DAC scan

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2021 Beam test, ELPH annual report

In the beam test at Tohoku University ELPH in 2021,

I mainly analyzed the DAC scan data.

In order to write the annual report of ELPH, I summarized the analysis process and results.

About DAC scan

The purpose of the DAC scan is to find the precise MIP peak and obtain the signal-to-noise ratio from the energy deposition curve.

In the beam test, we performed eight measurements with fine DAC settings.

	DAC0	DAC1	DAC2	DAC3	DAC4	DAC5	DAC6	DAC7
Run_{8-36}	8	12	16	20	24	28	32	36
Run_{28-56}	28	32	36	40	44	48	52	56
Run_{48-76}	48	52	56	60	64	68	72	76
Run_{68-96}	68	72	76	80	84	88	92	96
Run_{88-116}	88	92	96	100	104	108	112	116
$\mathrm{Run}_{108-136}$	108	112	116	120	124	128	132	136
$\mathrm{Run}_{128-156}$	128	132	136	140	144	148	152	156
$\mathrm{Run}_{148-176}$	148	152	156	160	164	168	172	176

Data set of DAC scan

Event cut

1. Hit cut for non-existing modules
2. Hit cut in hot channel, which is considered unrelated to the beam
3. Hit cut where the same hit is output for 2 consecutive hits
   (Cut of Double Saving Event)

Event cut（DSE cut）

In 2021 beam test, there were events where the same hit is output for 2 consecutive hits. We call it DSE（Double Saving Event）.

It is presumed that DSE appears more often when $\Delta bco\_full \leq 5$ in the hit before and after. So, if $\Delta bco\_full \leq 5$ and hit with same chip, channel, ADC and module, I cut second hit.

No.	bco_full	chip_id	chan_id	adc	module
1	48678	9	30	6	6
~~2~~	~~48679~~	~~9~~	~~30~~	~~6~~	~~6~~
	bco_full ≤ 5	same	same	same	same

hit cut

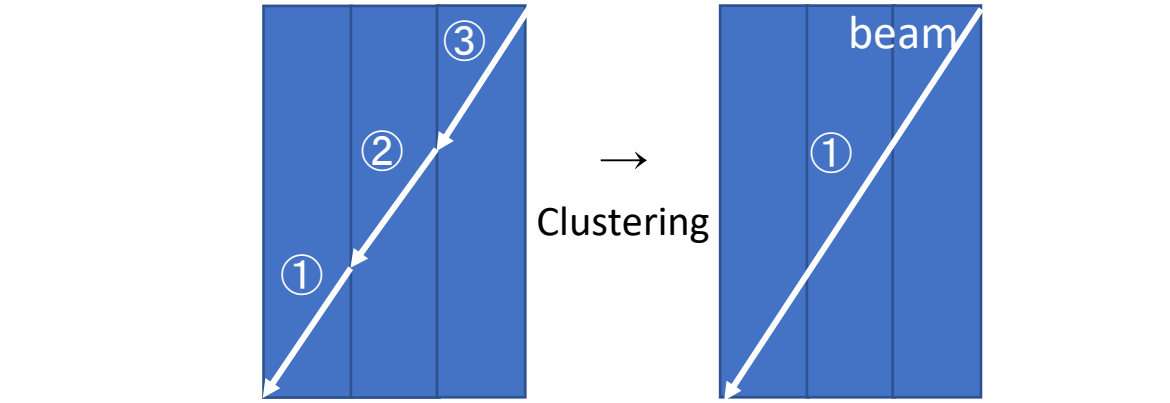
Example of DSE cut

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

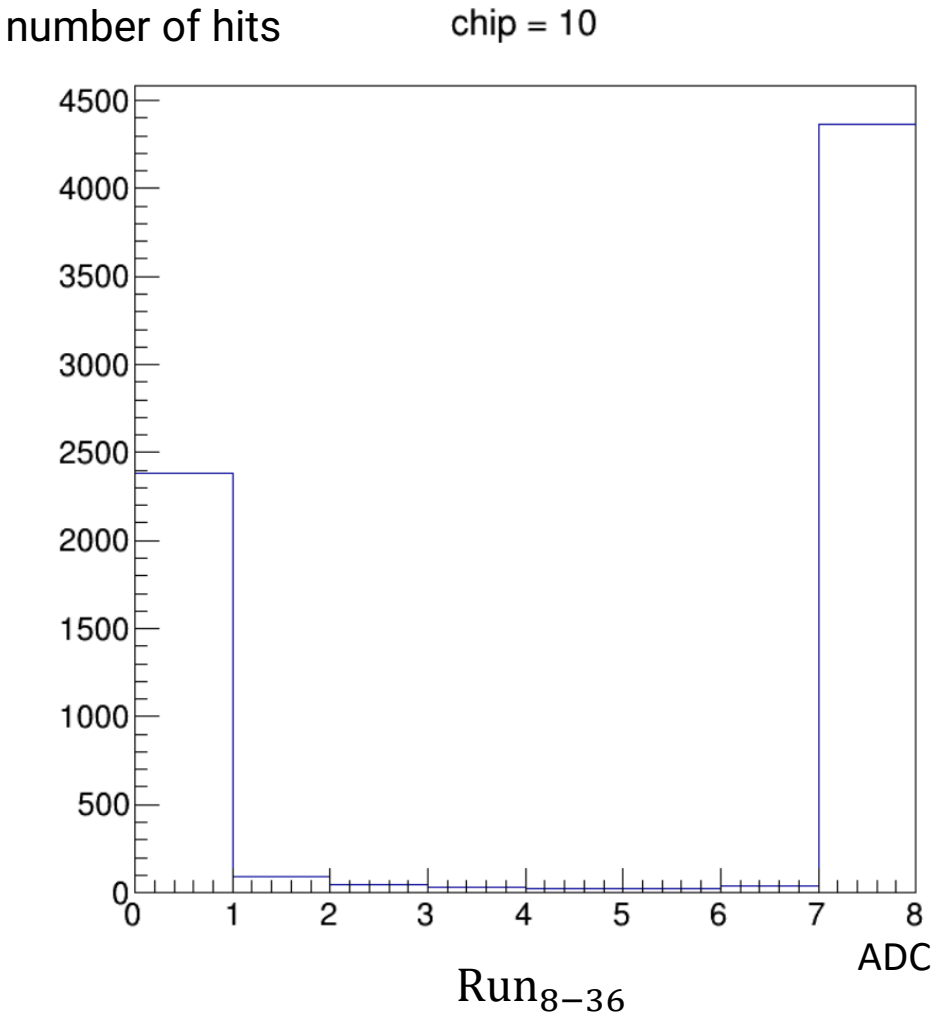
I will explain the details on the following pages.

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

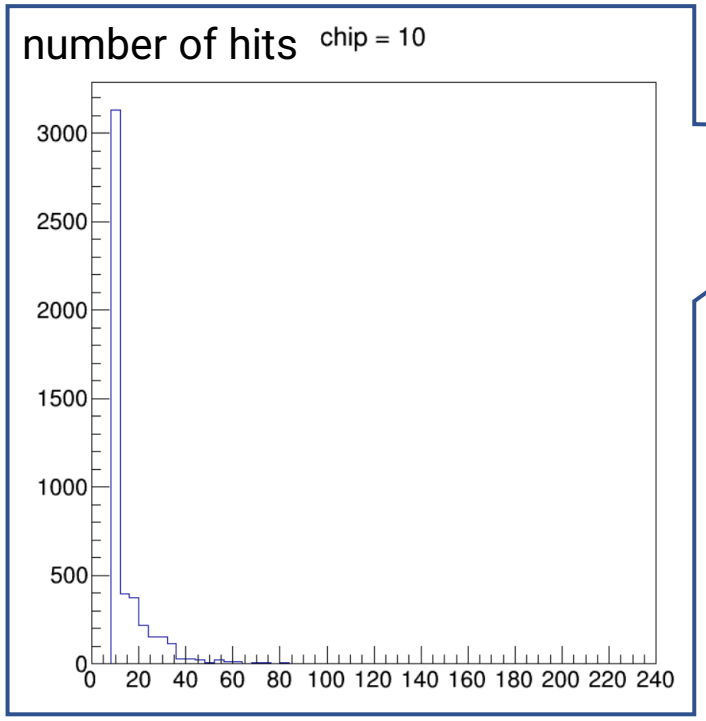


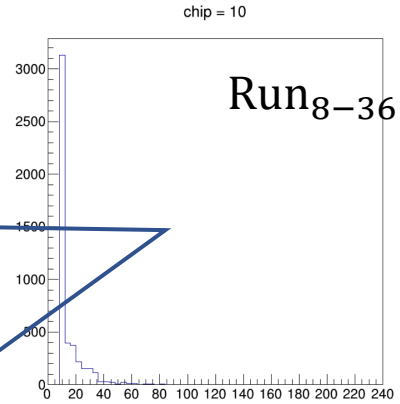
Run_{8-36}

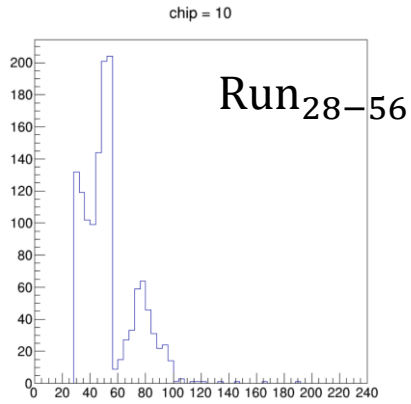
The relationship between ADC and DAC values for Run_{8-36}

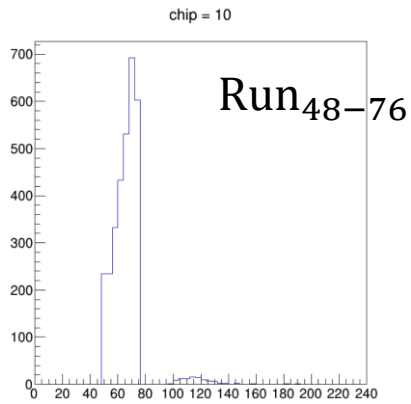
How to make an ADC distribution

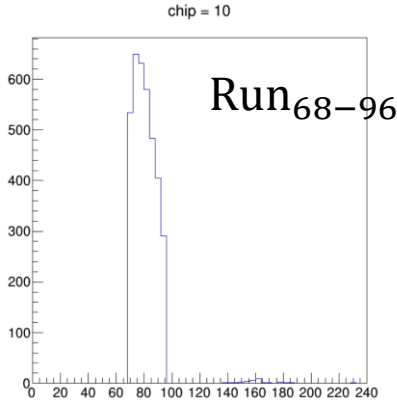
2. After cutting ADC7, I obtained the ADC distribution from Run_{8-36} to $\mathrm{Run}_{148-176}$respectively.

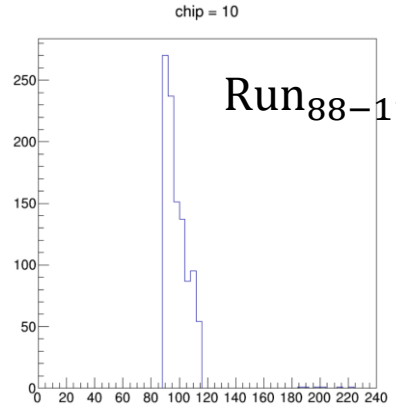


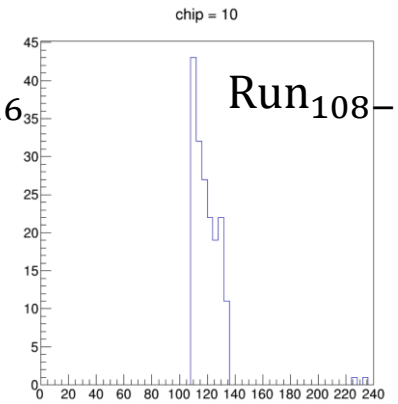


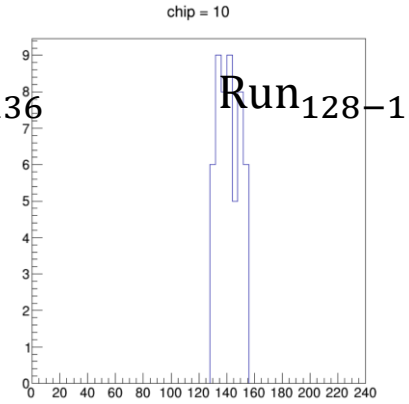


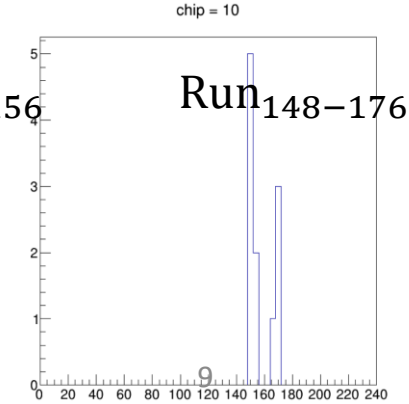












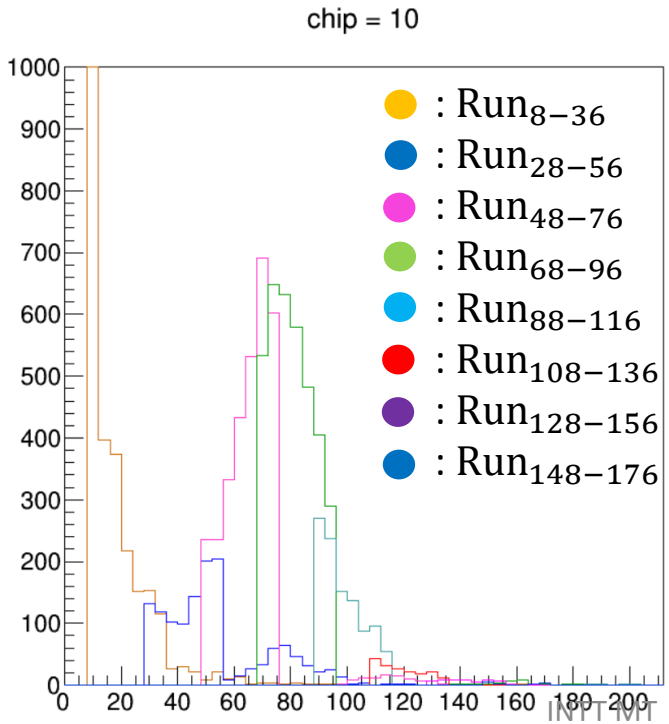
※Y-axis tick interval varies for each distribution

How to make an ADC distribution

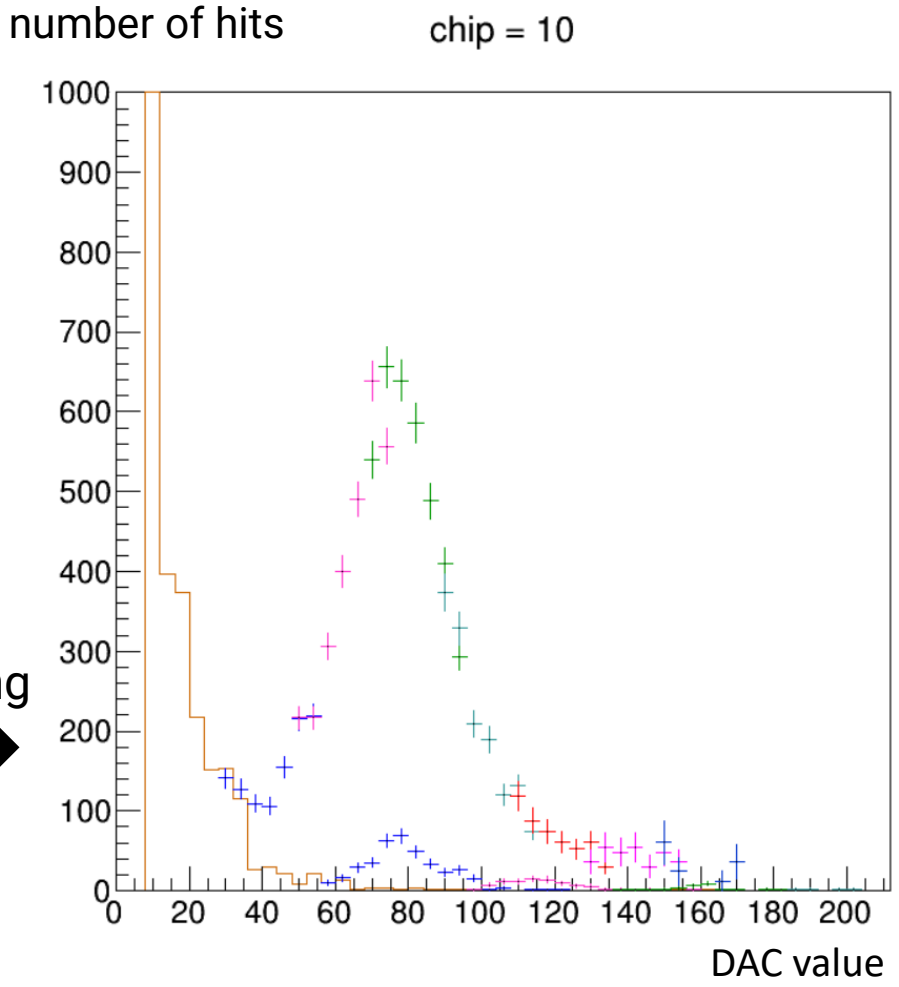
3. I normalized the ADC distribution by the number of entries in the overlapping two bins.

I will explain the details on the following pages.

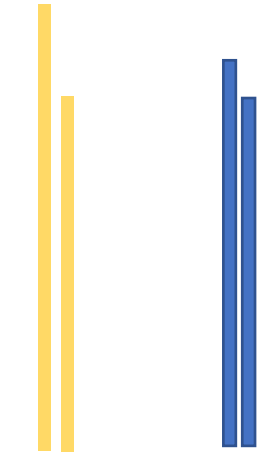
In the right figure, ADC distribution overwritten with color-coded data



Normalizing



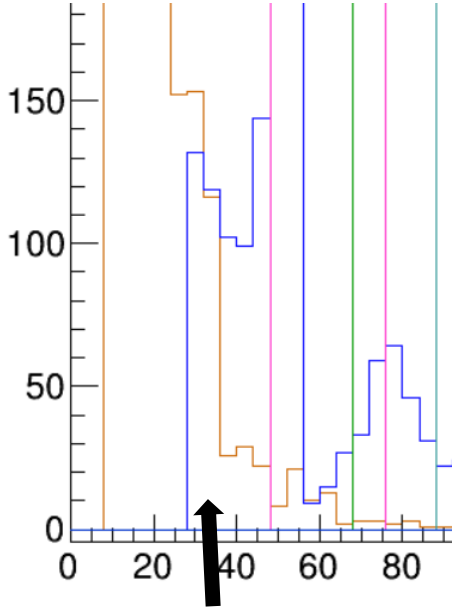
In Run_{8-36} and Run_{28-56}

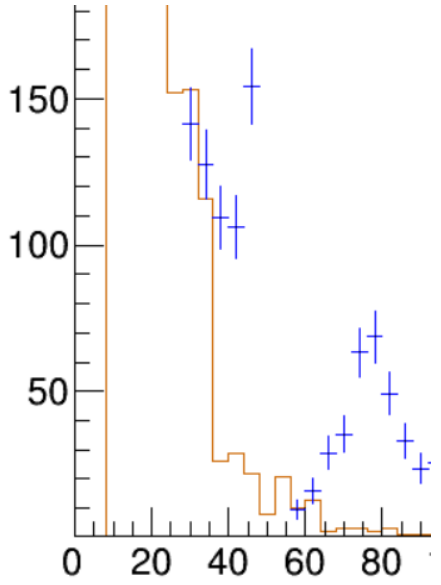


sum1 sum2

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

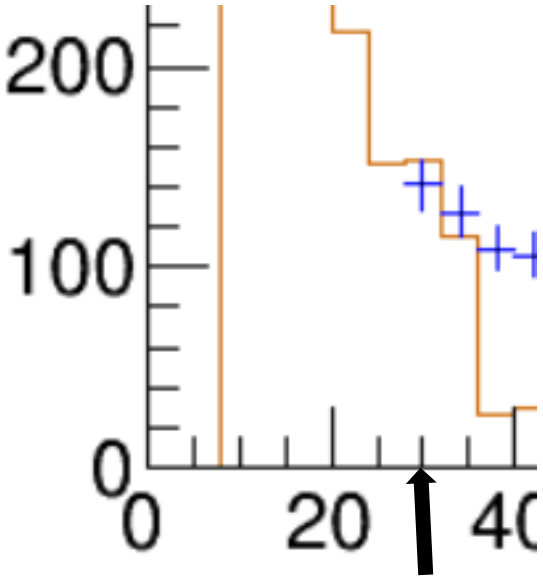
sum2

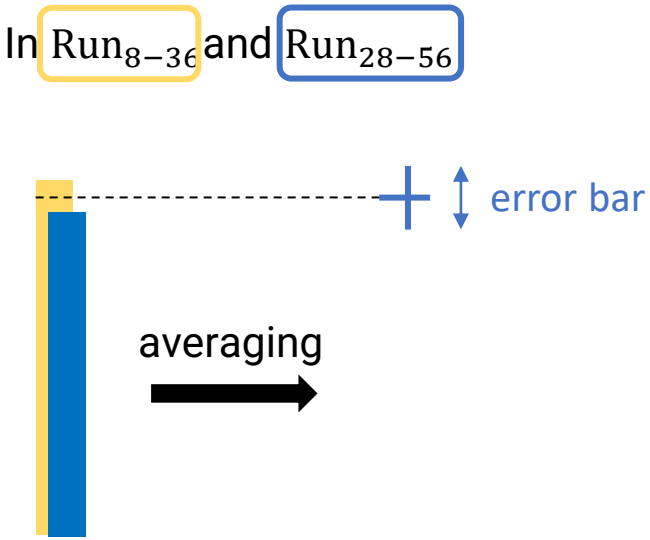


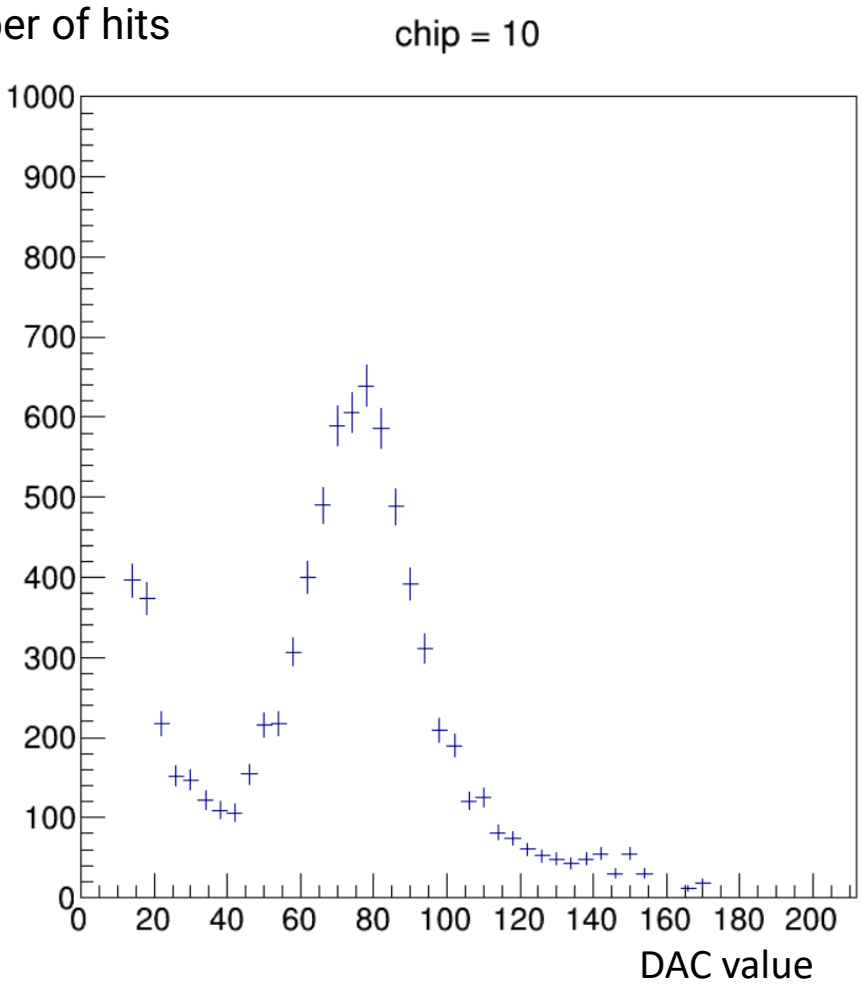


How to make an ADC distribution

4. I averaged the number of hits in overlapping bins.
   Then one ADC distribution was obtained.





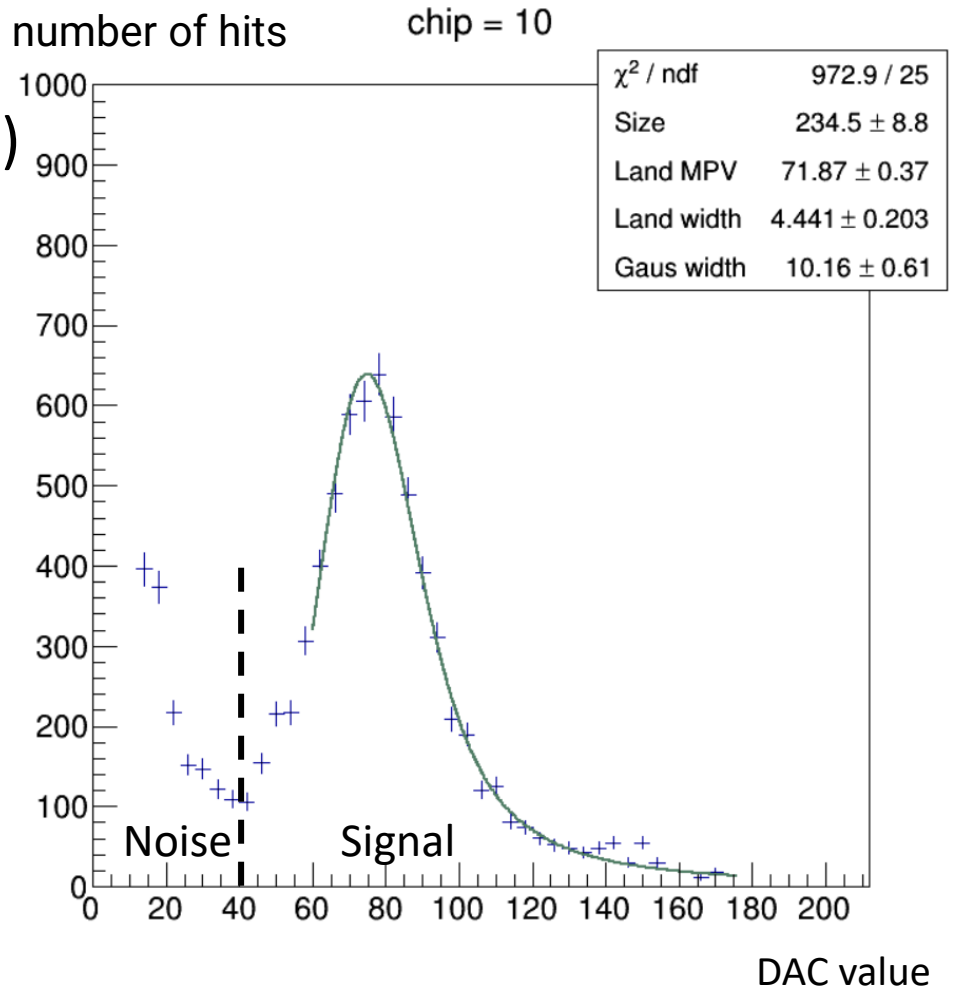


How to make an ADC distribution

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**.

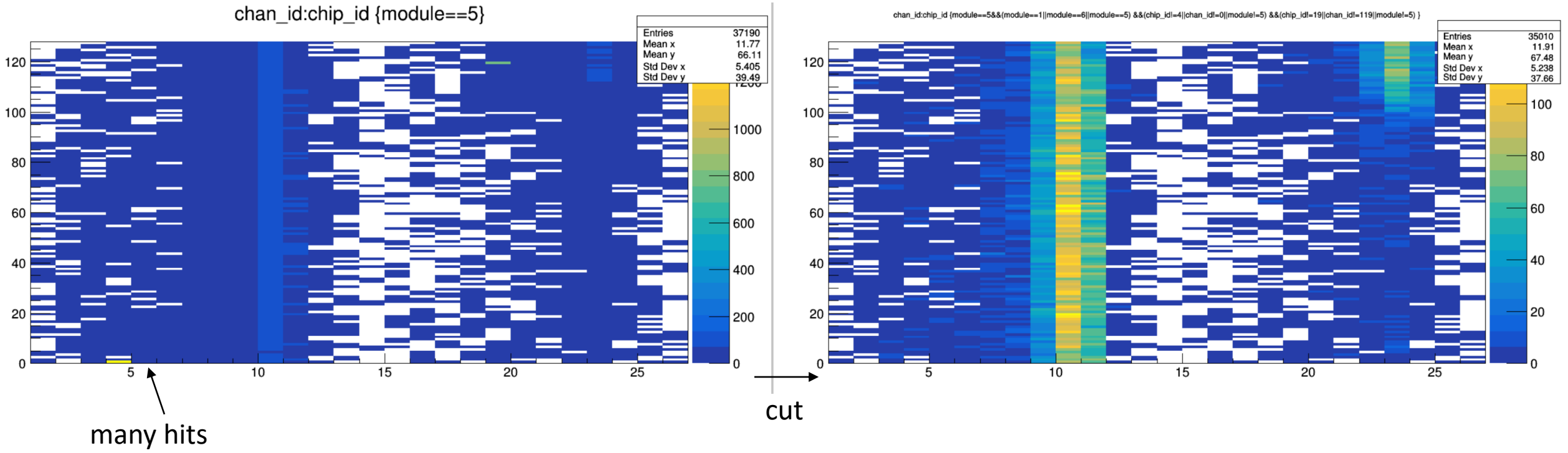


To do list

- Comparison of this ADC distribution and single hit only ADC distribution
- Fit not only the signal part but also the noise part
- Writing an ELPH annual report manuscript

Back up

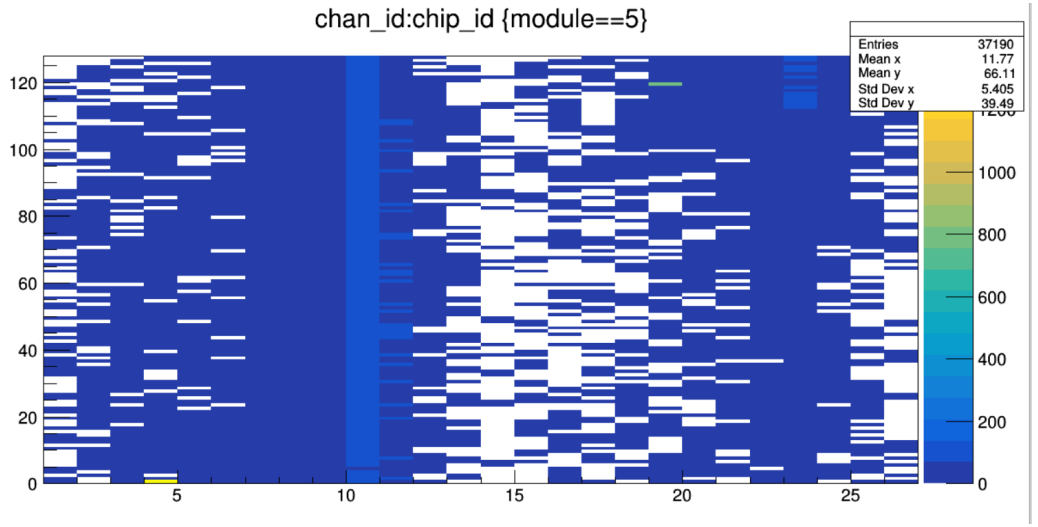
Event cut（in hot channel）



Example of event cut in hot channel

data	Cut condition
Run_{8-36}	(chip_id!=19||chan_id!=119||module!=5)
Run_{28-56}	(chip_id!=4||chan_id!=0||module!=5) &&(chip_id!=19||chan_id!=119||module!=5)
Run_{48-76}	(chip_id!=4||chan_id!=0||module!=5) &&(chip_id!=19||chan_id!=119||module!=5)
Run_{68-96}	(chip_id!=4||chan_id!=0||module!=5)
Run_{88-116}	無
$\mathrm{Run}_{108-136}$	(chip_id!=2||chan_id!=0||module!=1) &&(chip_id!=2||chan_id!=0||module!=5)
$\mathrm{Run}_{128-156}$	(chip_id!=2||chan_id!=0||module!=5)
$\mathrm{Run}_{148-176}$	無

Before hit cut in hot channel



After hit cut in hot channel