DAC scan progress report

2022/12/16

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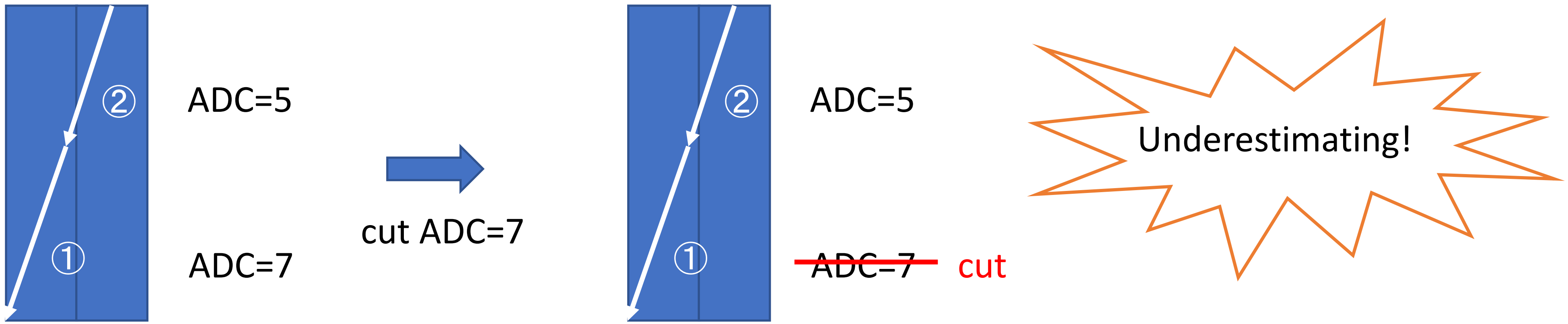
Changes from last week

- I cut clusters including ADC7.
- I fitted to noise and signal in the range of DAC value 12-136.
- I compared multi-hit and single-hit ADC distribution.

I am still working on the DAC scan analysis.

Cut clusters including ADC7

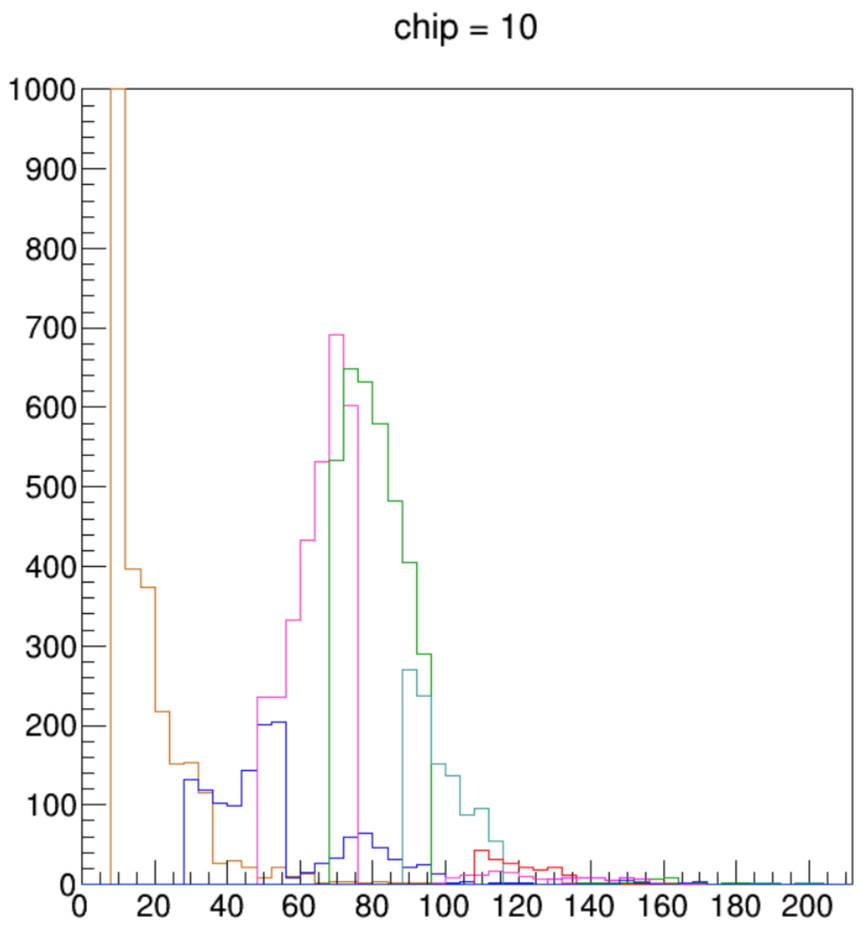
Previously, hits with ADC7 were cut individually. In this case, if the cluster includes two hits with ADC=5 and ADC=7, only ADC7 hit was cut and another hit was left. Therefore, it underestimated the energy loss.



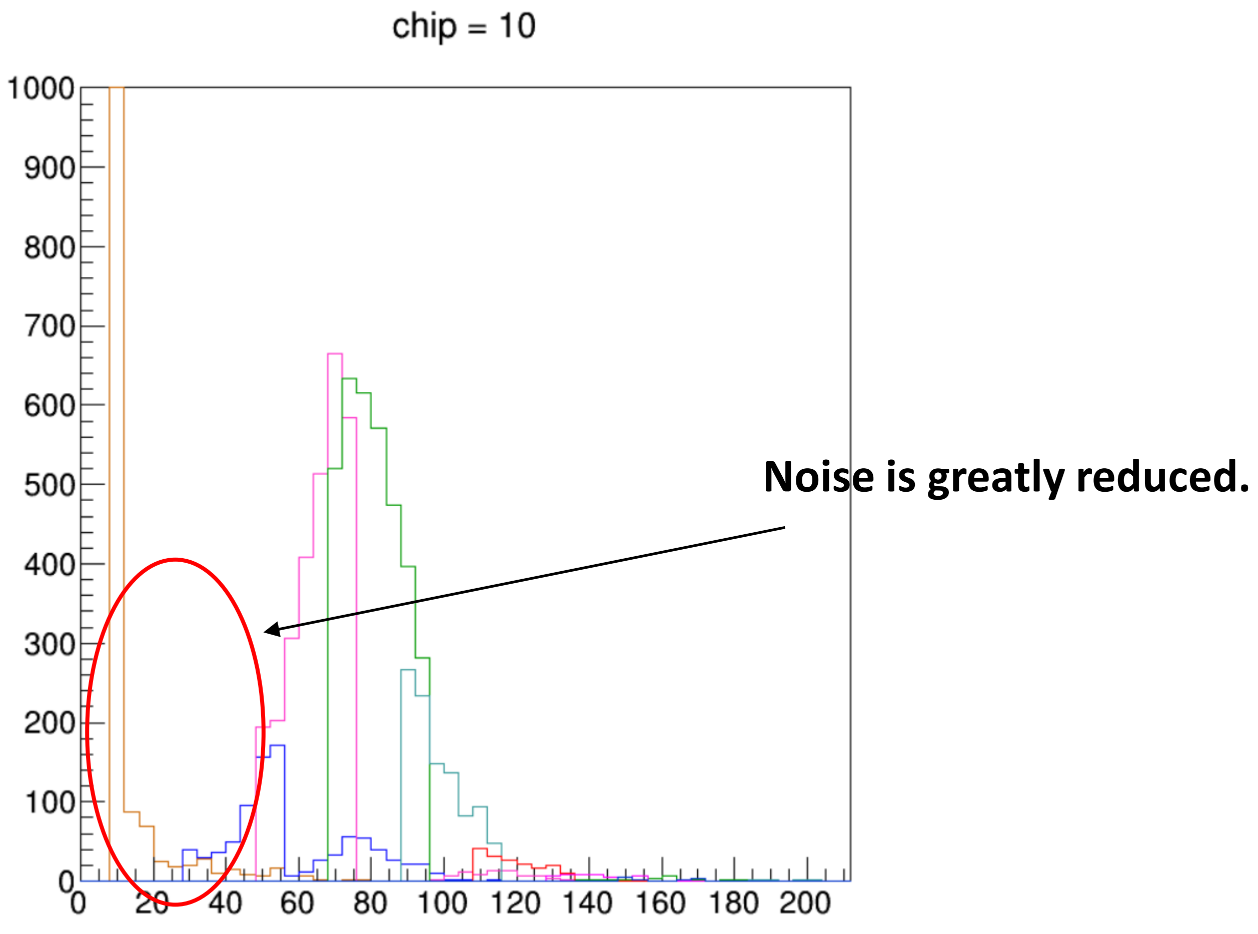
I decided to cut the cluster including ADC7.z

Cut clusters including ADC7

Both, also including multi-hit.



Before cutting clusters including ADC7



After cutting clusters including ADC7

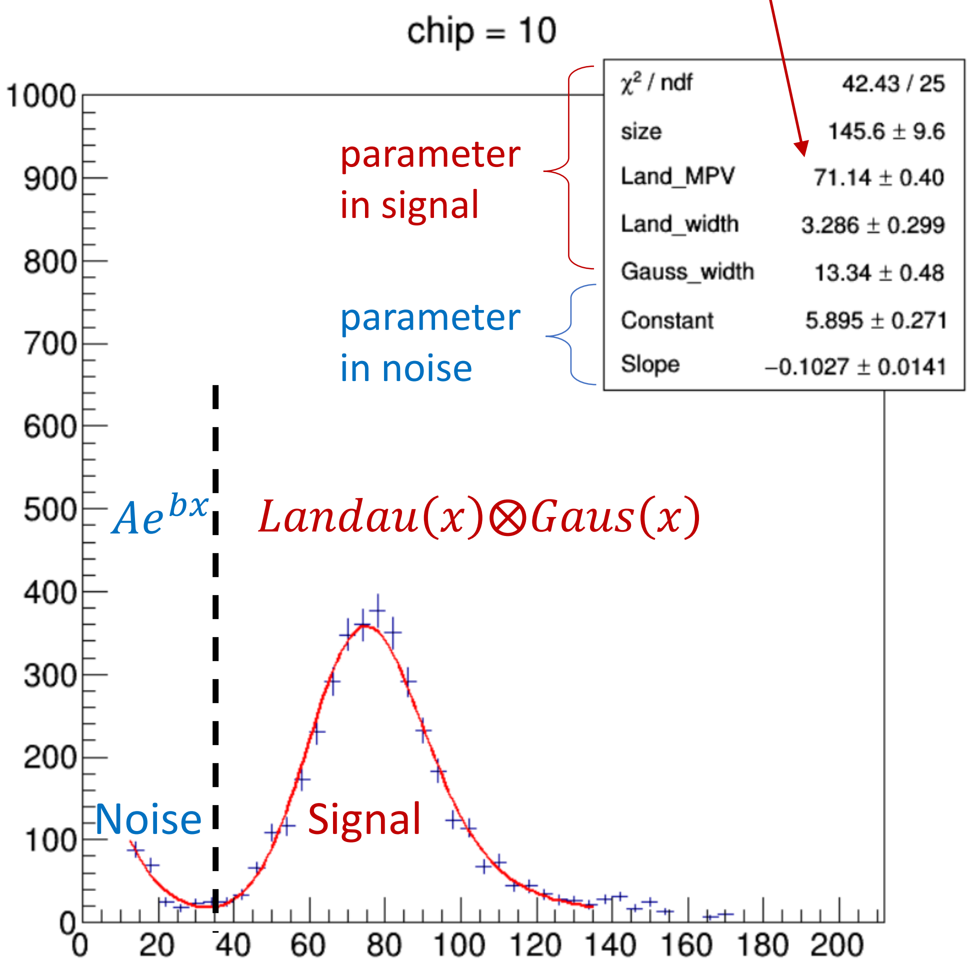
Fitting to noise and signal

I fitted by (Landau ⊗ Gauss convolution + exponential function) from 12 to 136.

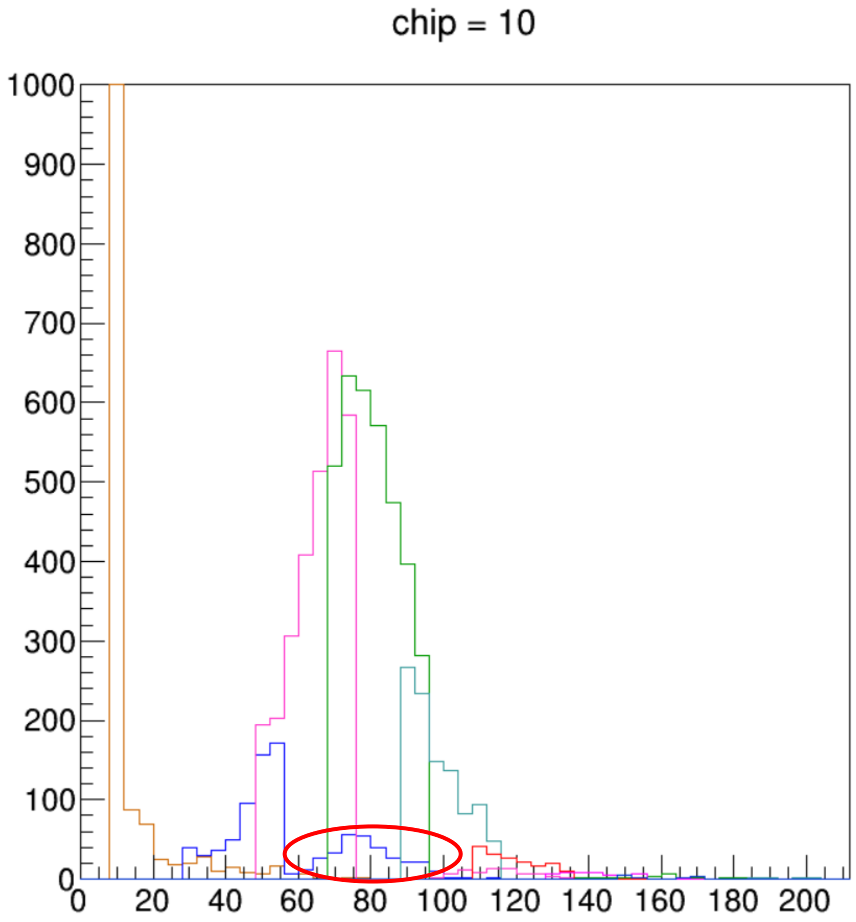
$$f(x) = \underbrace{Landau(x) \otimes Gauss(x)}_{\text{Signal}} + \underbrace{Ae^{bx}}_{\text{Noise}}$$

(Fitting range: $12 \leq x \leq 136$)

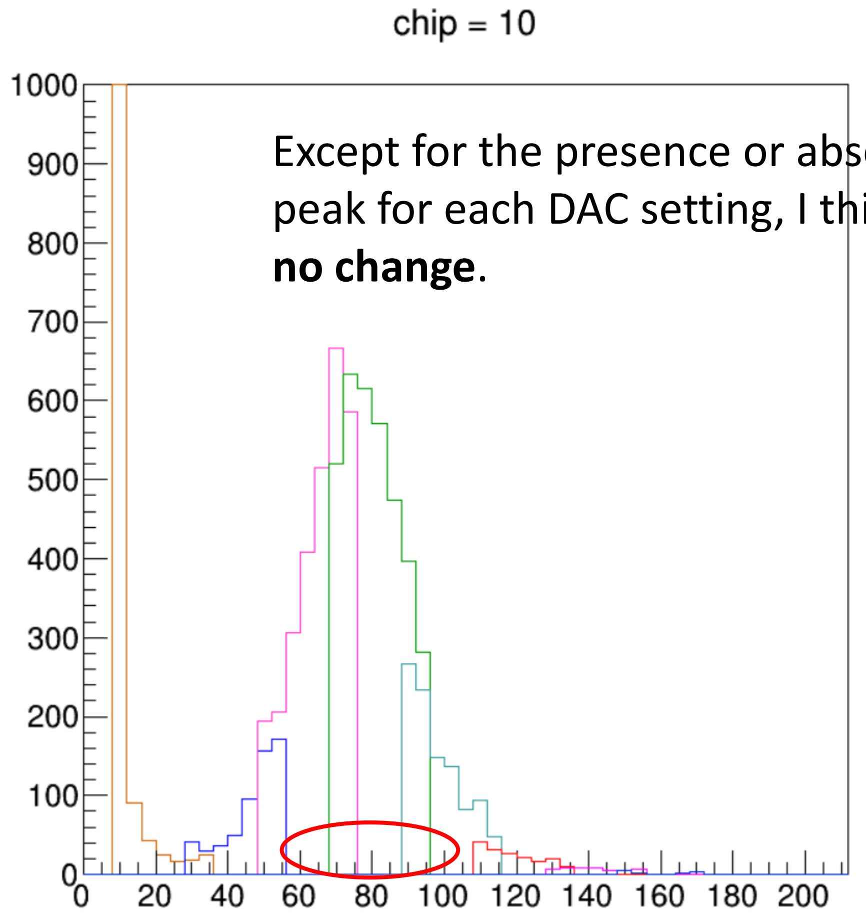
Land_MPV is regarded as MIP peak.



Multi-hit and single-hit ADC distribution comparison



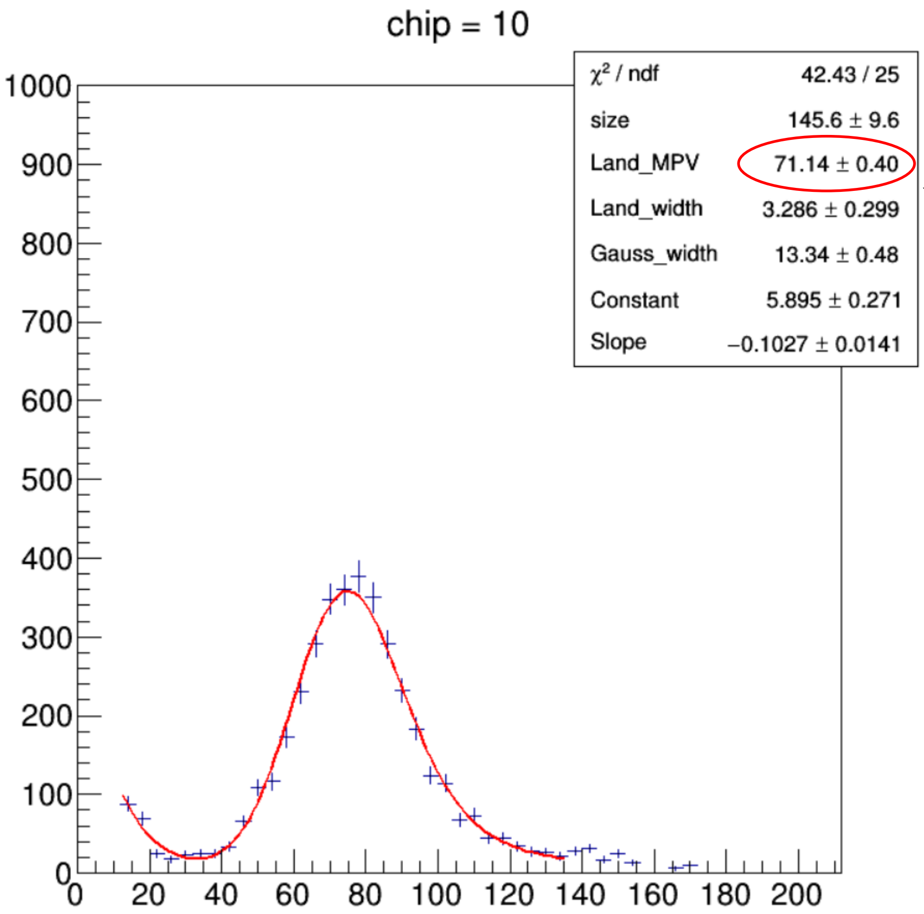
Also including multi-hit



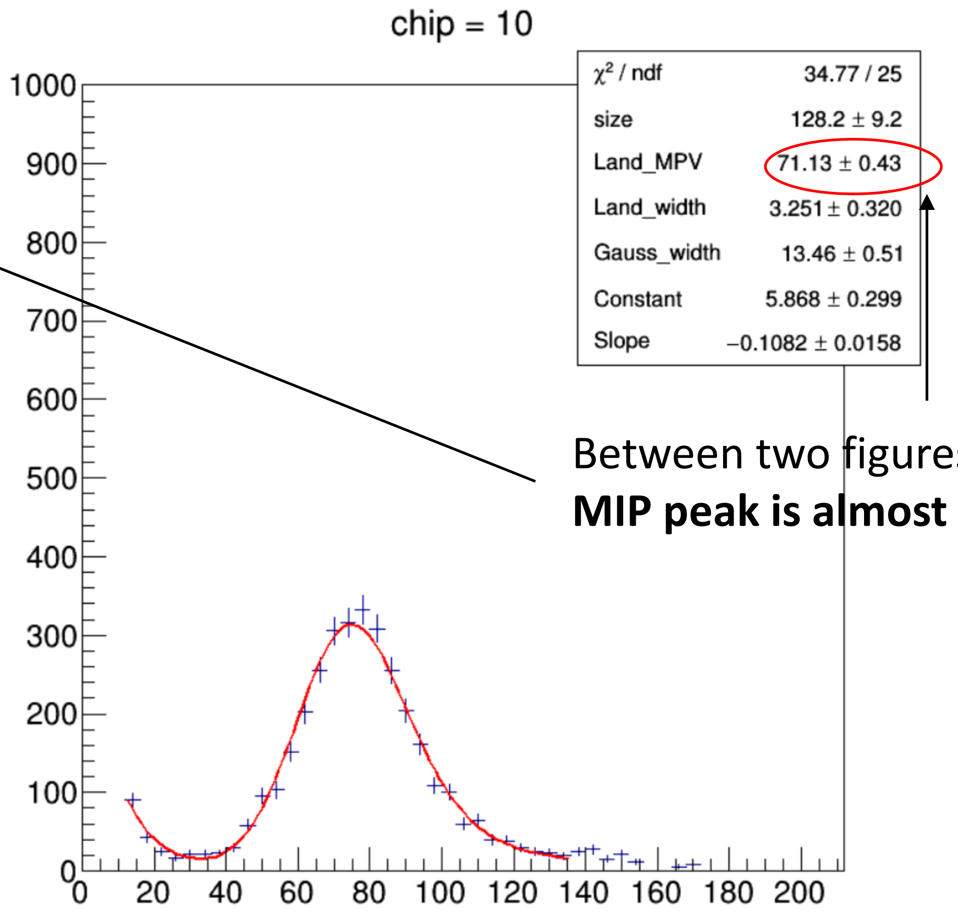
Except for the presence or absence of the second peak for each DAC setting, I think **there is almost no change**.

Only single hit

Multi-hit and single-hit ADC distribution comparison



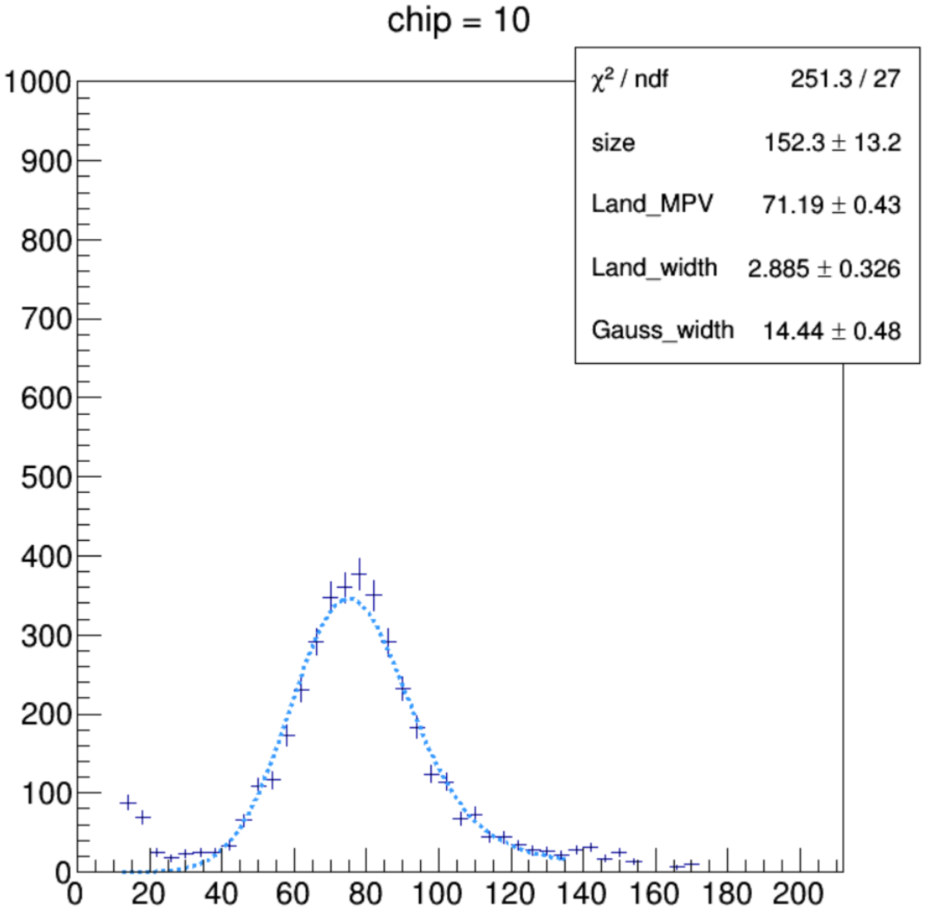
Also including multi-hit



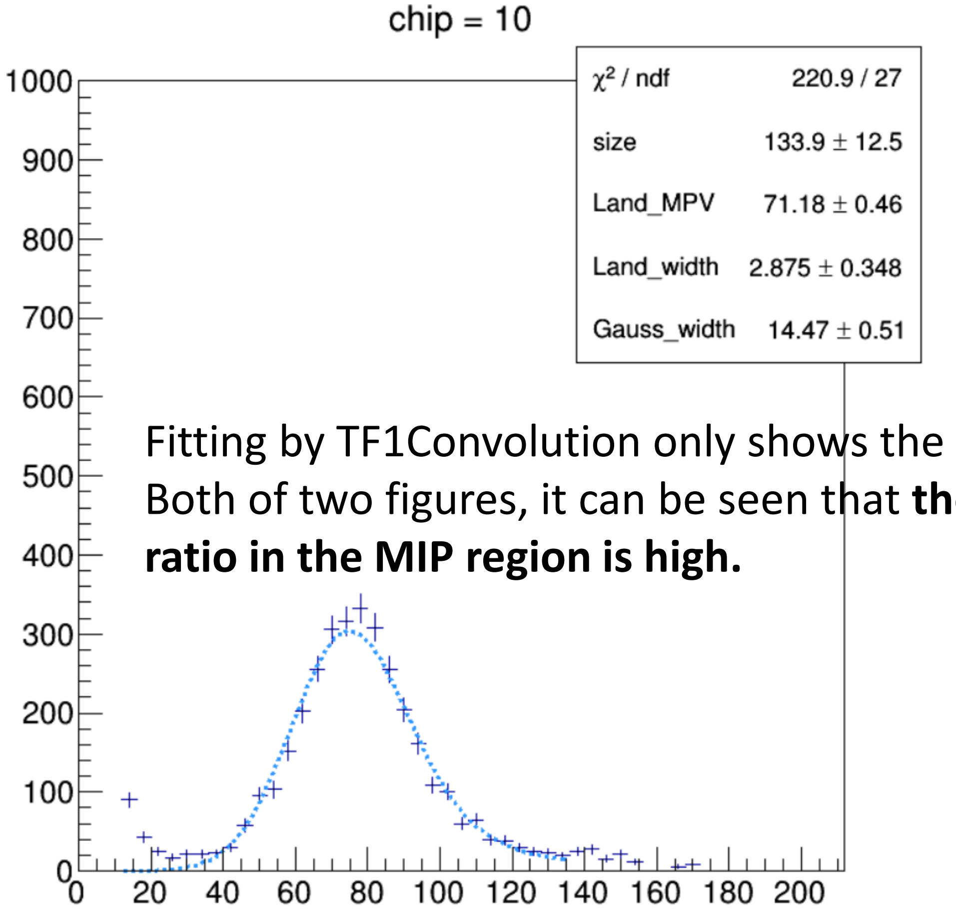
Only single hit

Between two figures,
MIP peak is almost unchanged.

Signal ratio（Only TF1Convolution fit）



Also including multi-hit



Fitting by TF1Convolution only shows the signal ratio. Both of two figures, it can be seen that **the signal ratio in the MIP region is high.**

Only single hit

Summary

- When I cut clusters including ADC7, noise is greatly reduced.
- I was able to fit by (convolution + exponential function) from DAC value 12 to 136.
- In multi-hit and single-hit ADC distribution comparison, shape of ADC distribution and MIP peak is almost unchanged.
- According to only TF1Convolution fit, the signal ratio in the MIP region is high.

I'm considering **whether** to include an ADC distribution with **multi-hit** or **only a single hit** in the ELPH report.

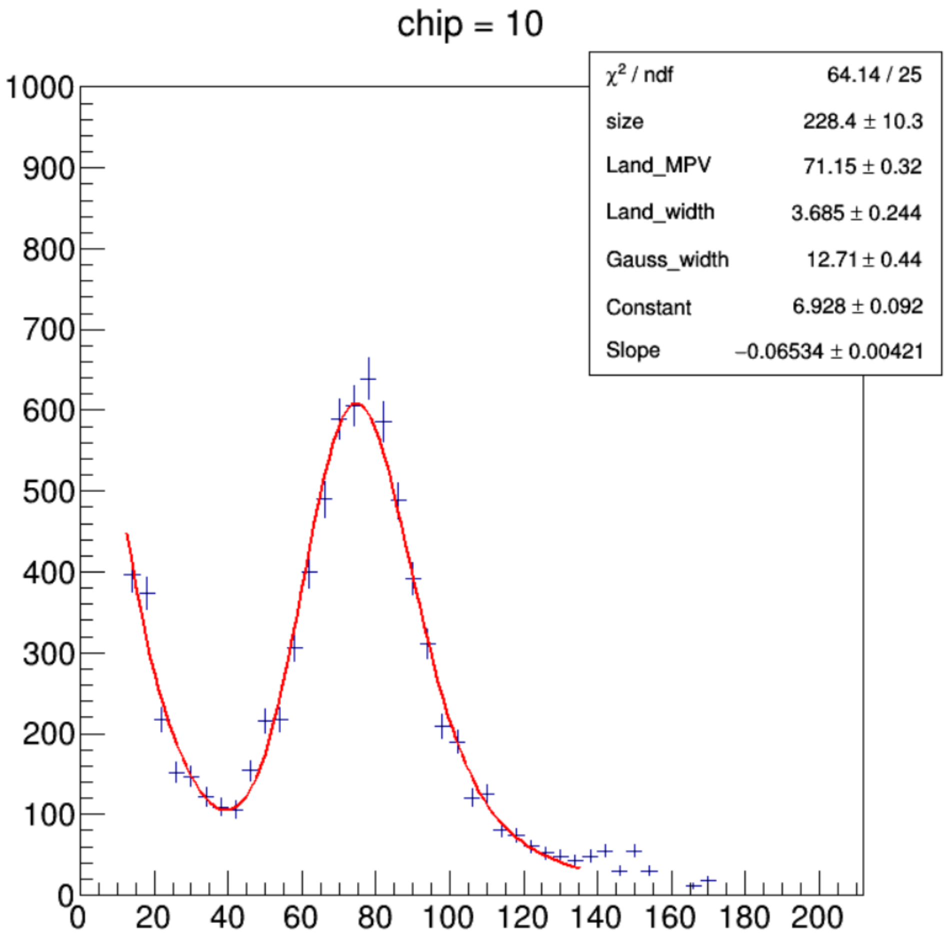
To do list

- Determining the ADC distribution used for ELPH report
- Correction of Japanese manuscript
- Japanese manuscript translated into English

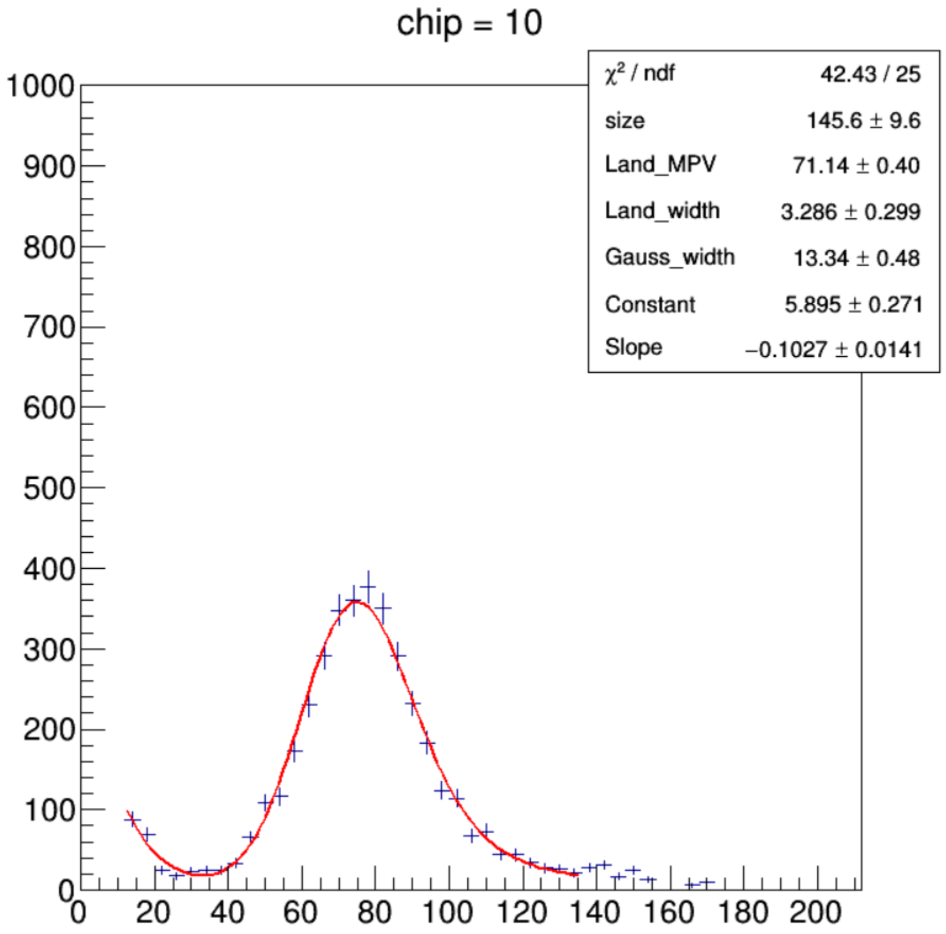
Back Up

Cut clusters containing ADC7

Both, also including multi-hit,
no limit on the number of clusters.



Before cutting clusters containing ADC7



After cutting clusters containing ADC7

Fitting to noise and signal

1. I did Landau and Gaussian convolution.
2. I defined the convolution and the exponential function in the TF1 class respectively.
3. I defined (exponential function + convolution) with lambda expression in C++.

Below I made the exponential function + convolution function.

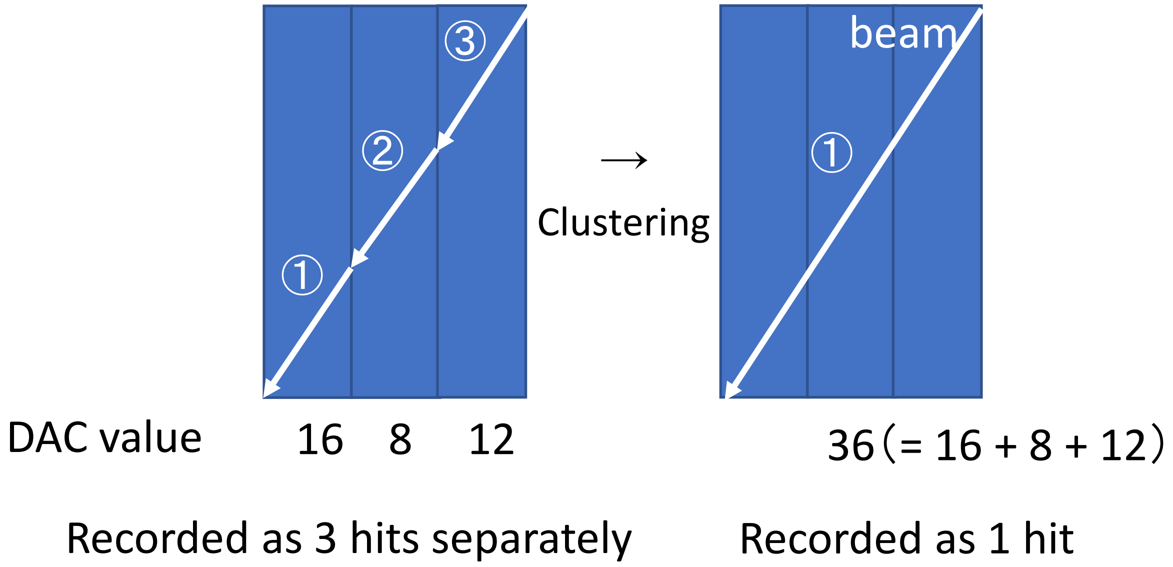
```
convolution function
TF1* f3 = new TF1("sum",
    // Define a function with a lambda expression.
    [=](double* x, double* p) { return f_conv->EvalPar(x, p) + f_noise->EvalPar(x, p + npar3); },
    xmin, xmax, npar3 + f_noise->GetNpar());
```

Clustering

When the beam enters at an angle, events are recorded separately across multiple channels.

I combine hits with adjacent channels at the same time and chip.

Also, I sum the DAC values. This is called clustering.



Schematic diagram of clustering

How to make an ADC distribution

1. ADC7 cutting
2. Get the ADC distribution from Run_{8-36} to $\mathrm{Run}_{148-176}$ respectively
3. normalize the distribution
4. average the number of hits in overlapping bins
5. fit by the TF1Convolution function

I will explain the details on the following pages.

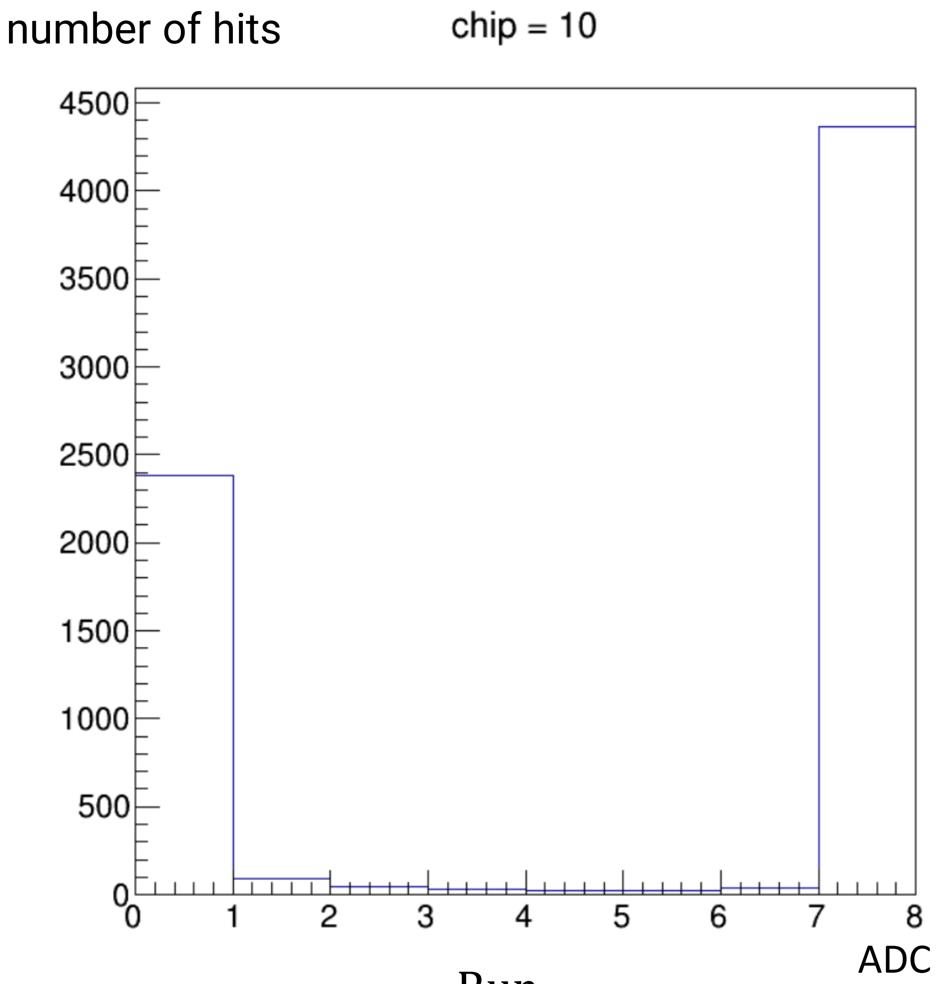
How to make an ADC distribution

1. ADC7 is considered as noise, so I cut ADC7.

For example, in Run_{8-36}, ADC7 picks up signals with a DAC value of 36 or higher.

ADC	DAC
0	8
1	12
2	16
3	20
4	24
5	28
6	32
7	36

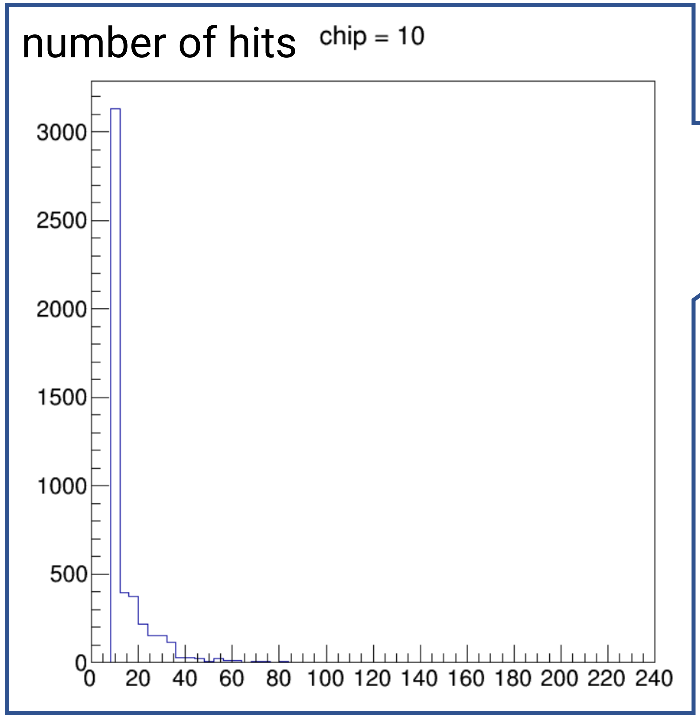
The relationship between ADC and DAC values for Run_{8-36}



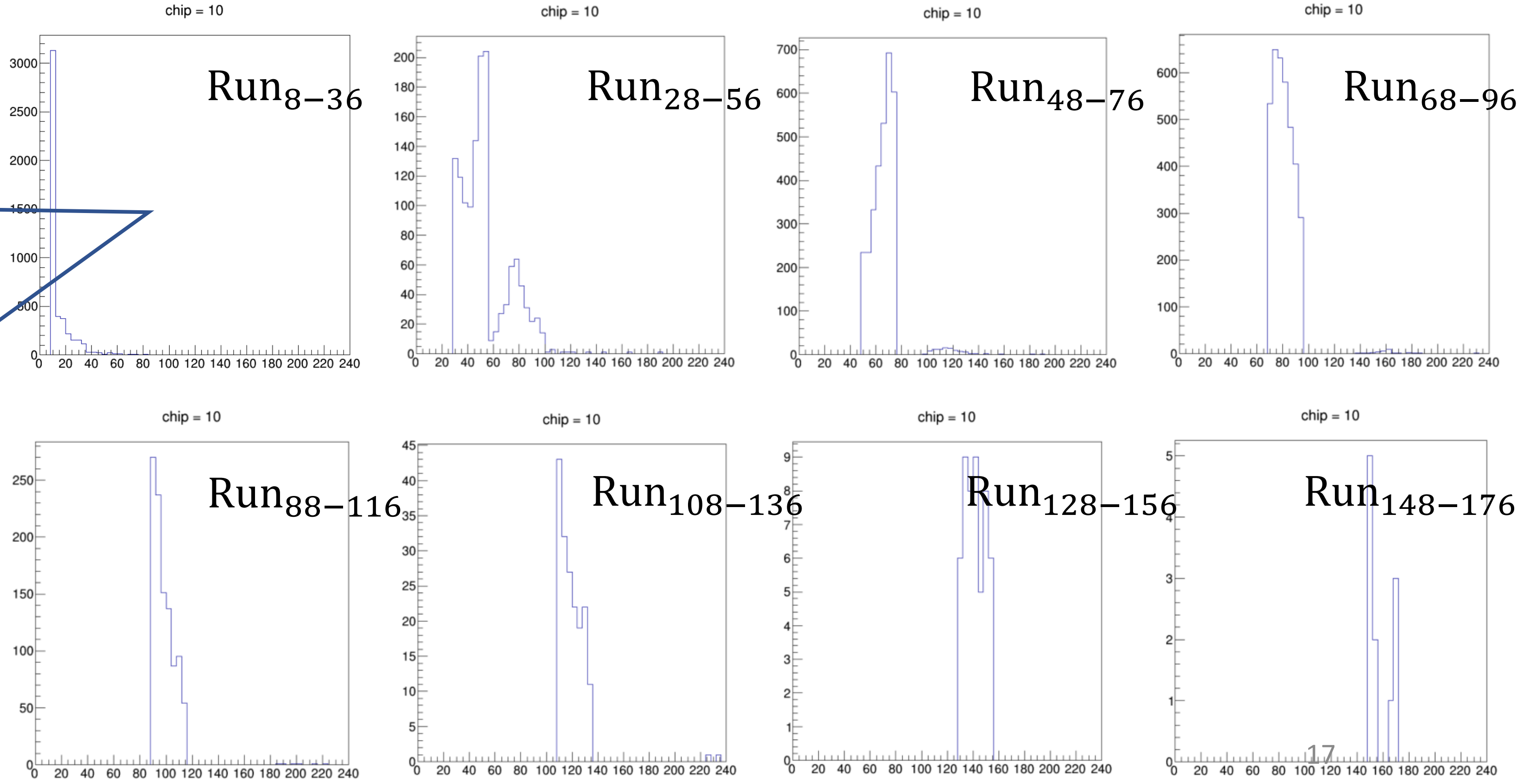
Run_{8-36}

How to make an ADC distribution

2. After cutting ADC7, I obtained the ADC distribution from Run_{8-36} to $\mathrm{Run}_{148-176}$ respectively.



DAC value

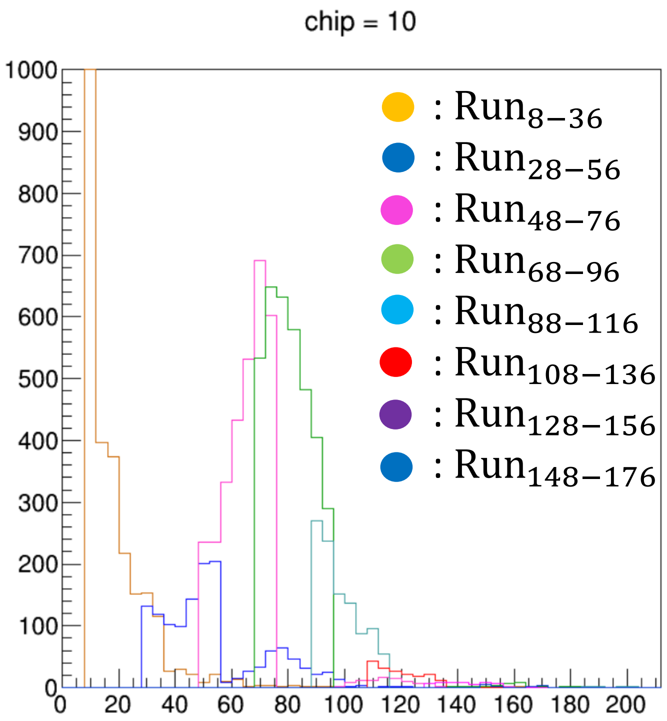


※Y-axis tick interval varies for each distribution

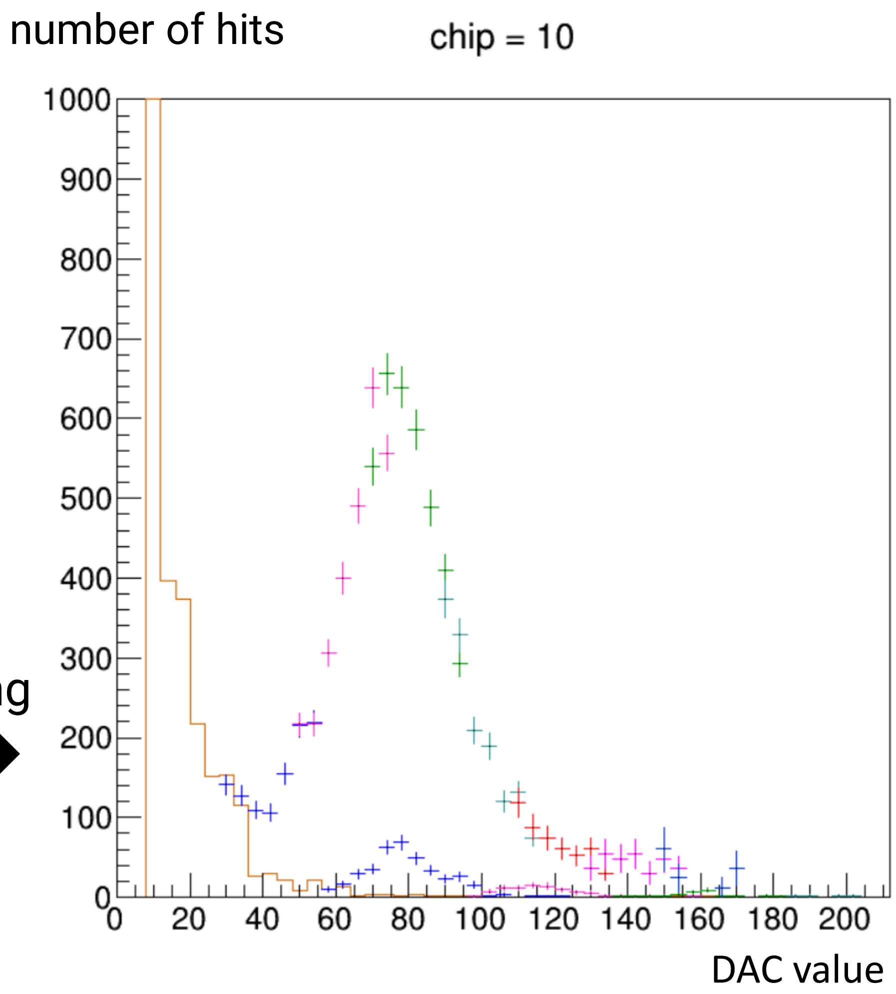
How to make an ADC distribution

3. I normalized the ADC distribution by the number of entries in the overlapping two bins.

I will explain the details on the following pages.

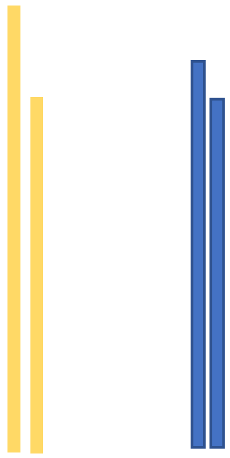


Normalizing



In the right figure, ADC distribution overwritten with color-coded data

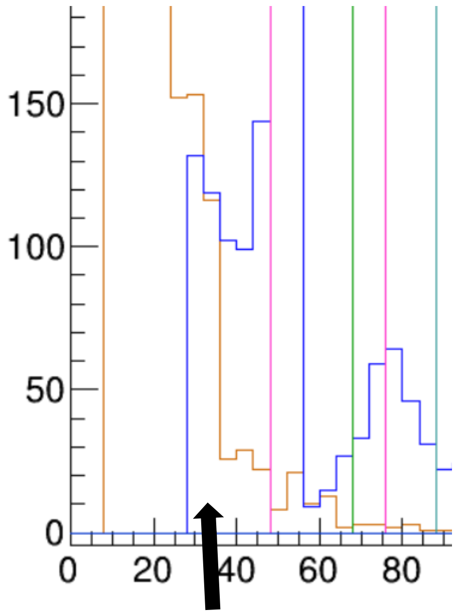
In Run_{8-36} and Run_{28-56}

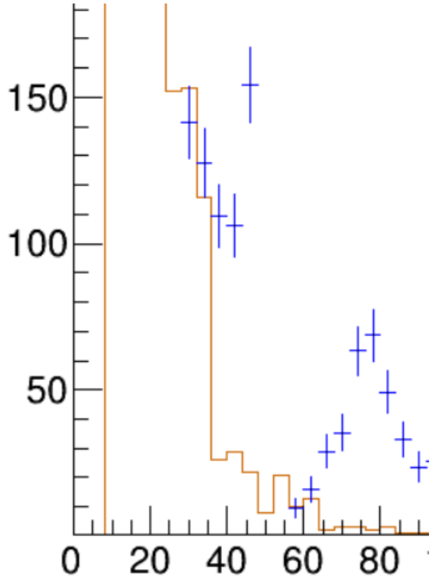


sum1 sum2

Scale the blue ADC distribution using Scale(sum1/sum2) .

sum2

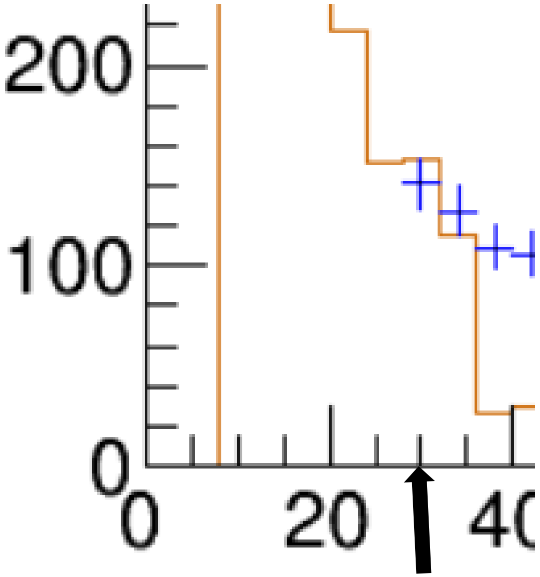


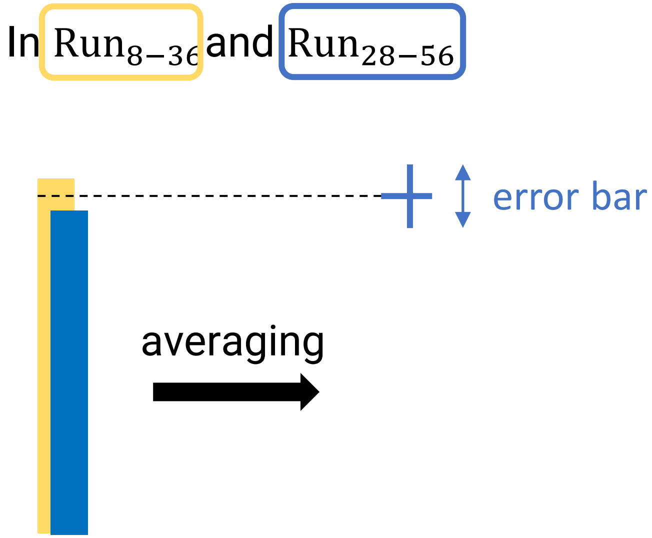


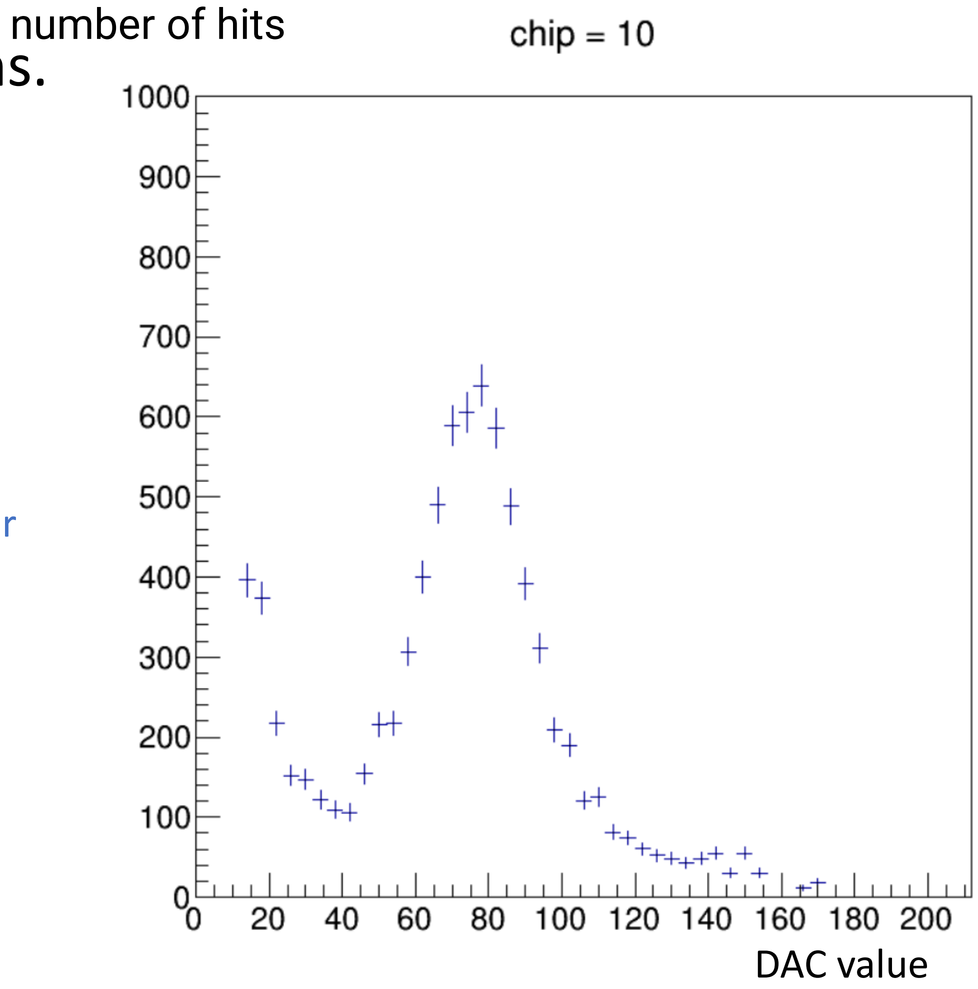
How to make an ADC distribution

4. I averaged the number of hits in overlapping bins.

   Then one ADC distribution was obtained.







How to make an ADC distribution

5. I fitted by the TF1Convolution function.
   (Convolution integral with Gaussian and Landau)

The reason is that it can be represented by Gauss Landau convolution in a thin absorber.

Landau MPV can be regarded as MIP peak.
Therefore, the MIP peak of the DAC scan is **71.87±0.37**.