

# The 3rd Test Beam Experiment @ELPH in Tohoku Univ.

G. Nukazuka (RBRC)



Genki  
Nukazuka  
from  
USA



Itaru  
Nakagawa  
taking  
this photo



Cheng-Wei  
Shih  
from  
Taiwan



Masato  
Tsuruta  
from  
ELPH



Hideto  
En'yo

Yumika  
Namimoto

Miu  
Morita

Misaki  
Hata

Mai  
Takahama

Takashi  
Hachiya

Shoichi  
Hasegawa

Mika  
Shibata

Yasuyuki  
Akiba

Yusuke  
Nakamura

Genta  
Nakano

Hikaru  
Imai

# Purpose

## Determination of the detection efficiency

Past beam experiments showed 96% efficiency. But it must be almost 100%.

Mismatch of the BCO phase and beam can explain the reason.

We are ready to take the external trigger information and BCO phase with the CAMAC system.

Cosmic-ray measurements with the CAMAC system showed 98% efficiency. More improvements are not easy since statistics are limited, optimization of the geometry is so delicate.

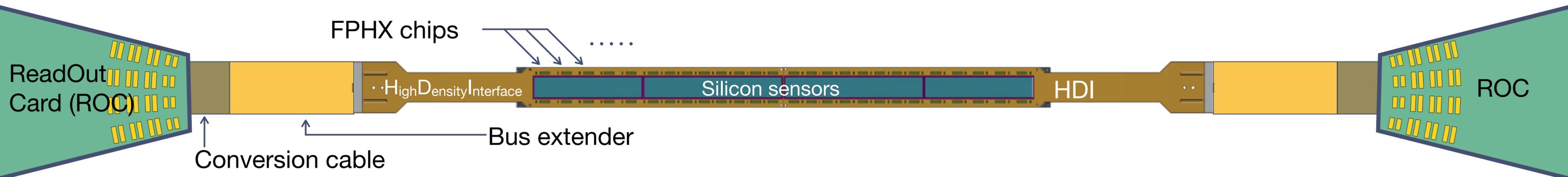
→ We need test beam measurements with the CAMAC system to proof ~100% efficiency

## Beam measurements with the production ladders

We need to see performance of the production ladder with a beam.

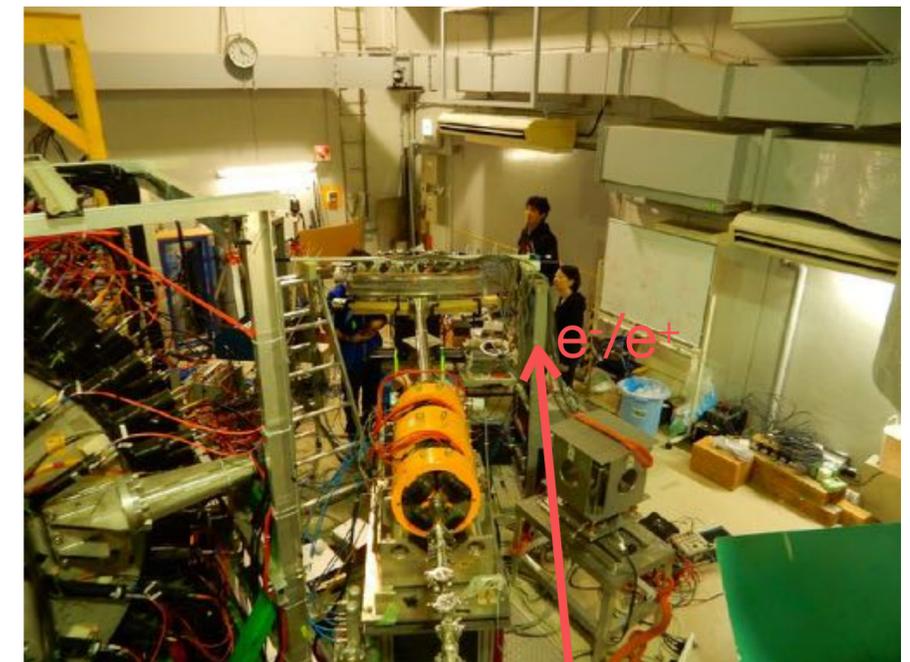
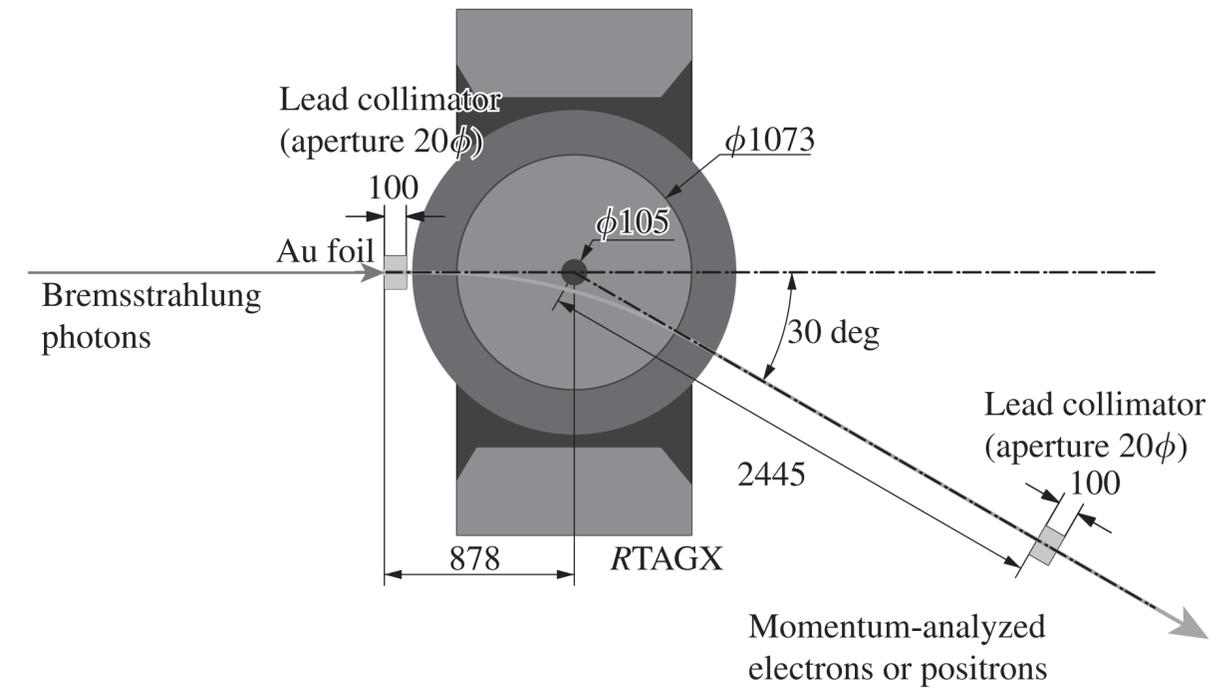
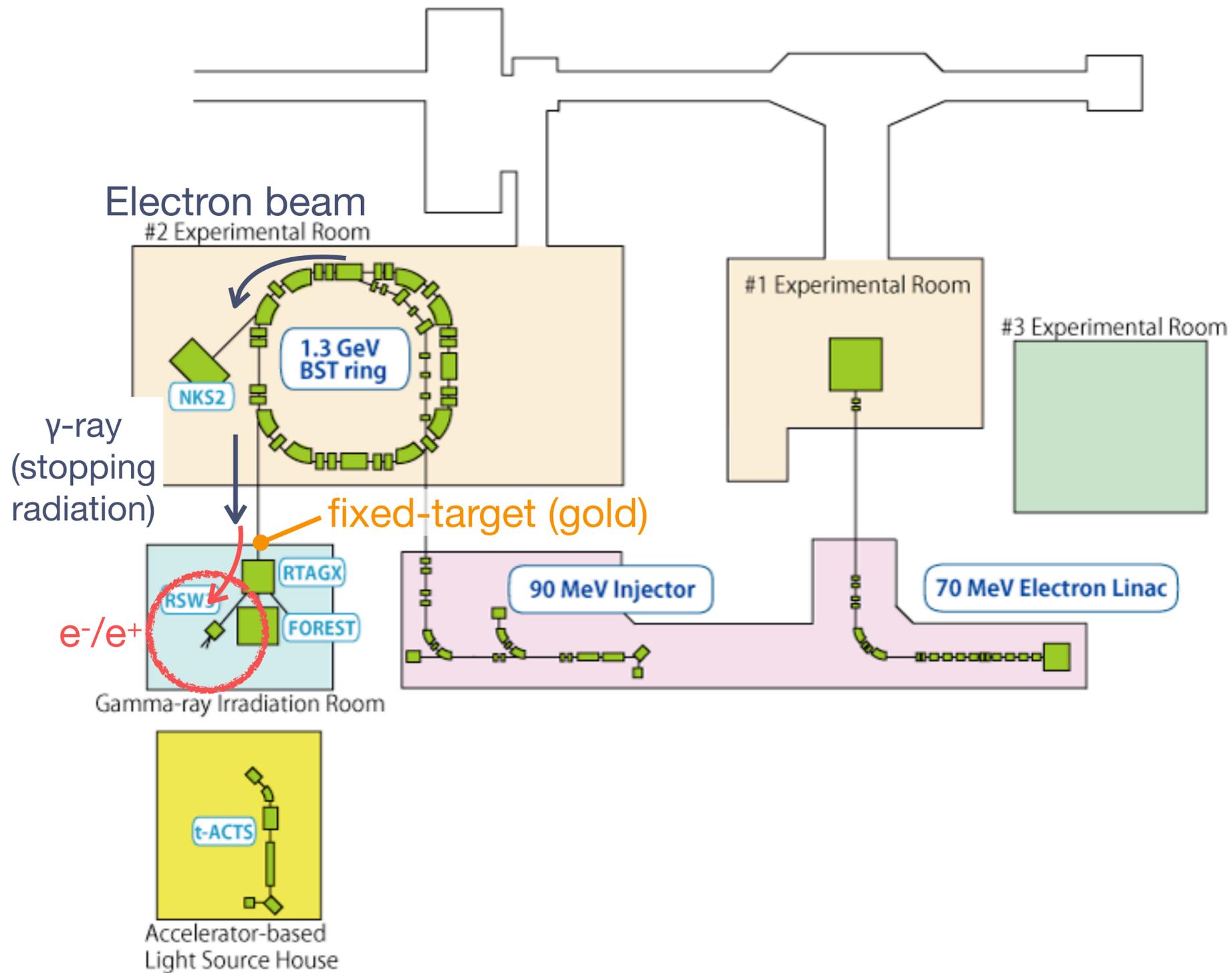
## Beam measurements with the latest bus extenders and the co-axial conversion cables

The design of the bus extender was finalized. We will get the co-axial conversion cable some months later. So they should be tested with a beam.



# Research Center for **EL**ectron **PH**oton Science (ELPH)

[NIM A 694 \(2012\) 348](#)



# Beam features@ELPH GeV- $\gamma$ area

## Electron test beam

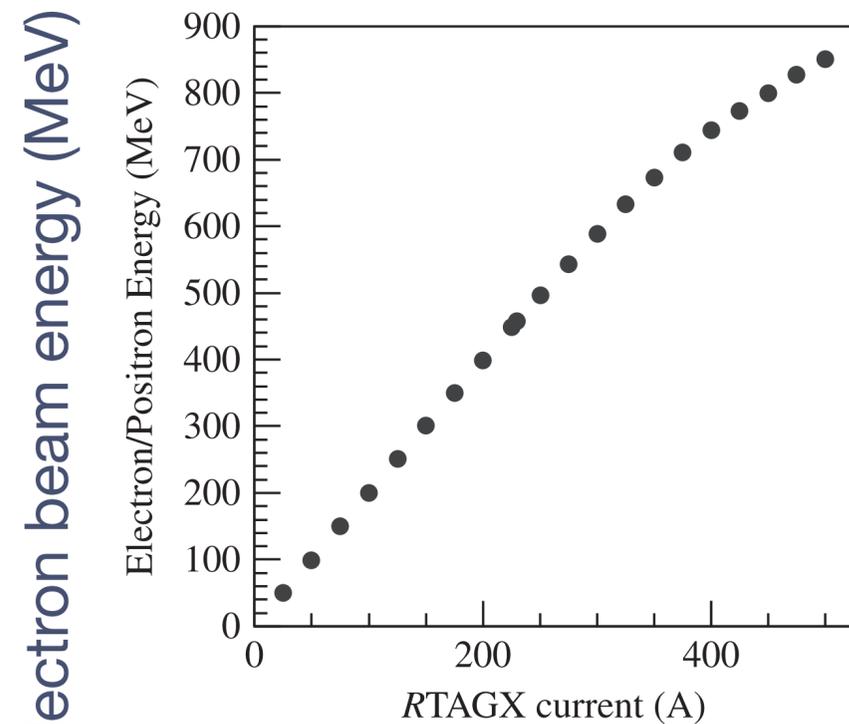
Beam	Beam line	Maximum beam energy
Positron / Electron	$\pm 30$ deg	~840 MeV
Positron	-23 deg	~1000 MeV

[HomePage](#)

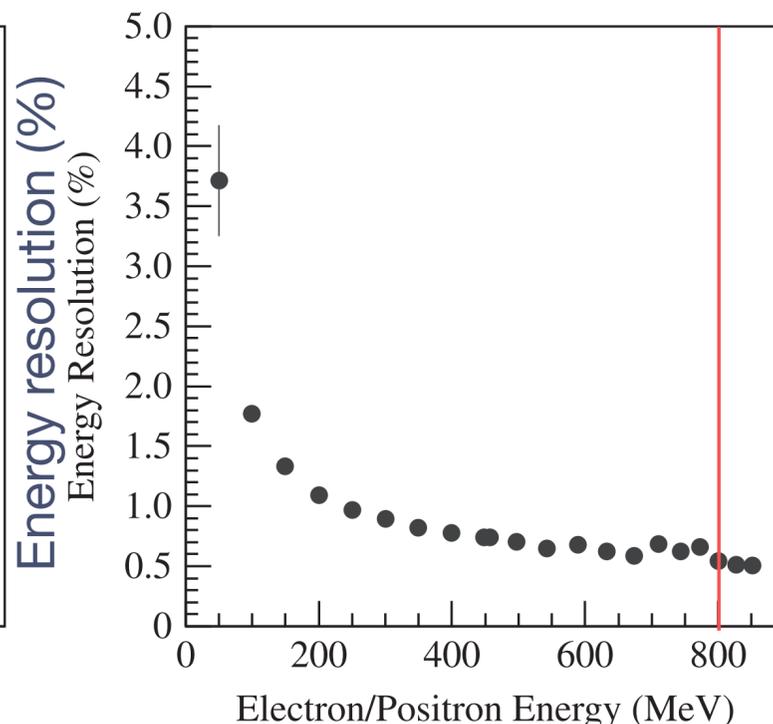
## Tagged gamma-ray beam

Beam line	Energy Range (R <sub>int</sub> Energy: 1.3 GeV)	# of Bins	Intensity	Duty
BST-Tagger-I	0.8 ~ 1.26 GeV	160	TBC	~60% (NKS2)
BST-Tagger-II	0.9 ~ 1.25 GeV	116	TBC	~50% (FOREST)

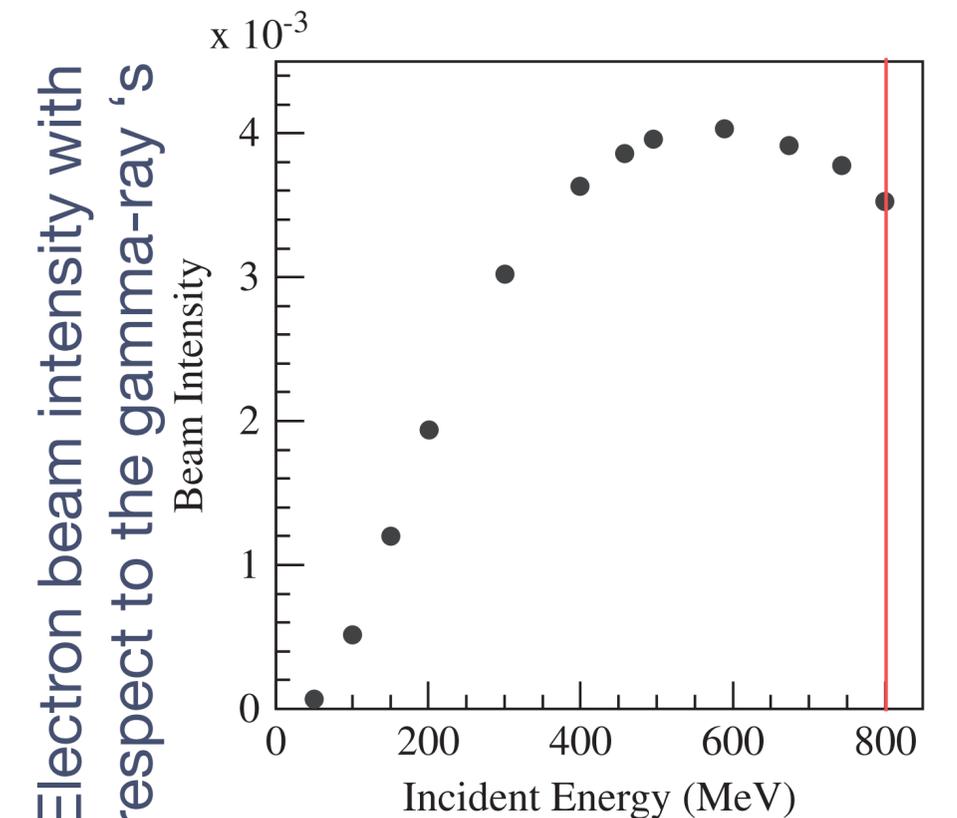
[HomePage](#)



Current for the magnet (A)

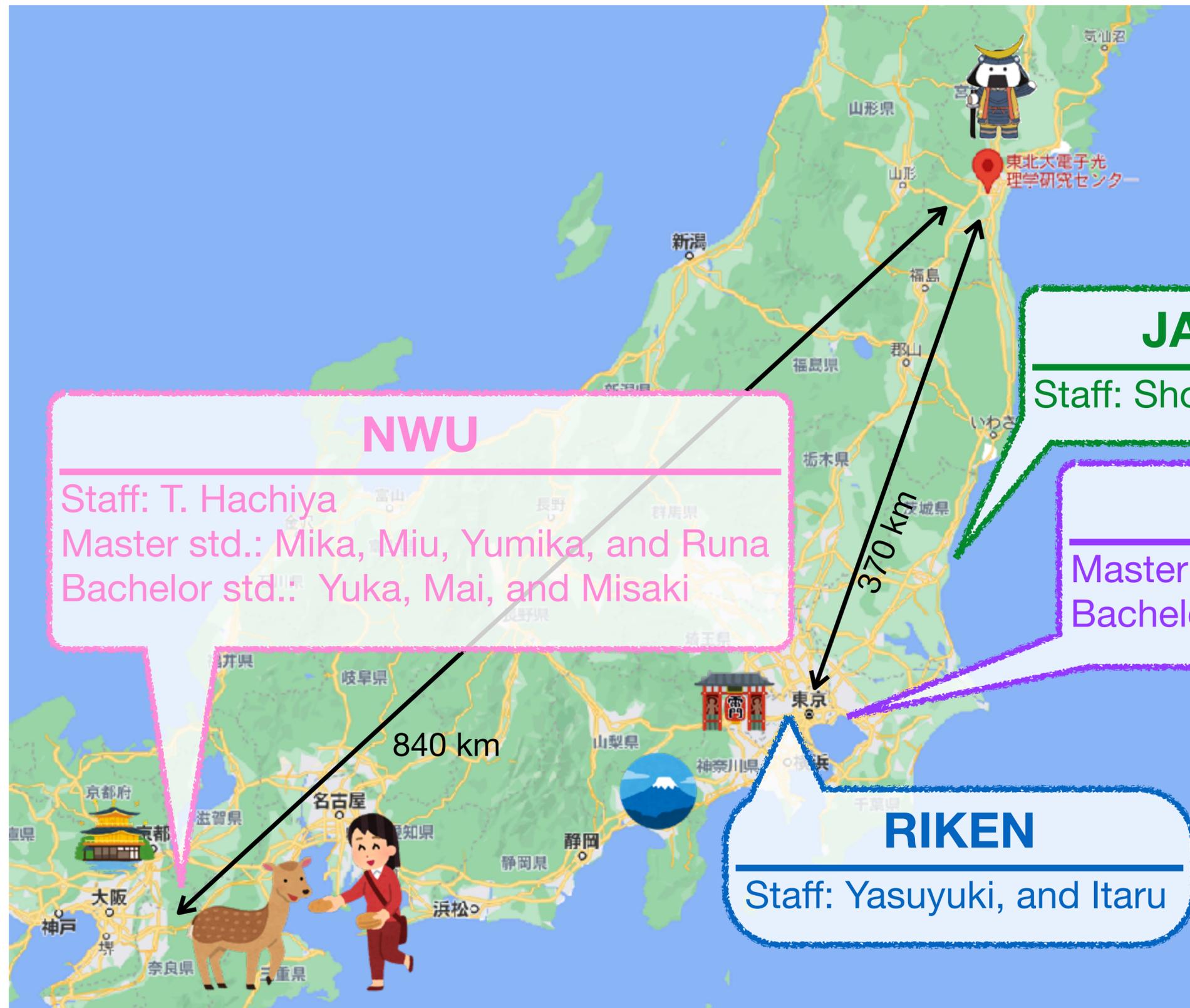


Electron beam energy (MeV)



Gamma-ray energy (MeV)

# Tentative Member



**NWU**  
Staff: T. Hachiya  
Master std.: Mika, Miu, Yumika, and Runa  
Bachelor std.: Yuka, Mai, and Misaki

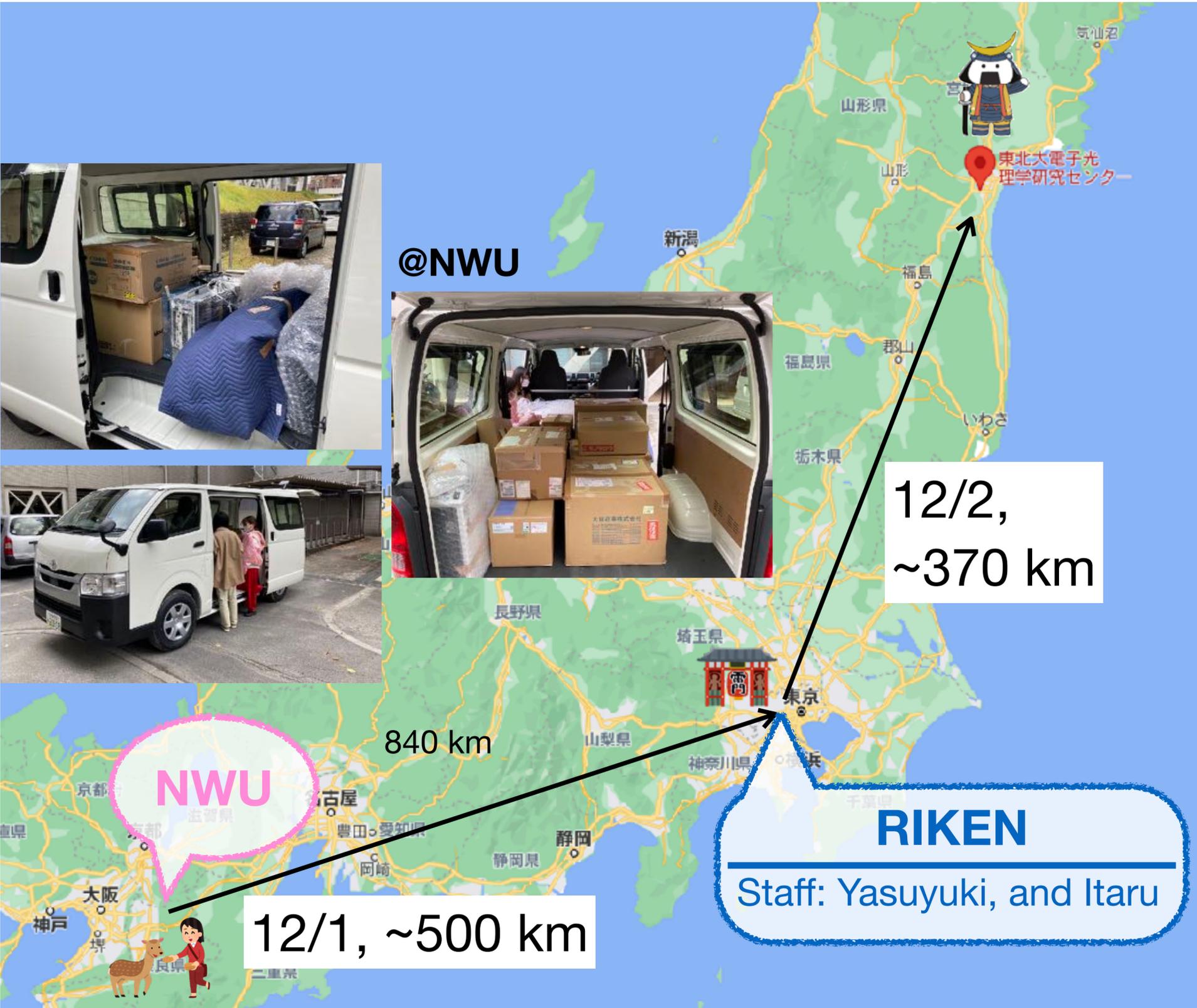
**JAEA**  
Staff: Shoichi

**Rikkyo Univ.**  
Master std.: Hikaru  
Bachelor std.: Yusuke & Genta

**RIKEN**  
Staff: Yasuyuki, and Itaru

Under current self quarantine policy for people from overseas, it's hard to come. Recently I heard the rumor that the policy may be loosen. No official statements were made for the moment.  
Cheng-Wei?

# Transportation



@ELPH



@RIKEN



# Schedule

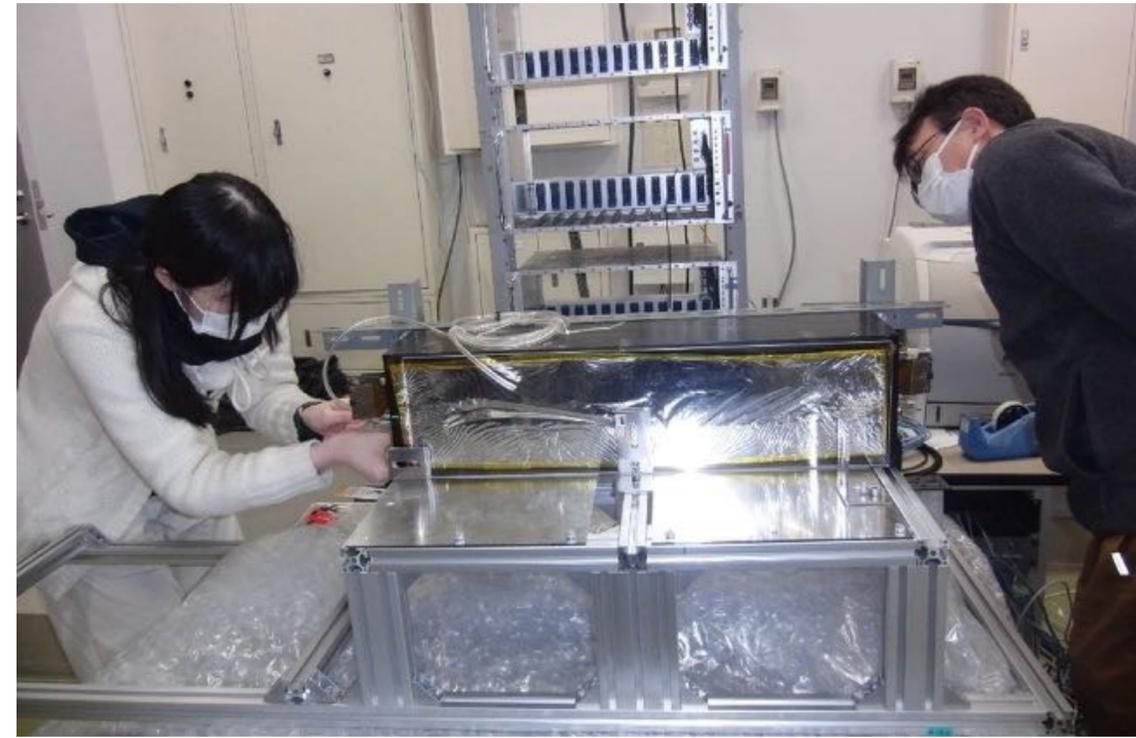
Date	Plan
2021/12/1	Baggage departs from NWU ( Driver: Itaru & Takashi)
2021/12/2	Baggage at RIKEN also departs
2021/12/3	Radiation safety course, Lecture on QGP physics by Yasuyuki
2021/12/4	Setup construction Checking baggage, Carry-in, Testing INTT, Testing trigger scintillators
2021/12/5	Setup construction Chiller installation, Source measurements, Operating in the external trigger mode,
2021/12/6	Setup construction, Lecture of QGP physics by Takashi Remote operation, Alignment, Simulating other setups
2021/12/7	Beam 09:00 - 21:00
2021/12/8	Beam 09:00 - 21:00
2021/12/9	Beam 09:00 - 21:00
2021/12/10	Beam 09:00 - 21:00
2021/12/11	Disassembling the setup, packing & transportation (Driver: ??? ) Baggage arrives at RIKEN
2021/12/12	Baggage arrives at NWU



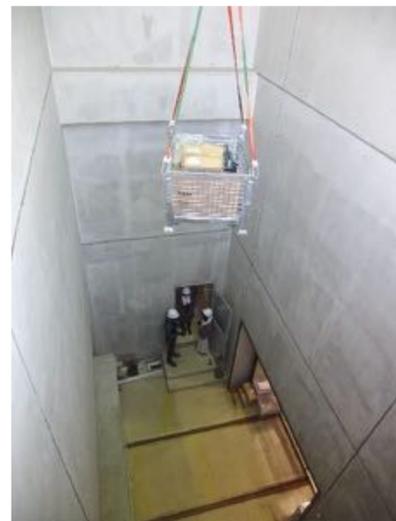


Some larger items were moved by a crane.

# Setup construction



Ladder insertion in the ground floor.



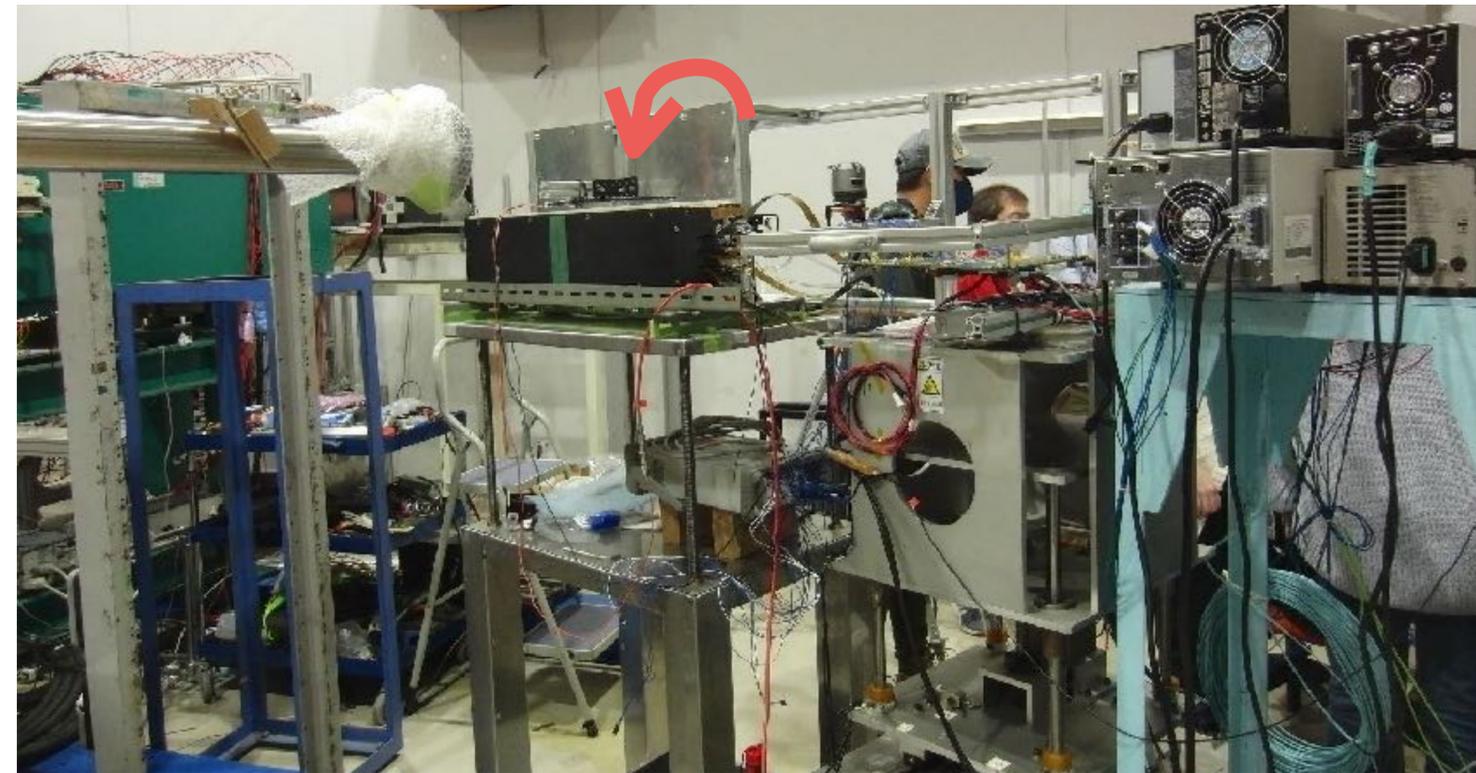
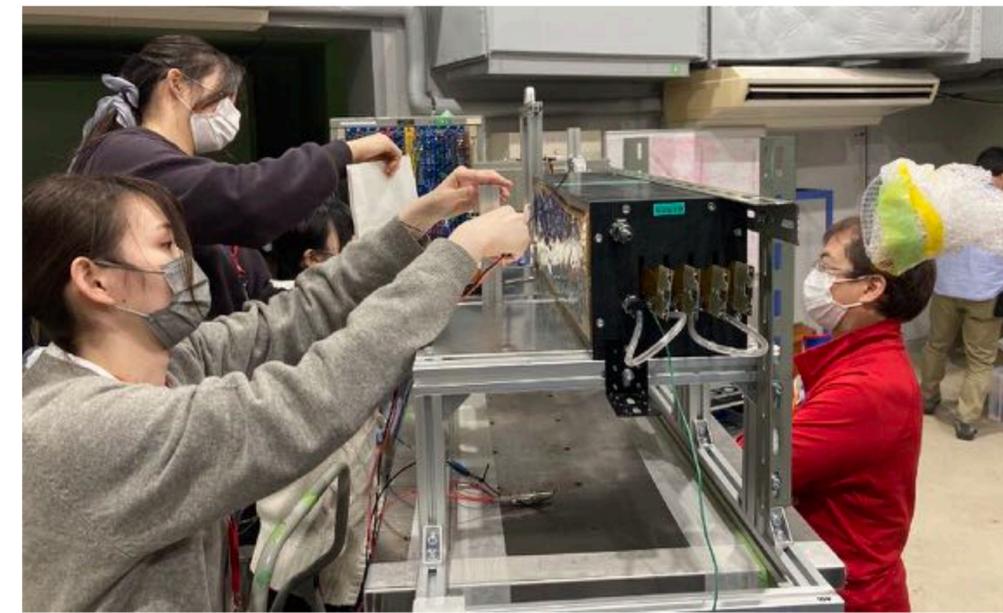
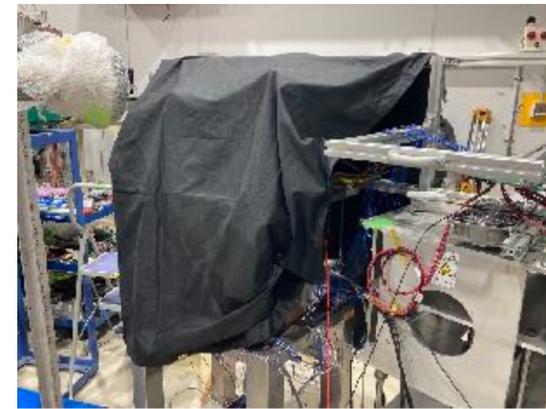
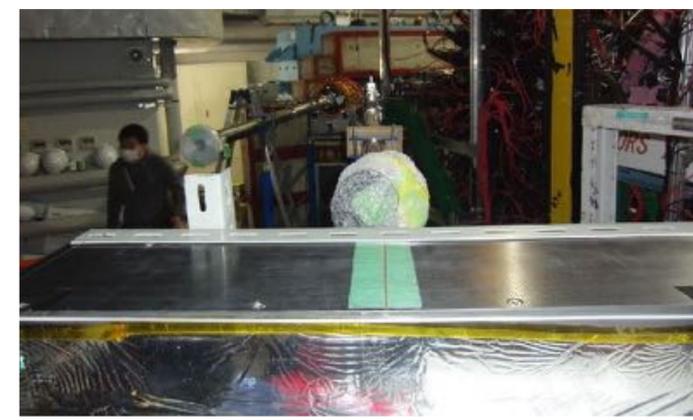
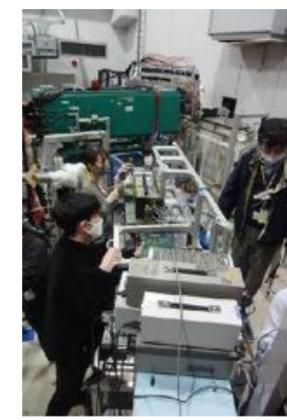
The ladders and the dark box were moved by hand.



# Setup construction

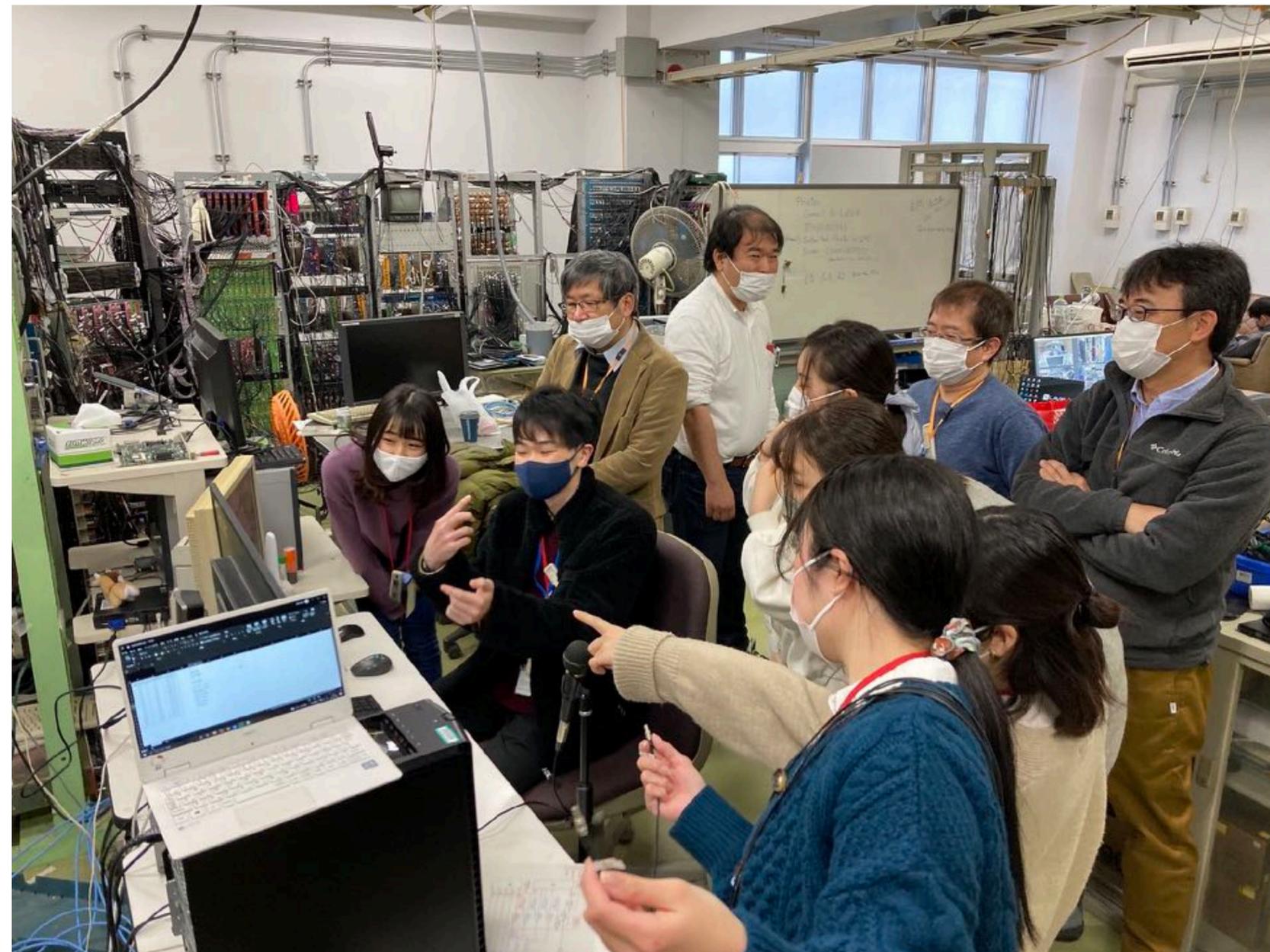
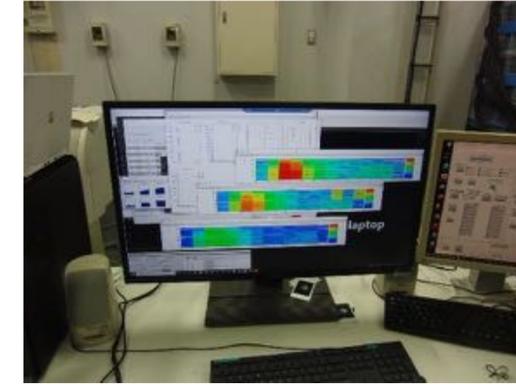


# Setup construction



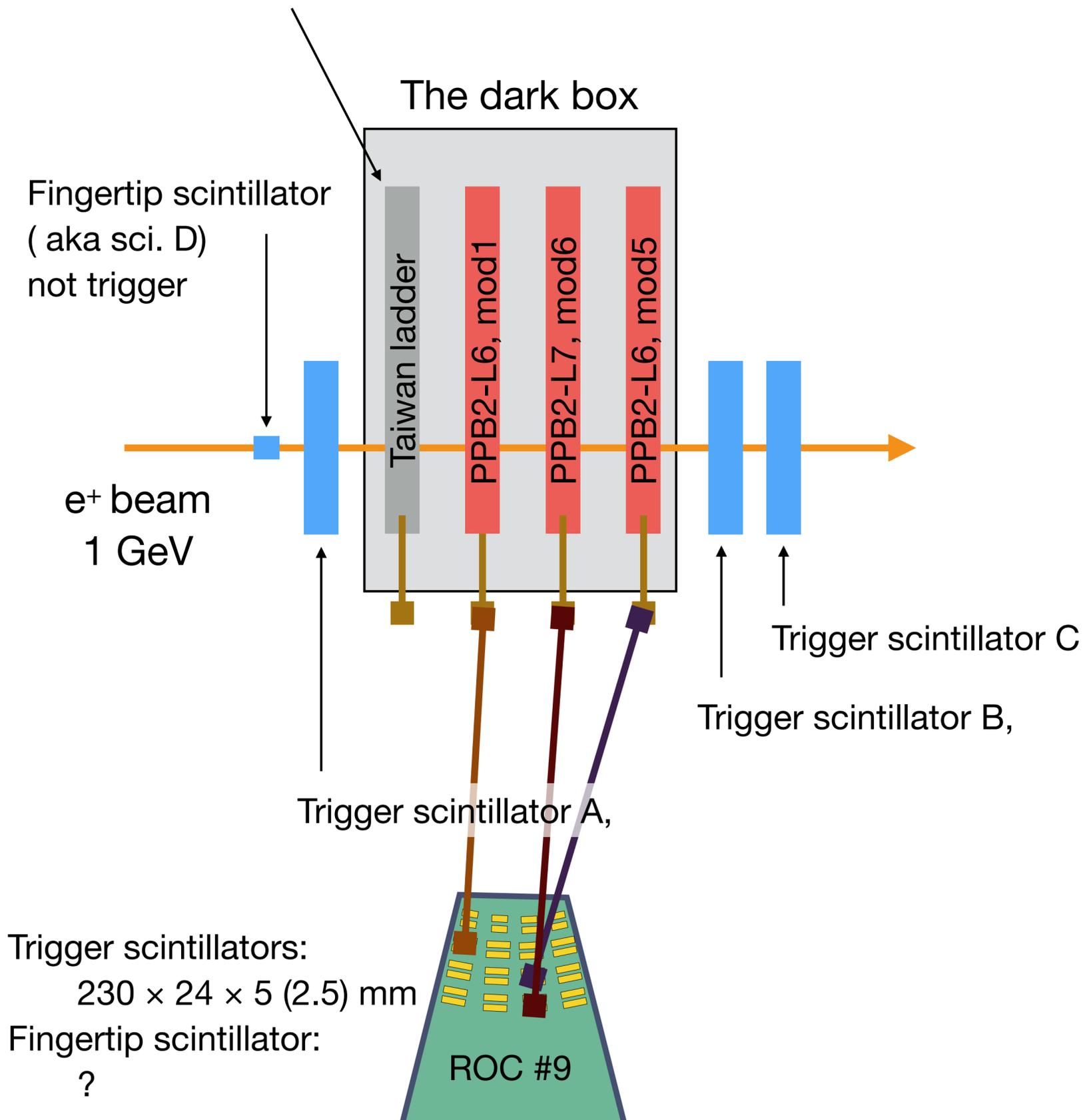
The setup rotate by  $90^\circ$  for cosmic ray measurements

# Setup construction



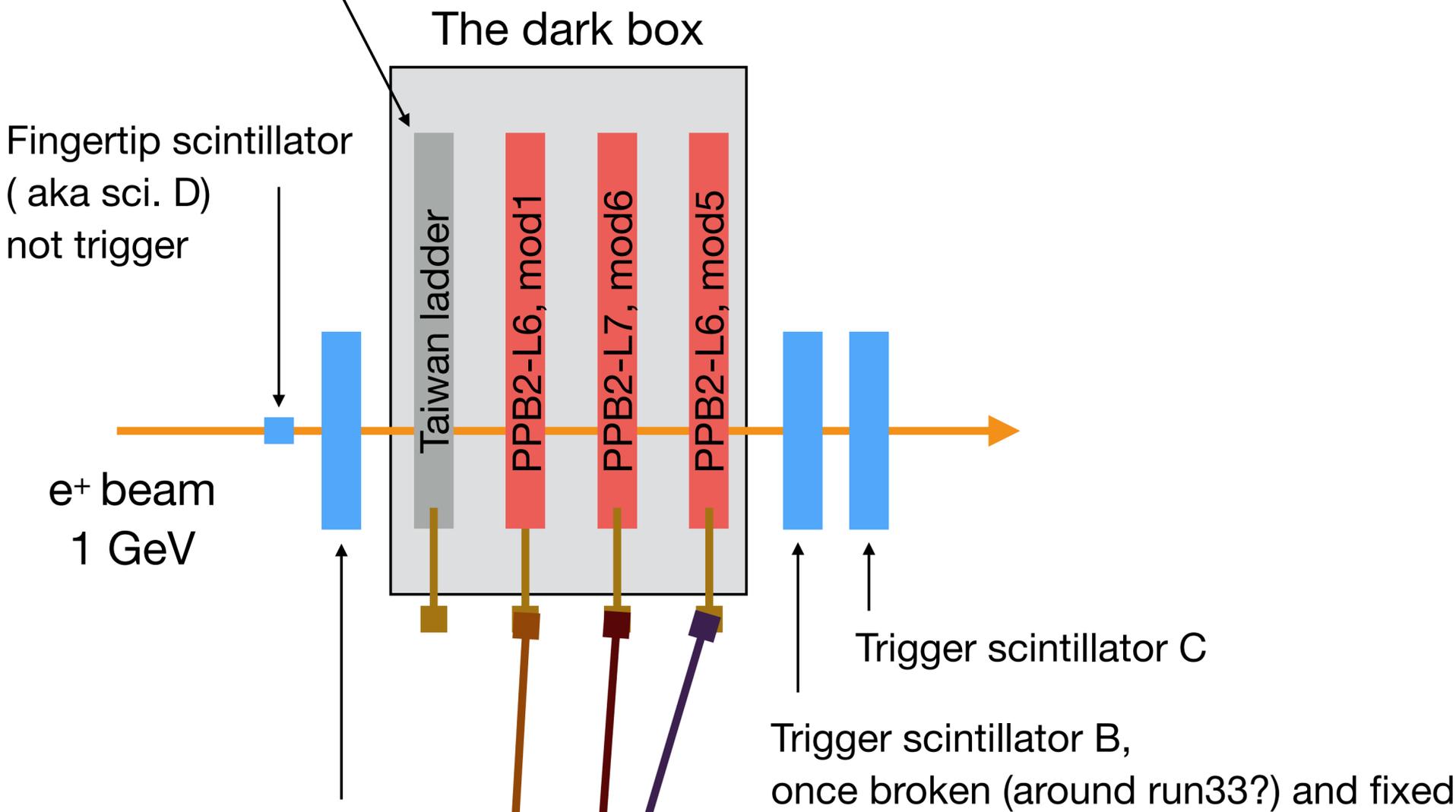
# The setup

We couldn't operate it.  
It worked well after blowing dusts away at NWU...

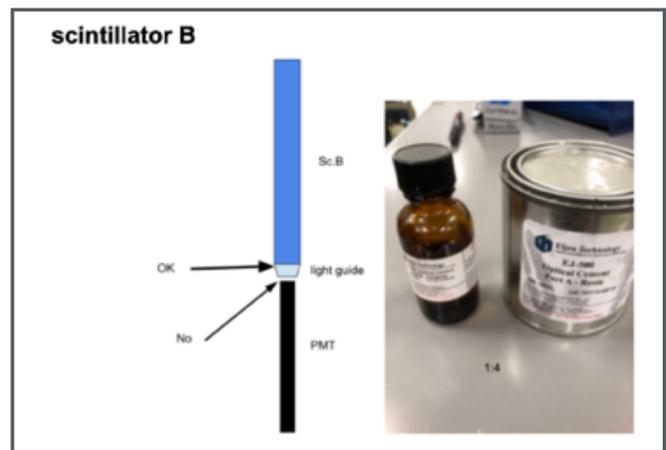


We couldn't operate it.  
It worked well after blowing dusts away at NWU...

# The setup

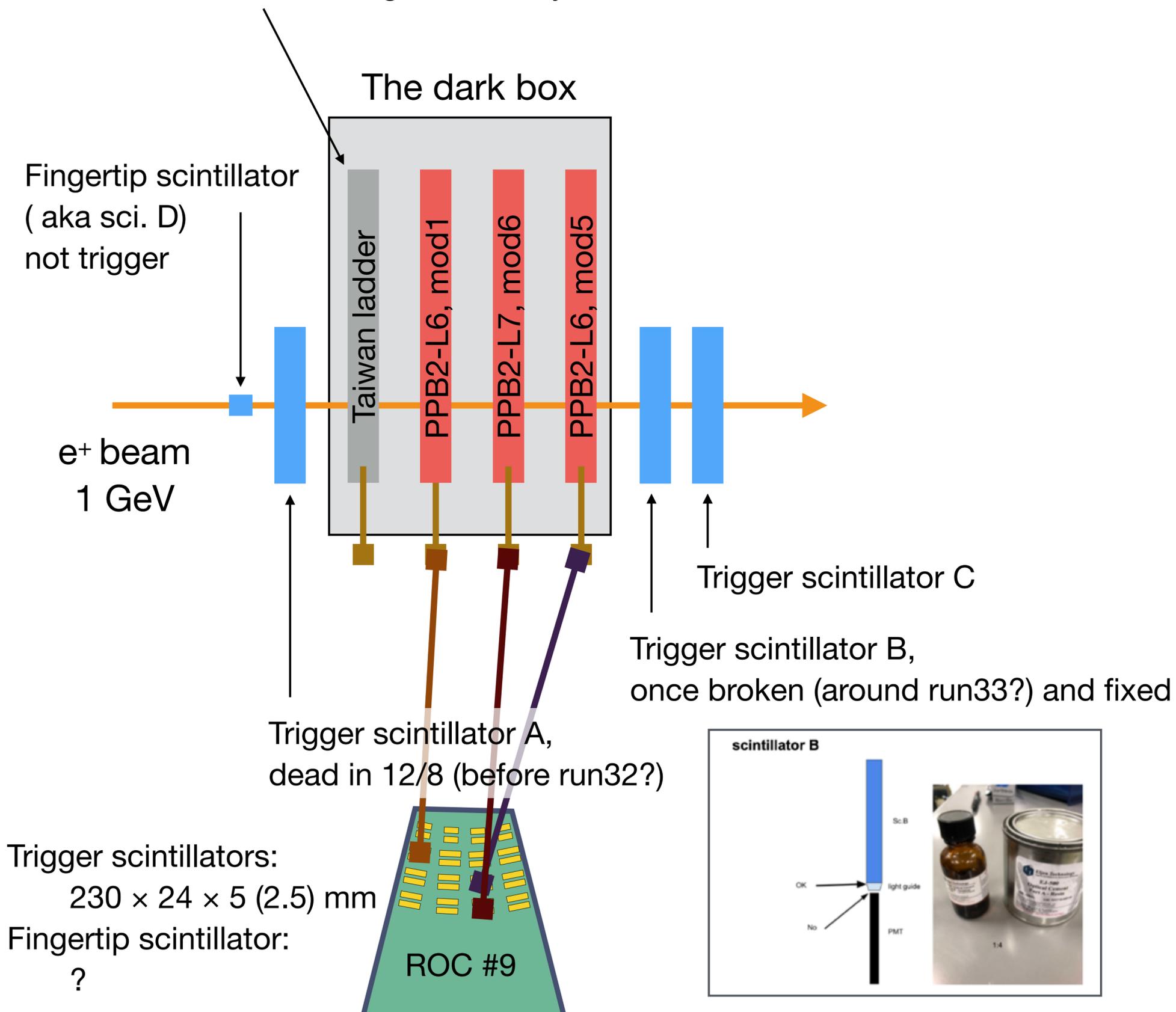


Trigger scintillators:  
230 × 24 × 5 (2.5) mm  
Fingertip scintillator:  
?

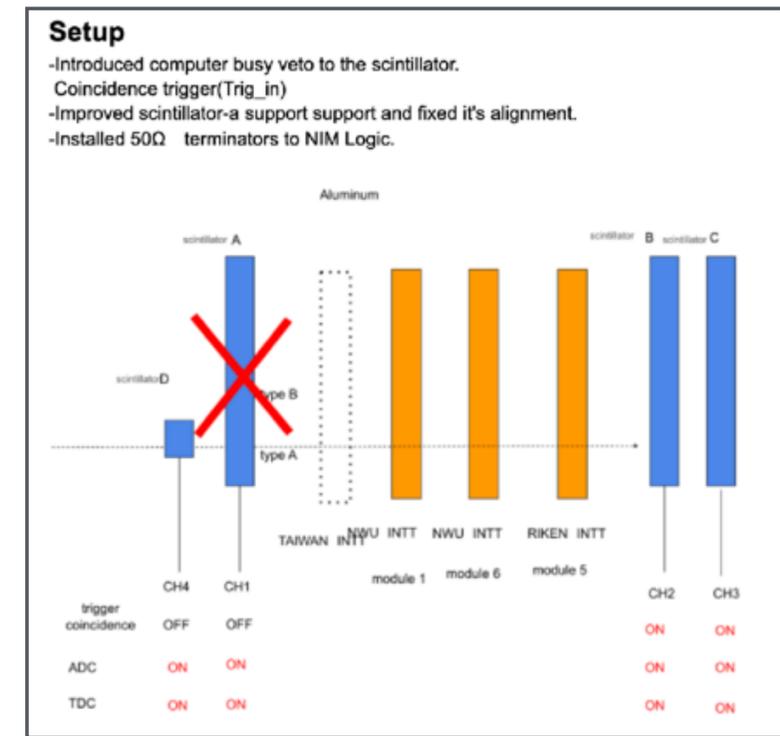


We couldn't operate it.  
It worked well after blowing dusts away at NWU...

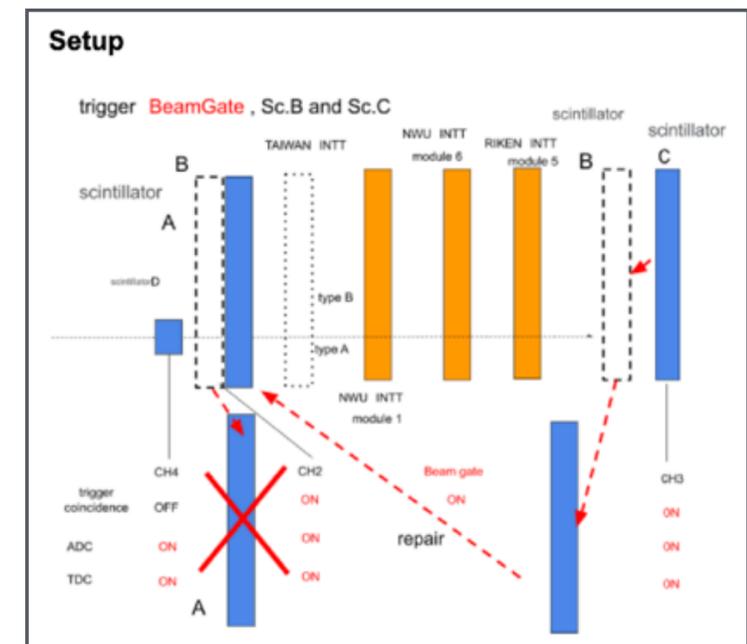
# The setup



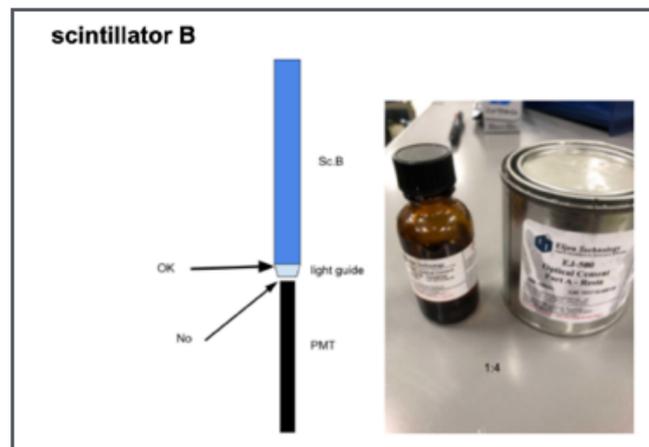
Trigger scintillators:  
230 × 24 × 5 (2.5) mm  
Fingertip scintillator:  
?



Setup of run31 from log book

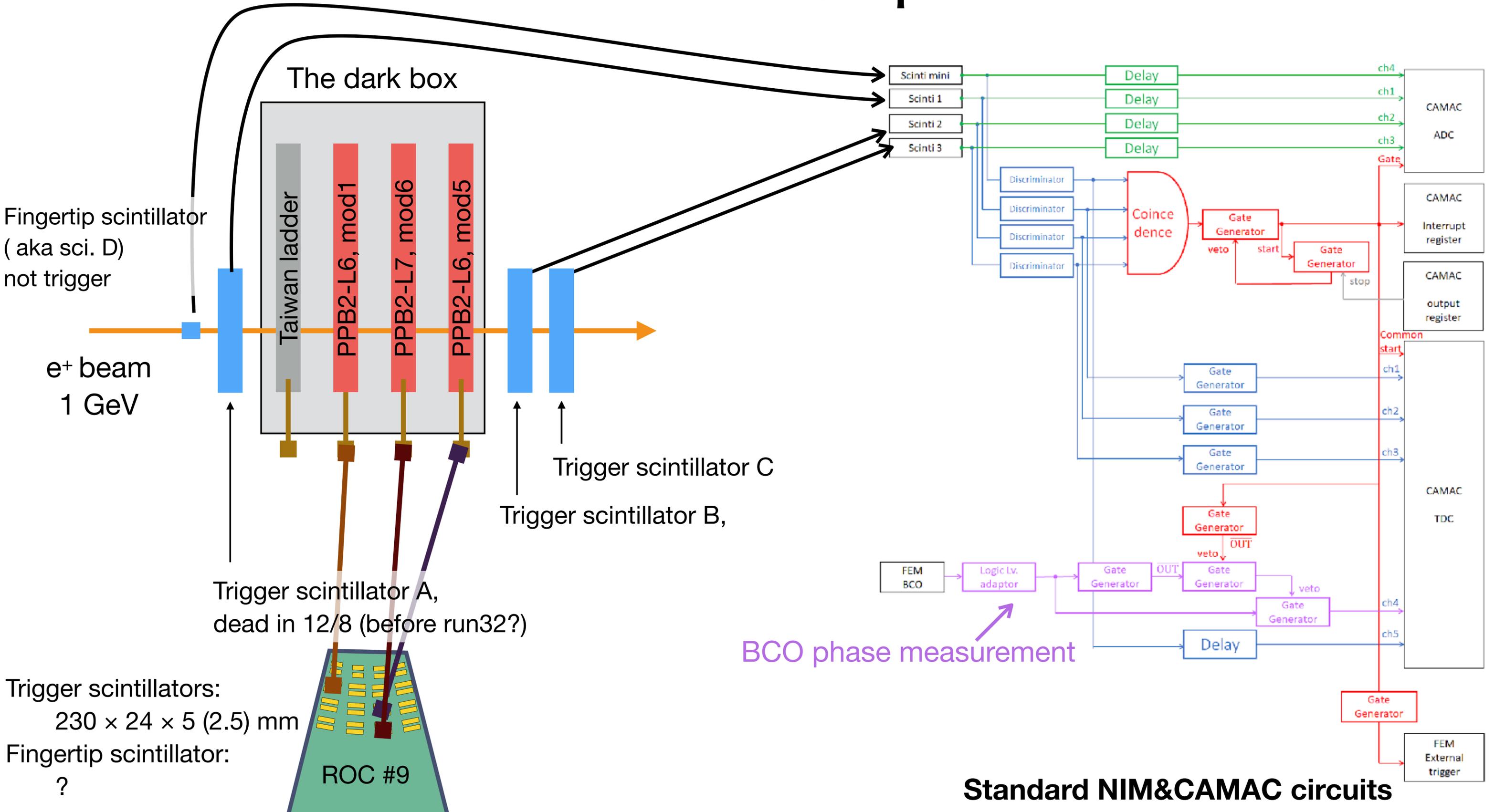


Setup of run33 from log book



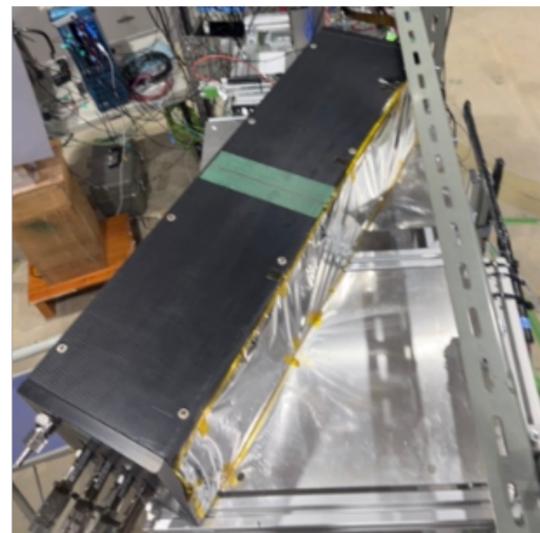
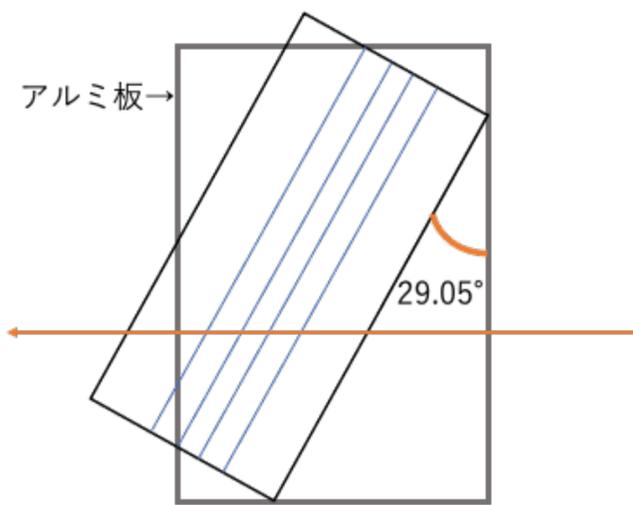
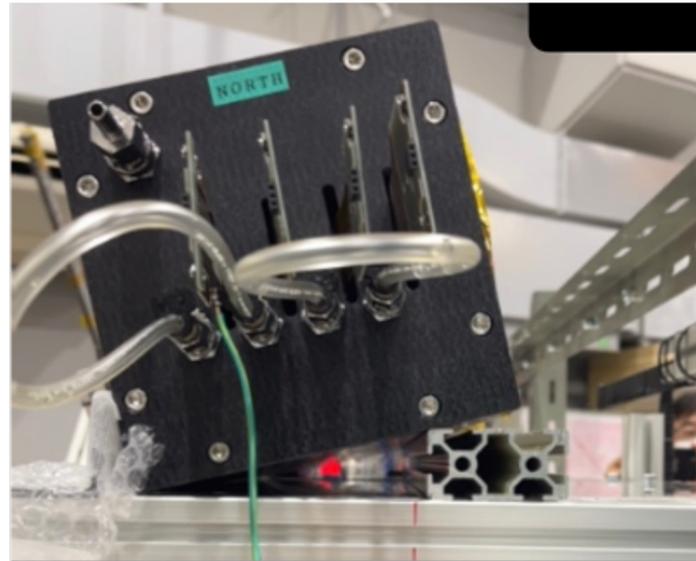
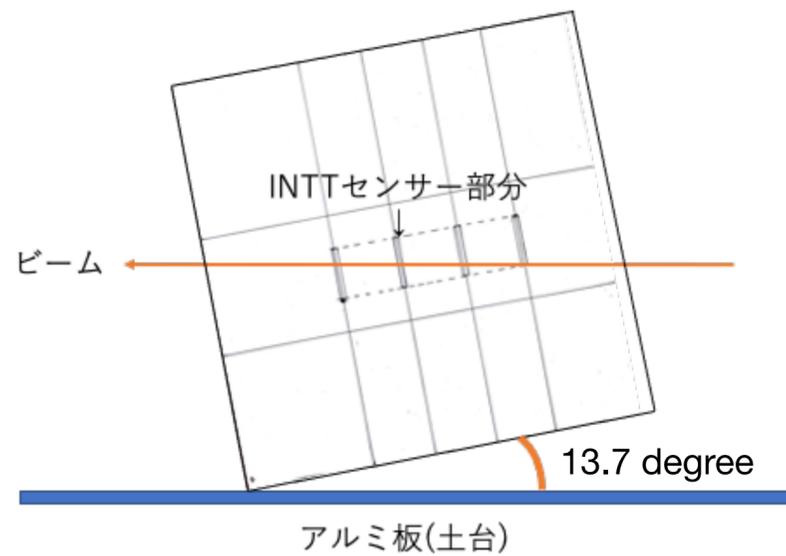
# The setup

Note. configuration depends on the run

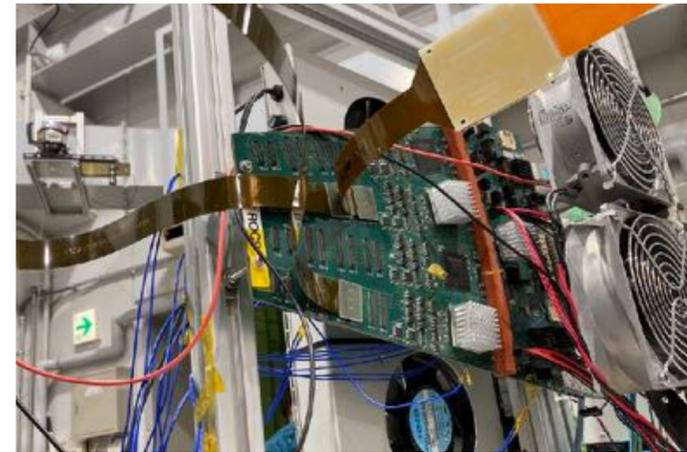


# The setup, additional trials

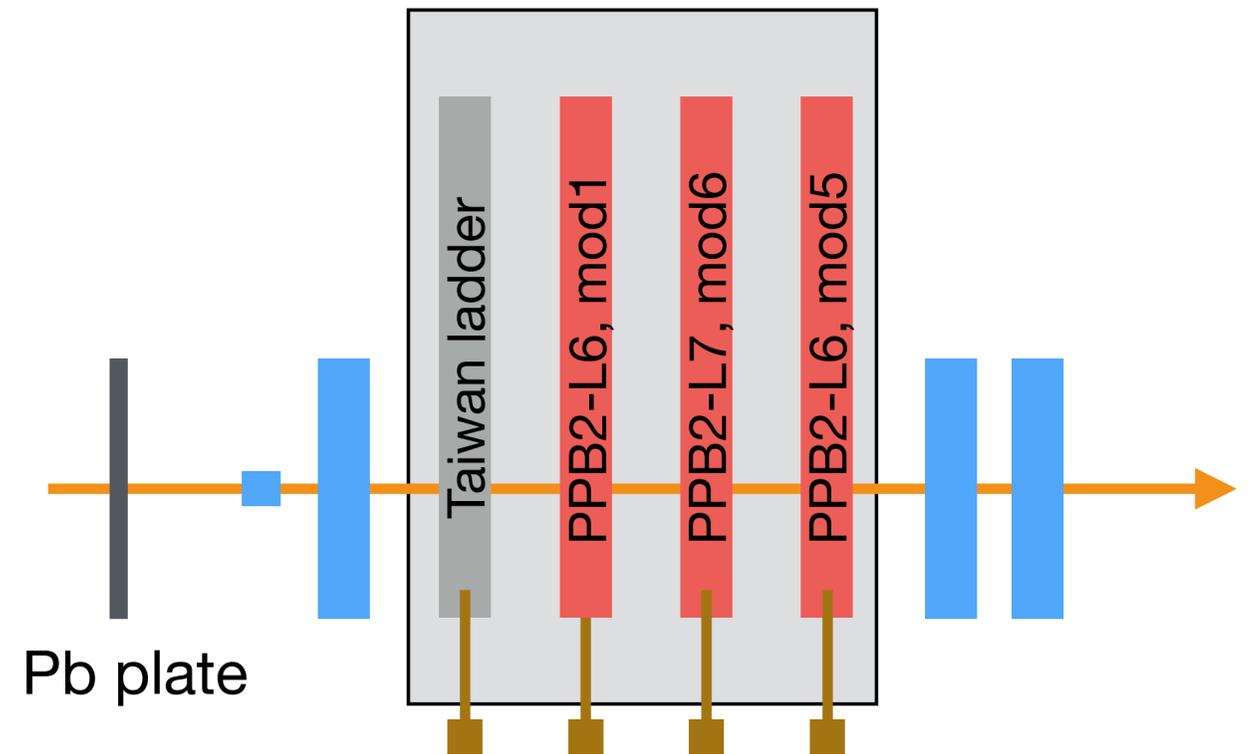
Tilted/Rotated setup wrt. the beam



The setup with a bus extender

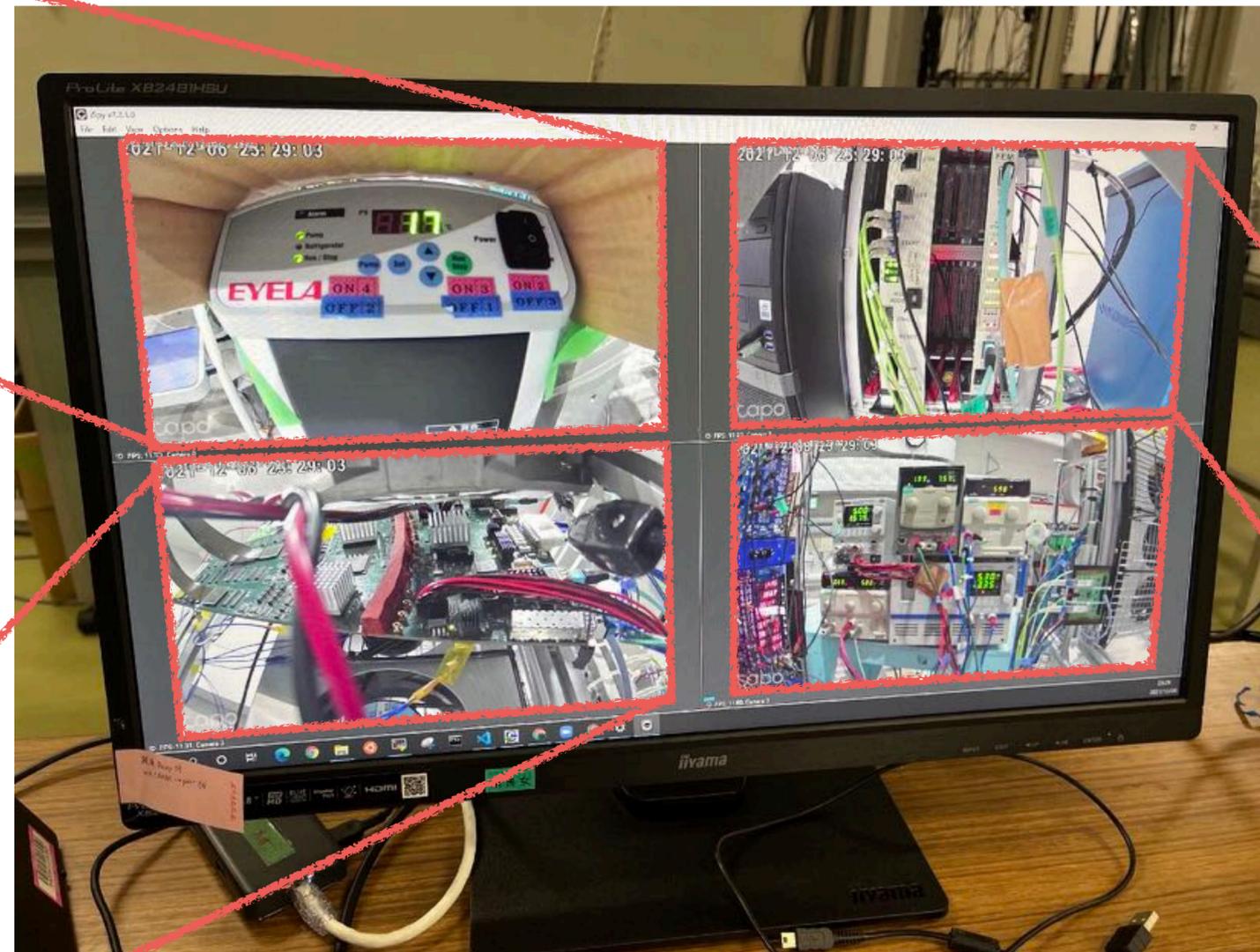
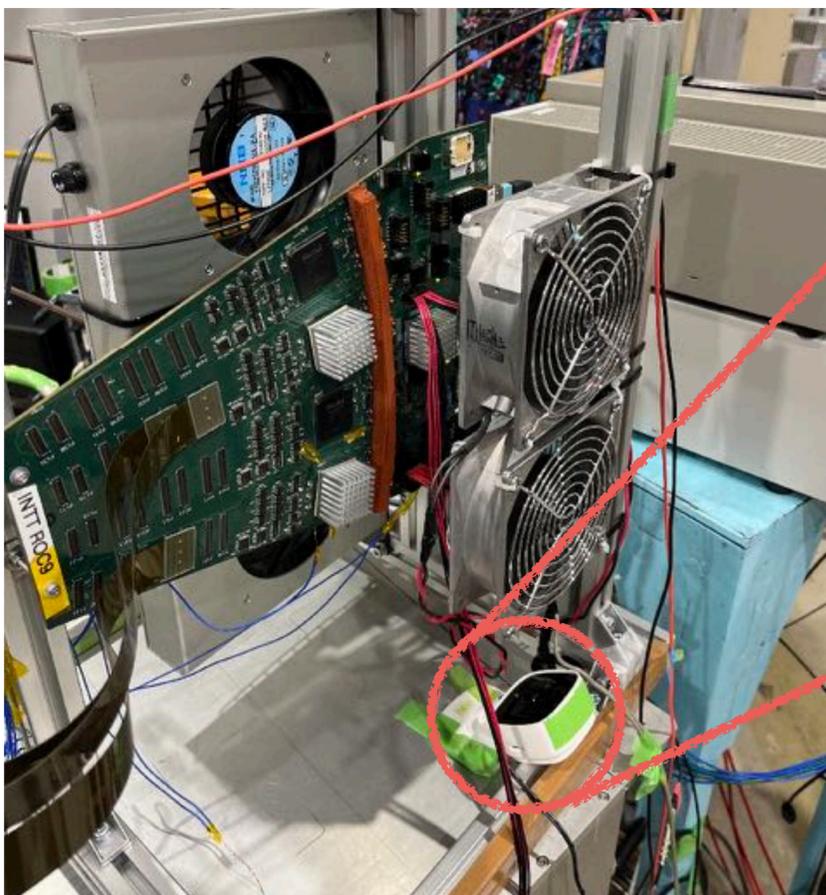
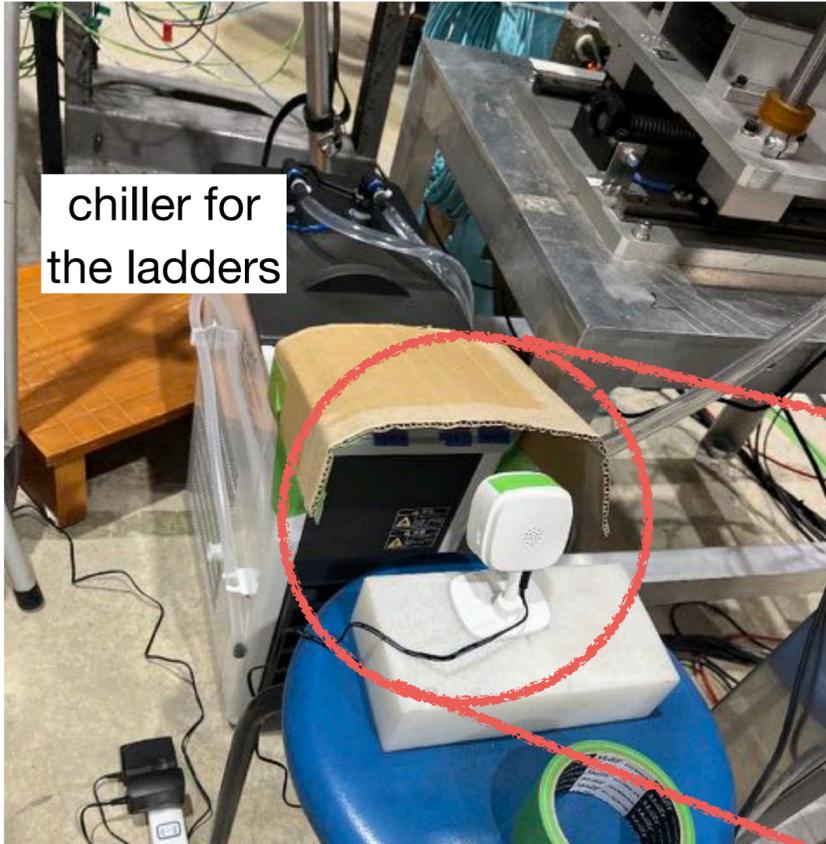


Multiple-track condition



# Web camera monitoring

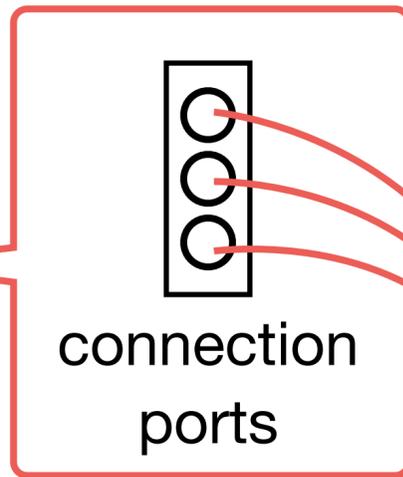
by Genta Nakano (Rikkyo)



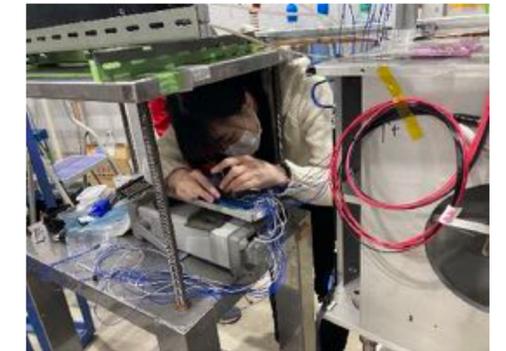
TP Link  
Tapo C100  
~\$35

**The system worked very nicely!**

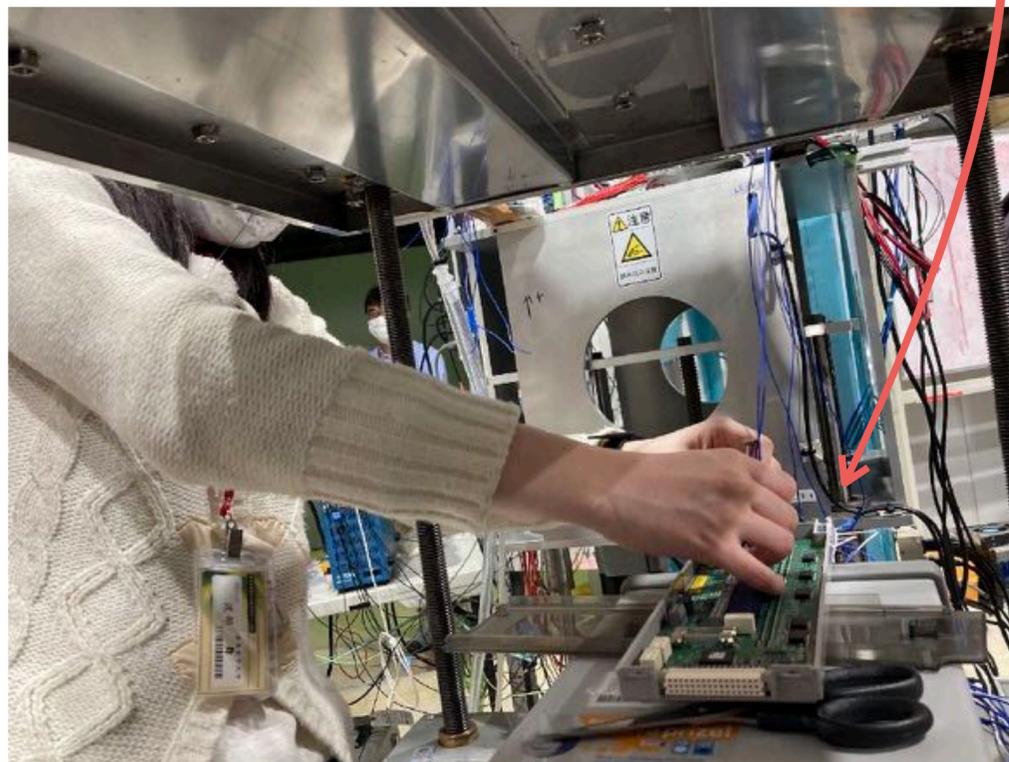
# Ladder&ROC temperature monitoring



Graph	Measurement point
101	PPB2-L5, 10 mV
102	PPB2-L5, 10 mV
103	PPB2-L6, 10 mV
104	PPB2-L6, 10 mV
105	Taiwan ladder?, 10 mV
106	Taiwan ladder?, 10 mV
107	PPB2-L7?, 10 mV
108	PPB2-L7?, 10 mV
109	ROC U603
110	ROC U8
111	ROC U628 for digital line of the port C3
112	ROC U100 for DATA FPGA column-A
113	ROC U500 for FPGA
114	ROC U622 for the digital line of port A2
115	ROC U300 for the DATA FPGA column-C
116	ROC U620 for the digital line of the port C1



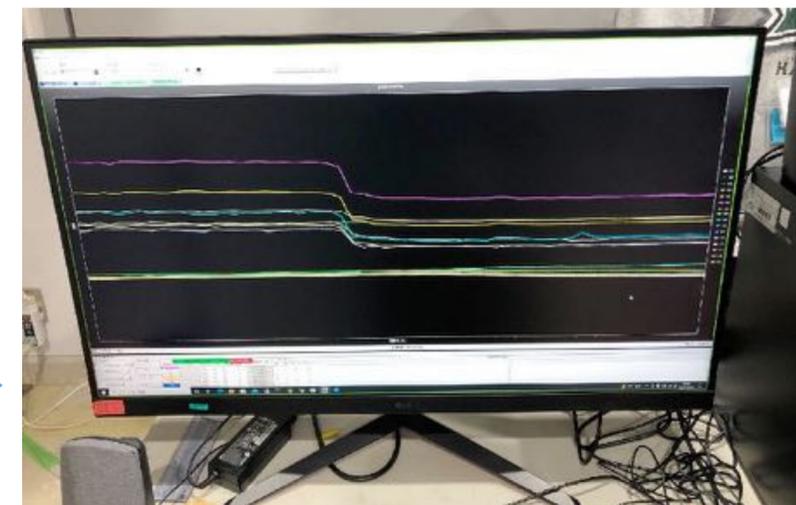
by Mai Watanabe (NWU)



GPIB



USB

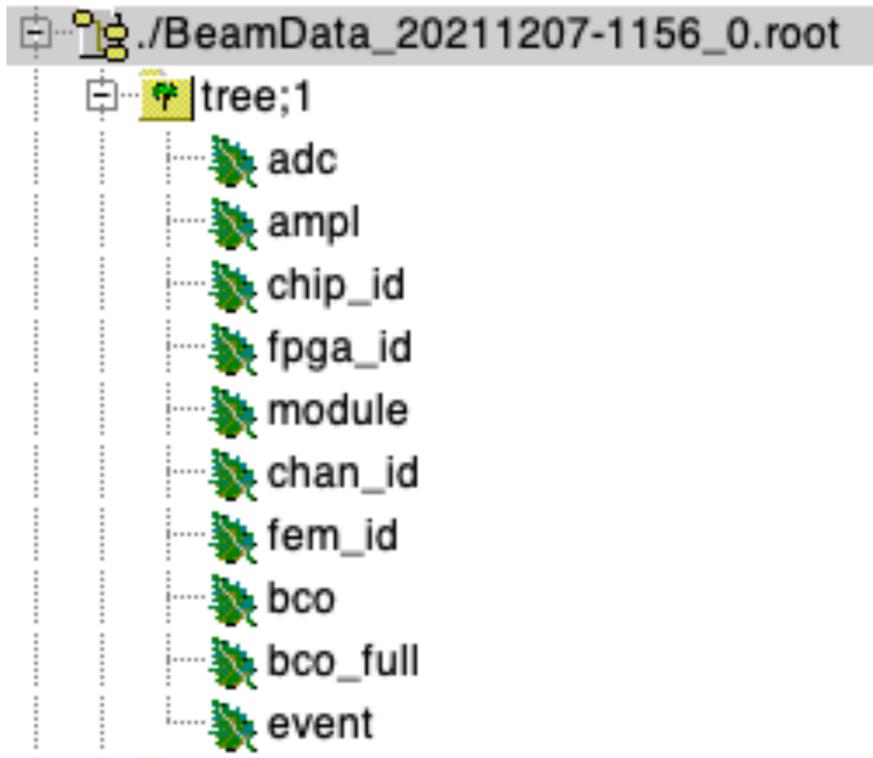


**The system worked very nicely!**

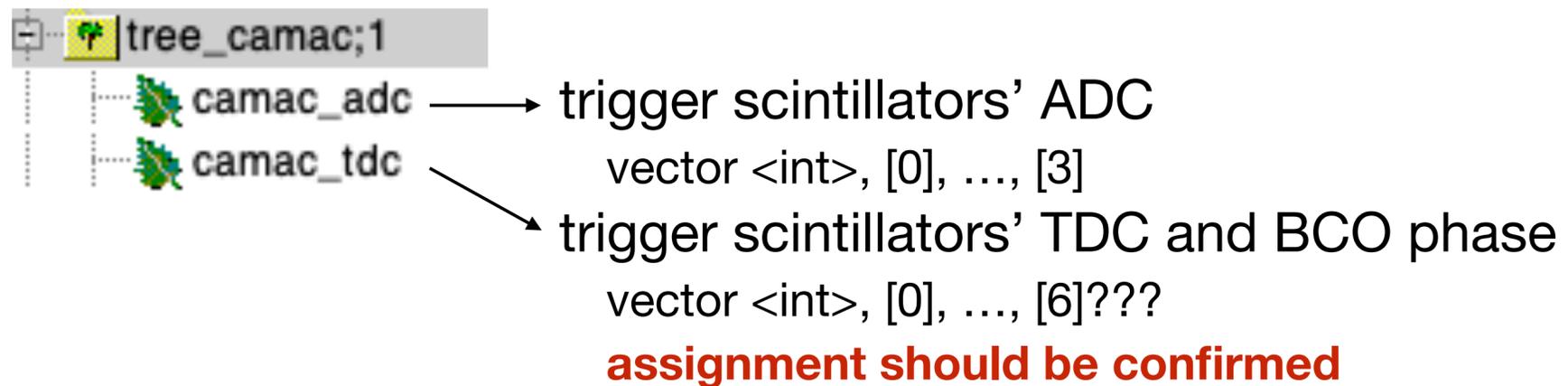
Unfortunately, we saw noise hits correlated to the read-out of the thermometers, so we stopped the system at some point... Investigation is ongoing.

# What we obtained

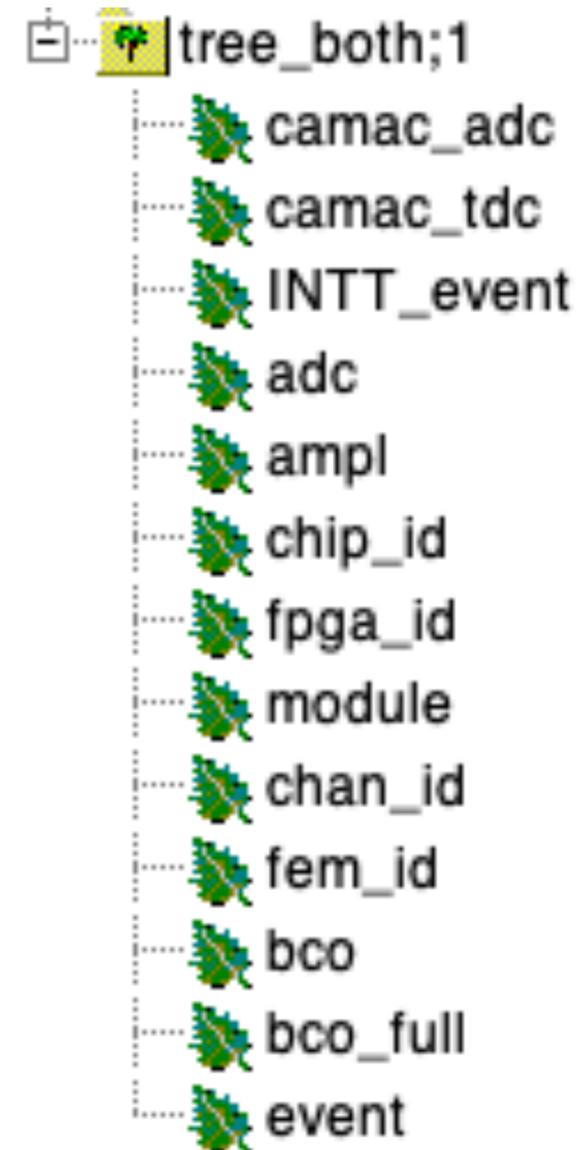
## 1. the standard INTT data



## 2. CAMAC data



## 3. CAMAC data (trigger data) and associated INTT data

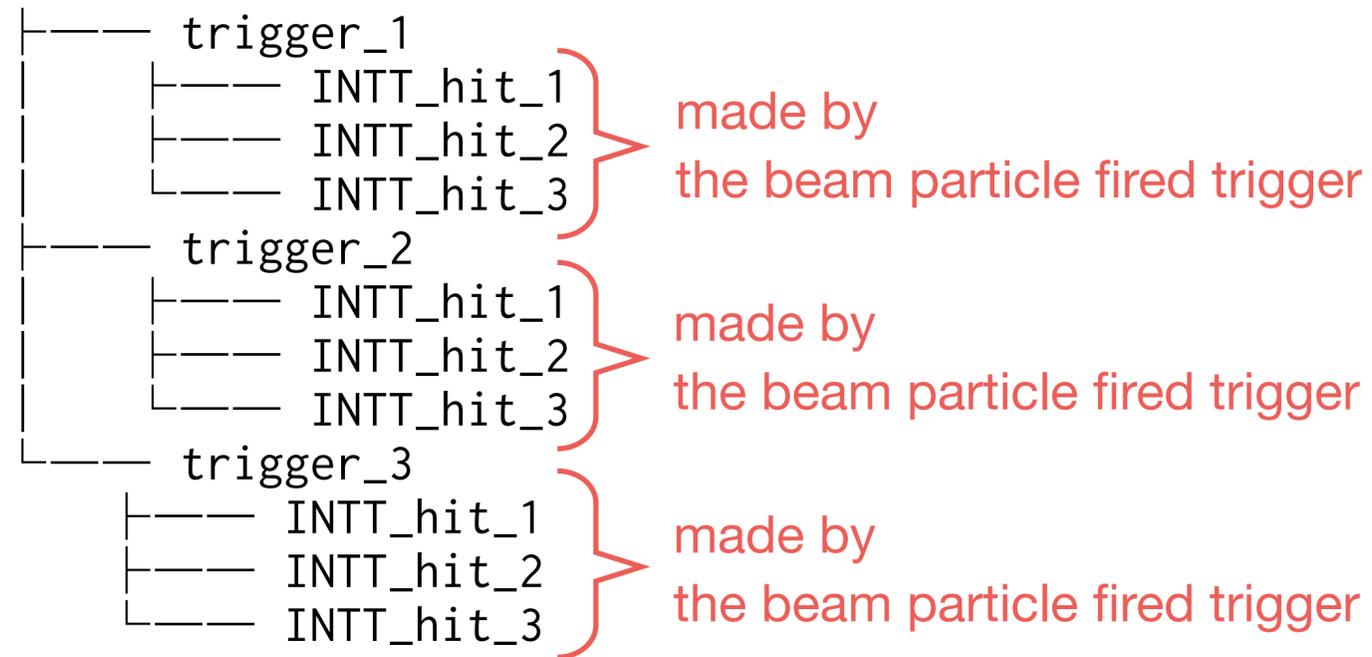


# What we obtained

## 3. CAMAC data (trigger data) and associated INTT data

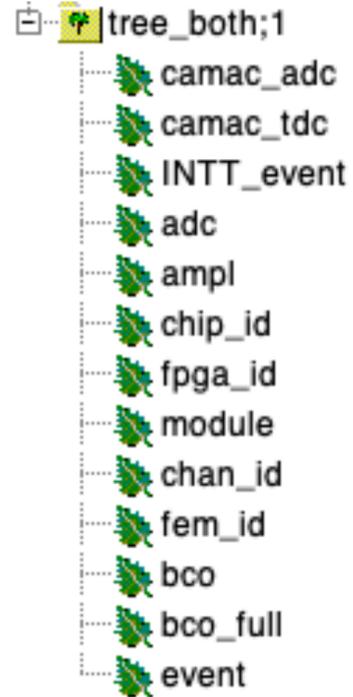
```
tree_both;1
├── camac_adc
├── camac_tdc
├── INTT_event
├── adc
├── ampl
├── chip_id
├── fpga_id
├── module
├── chan_id
├── fem_id
├── bco
├── bco_full
└── event
```

We expected to get, for example:

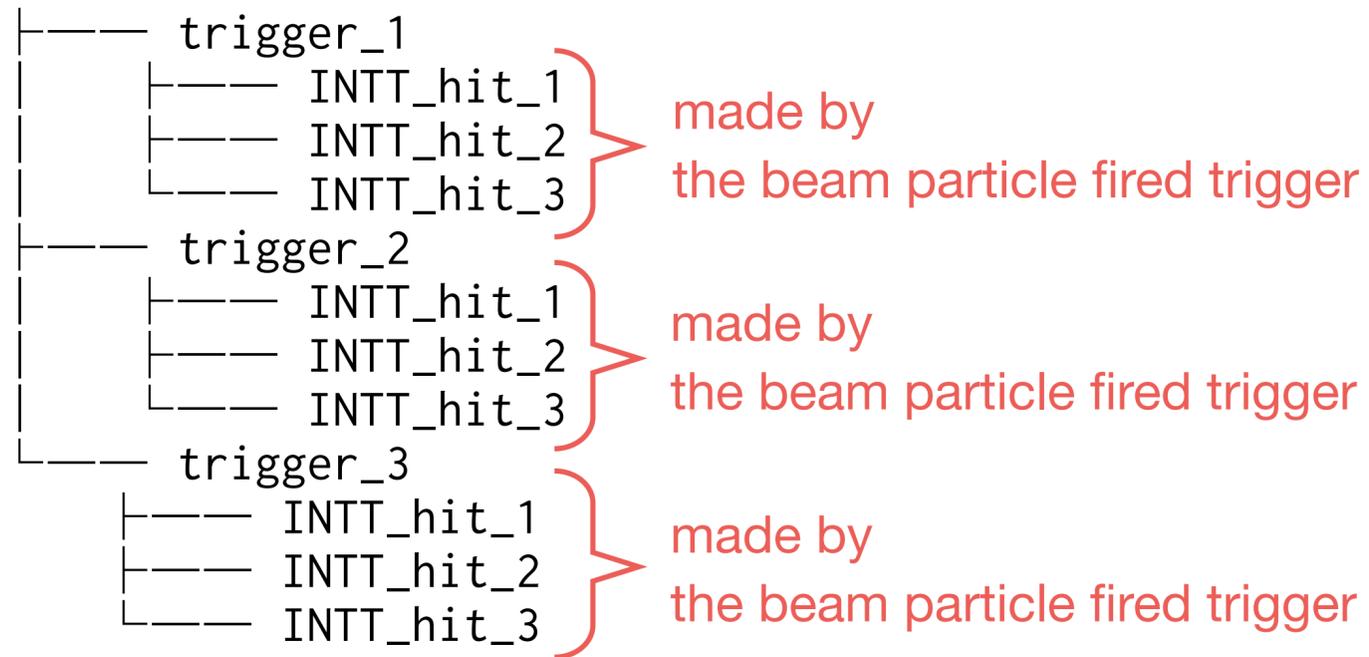


# What we obtained

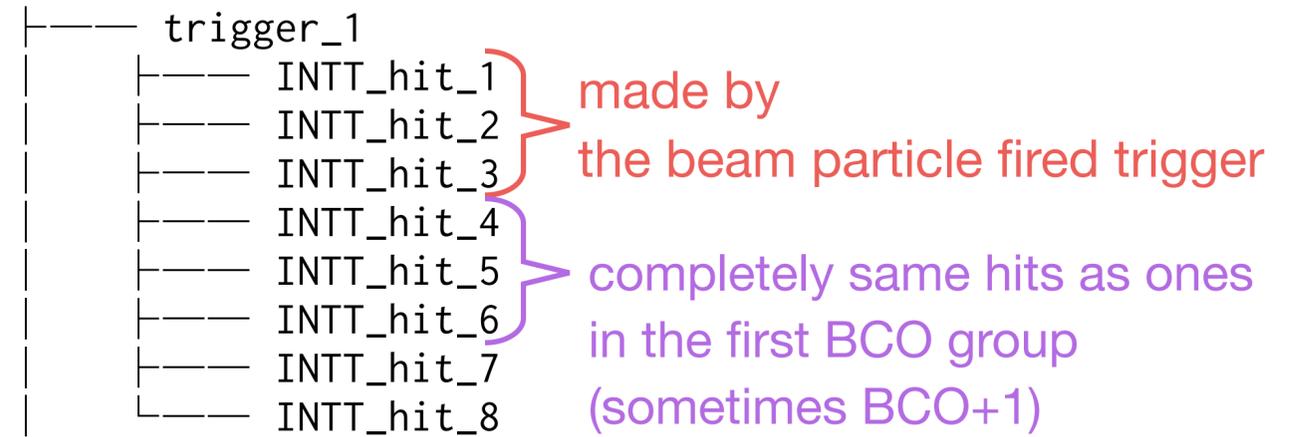
## 3. CAMAC data (trigger data) and associated INTT data



We expected to get, for example:

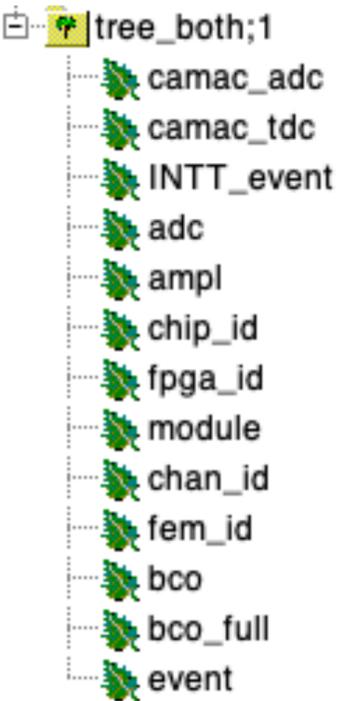


But actually, we could get

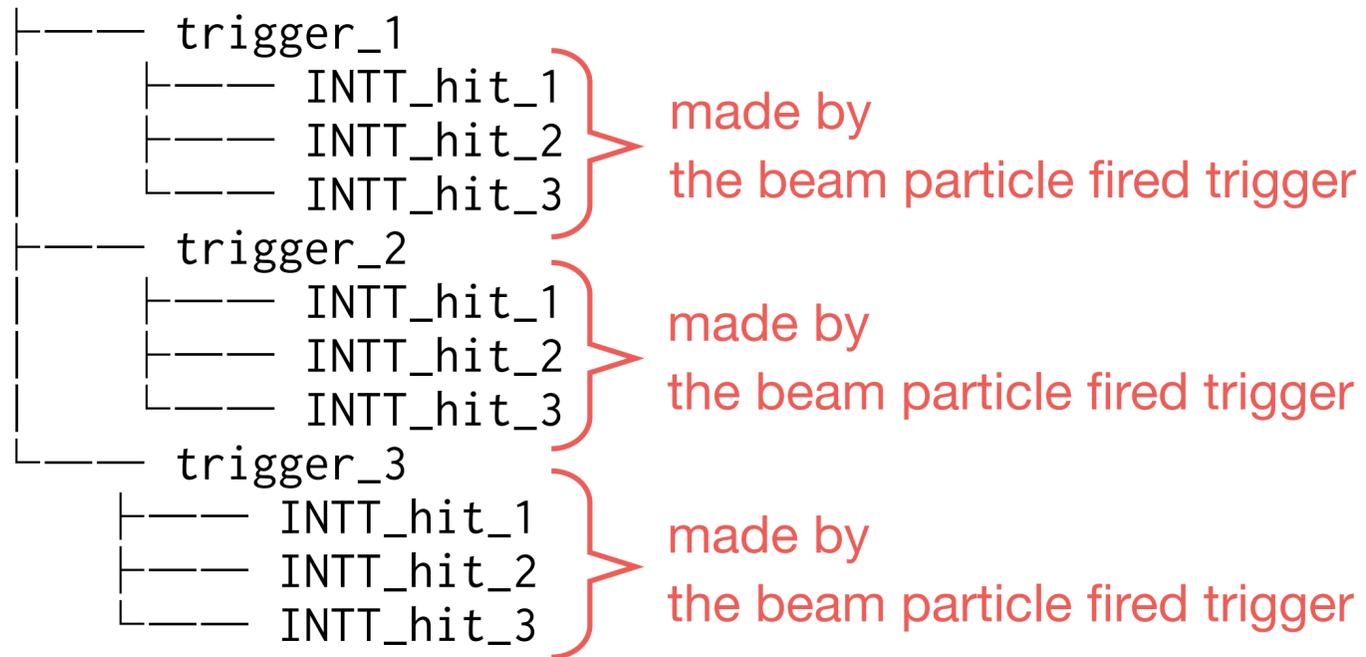


# What we obtained

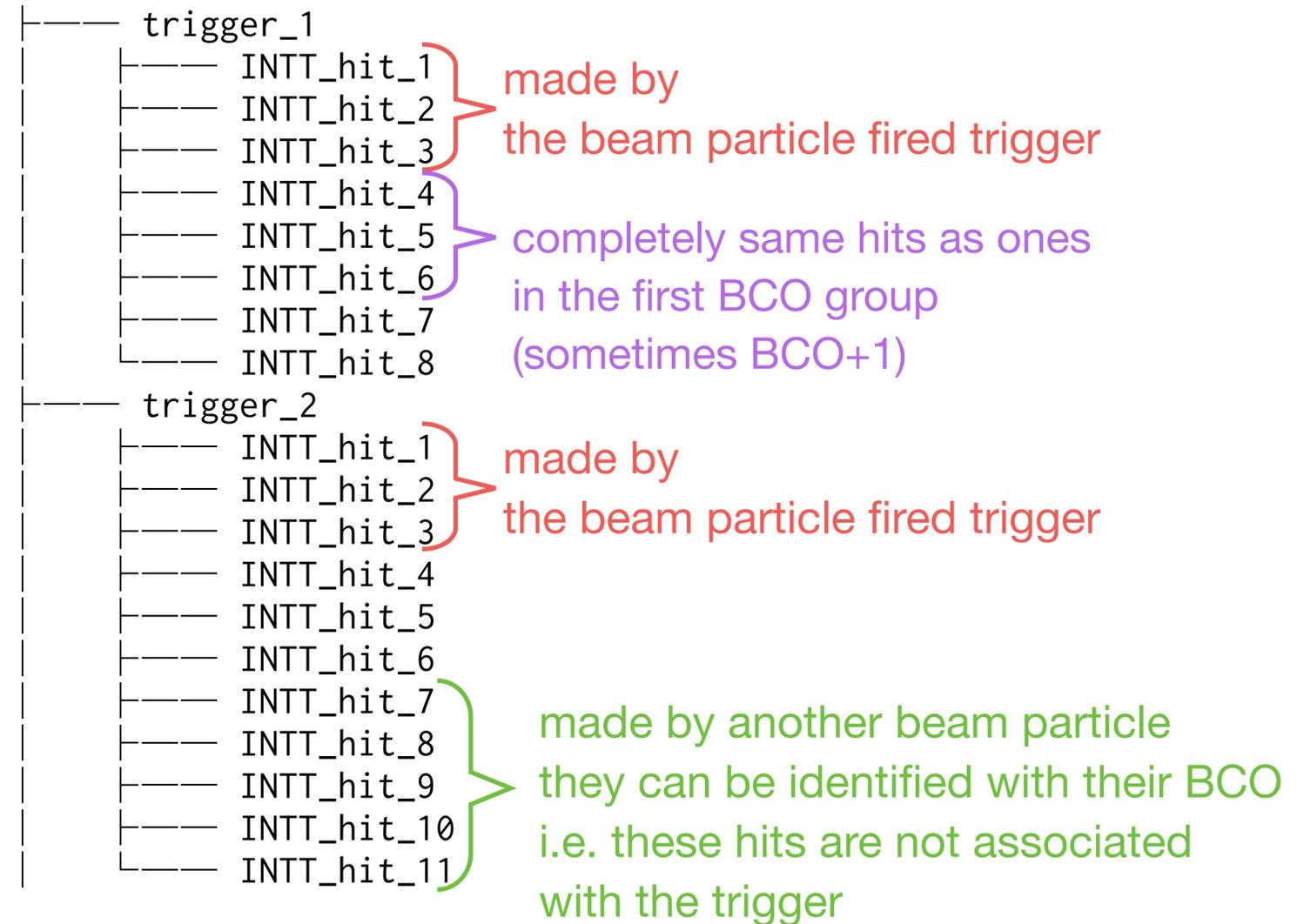
## 3. CAMAC data (trigger data) and associated INTT data



We expected to get, for example:

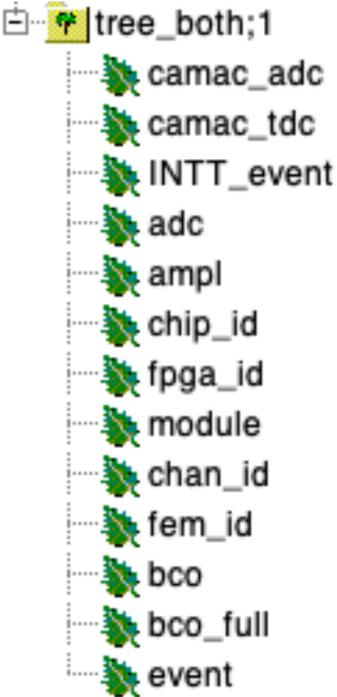


But actually, we could get

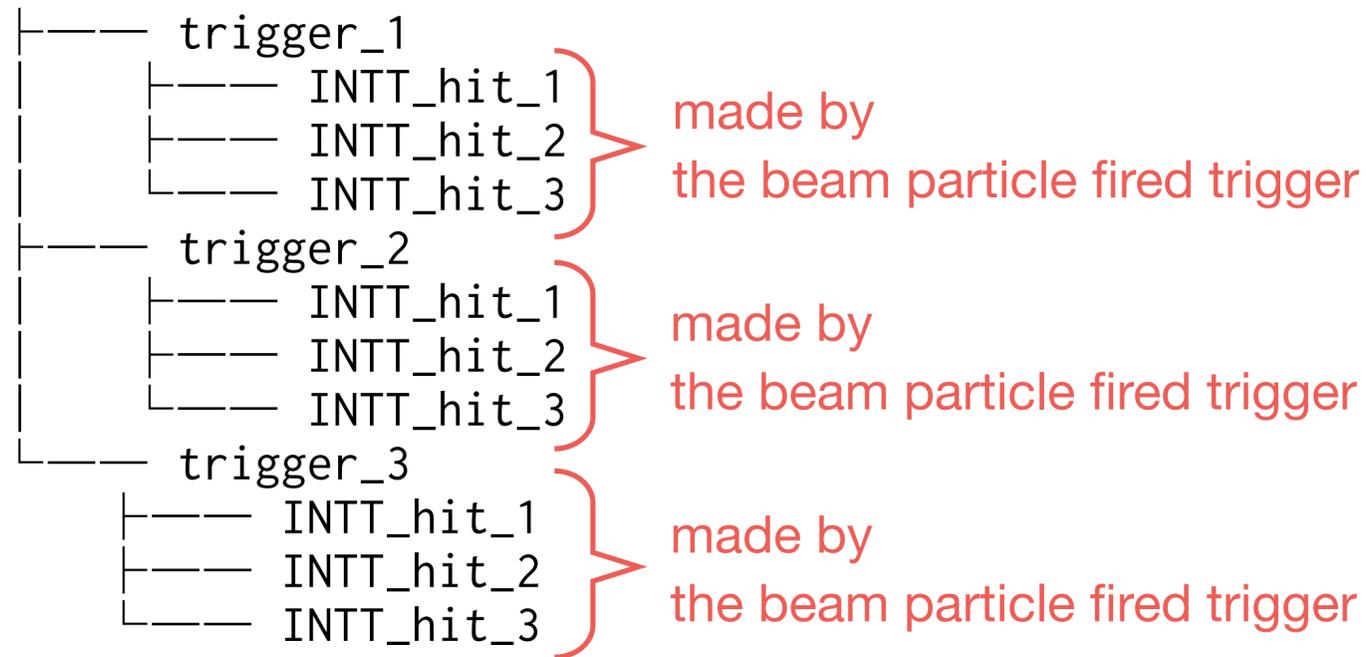


# What we obtained

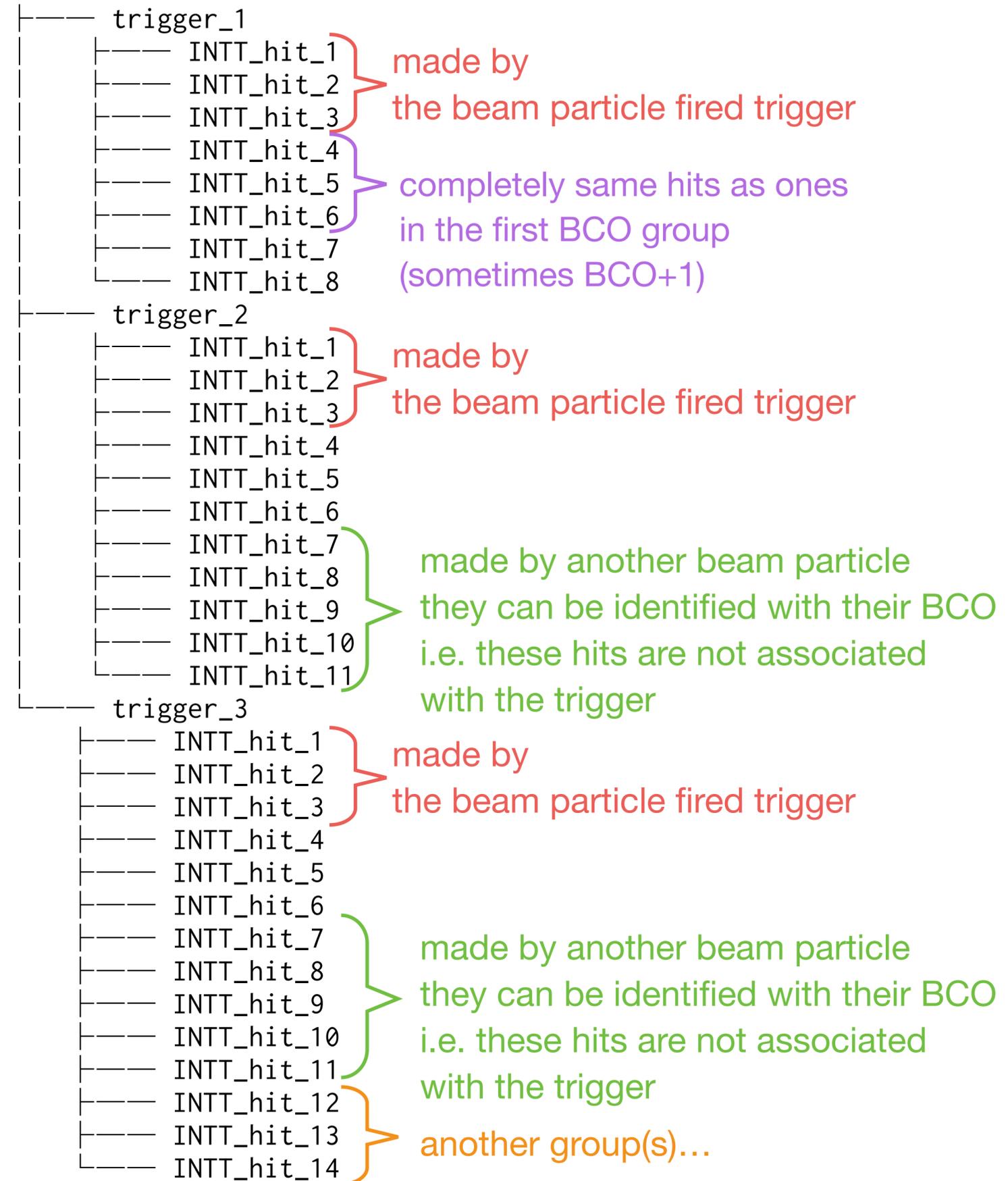
## 3. CAMAC data (trigger data) and associated INTT data



We expected to get, for example:



But actually, we could get



# What we obtained —why it happened?—

In read\_DAQ.exe:

```
void
AcquireData(std::string ports, std::string pfi, double sampleHz,
            FILE* fp, FILE* fp2, FILE* fp3)
{
    /* some lines omitted now */

    while( /* int take_data, controlled by GUI */ ) // infinite loop
    {

        // CAMAC data were read at first, made by Genki
        // software veto wasn't used
        camac->TakeSingleData();

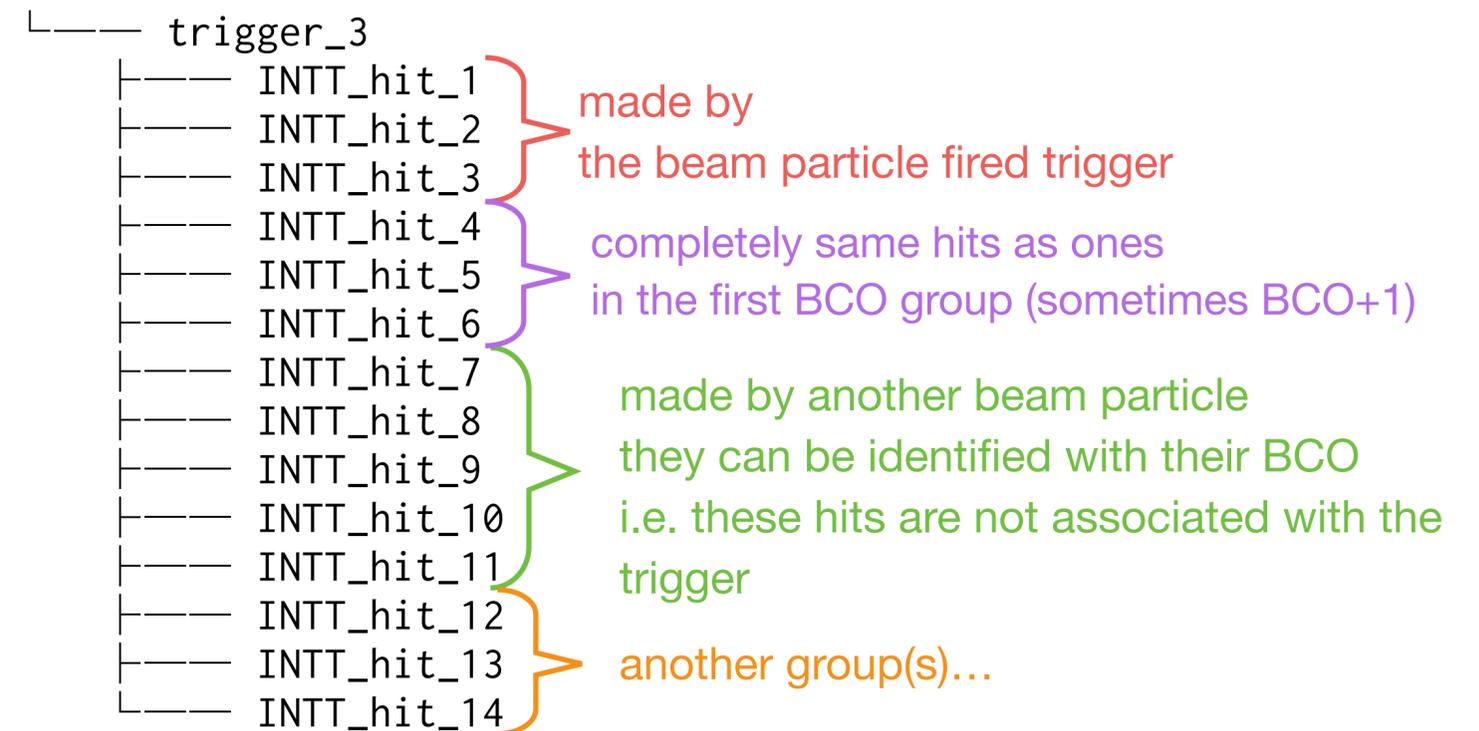
        // INTT data were read with NI's function
        // it takes ~250ms
        DAQmxErrCheck(
            DAQmxReadDigitalU32(taskHandle, -1, 10.0, DAQmx_Val_GroupByChannel,
                               data, kData_size, &numRead, NULL)
        );
        /* some processes for INTT data */

        // write CAMAC data, and INTT data in the buffer to a file
        bytesOut += WriteDataWithExternalTrigger(fp, cnt, data1, camac);

    } // end of while loop
} // end of void AcquireData
```

buffer to store INTT data

But actually, we could get



## Problem: veto was not perfect

- The software veto, which kills the circuit until the event process ends, was disabled somehow (maybe mistaken by me).
- People hired hardware veto, which kills the circuit for up to 20 ms.
- Since processes for INTT takes ~250 ms, the hardware veto was not long enough. After the end of veto, new INTT data, we don't want, were taken.

# What we obtained —why it happened?—

In read\_DAQ.exe:

```
void
AcquireData(std::string ports, std::string pfi, double sampleHz,
            FILE* fp, FILE* fp2, FILE* fp3)
{
    /* some lines omitted now */

    while( /* int take_data, controlled by GUI */ ) // infinite loop
    {

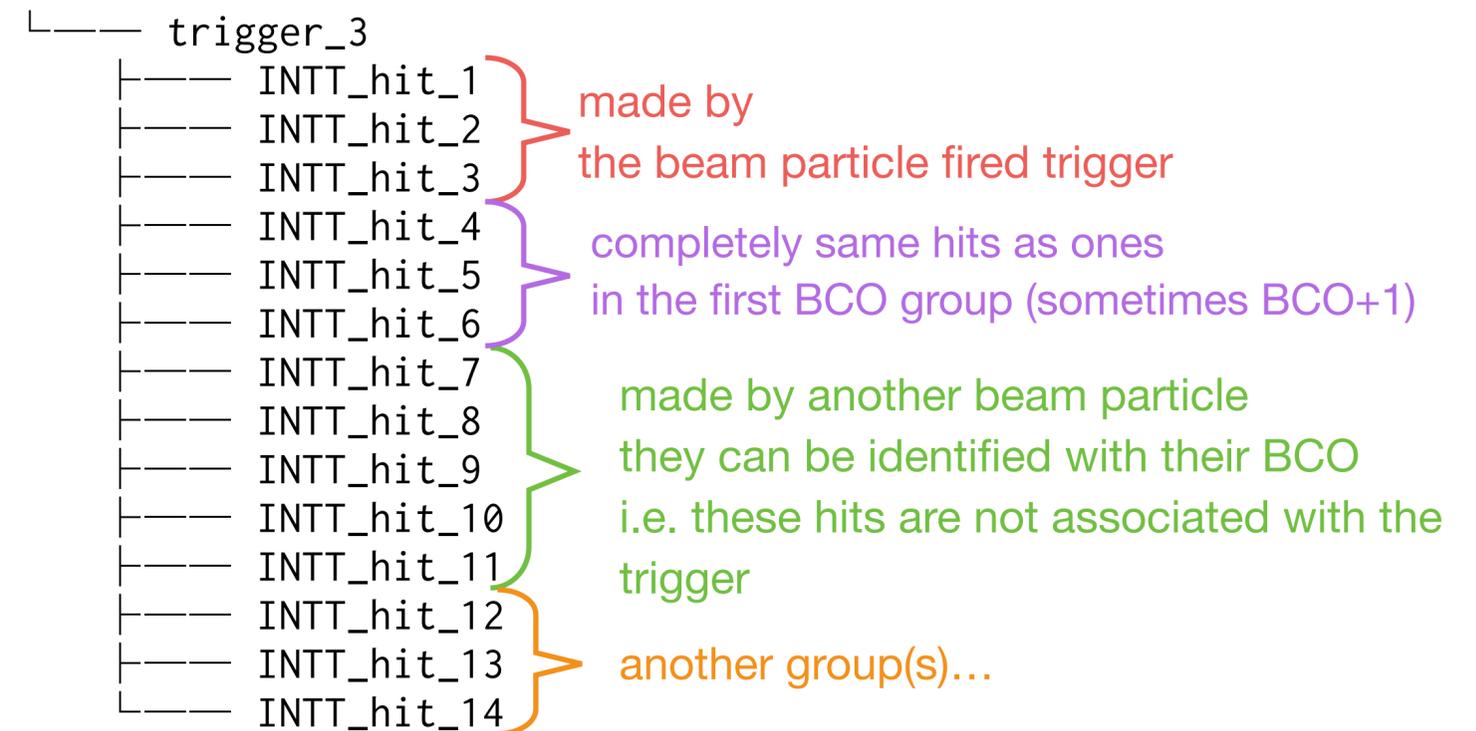
        // CAMAC data were read at first, made by Genki
        // software veto wasn't used
        camac->TakeSingleData();

        // INTT data were read with NI's function
        // it takes ~250ms
        DAQmxErrCheck(
            DAQmxReadDigitalU32(taskHandle, -1, 10.0, DAQmx_Val_GroupByChannel,
                               data, kData_size, &numRead, NULL)
        );
        /* some processes for INTT data */

        // write CAMAC data, and INTT data in the buffer to a file
        bytesOut += WriteDataWithExternalTrigger(fp, cnt, data1, camac);

    } // end of while loop
} // end of void AcquireData
```

But actually, we could get



## Problem: veto was not perfect

- The software veto, which kills the circuit until the event process ends, was disabled somehow (maybe mistaken by me).
- People hired hardware veto, which kills the circuit for up to 20 ms.
- Since processes for INTT takes ~250 ms, the hardware veto was not long enough. After the end of veto, new INTT data, we don't want, were taken.

## What we did

- We optimized DAQ to speed up. It helps little bit, but does not solve the problem.

We made the decision on the 3rd day at midnight that we accept the contamination of non-associated INTT hits. We can select them in the analysis.

# Runs

List of runs is [here](#)

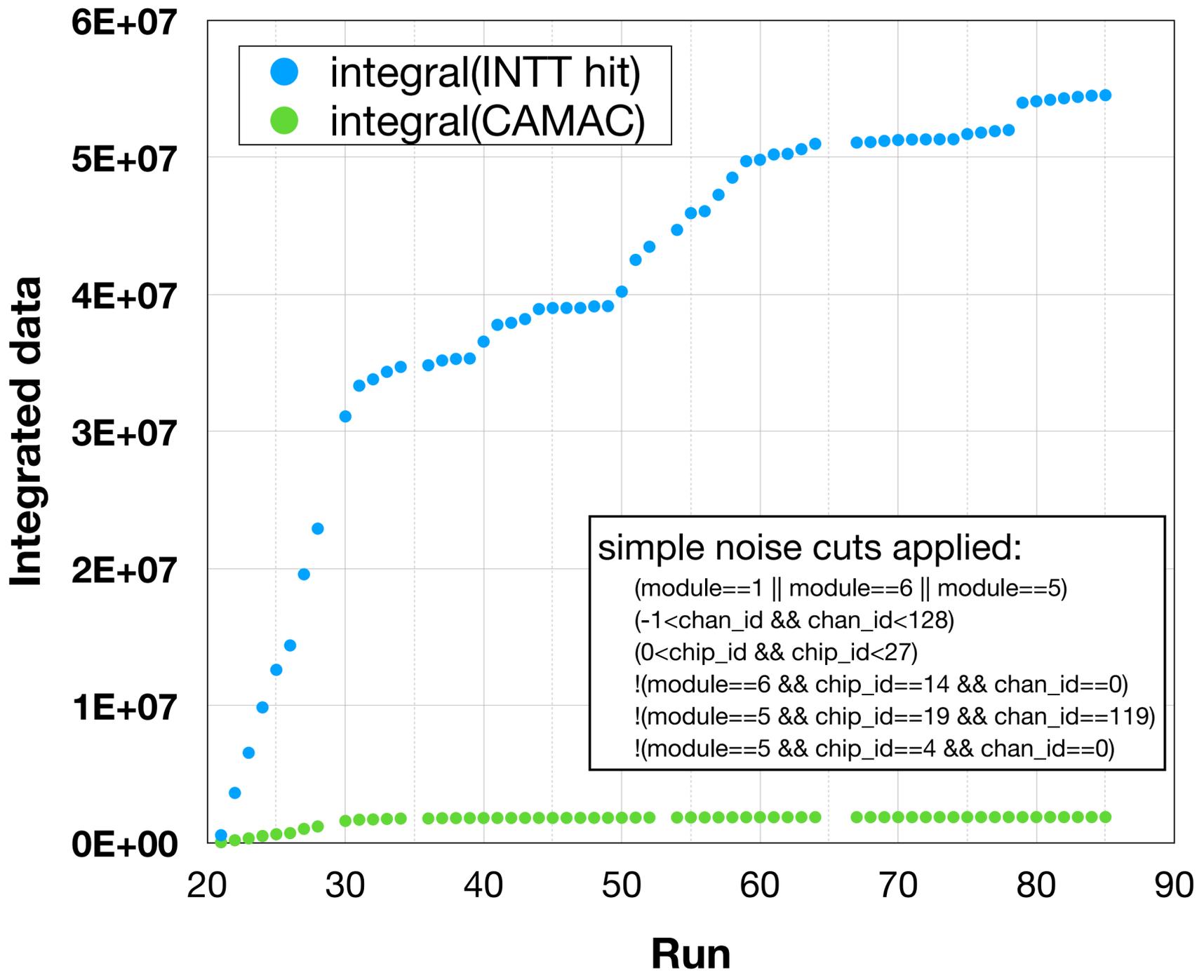
#	Data	#INTT hit	#Trigger
21	fphx_raw_20211207-0917_0.dat	535284	26346
22	BeamData_20211207-1156_0.dat	3085754	142211
23	BeamData_20211207-1229_0.dat	2929598	136416
24	BeamData_20211207-1302_0.dat	3311914	173111
25	BeamData_20211207-1337_0.dat	2740585	130045
26	BeamData_20211207-1425_0.dat	1779983	82767
27	BeamData_20211207-1518_0.dat	5189504	309088
28	NWU_fphx_raw_20211207-1625_0.dat	3332741	173418
30	BeamData_20211207-1912_0.dat	8186349	405946
31	BeamData_20211208-1602_0.dat	2243559	88967
32	BeamData_20211208-1648_0.dat	464916	19741
33	BeamData_20211209-1101_0.dat	545087	37210
34	BeamData_20211209-1146_0.dat	359512	26182
36	BeamData_20211209-1512_0.dat	120009	5891
37	BeamData_20211209-1531_0.dat	349724	20460
38	BeamData_20211209-1609_0.dat	114674	5732
39	BeamData_20211209-1627_0.dat	28604	1425
40	BeamData_20211209-2145_0.dat	1233498	4483
41	BeamData_20211209-2218_0.dat	1223520	4627
42	BeamData_20211209-2309_0.dat	147664	599
43	BeamData_20211209-2346_0.dat	274100	1140
44	BeamData_20211210-0005_0.dat	729594	3444
45	BeamData_20211210-0029_0.dat	79290	274
46	BeamData_20211210-0031_0.dat	1669	353
47	BeamData_20211210-0035_0.dat	497	1463
48	BeamData_20211210-0045_0.dat	115114	1009
49	BeamData_20211210-0054_0.dat	16254	810
50	BeamData_20211210-0115_0.dat	1059705	6816
51	BeamData_20211210-0206_0.dat	2316824	8596
52	BeamData_20211210-0302_0.dat	957292	3754
54	BeamData_20211210-0427_0.dat	1229306	4727
55	BeamData_20211210-0458_0.dat	1220617	4706
56	BeamData_20211210-0602_0.dat	141477	595
57	BeamData_20211210-0609_0.dat	1198328	4814
58	BeamData_20211210-0642_0.dat	1250164	4917
59	BeamData_20211210-0716_0.dat	1202287	4805

#	Data	#INTT hit	#Trigger
60	BeamData_20211210-0920_0.dat	104300	359
61	BeamData_20211210-0928_0.dat	386293	1283
62	BeamData_20211210-1042_0.dat	44024	164
63	BeamData_20211210-1048_0.dat	340986	1325
64	BeamData_20211210-1125_0.dat	390088	1238
67	BeamData_20211210-1407_0.dat	91110	489
68	BeamData_20211210-1419_0.dat	37298	480
69	BeamData_20211210-1428_0.dat	82742	449
70	BeamData_20211210-1436_0.dat	68195	929
71	BeamData_20211210-1452_0.dat	33684	474
72	BeamData_20211210-1501_0.dat	11801	465
73	BeamData_20211210-1510_0.dat	5563	470
74	BeamData_20211210-1519_0.dat	3421	516
75	BeamData_20211210-1526_0.dat	376088	464
76	BeamData_20211210-1534_0.dat	108592	461
77	BeamData_20211210-1541_0.dat	106565	499
78	BeamData_20211210-1549_0.dat	80235	454
79	BeamData_20211210-1603_0.dat	1995373	530
80	BeamData_20211210-1615_0.dat	105941	445
81	BeamData_20211210-1621_0.dat	106152	474
82	BeamData_20211210-1641_0.dat	109872	492
83	BeamData_20211210-1649_0.dat	101412	511
84	BeamData_20211210-1656_0.dat	87753	592
85	BeamData_20211210-1702_0.dat	39316	579

Data taking condition depends on runs:

- #trigger sci.
- self trigger mode or external trigger mode
- before/after DAQ optimization

# Runs

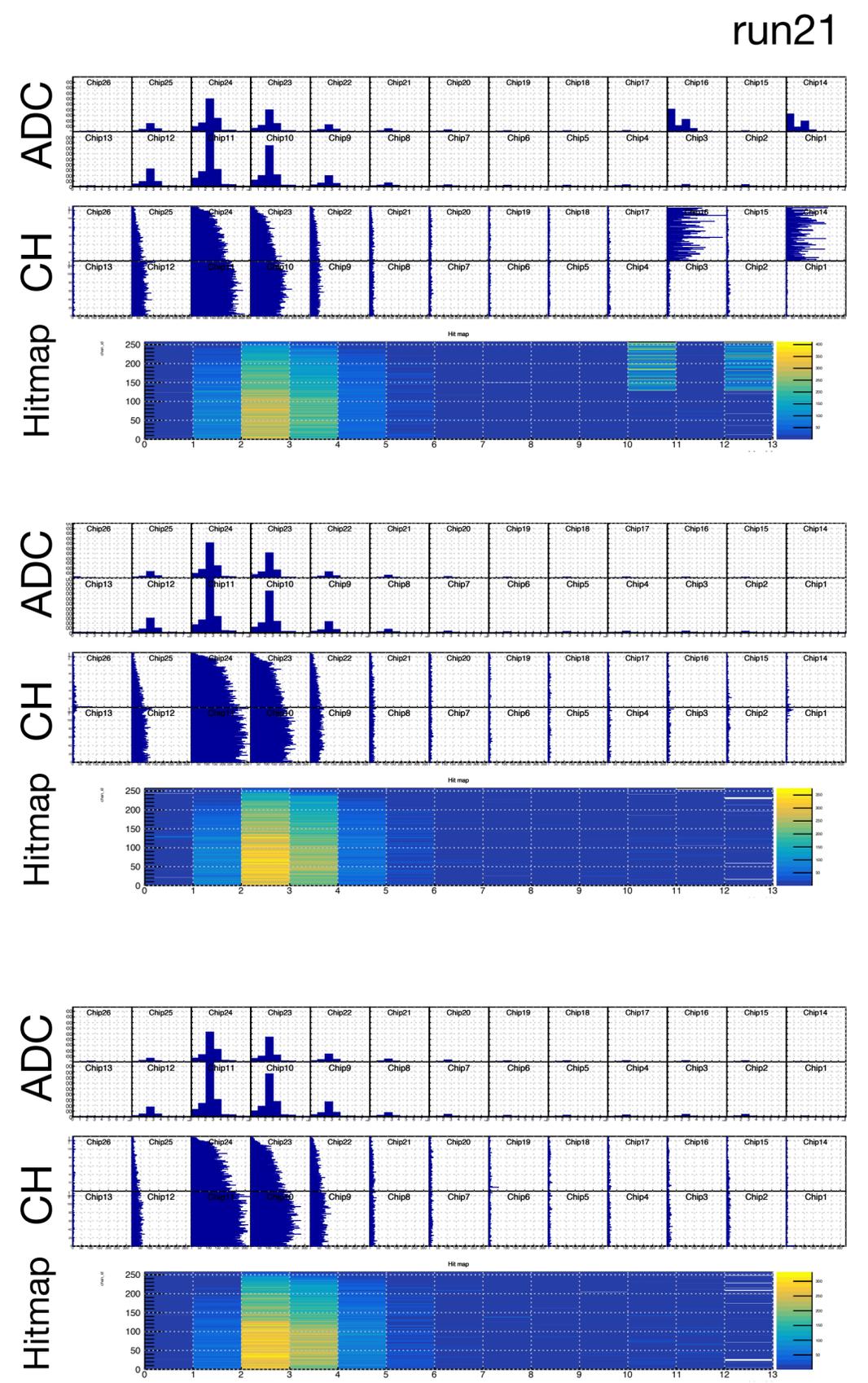


Integrated #INTT hit and #trigger

Upstream

Middle

Downstream



The first data with beam

# Analysis

## Detection efficiency

- Genki
- Miu (as a part of her Master thesis)
- Cheng-Wei

## ADC distribution (perpendicular beam, tilted beam)

- Yuka (bachelor thesis)
- Genta (bachelor thesis)

## Comparison with/without bus extender

- ?

## Multiple-track condition (Pb plate in front of the setup)

- ?

## DAC scan

- ?

## Some service tasks

- Implementation of the Geant4 simulation
- Implementation of useful framework(s) (Genki)

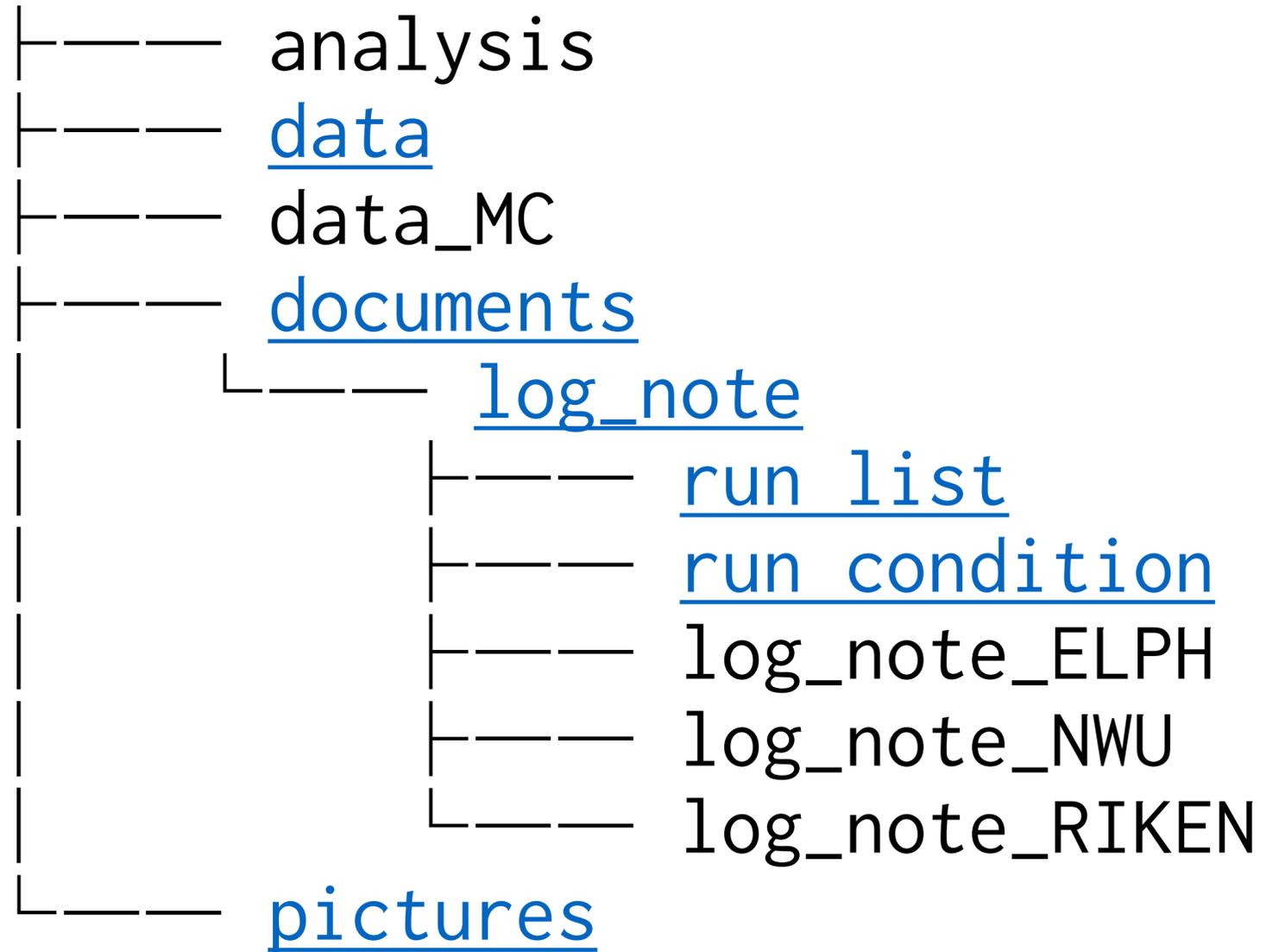
## There are some more topics:

- charge diffusion between strips (same as ADC dist.?)
- acceptance edge effects
- track angle dependence
- more topics?

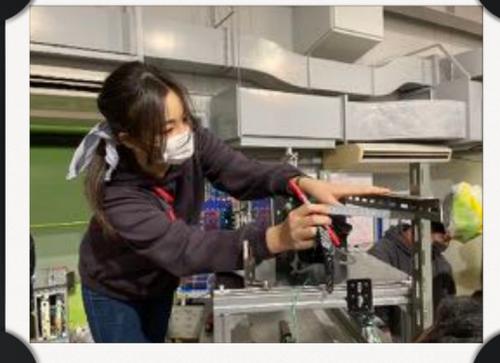
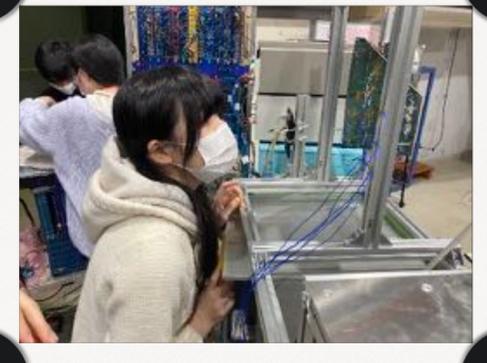
**Volunteers  
Are  
Needed!**

# Links

## Google Drive



- Video1
- Video2



**Thank you!**  
*why don't you analyze data?*

