Radiation measurement with the Felix readout
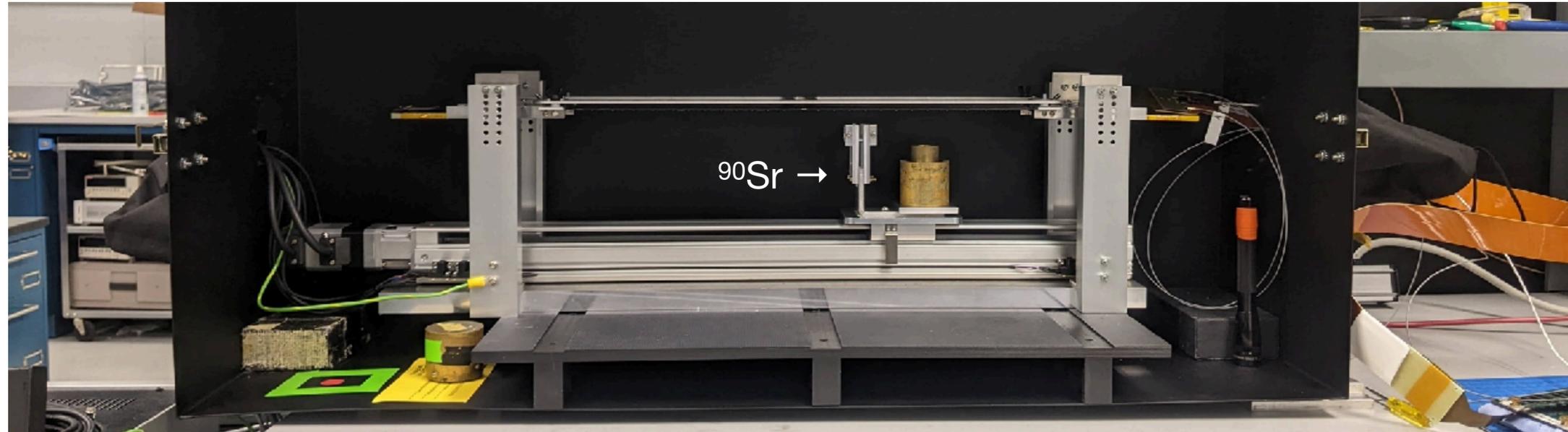
Raul Cecato (BNL)
Genki Nukazuka (RBRC)

Last report was on April/21/2022

Measurement condition

The motor controller→　　　　　　　　　　　　　　　ROC here

^{90}Sr →

Setup

Ladder: PB1-L007N or PB1-L017S　　　←Both were tested with ^{90}Sr and turned out to be good.
Duration: 5 min or 10 min
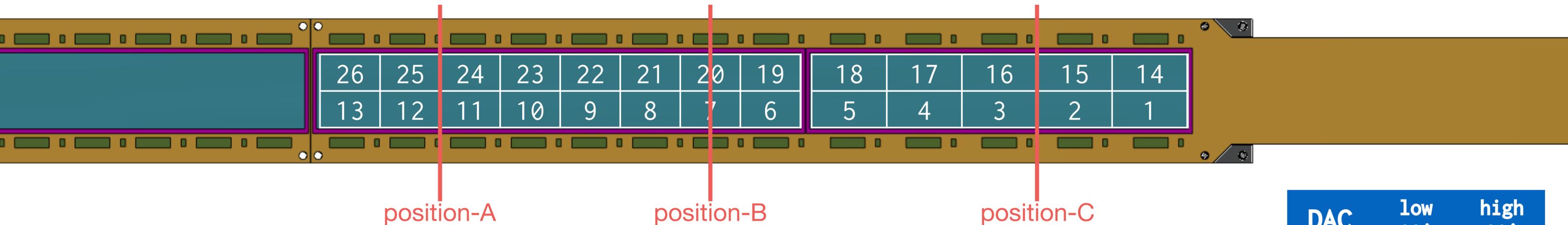Radiation source: ^{90}Sr

Measurements

- FEM/FEM-IB slow control + FEM readout
- FEM/FEM-IB slow control + Felix readout

Data

- You can access data: https://riken-share.box.com/s/j7a3ch2xhn14uqhqvpdeymw3k3r8ebqv
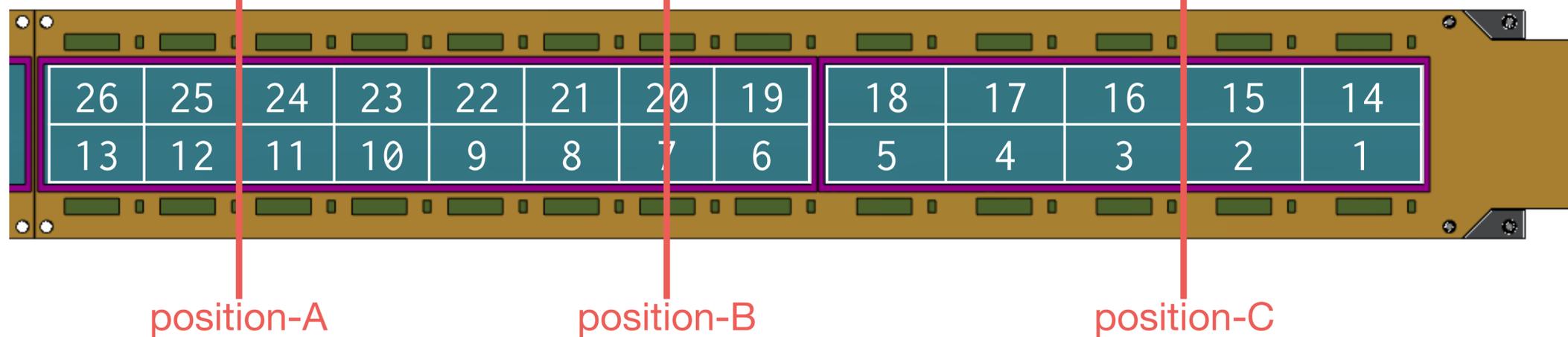
Measurements

1. ^{90}Sr at a fixed position for 5 min:
   - below chip11, 12, 24 and 25 (position-A)
   - below chip7 and 20 (position-B)
   - below chip2, 3, 15, and 16 (position-C) ← already reported on April/21/2022.

2. ^{90}Sr on the moving stage at speed 7

3. Without a radiation source for 5 min
   - High DAC setting same as the source test. The motor controller was unplugged.
   - Low DAC setting (Takashi's setting). The motor controller was unplugged.
   - High DAC setting same as the source test with the moving stage at speed 7.

4. With (a) metal plate(s) with 0.8 mm thickness for 5 min
   - 1 plate, mm in total
   - 2 plates, mm in total

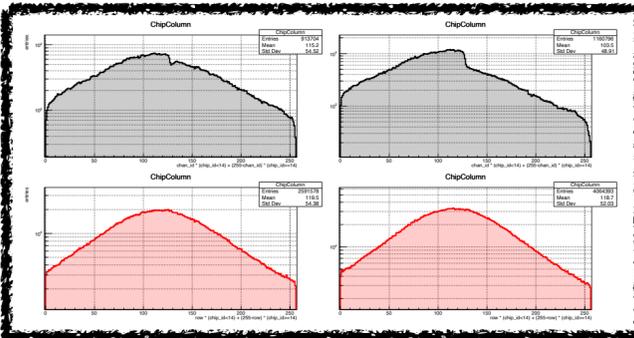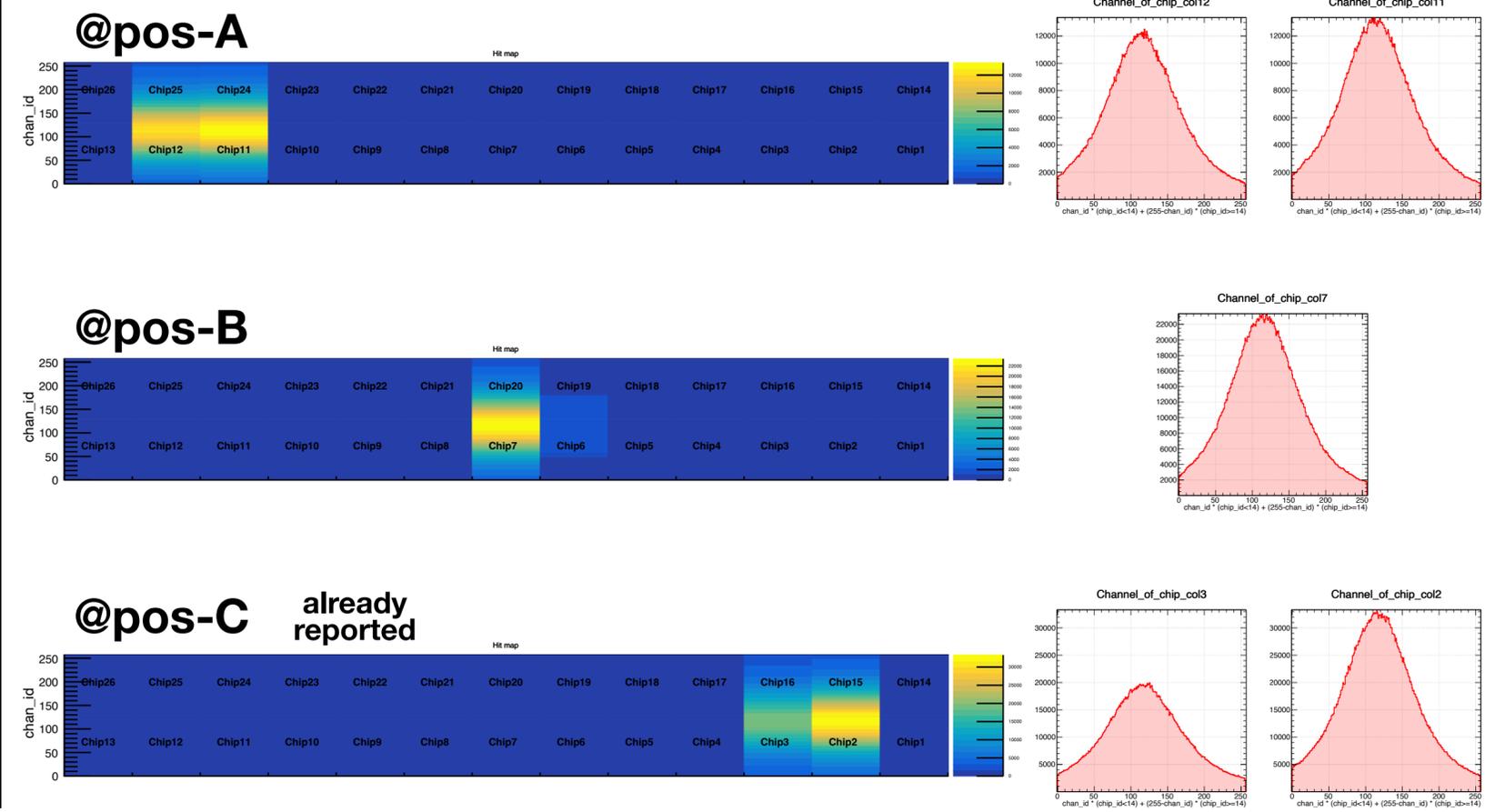| DAC	low setting	high setting
0	15	40
1	30	50
2	60	60
3	90	90
4	120	120
5	150	150
6	180	180
7	210	210

Measurements
⁹⁰Sr at a fixed position

position-A   position-B   position-C

FEM

Felix

@pos-A

@pos-B

@pos-C **already reported**

@pos-A

@pos-B

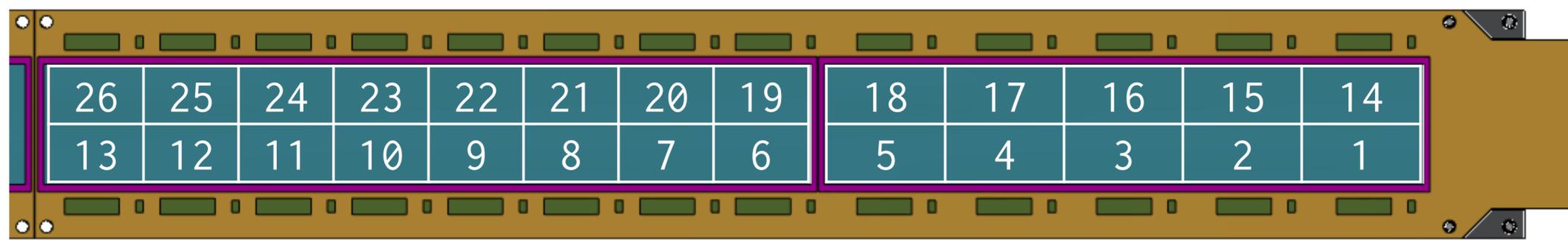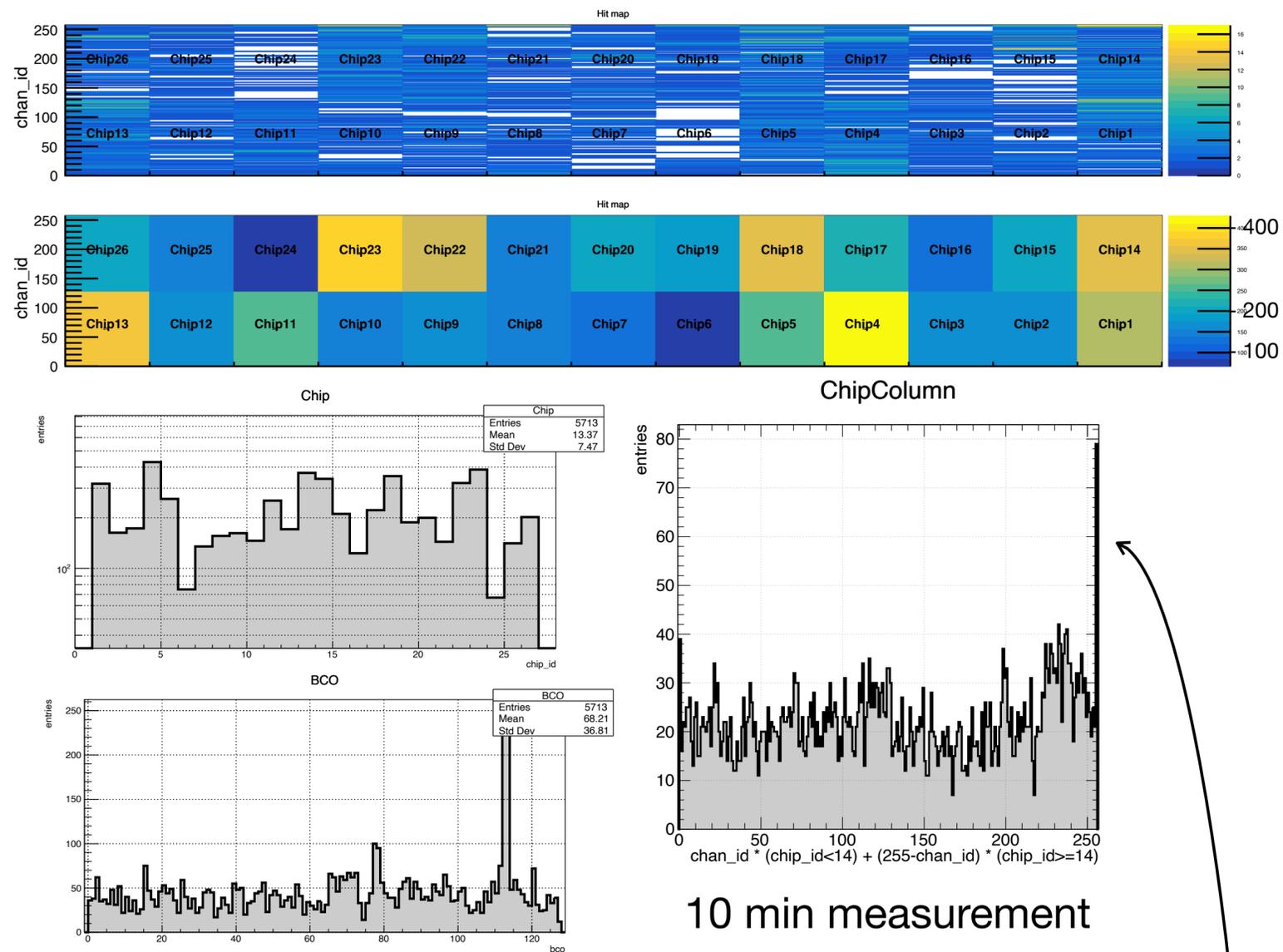@pos-C **already reported**
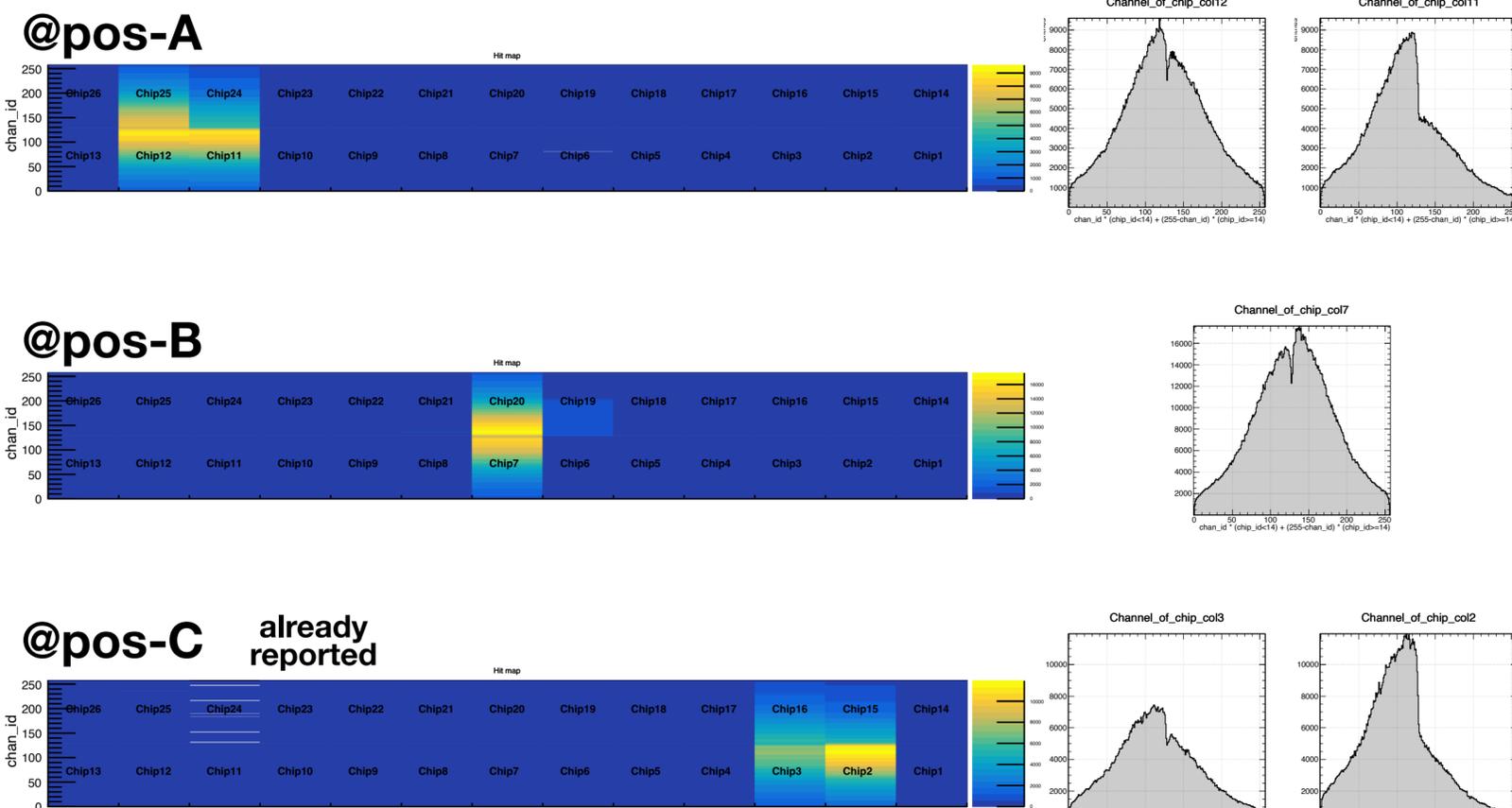
The Felix system obtained reasonable distributions at various positions of the radiation source. The channel distributions obtained by the FEM had 2 dropping regions at both ends, which cannot be explained by physics.

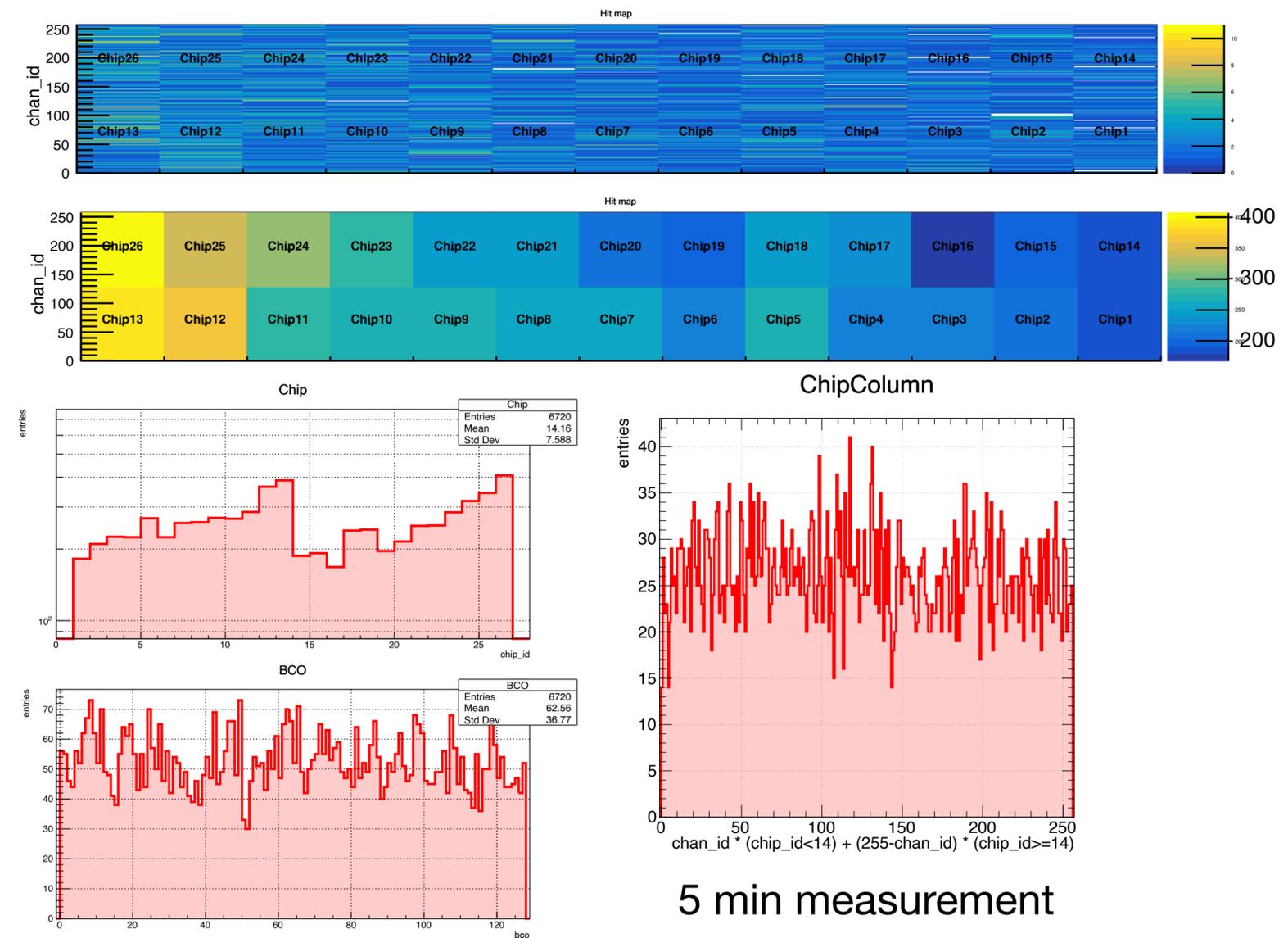# Measurements
without ⁹⁰Sr
high DAC setting

FEM

10 min measurement

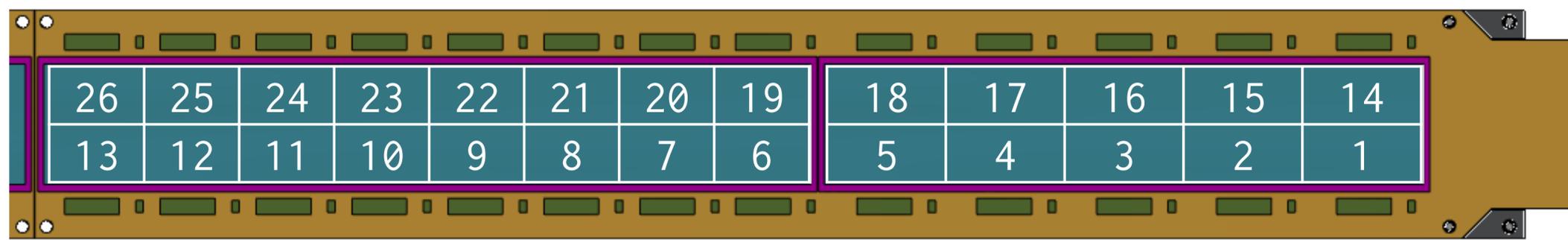## Felix

5 min measurement

Chip14 ch127 with FEM system has more noise.

Measurements
Moving ⁹⁰Sr

26	25	24	23	22	21	20	19	18	17	16	15	14
13	12	11	10	9	8	7	6	5	4	3	2	1

⁹⁰Sr

FEM
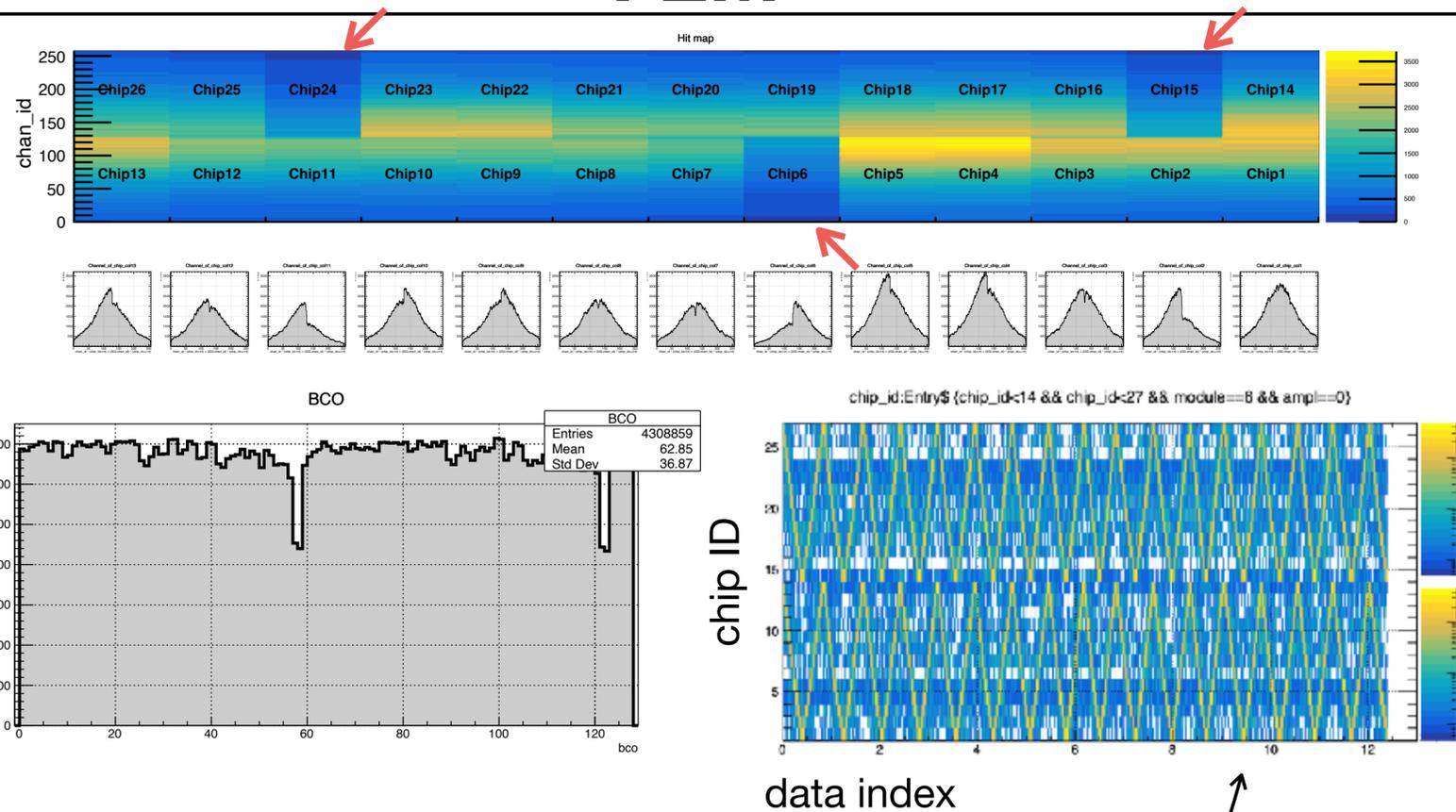
The source position is visible.

Felix

Chip6, 15, and 24 had less data when the FEM system was used. The same tendency was observed with 2 other half-ladders. That's strange. How about other test benches?

Measurements
Moving ^{90}Sr

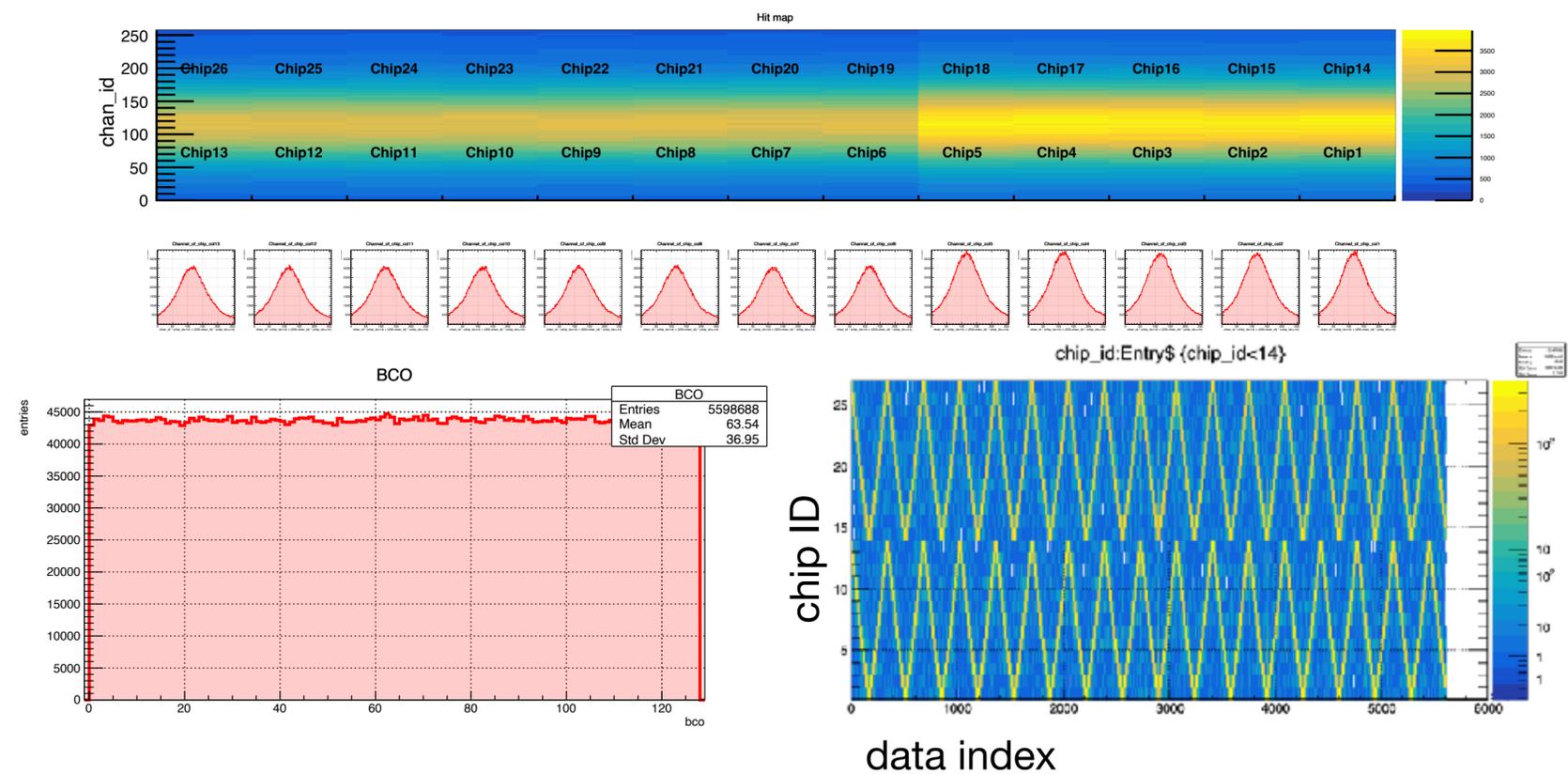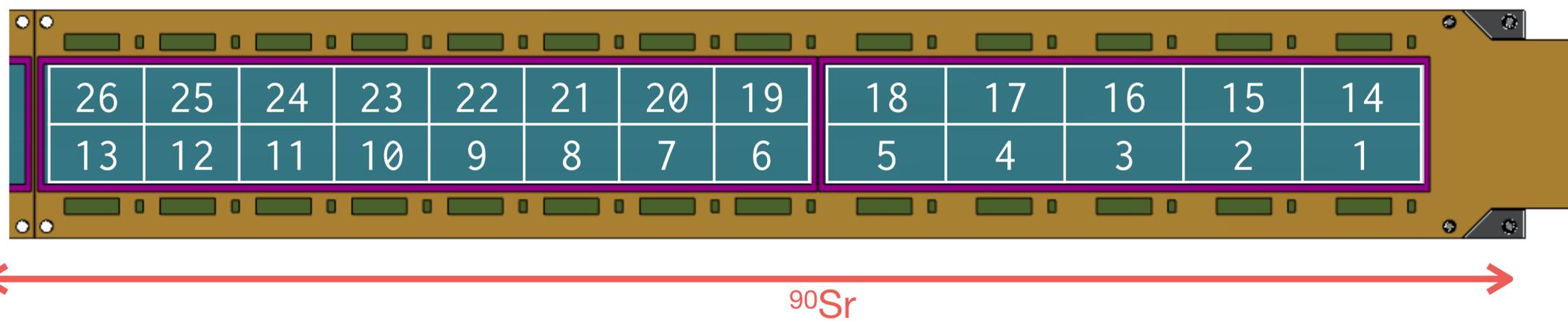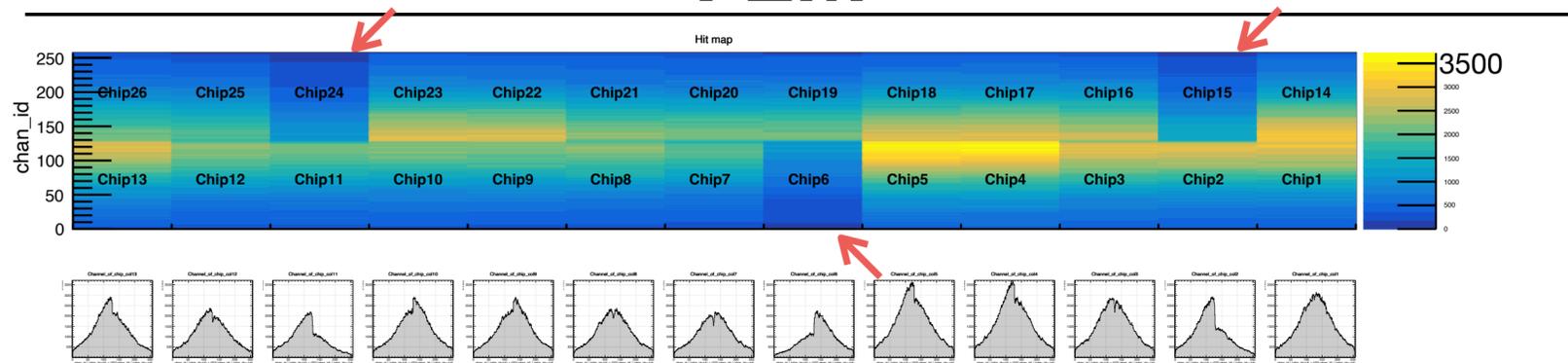| 26	25	24	23	22	21	20	19	18	17	16	15	14
13	12	11	10	9	8	7	6	5	4	3	2	1

^{90}Sr

FEM

NWU (Yumika)

less data?   less data?
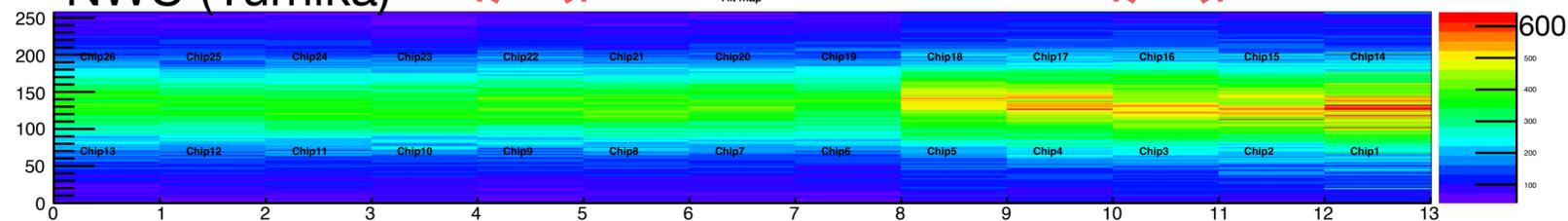
The same measurement at NWU for 4 hours.

Taiwan (Cheng-Wei)
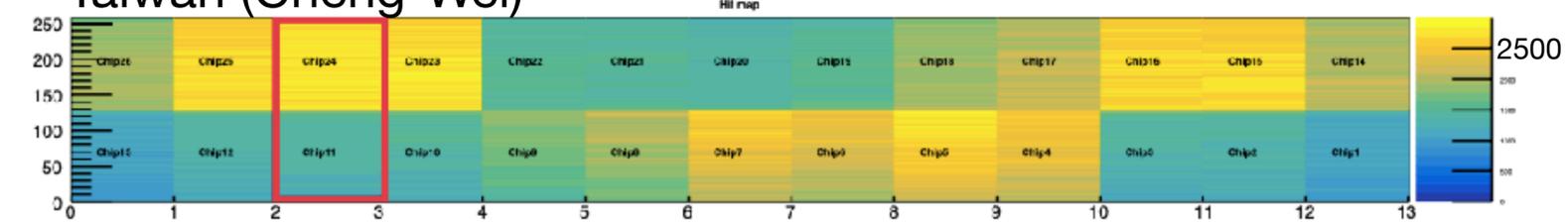
Each chip is exposed under Sr-90 for 2 mins, the # of entry is expected to be similar

The number of entry is not symmetry
Still OK for the source test QA (I think)

Felix

chip_id:Entry$ {chip_id<14}

chip ID

data index
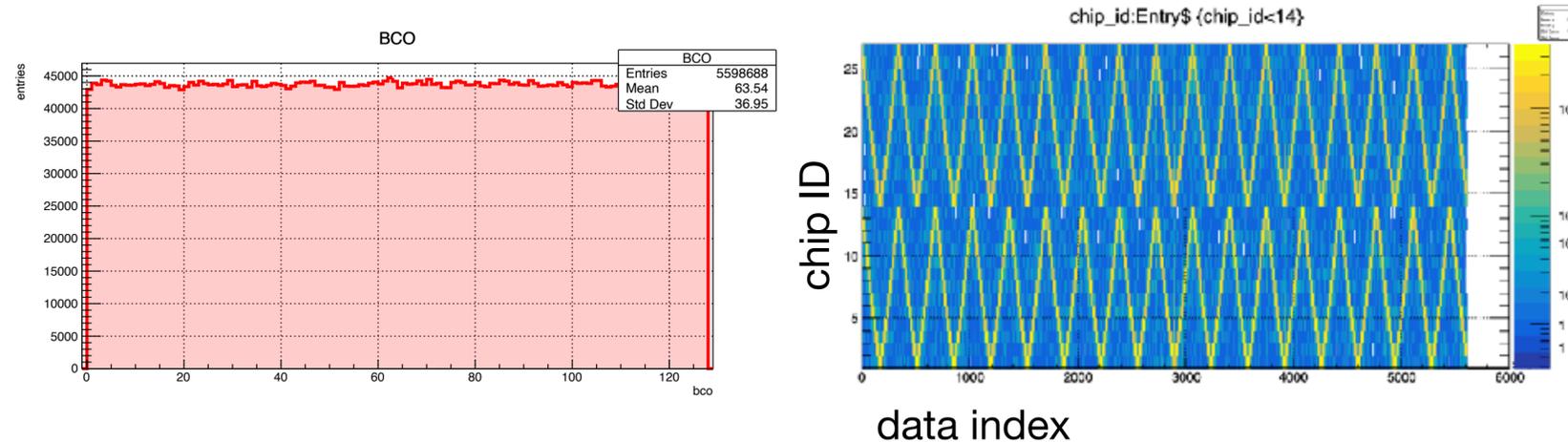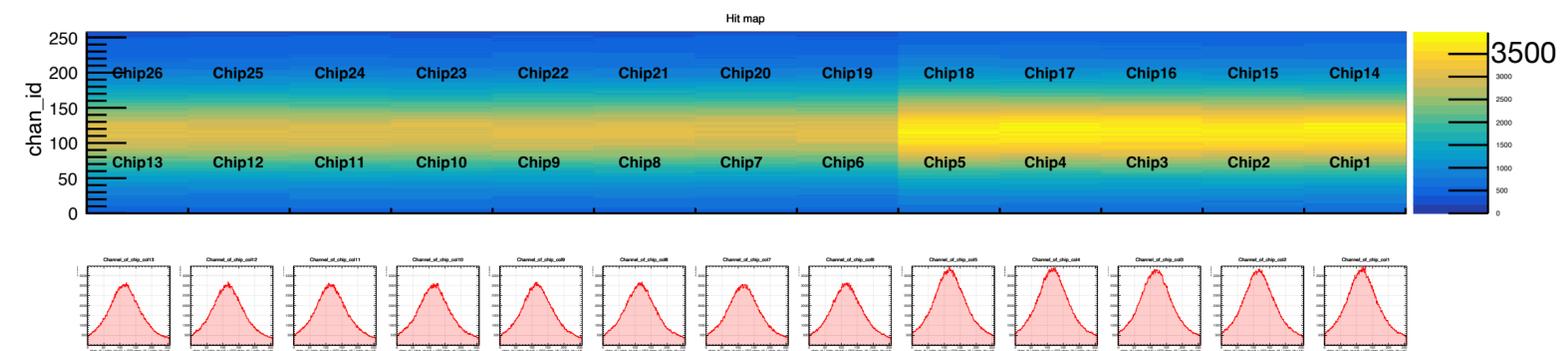
BNL: There is a chip variation.
NWU: It looks fine, but there may be a chip variation.
Taiwan: There is a chip variation.
BNL(Felix): It looks good.

Measurements
⁹⁰Sr & metal plates
~0.8 mm thick/plate

position-B

FEM

Felix

0 plate
9 kHz
11 kHz

1 plate
200 Hz
470 Hz

2 plates
180 Hz
430 Hz
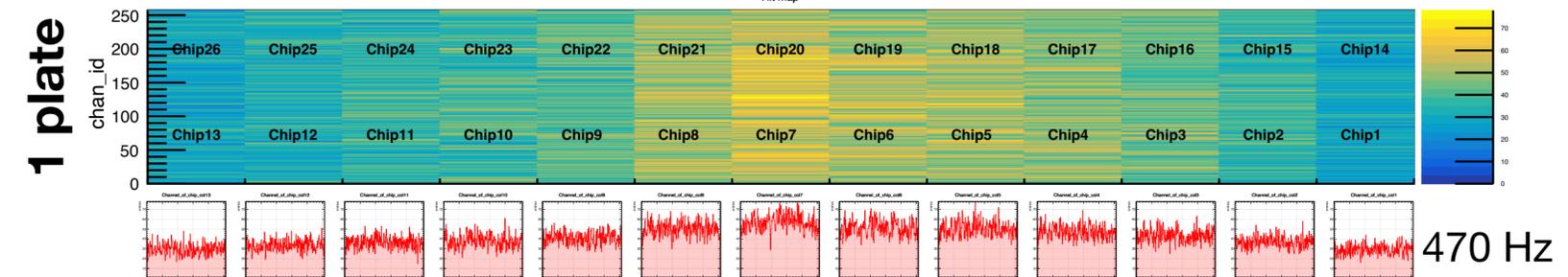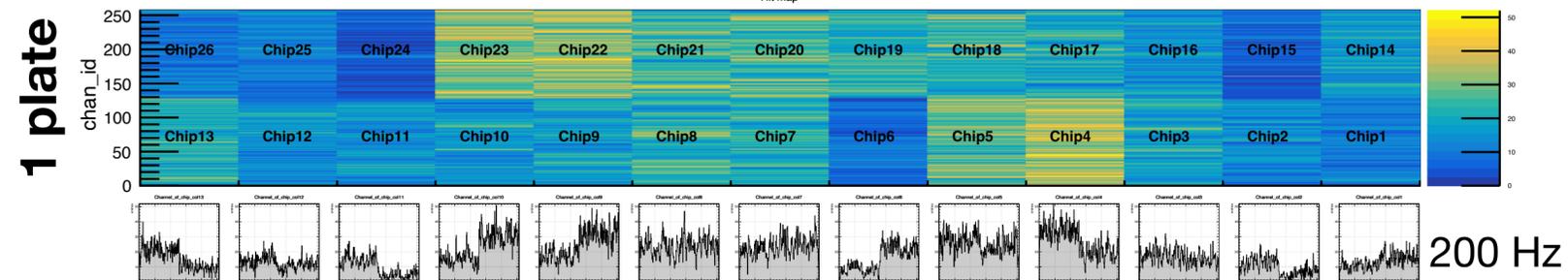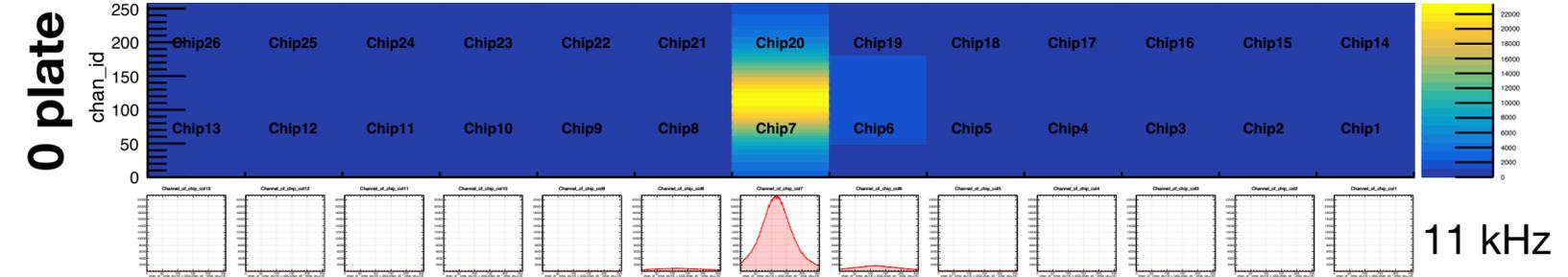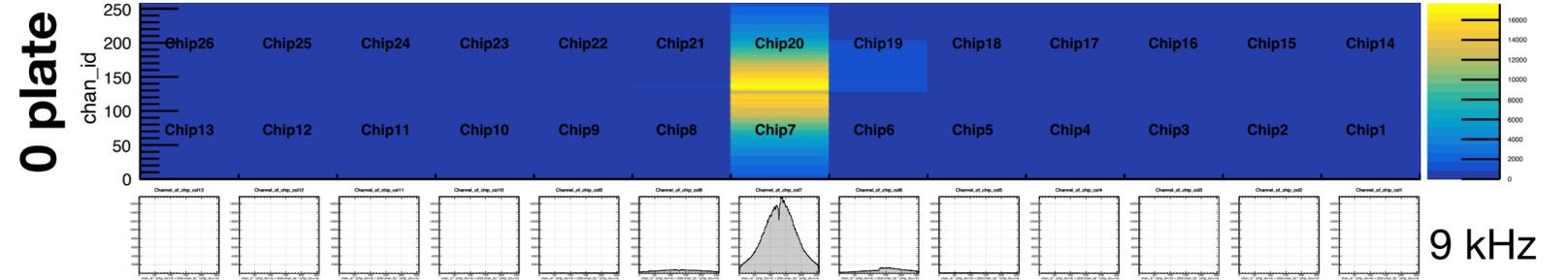
Range of y-axes is not same

#stored hits didn't depend on the hit rate.

Measurements
Statistics

position-A   position-B   position-C

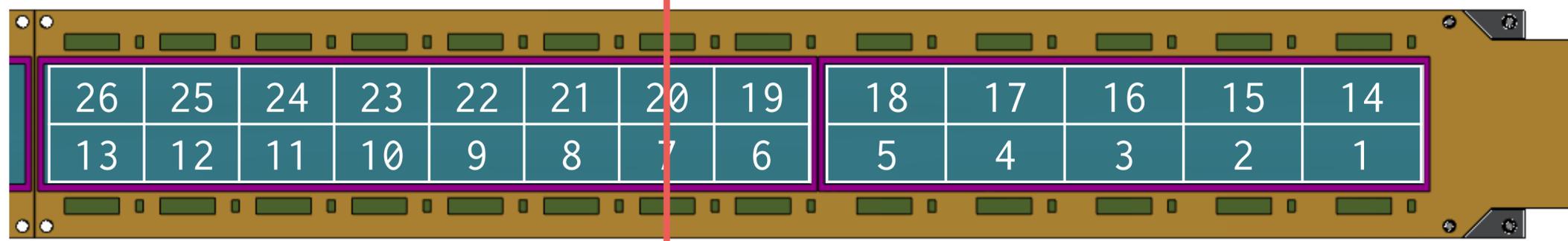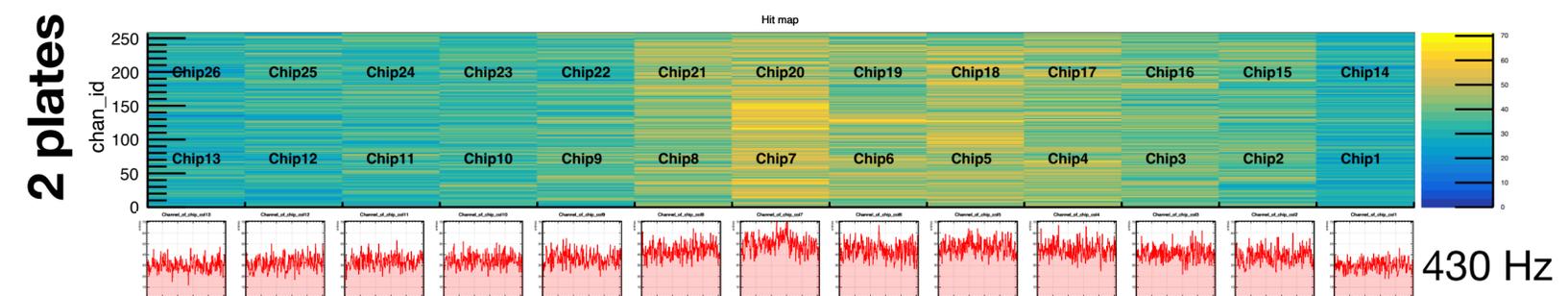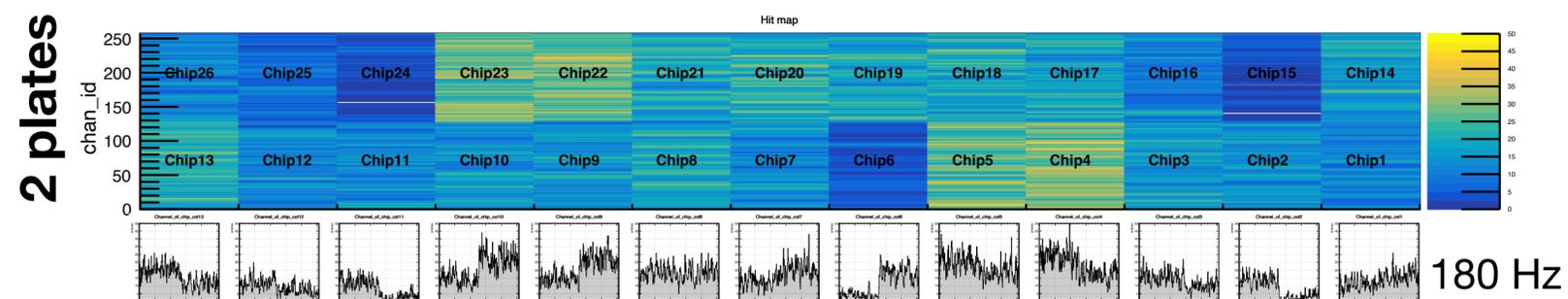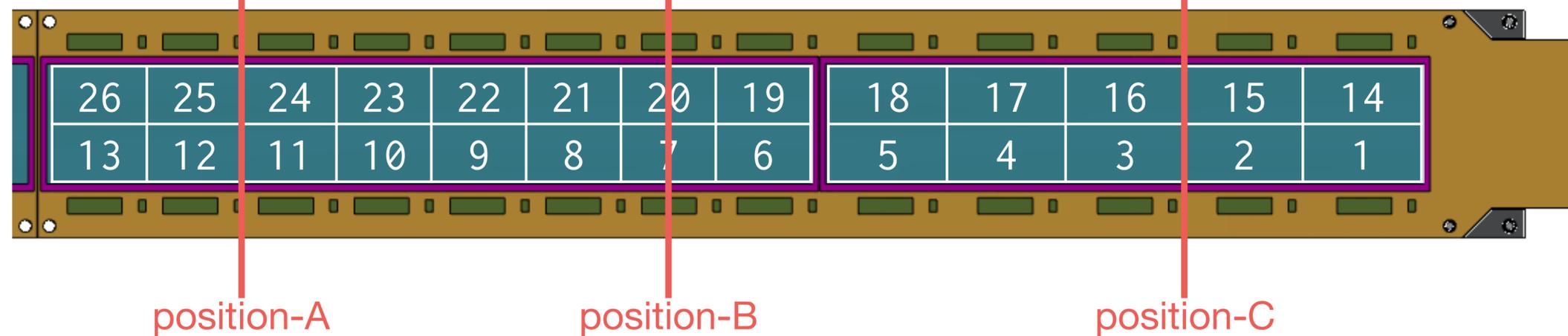|	Time (min)	DAC setting	FEM	FEM, Rate (Hz)	Felix	Felix, Rate (Hz)	Felix/FEM (%)
^{90}Sr at pos-A	5	high	2.2E+06	7.2E+03	3.4E+06	1.1E+04	157%
^{90}Sr at pos-B	5	high	2.6E+06	8.5E+03	3.4E+06	1.1E+04	133%
^{90}Sr at pos-C	5	high	2.2E+06	7.3E+03	7.0E+06	2.3E+04	320%
moving ^{90}Sr	10	high	4.3E+06	7.2E+03	5.6E+06	9.3E+03	130%
BG	5	high	2.9E+03	9.5E+00	6.7E+03	2.2E+01	235%
BG	5	Takashi	7.2E+03	2.4E+01	1.1E+04	3.8E+01	156%
BG with moving stage	10	high	6.9E+03	1.1E+01	6.3E+03	1.0E+01	91%
^{90}Sr at pos-B with 0.8 mm? thick metal plate	5	high	6.2E+04	2.1E+02	1.4E+05	4.7E+02	225%
^{90}Sr at pos-B with 0.8 mm? thick metal plate×2	5	high	5.3E+04	1.8E+02	1.3E+05	4.3E+02	247%

more or less the same number of hits

Though the measurement time is the same for both readout systems, the number of data recorded is different. The difference is independent of the hit rate.

1/32 inch = 0.794 mm

NI's DAQ board PCIe-6536B

PCIe-6536B
Digital I/O Device

Starting from $ 3,766.00

VIEW PRODUCT DETAILS

32-Channel, 25 MHz, 100 MB/s Digital I/O Device—The PCIe-6536 can continuously stream data over the PCI Express bus. It's an ideal solution for interfacing and testing image sensors or display panels. The module is also well-suited for other common digital applications such as pattern I/O, change detection, protocol emulation, or other custom digital interfacing. It features selectable voltage levels and per-channel directional control of the digital lines.

A discussion about the NI DAQ board was made in the NI Japanese forum: My question at NI forum (in Japanese)

GenkiN
Member

Translated by **Google** Translate

I am using PCIe-6536B in a C language program.

The data of the measuring instrument operating at 10 MHz (data is generated at about 10 kHz to 1 MHz) is acquired and stored in the buffer. When sufficient data is accumulated in the buffer, the data is read by DAQmxReadDigitalU32 and the data collection is continued. But how long does it take to read the data?

Also, will the data acquired while reading the data be discarded?

Yu.T
Active Participant

The data acquired by the DAQmx device is immediately transferred to the buffer on the PC. The buffer size on this PC is determined automatically, but it can also be set manually. Allocation of DAQmx buffer size for finite or continuous collection Reading the data itself takes almost no time because it is obtained directly from the PC buffer. Of course, it will change a little depending on the specifications of the PC,
If you instructed to "get 10 points of data from the buffer" but the points of data are not in the buffer. There, we will wait until the data is accumulated. For example
    Sampling rate 1kHz
    Number of samples to read 500sample
Under the condition of, the Read function is executed every 500 milliseconds. (Since 1 point of data is recorded every 1 millisecond = 1kHz, it takes 500 milliseconds to accumulate 500 points)
Since the data acquired during data reading is saved in the PC buffer, no data loss can occur. But for example, even though the buffer size is only 10. I couldn't give the instruction to "get 20 points of data from the buffer". In this case, the data is missing and a buffer overflow error is returned by the Read function.

Certified LabVIEW Developer
There are only two ways to tell somebody thanks: Kudos and Marked Solutions

read_DAQ.c

```
263  void
264  AcquireData(std::string ports, std::string pfi, double sampleHz, FILE* fp, FILE* fp2, FILE* fp3)
265  {
266  #ifdef __linux__
267  #else
268          std::cout << "Acquiring data on " << ports << " with " << pfi << std::endl;
269
270          /*********************************************************/
271          // DAQmx Configure Code
272          /*********************************************************/
273          TaskHandle taskHandle=0;
274          uInt32 data[1000000];   ← array to contain the sample
275          int32 cnt = 0;
276          int32 datacnt = 0;
277          //int32 cksum = 0;
278          uInt32  data1[163840];
279          uInt32 PacketData[10000];
280
281          try
282          {
283                  DAQmxErrCheck (DAQmxCreateTask("",&taskHandle));
284                  DAQmxErrCheck (DAQmxCreateDIChan(taskHandle,ports.c_str(),"",DAQmx_Val_ChanForAllLines));
285                  DAQmxErrCheck (DAQmxCfgSampClkTiming(taskHandle,"",sampleHz,
286                          DAQmx_Val_Rising,DAQmx_Val_FiniteSamps,1000000));
287                  DAQmxErrCheck (DAQmxExportSignal(taskHandle,DAQmx_Val_SampleClock,pfi.c_str()));
```

sampling rate: 5 MHz

#sample to acquire: 1M

```
311                  while ( take_data )     {
312                          DAQmxErrCheck (DAQmxStartTask(taskHandle));
313                          DAQmxErrCheck (DAQmxReadDigitalU32(taskHandle,-1,10.0,DAQmx_Val_GroupByChannel,
314                                  data,1000000,&numRead,NULL));
315                          DAQmxErrCheck (DAQmxStopTask(taskHandle));
```

the Read function

According to the discussion, data taken during reading out is saved in the PC buffer, i.e., data cannot be lost. In our case, 1M samples (~4M byte) are corrected to the buffer of 1M samples at 5 MHz. Since the buffer is full when reading out, I'm not sure that data taken during reading out can be stored (somewhere?). The discussion is ongoing.

The buffer allocation is (maybe) done by the board

Sample Rate	Buffer Size
0-100 S/s	1 kS
100-10,000 S/s	10 kS
10,000-1,000,000 S/s	100 kS
>1,000,000 S/s	1 MS

ref

Can we trust the Felix readout system?

The results from the Felix readout system LOOK reasonable. But it's not enough to trust the system. We need to measure something predictable and check the consistency of the prediction. It can be done only at BNL. What is good for that? My idea is a hit count with MC simulation (not Geant4 but PHITS or something valid for low energy particle transportation).

Another approach should be performed: Why does the FEM readout system obtain such results? It can be done at all test benches.