COSMIC MEASUREMENTS IN NWU

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Timing dependence of detection efficiency with cosmic ray

- Last December, INTT JP team did beam test at Tohoku univ. in Japan.
- We got 99% detection efficiency, but we couldn’t confirm that effects of BCO on efficiency.

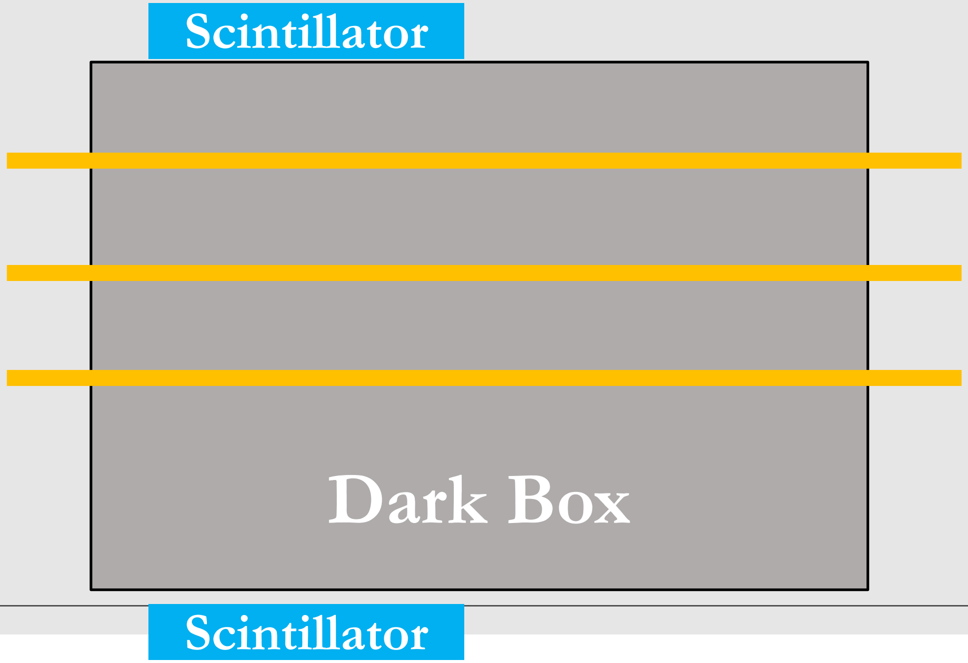
- Therefore we should do cosmic measurements to confirm BCO effects.

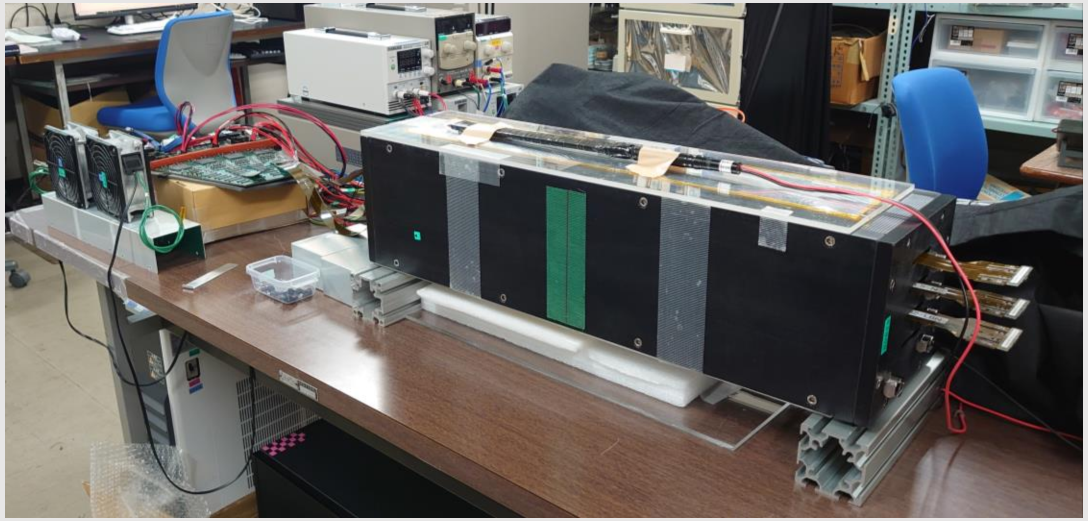
There are 2 analysis subjects.

1. Calculating the rate of double saving hits.
2. Calculating detection efficiency with BCO

Setup in NWU

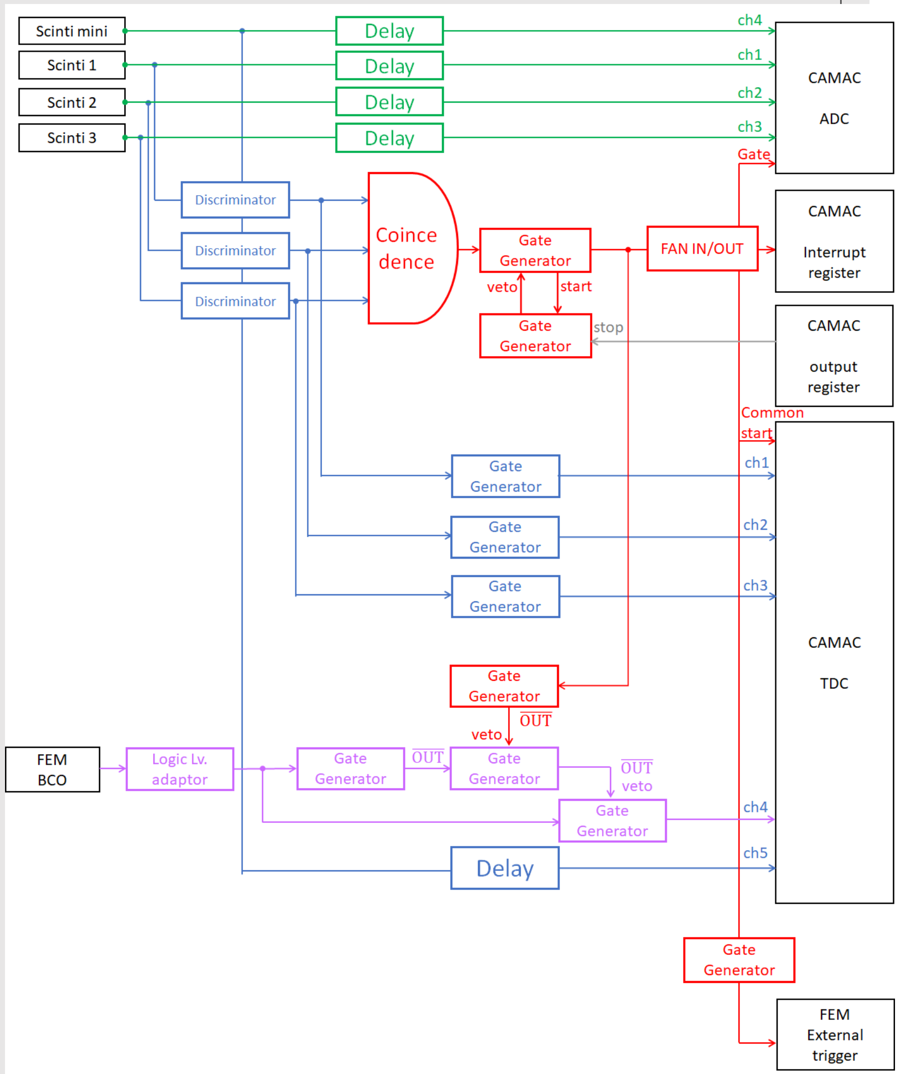
- We use 3 ladders for cosmic measurements. (Upper: Taiwan ladder, middle: PPB2-L5, lower: PPB2-L6)
    - Setup is same as beam test.
- Trigger: 2 scintillators





Setup in NWU

- Trigger logic is almost the same as the beam test logic.
  - You can see it in sPHENIX wiki.
- The coincidence of 2 scintillators become ADC GATE, TDC START and so on.
- We set hardware veto and software veto to the coincidence because beam test logic used it.



Double saving hit rate

- Double saving hit: A hit which has same data(e.g. adc, chip_id, chan_id) as the one before. BCO are different.

Row	adc	ampl	chip_id	fpga_id	module	chan_id	fem_id	bco
0	2	4	8	0	-1	12	0	0
1	3	4	9	0	6	46	8	0
2	1	4	9	0	6	47	8	0
3	3	4	9	0	5	35	8	0
4	2	0	8	0	4	62	2	48
5	0	0	9	0	6	67	8	48
6	3	0	8	0	5	70	8	48
7	2	0	9	0	6	68	8	48
8	2	0	8	0	4	62	2	49
9	0	0	9	0	6	67	8	49
10	3	0	8	0	5	70	8	49
11	2	0	9	0	6	68	8	49
12	5	0	17	0	4	104	2	39
13	1	0	18	0	6	53	8	39
14	2	0	18	0	6	54	8	39
15	3	0	17	0	5	76	8	39
16	5	0	17	0	4	104	2	40
17	1	0	18	0	6	53	8	40
18	2	0	18	0	6	54	8	40
19	3	0	17	0	5	76	8	40
20	3	0	3	0	4	0	2	49
21	4	0	4	0	5	17	8	49

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Analysis double saving

- I calculated double saving hit rate.

- Analysis steps

1. Select existing module hits for eliminate background noise. (module=4, 5, 6)
2. Classifying hits by BCO to make Event. (Event: Hits at the same BCO)
3. Compare a hit in an event with all hits in the previous event. If the data is same, add 1 to double saving hit counts.

$$\text{Double saving hit rate} = \frac{\text{Double saving hit counts}}{\text{Existing module hits}}$$

Double saving hit rate

- A cosmic data taking in April 26th – May 9th(approx. 13 days), has 9747 hits, coincidence received hardware and software vetoes,
  - double saving hit rate: **30.5%** $= \frac{\mathbf{2562}}{\mathbf{8389}}$
- Another data taking in June 27th - June 29th(approx. 2days), has 32626 hits, coincidence receive **no** veto,
  - double saving hit rate: **30.3 %** $= \frac{\mathbf{9915}}{\mathbf{32625}}$
- The rates are not different whether using vetos or not.
- Following analysis use the comic data that removed double saving hits.

Preparing for calculate efficiency

- To confirm effects of BCO on efficiency, we are planning the process.

1. Straight line tracking using the event which all 3 ladders has hits.
   - Develop the analysis code including clustering and straight line tracking.
2. Calculate detection efficiency
3. Study the efficiency vs BCO

- I’m in 1st step.

Residual distribution

- Cosmic rays go through up to 3 ladders in this measurement.
- If cosmic rays go through all 3 ladders, we can estimate the hit channel by calculate with 2 ladders hit channels.
- I made 2 residual distributions(Use: ladder 0, 1 Estimate: ladder 3 and Use ladder 2, 3 Estimate: ladder 0)

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1. Classifying hits by BCO. ("Event")
2. If an event has 2 or more hit in same module, it needs to calculate average channel weighting by ADC.
3. Draw 3 ladders hit channels.

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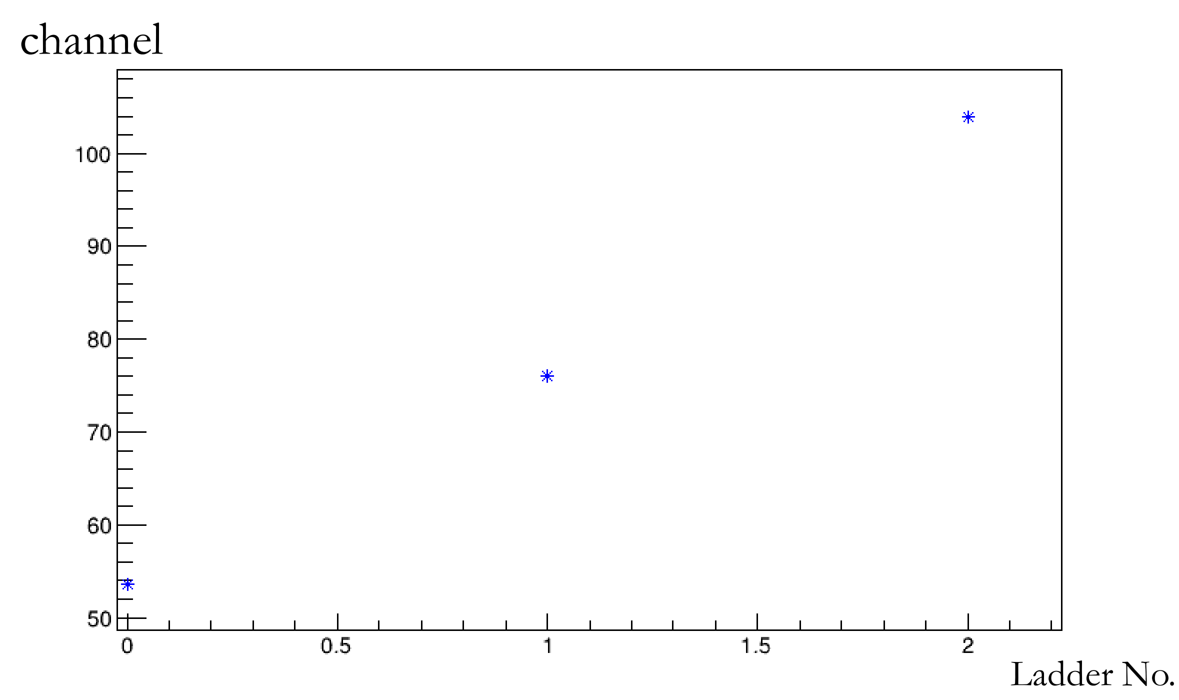

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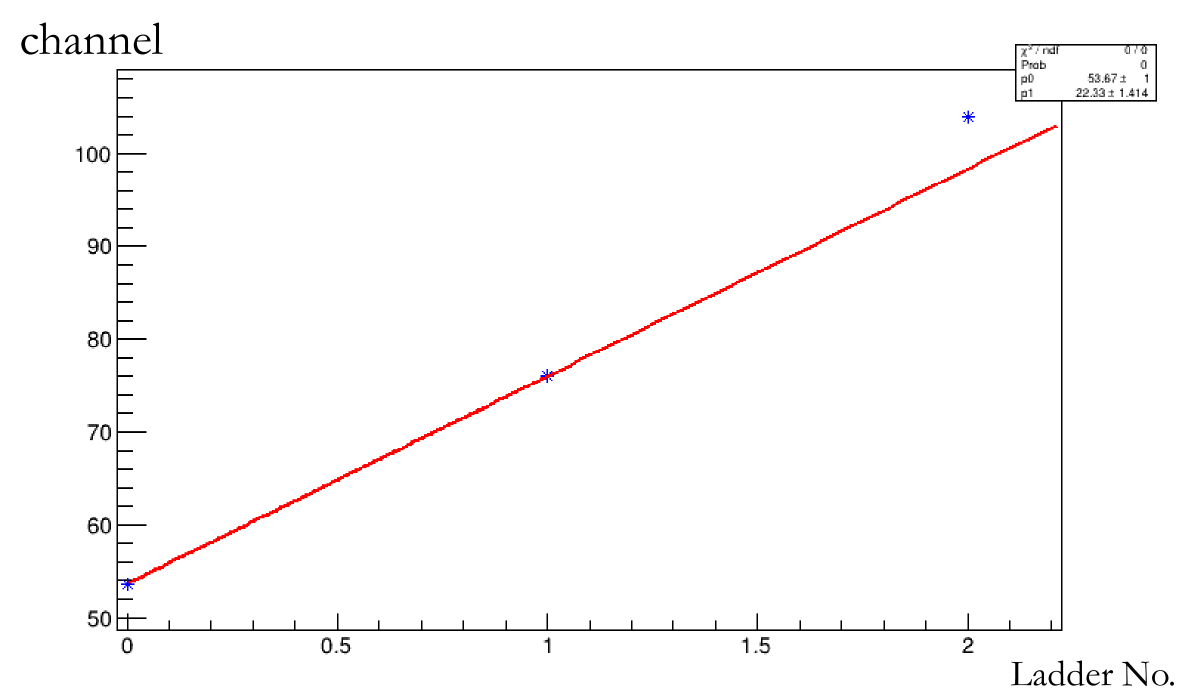

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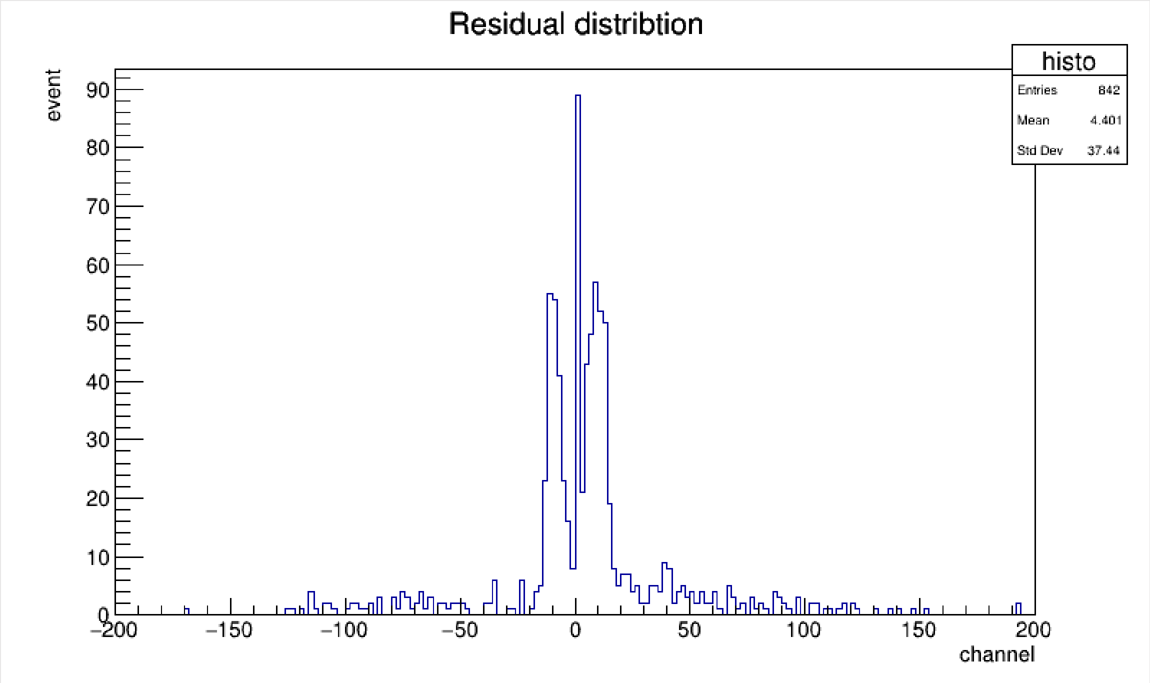
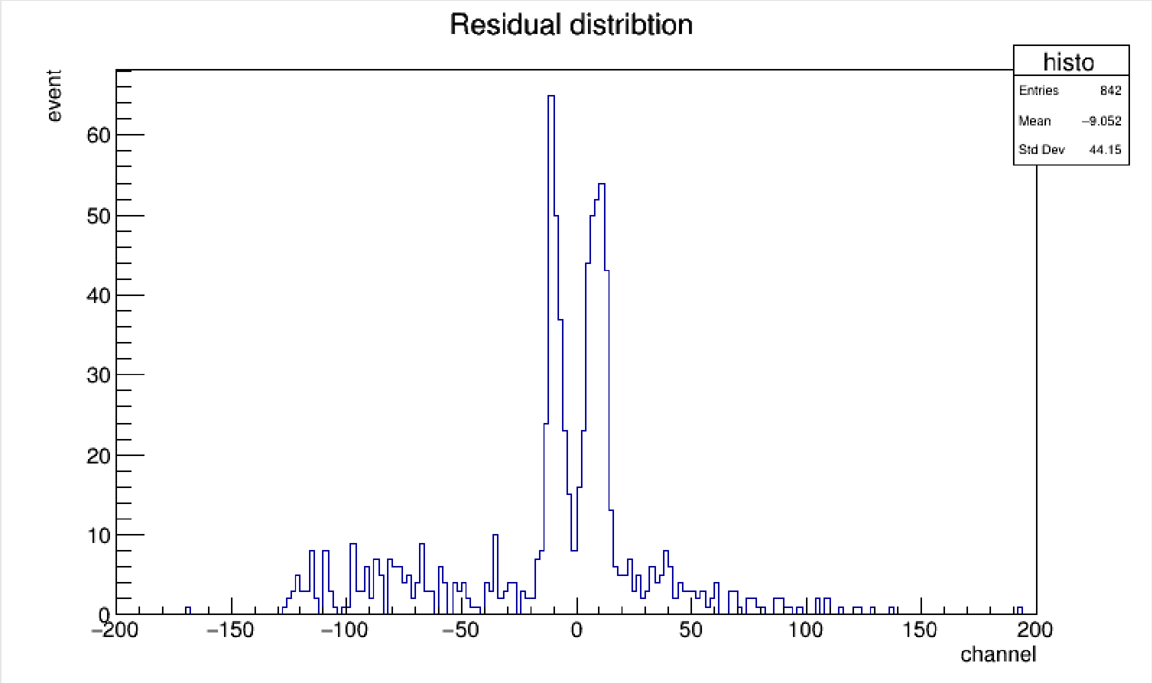
3. Draw 3 ladders hit channels.
4. Fitting. (by using ladder0, 1 or ladder2, 3)
5. Calculate the distance from fitting to real hit.

Residual distribution

- Left: Use ladder0, 1 and Estimate ladder2, has sharp peak in residual channel 0
- Right: Use ladder2, 3 and Estimate ladder0, has 2 peaks around residual channel +/- 10





Summary

- We continue cosmic measurement and analysis the data. Cosmic data increase more and more.

- Double saving hits are existed in both measurements using vetoes or no veto.
  - It is observed low data rate measurement like cosmic.

- To do next:
  - Another residual distribution(Use ladder0, 2 and estimate ladder 1)
  - Calculate efficiency
  - Check the effects of BCO on efficiency by using CAMAC data.