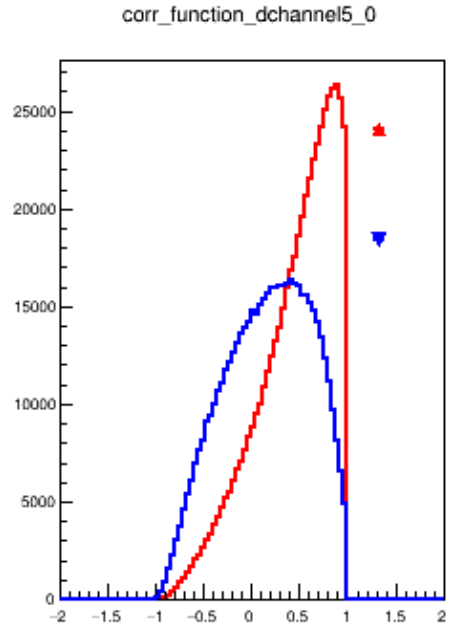


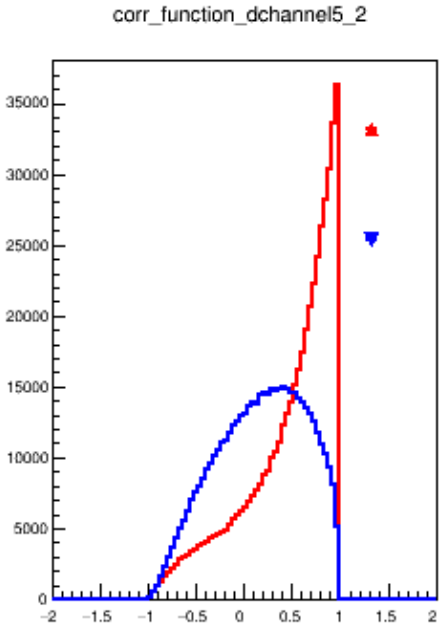


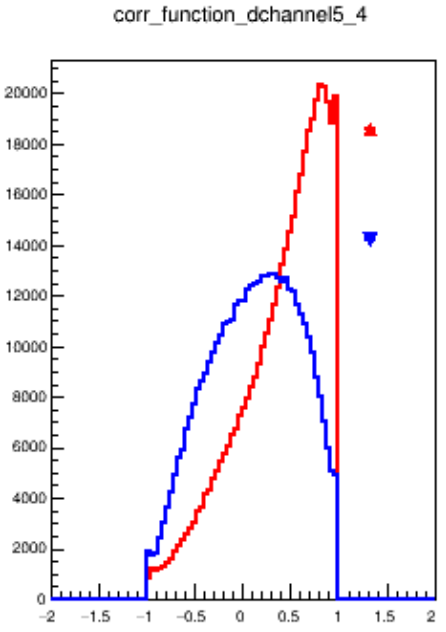


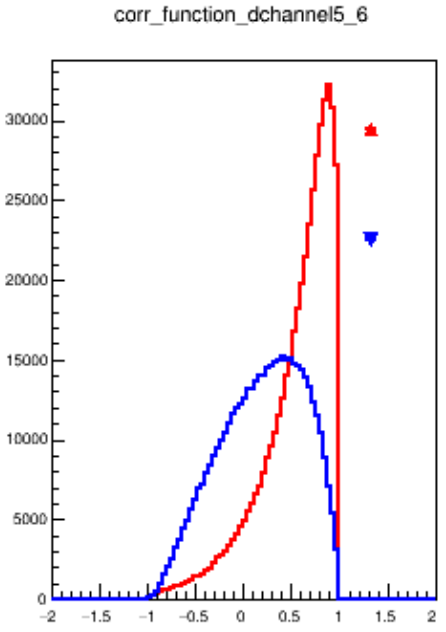
Distributions of R_{ij}: |i-j|=5;

Without and with CM correction.

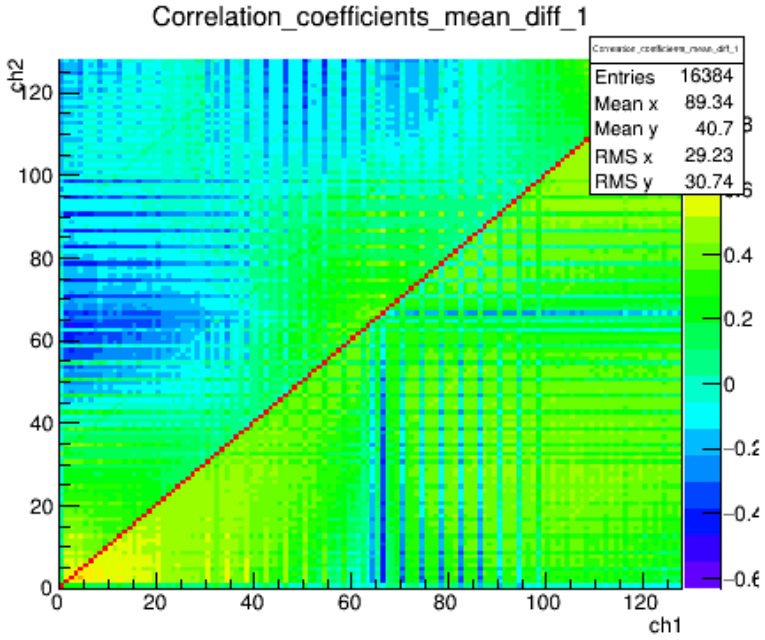


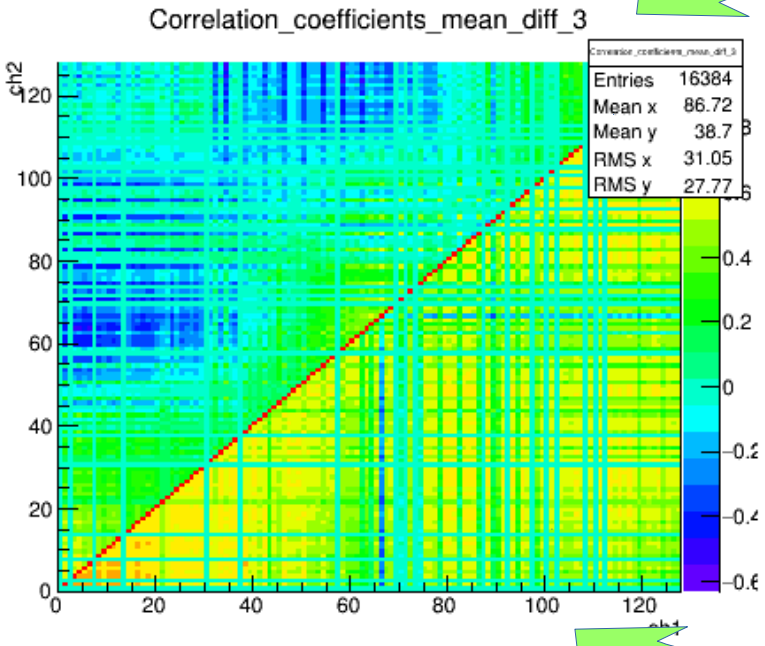






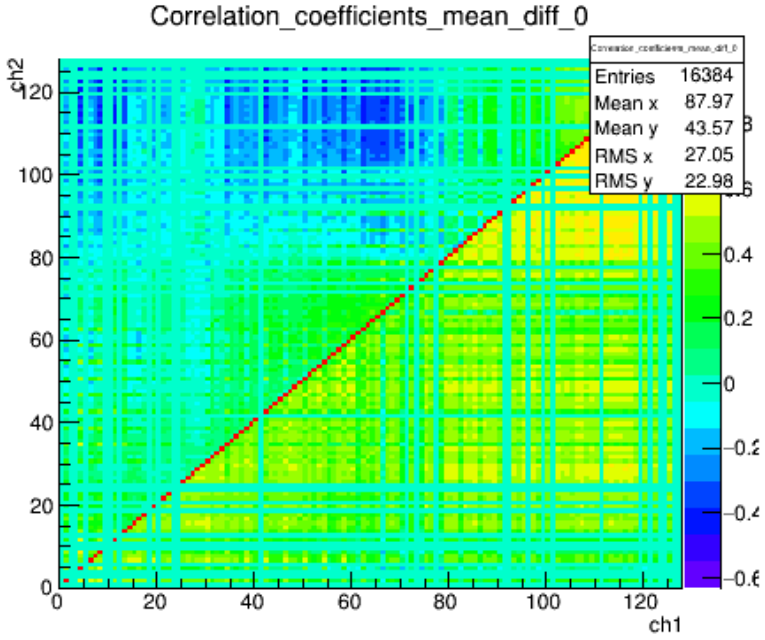
Mean Value of Correlation Coefficient Distribution, Run 122 at TAU

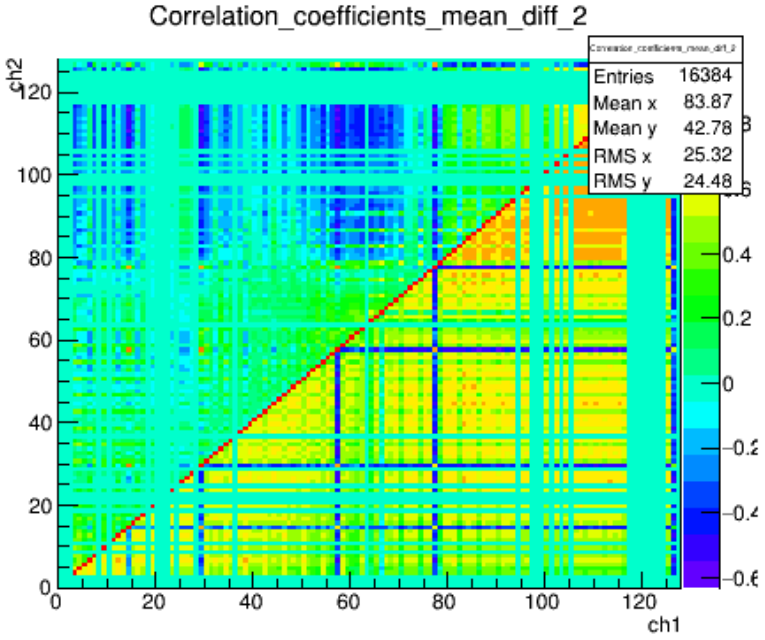




ch1 < ch2 : after CM correction

ch1 > ch2 : before CM correction





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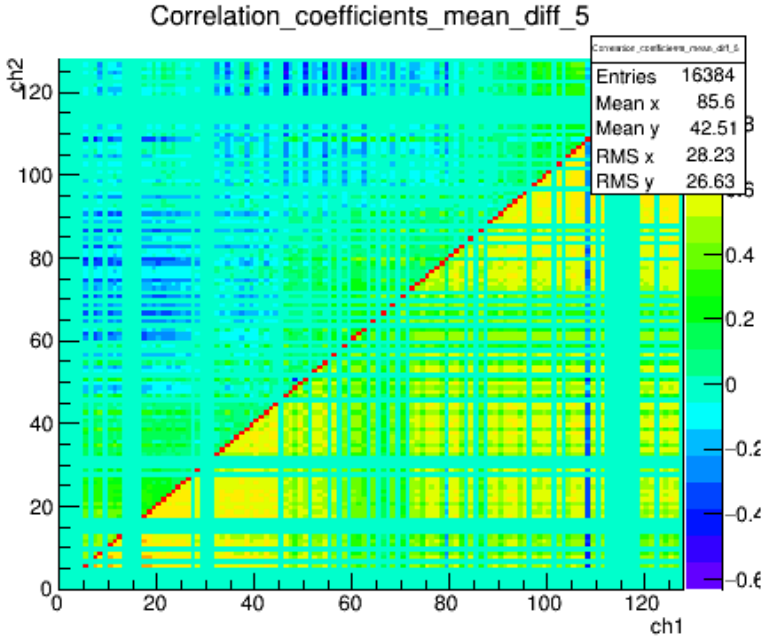
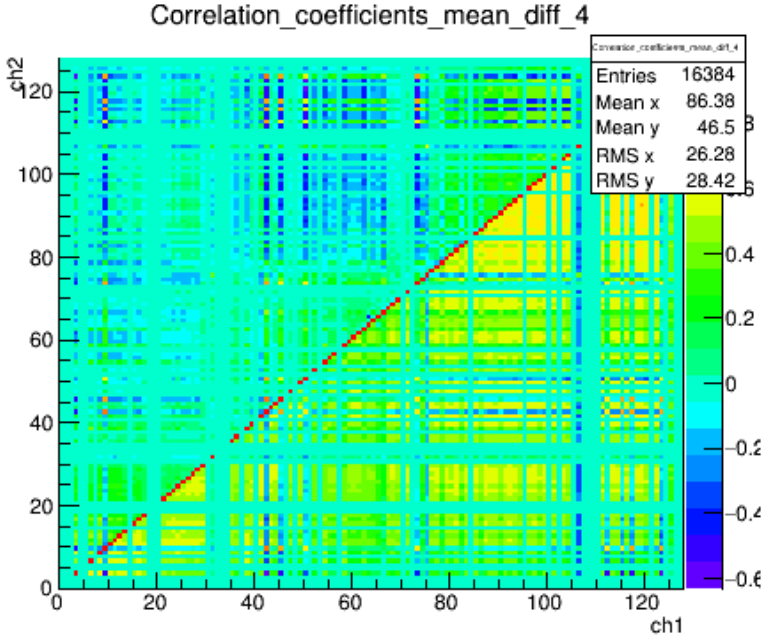
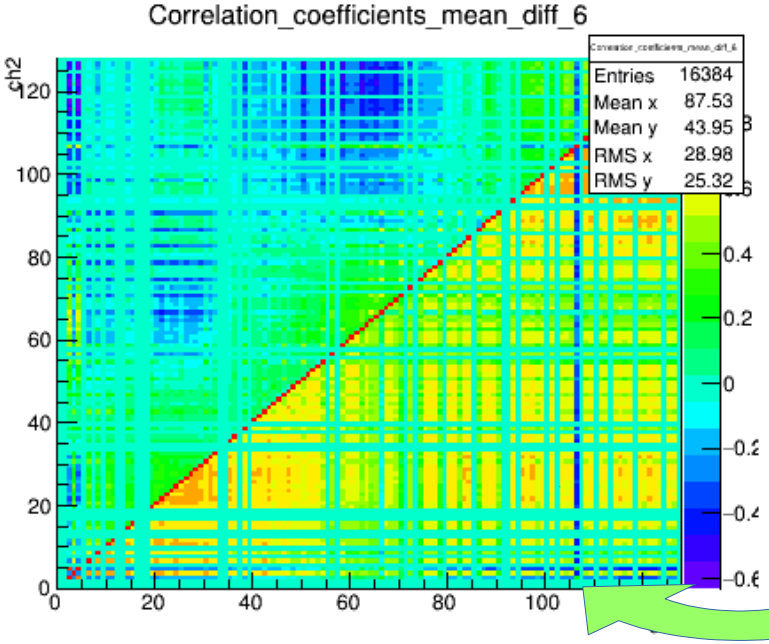


- Run 122, ~7000 events;
- MMDAQ configured not to make pedestal subtraction and zero suppression;
- Bad channels are masked and was not used for CM calculation;
- Changes are not well visible mostly because mean value of the R_{ij} distribution is not very sensitive to the shape changes caused by CM correction.

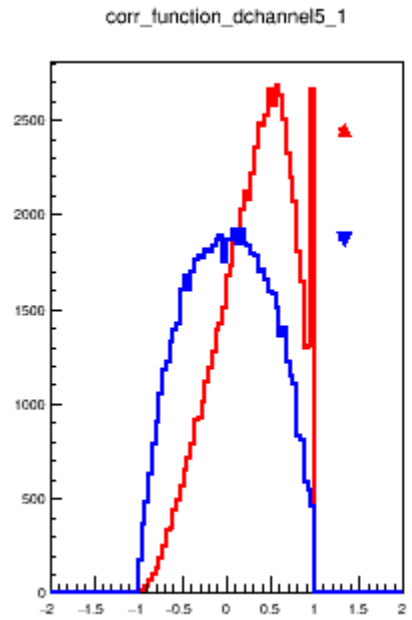


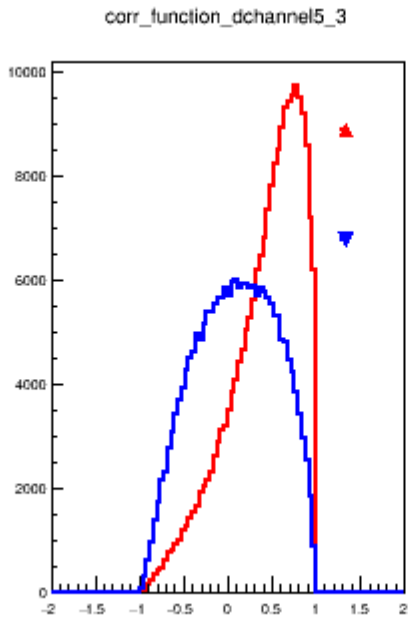


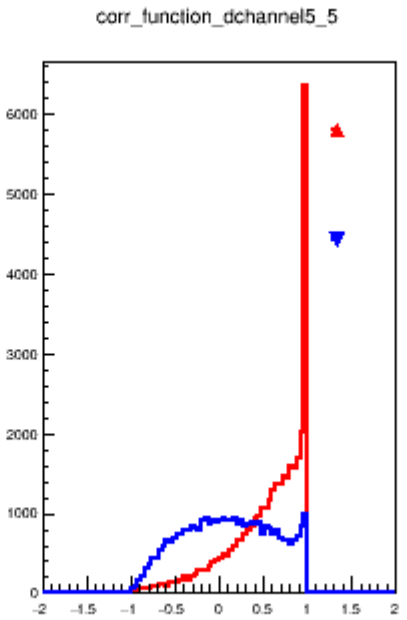
ch1 < ch2 : after CM correction

ch1 > ch2 : before CM correction

Correlation Coefficient, Run 106 at TAU



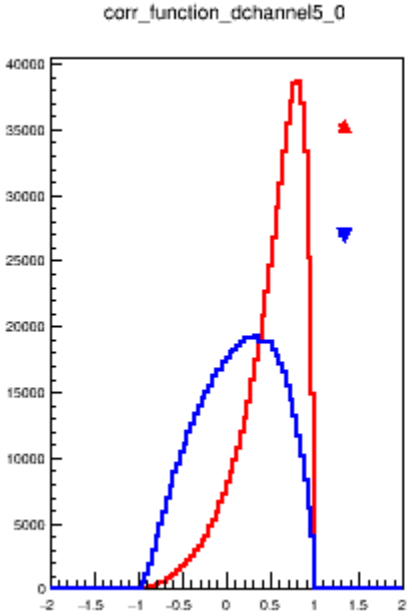


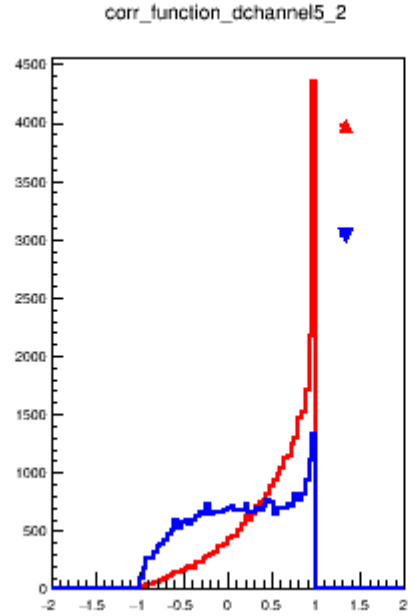


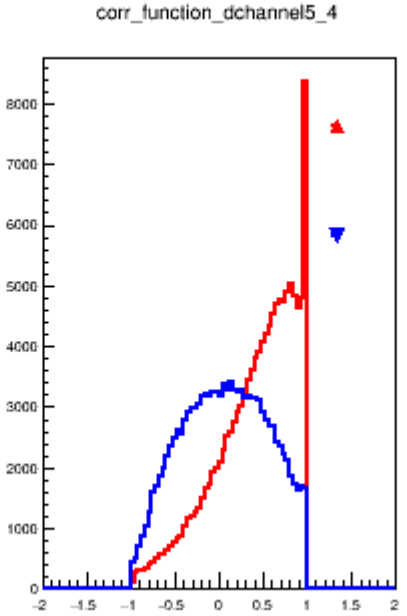
MMDAQ makes offset correction and ZS.

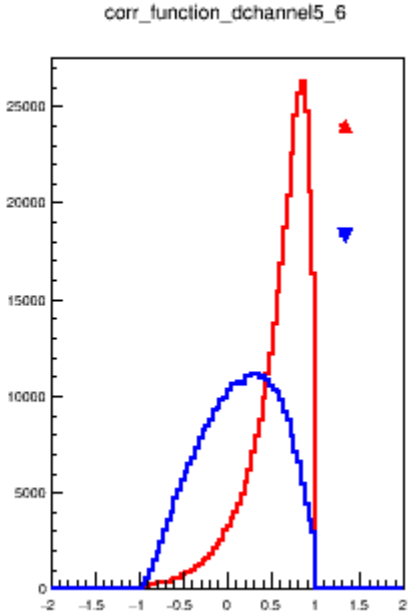
Distributions of R_{ij}: |i-j|=5;

Without and with CM correction.

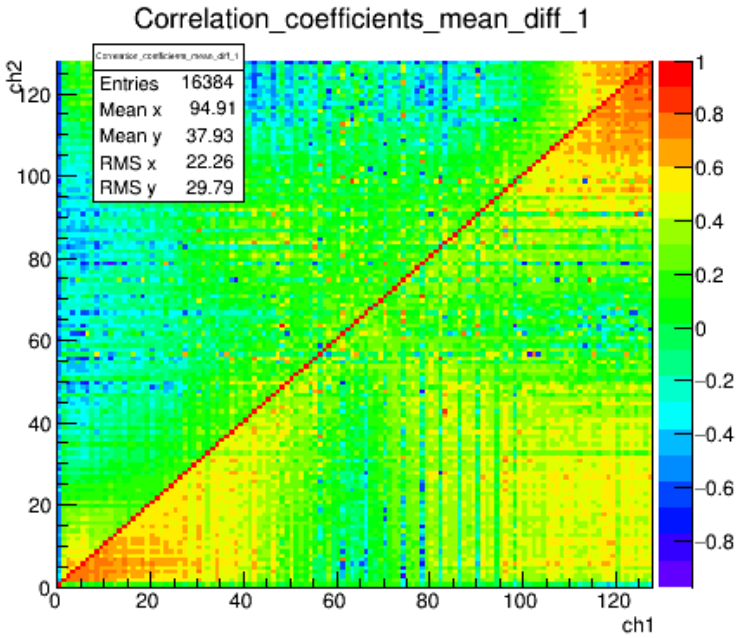


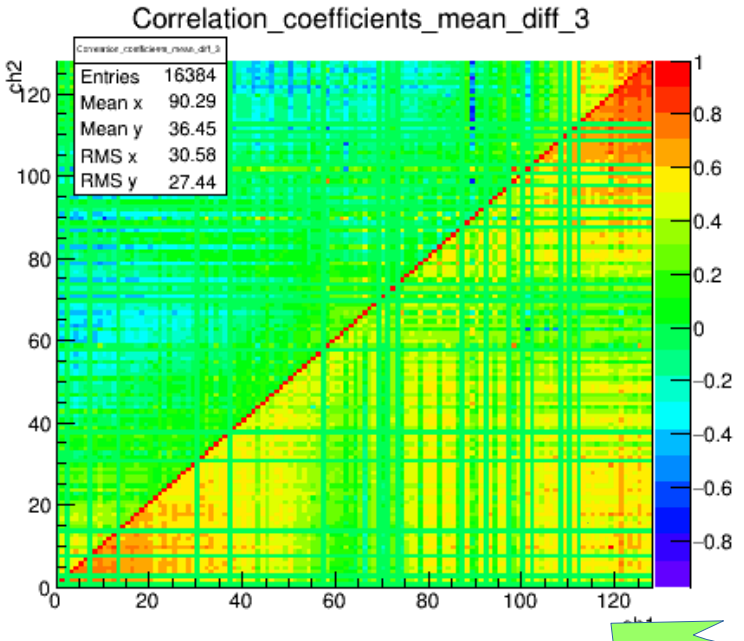






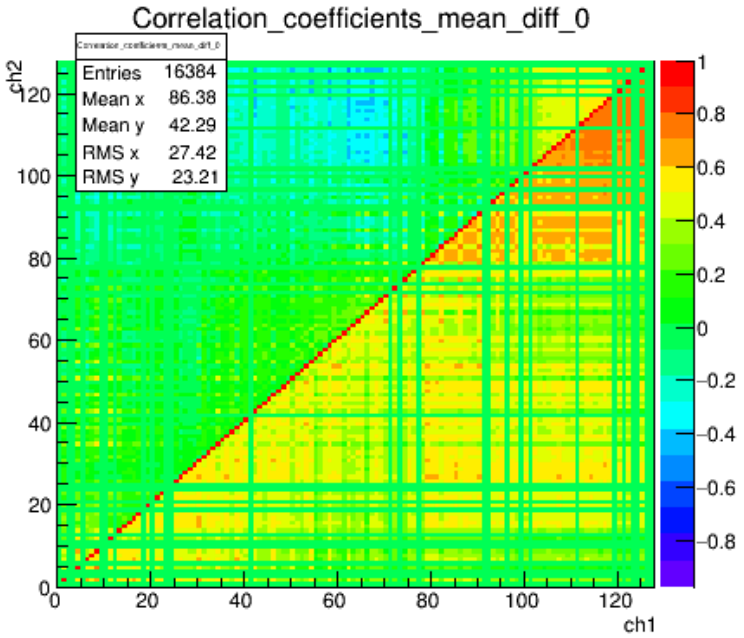
Mean Value of Correlation Coefficient Distribution, Run 106 at TAU

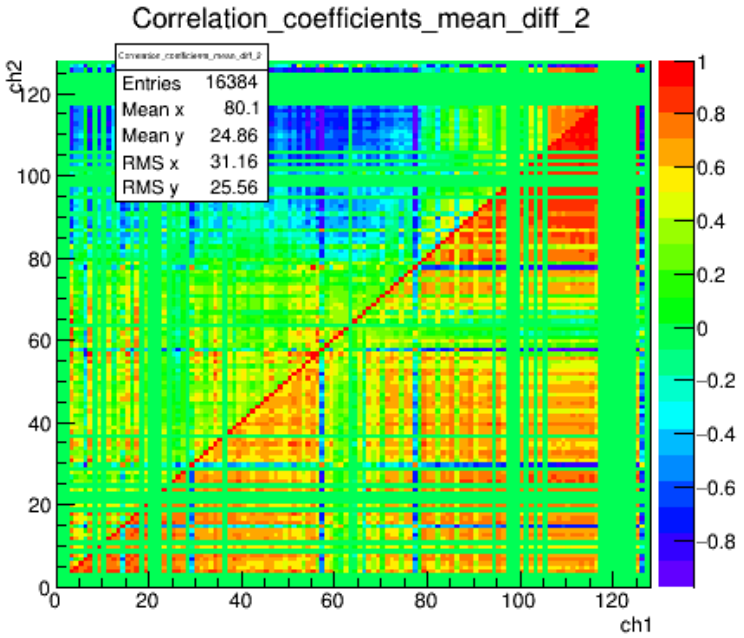




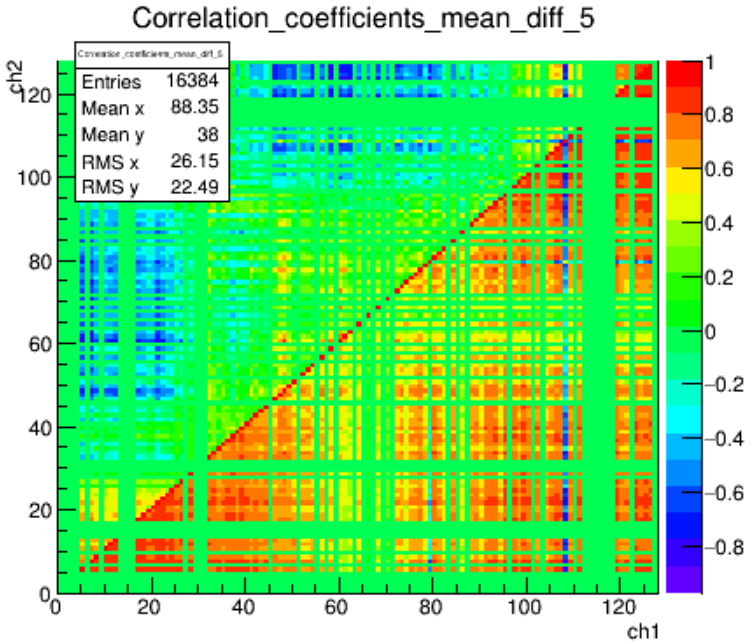
ch1 < ch2 : after CM correction

ch1 > ch2 : before CM correction

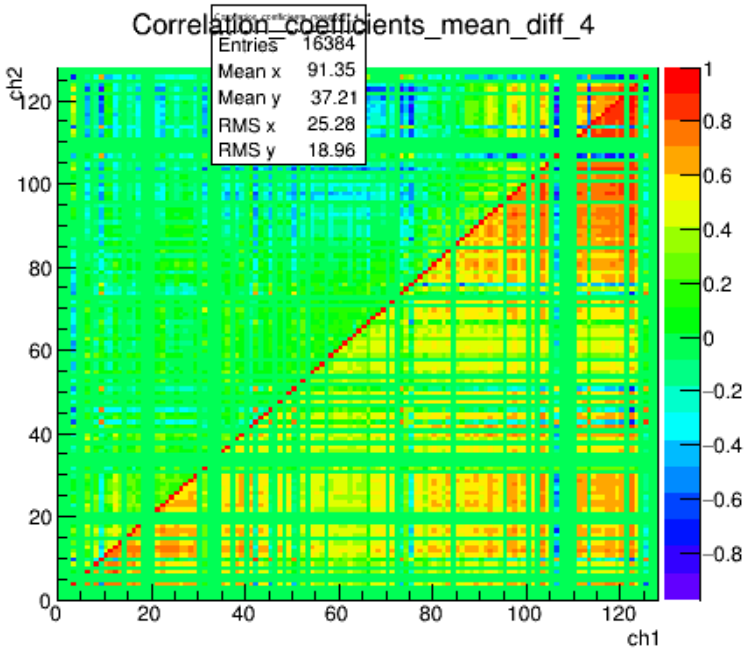


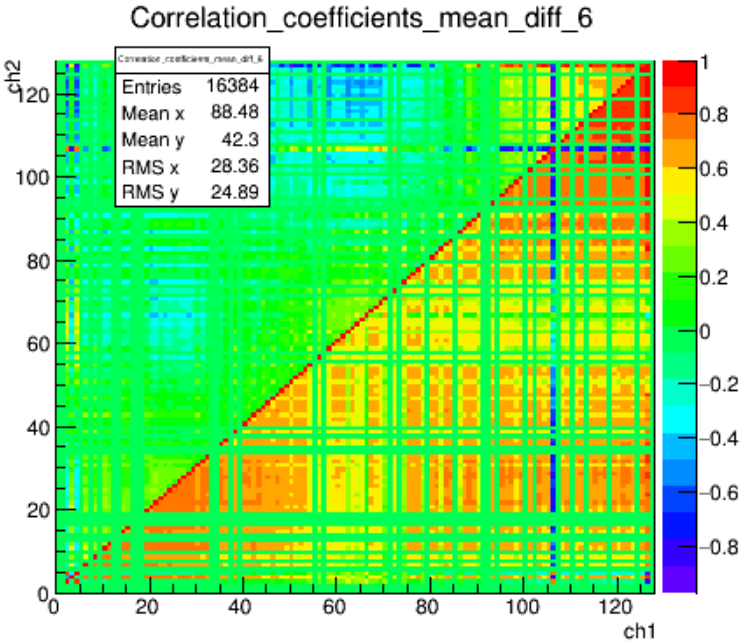


Mean Value of Correlation Coefficient Distribution, Run 106 at TAU

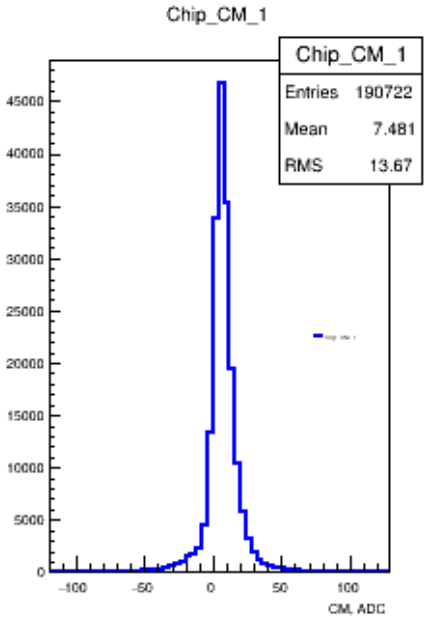


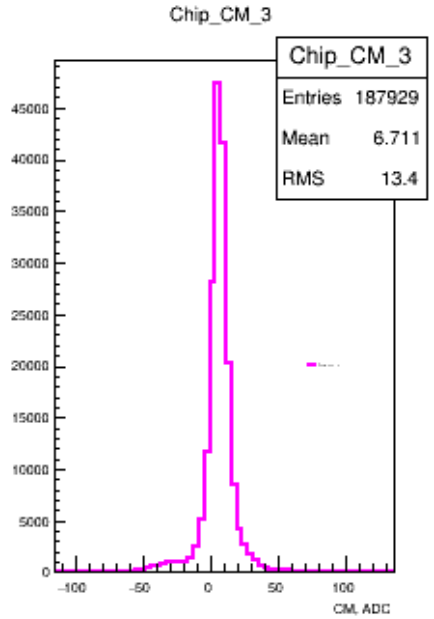
- Run 106, ~120k, only 10k events were used;
- MMDAQ configured to make pedestal subtraction and zero suppression;
- Bad channels are masked and was not used for CM calculation;

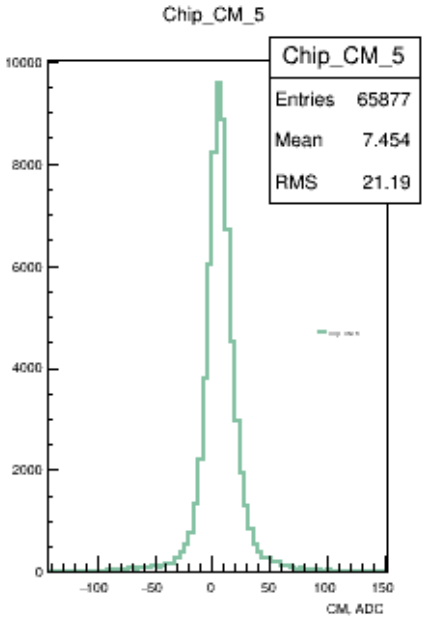


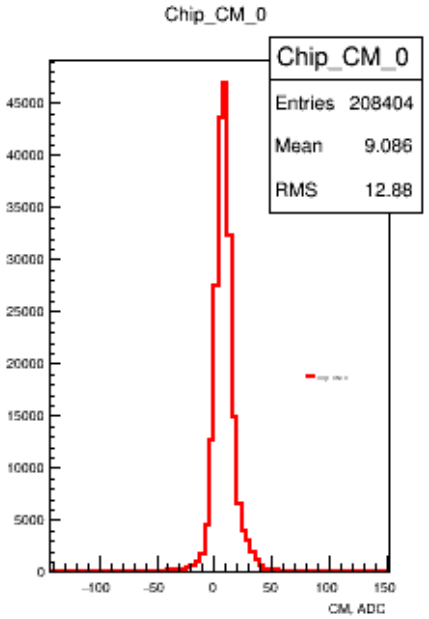


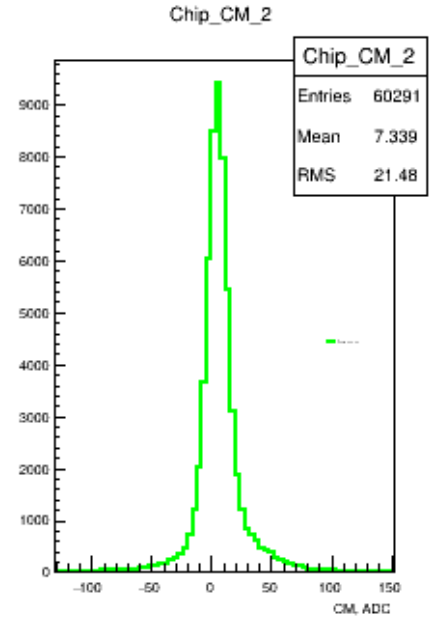
CM Distribution for Different APVs. Run 106 at TAU

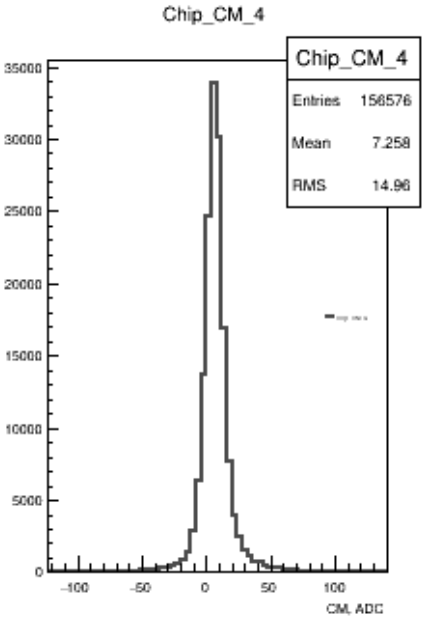


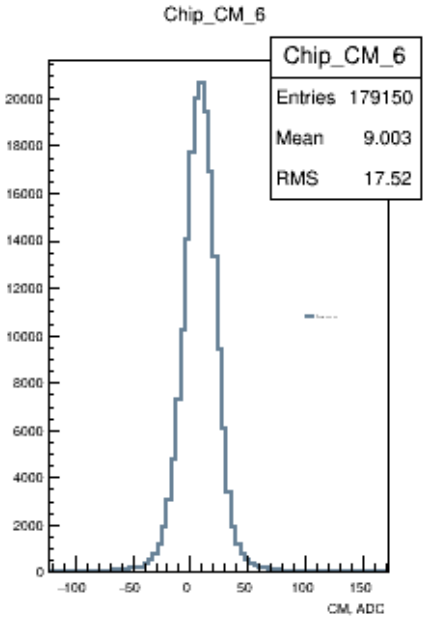




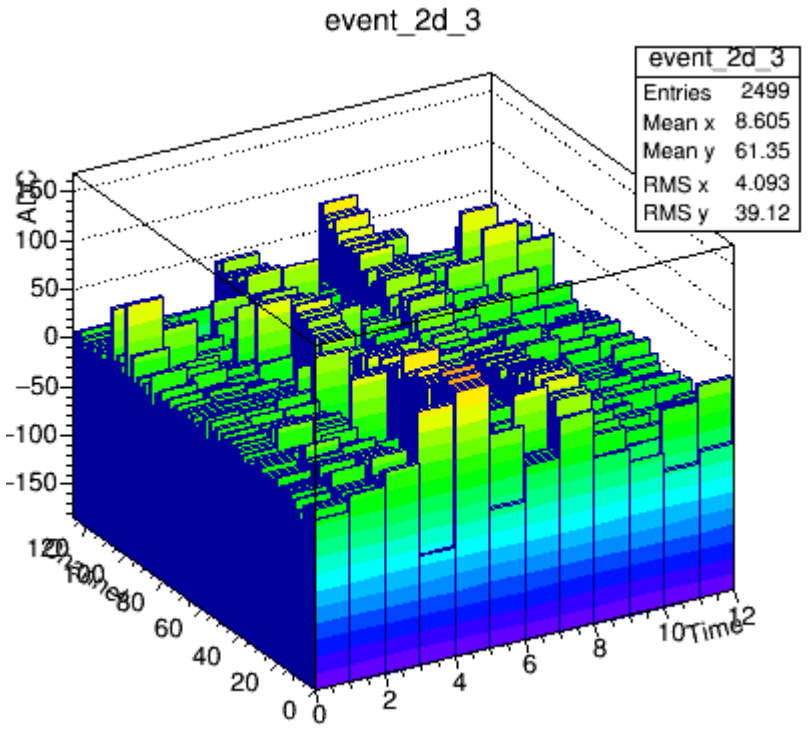


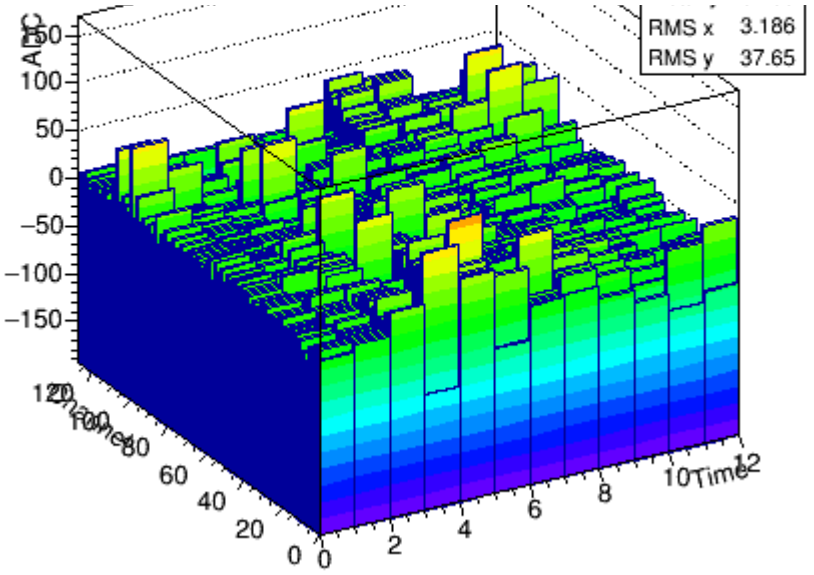


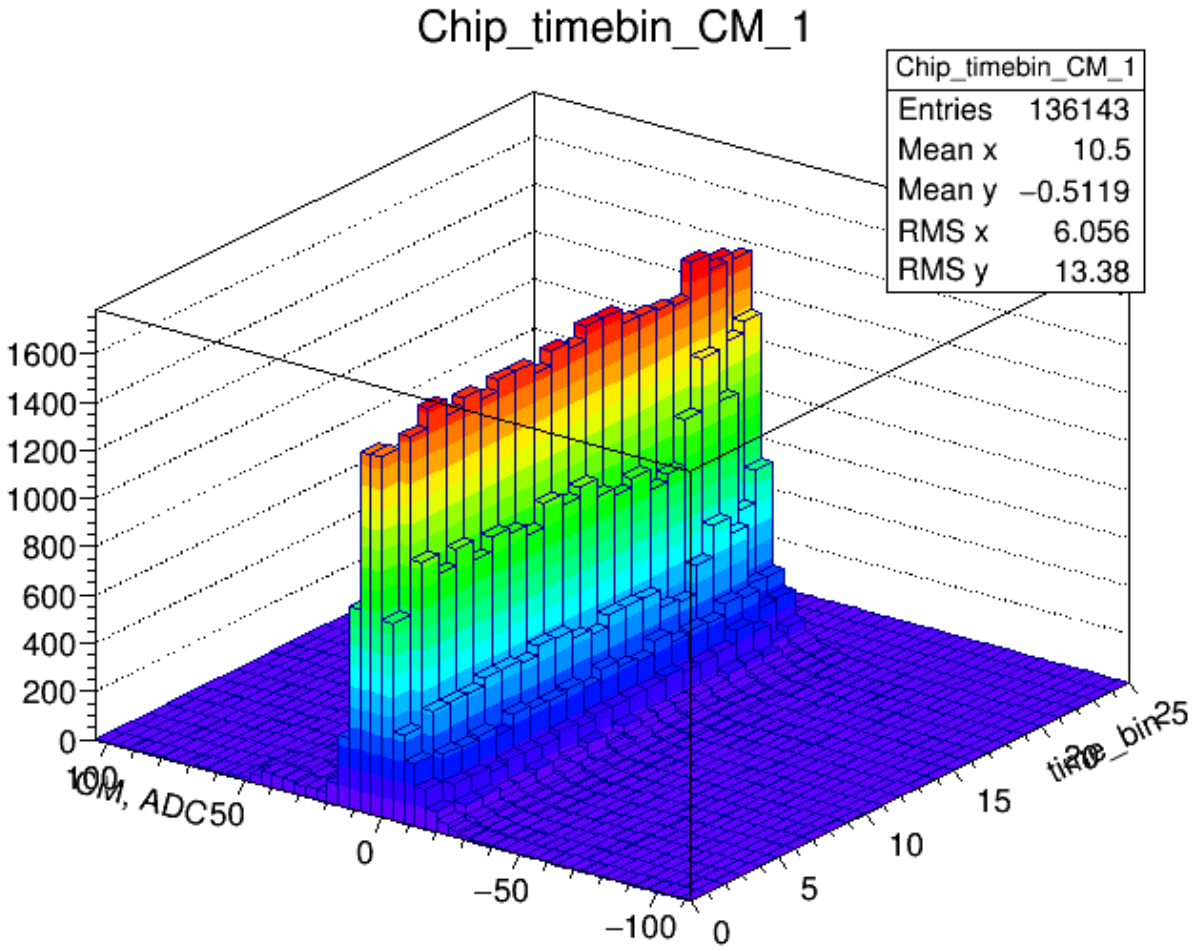




CM corrected Event and CM vs Time Bin







Bad Channels

int APV_0[] = {0, 2, 3, 5, 9, 10, 12, 18, 20, 23, 24, 41, 71, 73, 77, 91, 92, 96, 99, 101, 111, 119, 121, 123, 124, 126, 127};

int APV_2[] = {0, 1, 2, 8, 10, 18, 20, 21, 22, 24, 28, 36, 63, 94, 97, 98, 99, 101, 103, 105, 117, 118, 119, 120, 121, 122, 123, 124, 127};

int APV_3[] = {0, 2, 7, 13, 30, 37, 57, 69, 71, 73, 87, 92, 97, 100, 102, 108, 110, 112};

int APV_4[] = {0, 1, 2, 4, 5, 7, 14, 18, 19, 20, 30, 32, 33, 34, 37, 40, 46, 48, 51, 53, 57, 70, 72, 84, 95, 100, 102, 105, 107, 108, 109, 110, 121, 124, 126, 127};

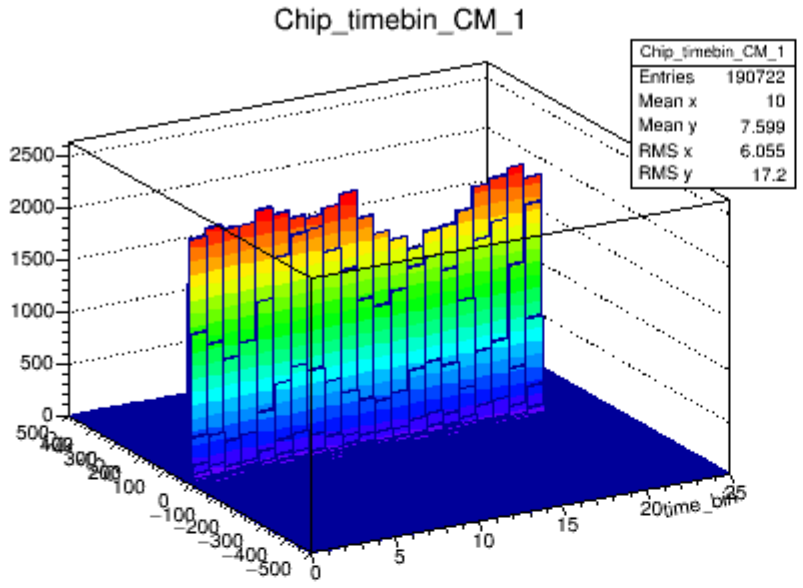
int APV_5[] = {0, 1, 2, 3, 4, 6, 9, 13, 14, 15, 16, 27, 29, 31, 45, 51, 55, 57, 59, 65, 67, 69, 71, 83, 85, 87, 96, 101, 103, 110, 112, 113, 116, 117, 118, 122, 127, 114, 115, 63, 30};

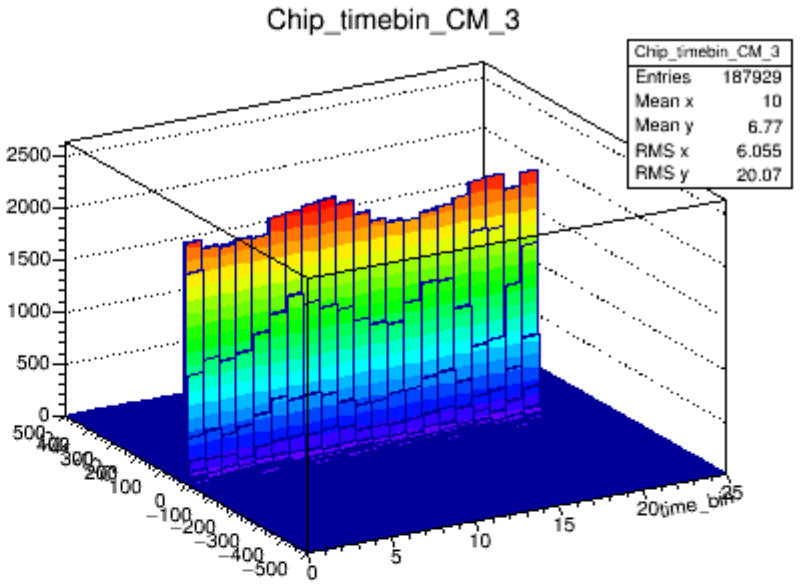
int APV_6[] = {0, 1, 5, 7, 9, 12, 13, 16, 17, 18, 33, 34, 37, 39, 55, 57, 71, 73, 79, 85, 91, 92, 94, 100, 102, 107, 110, 113, 118, 124, 127};

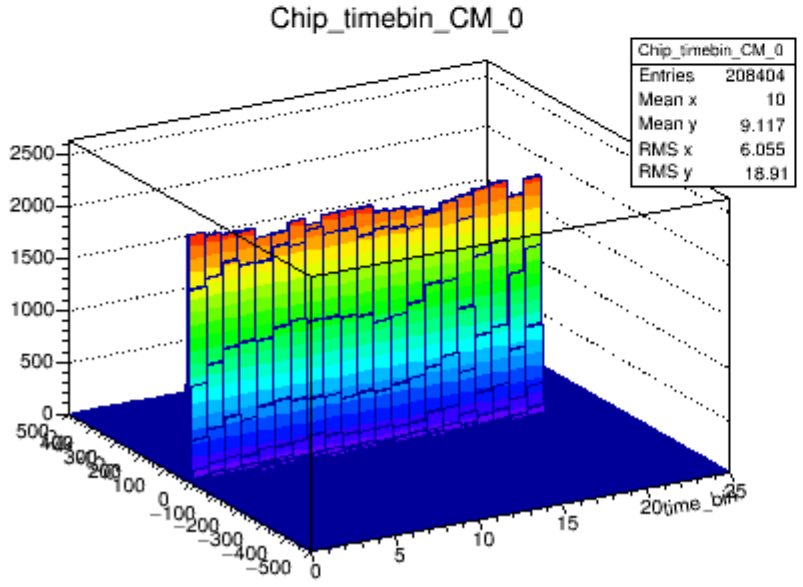
Summary

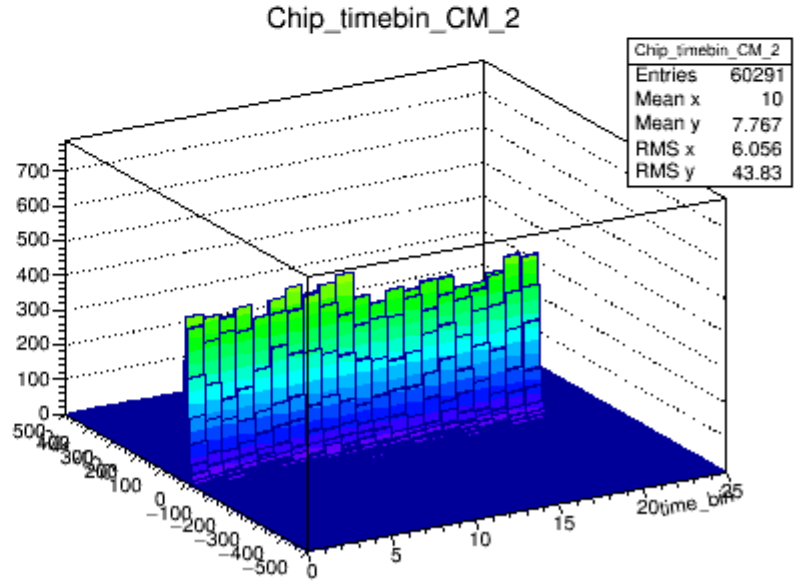
- There is essential signal correlation between channels of APV25 chip while connected to LumiCal modules.
- Signal correlation is essential in both MMDAQ configurations: w/ and w/o offset correction and ZS.
- CM correction algorithm reasonably well removes correlation between channels.
- CM values are similar for different time bins.
- CM correction is good to use for the calibration parameters calculation using muon run data. It is probably less important for shower development study as CM is mostly around 10-20 ADCs.

BACKUP

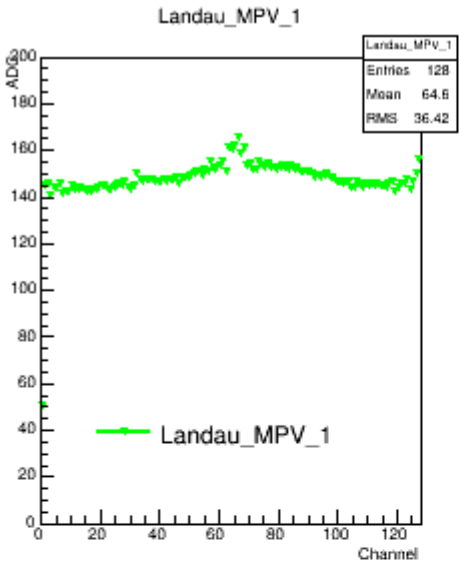

Chip_timebin_CM_1
Chip_timebin_CM_1
Entries 190722
Mean x 10
Mean y 7.599
RMS x 6.055
RMS y 17.2
2500
2000
1500
1000
500
0
500
400
300
200
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
time_bin
25

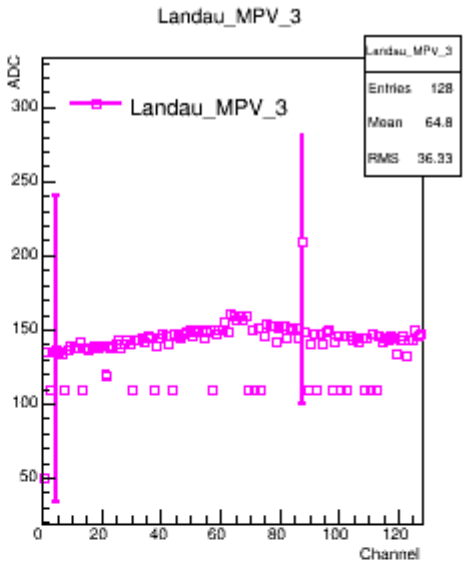

Chip_timebin_CM_3
Chip_timebin_CM_3
Entries 187929
Mean x 10
Mean y 6.77
RMS x 6.055
RMS y 20.07
2500
2000
1500
1000
500
0
500
400
300
200
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
time_bin
25

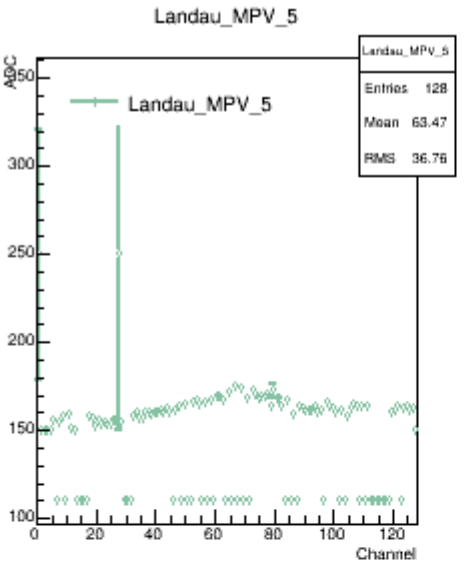

Chip_timebin_CM_0
Chip_timebin_CM_0
Entries 208404
Mean x 10
Mean y 9.117
RMS x 6.055
RMS y 18.91
2500
2000
1500
1000
500
0
500
400
300
200
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
time_bin
25

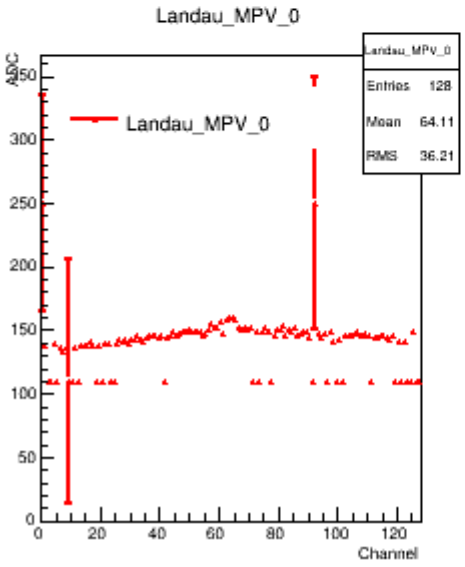

Chip_timebin_CM_2
Chip_timebin_CM_2
Entries 60291
Mean x 10
Mean y 7.767
RMS x 6.056
RMS y 43.83
700
600
500
400
300
200
100
0
500
400
300
200
100
0
−100
−200
−300
−400
−500
0
5
10
15
20
time_bin
25

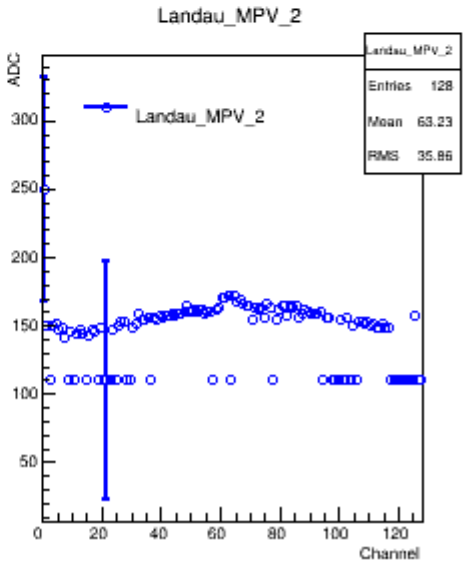
MPV for each channel w/o CM correction

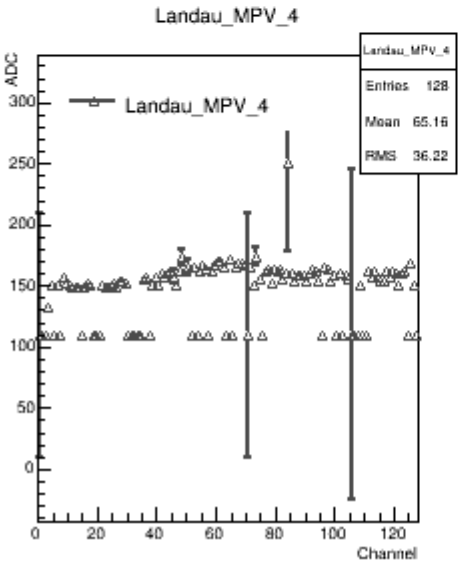


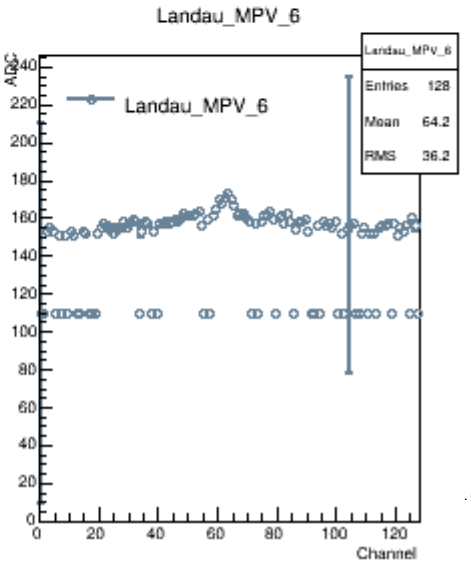




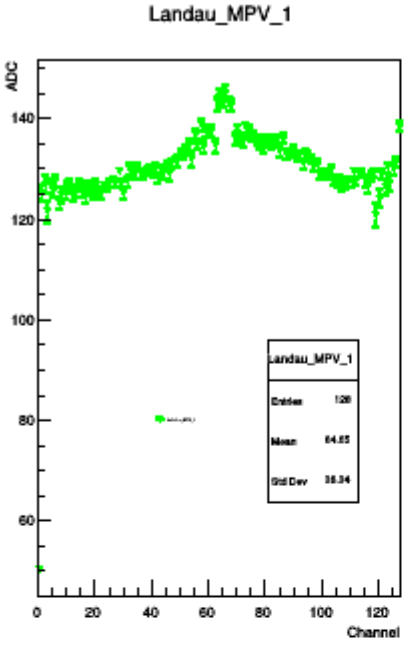


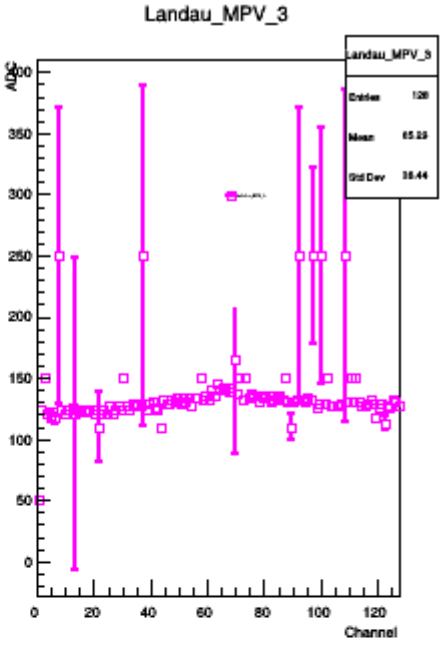


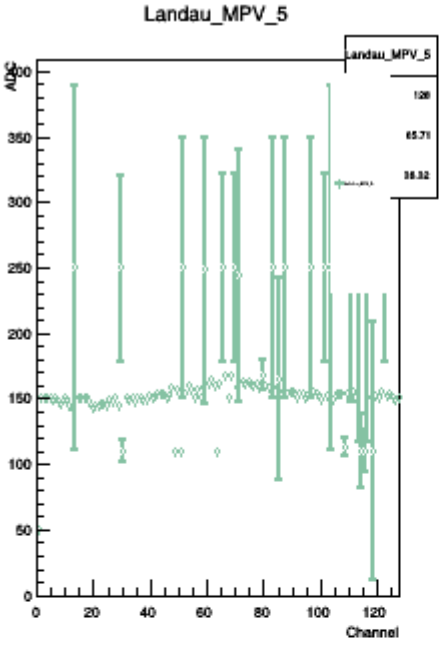


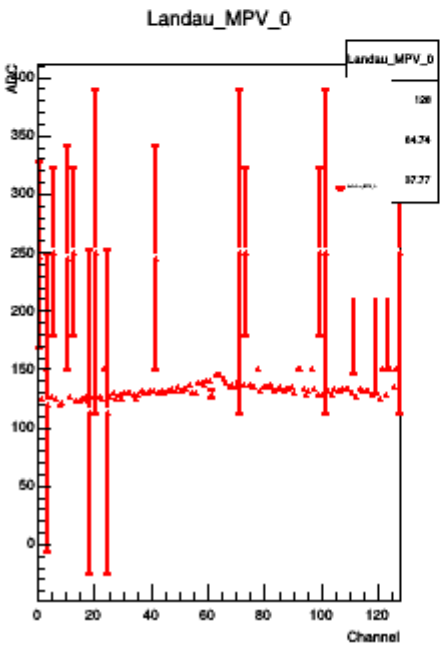


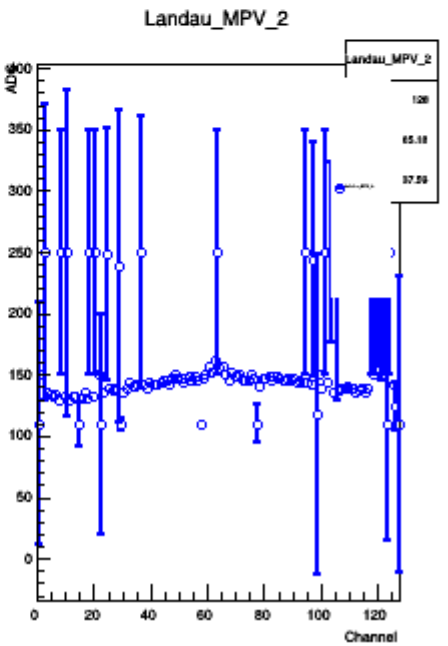
MPV for each channel w CM correction

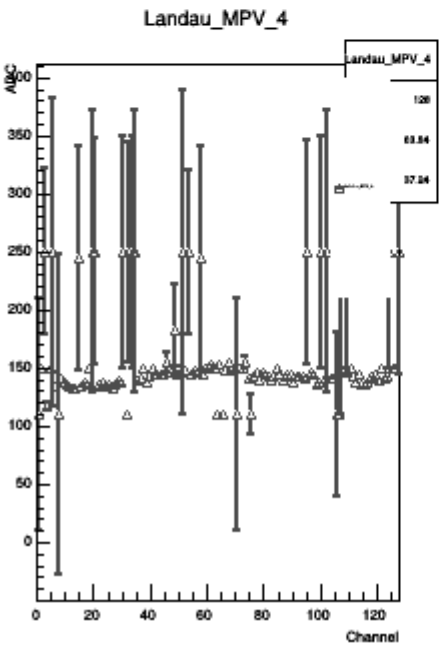


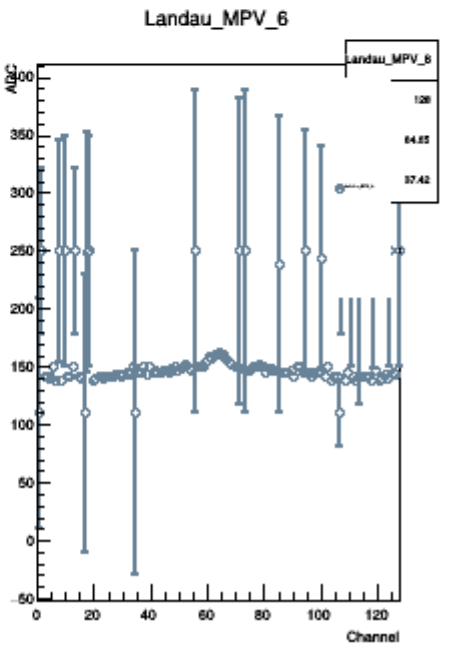








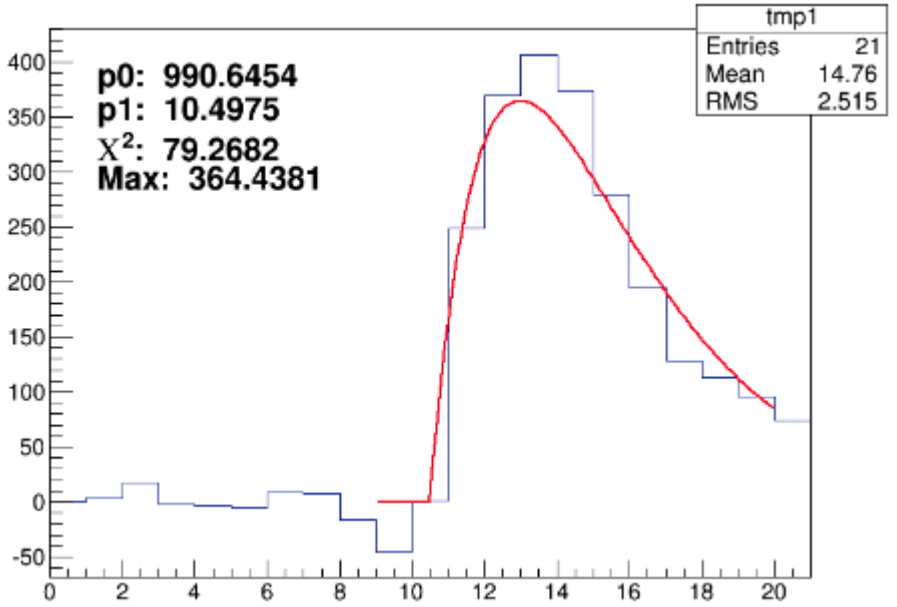


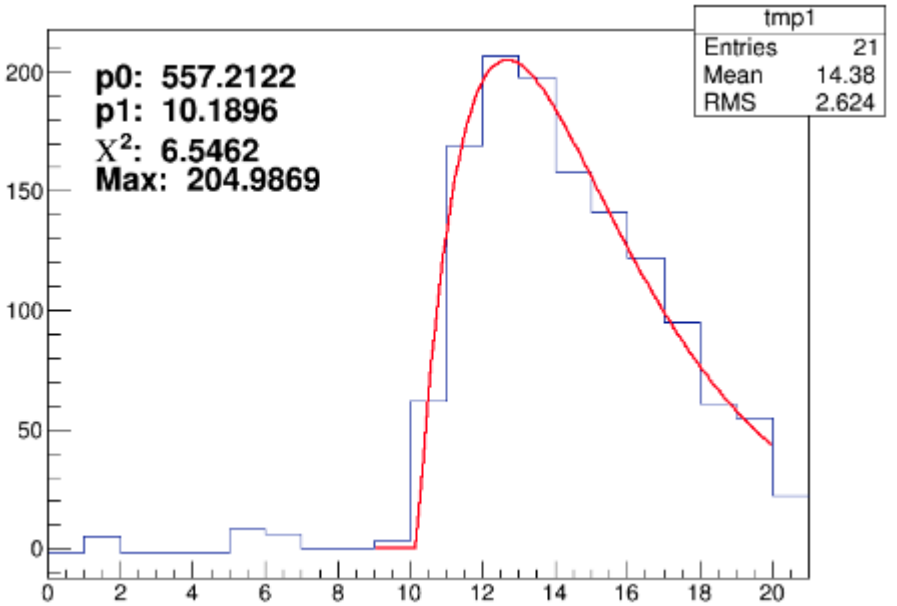


Signal Extraction Optimization

Fit signal with time response function of CR-RC filter:

$$V = \frac{e^{\frac{t0-t}{\tau}}\,(t-t0)\,P0}{\tau}$$





Possible cuts on: χ^2 and t0.

τ = 2.5 (bins) is fixed.
Maybe it should be also fit parameter with predefined range?

Gauss-Landau Fit for APV 1