CERN TB Preparation

26.7.21 BIC ESB/System Testing meeting

Jeongsu Bok

Outline

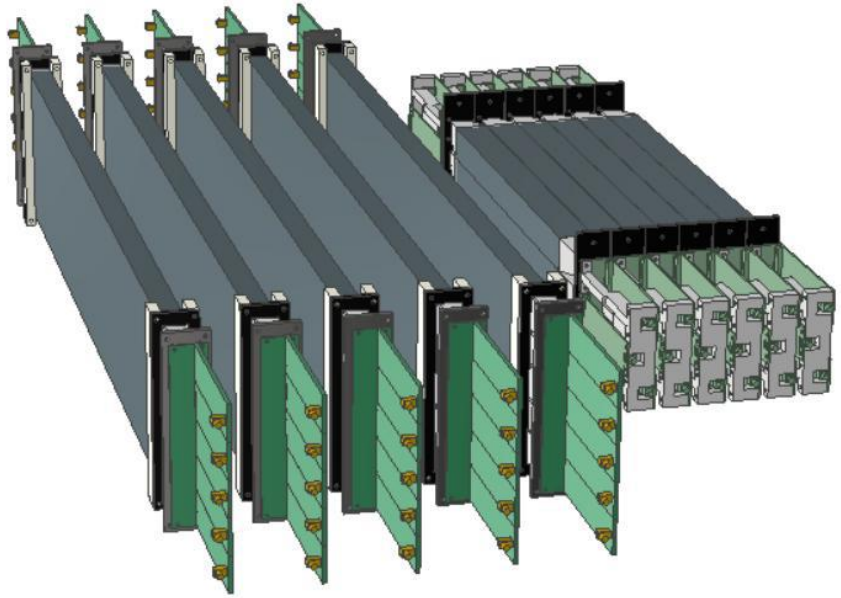
1. Preparation for CERN beam test
   a) Lessons from KEK TB
   b) Detector preparation
2. Timestamp matching at CERN
   a) Trigger-H2GCROC timestamp matching at KEK in May
   b) Idea for AstroPix-H2GCROC matching

1. Preparation for CERN TB

Lessons from KEK in May

- We can find optimal parameters to obtain signals through H2GCROC
- We are still studying H2GCROC data
- Event matching between Auxiliary detectors (FADC) and H2GCROC was succesful within +/- 1us
- AstroPix 9-chip was OK under 2.7kHz rate

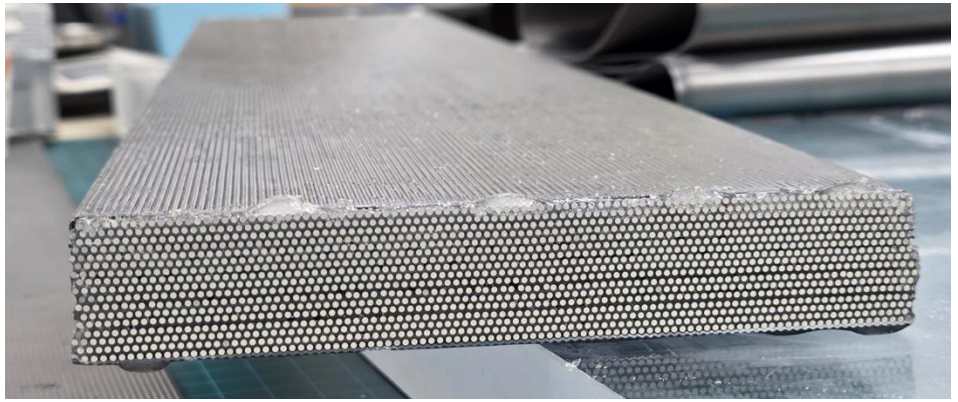
Possible Pb/SciFi setup at CERN

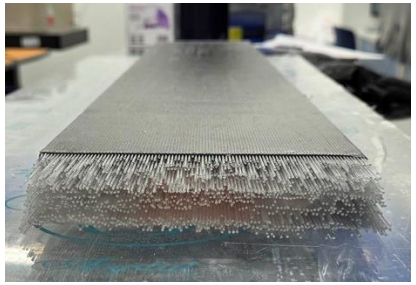


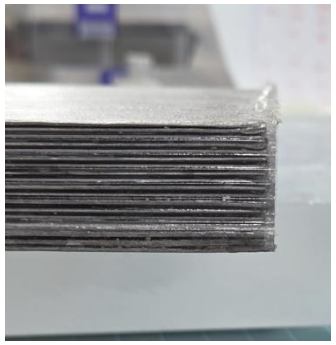
- 2~5 SFILs in front of
- 32x9x18cm module (reuse of previous prototype)
- AstroPix 9 chip module in various location
- Auxiliary: Cherenkov, Trigger, hodoscope

SFIL production at KNU

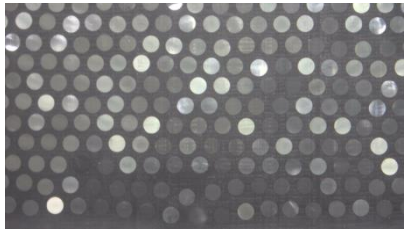
(Minsum Shim, Wonjun Ko, Huisu Lim, ki Seung, Hui, Changhui Lee)







First SFIL had with some defect <5% when we applied optical cement by brush.
Second SFIL using improved procedure

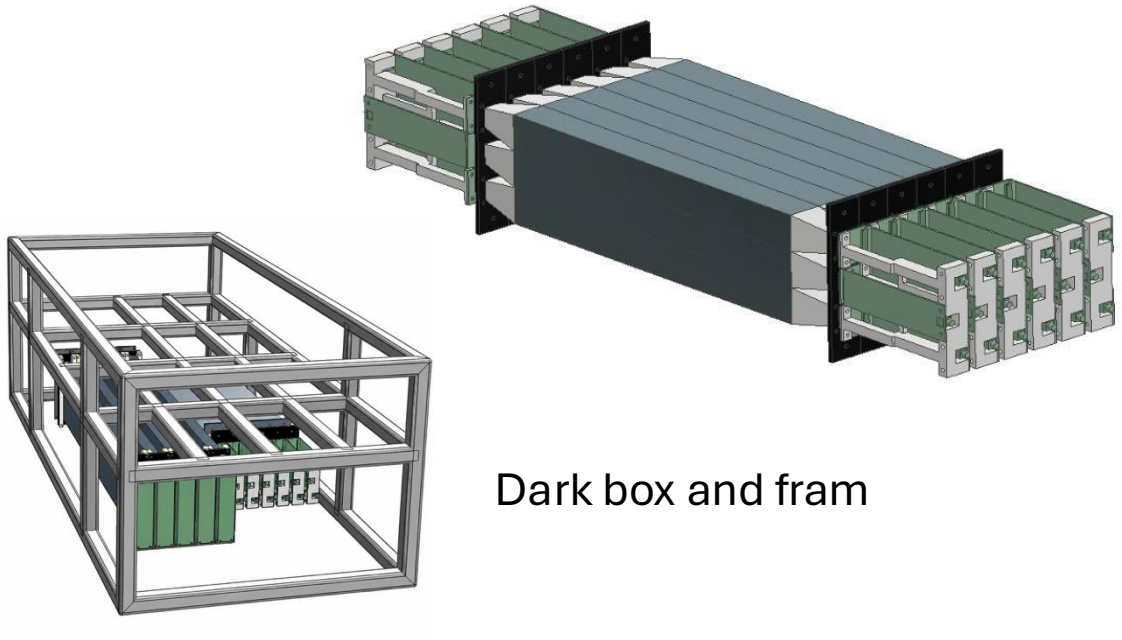


After milling 32x3x3cm^3 module (fibers are cured firmly)

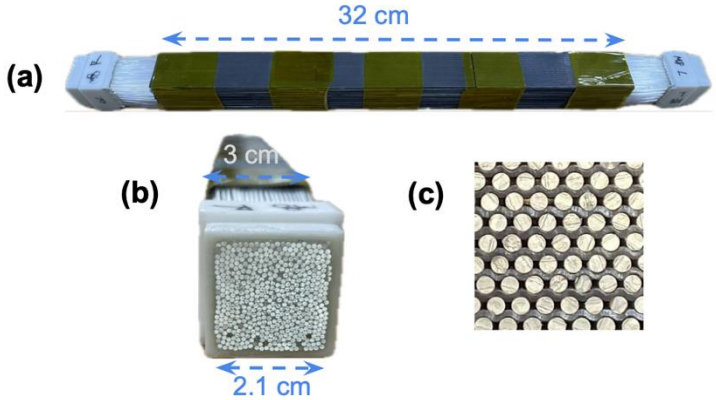
2 SFILs are ready, cutting at 2mm extra fiber+cement.
Dimension and thickness are under control.
We expect maximum 5 SFILs. a week for a SFIL production.
We contacted local company which provide cutting with Pb layers, as well as cutting for trapejoidal cross section.

Bulk section at CERN

- Reuse of 32x3x3 cm^3 modules, 3x6 array. 32x9x18cm^3
- So far, we have used bundled fiber mached to the PMT dimension.
- This time, we will use Light Guide (3x3 cm^2 to SiPM array) for all 36 channels.

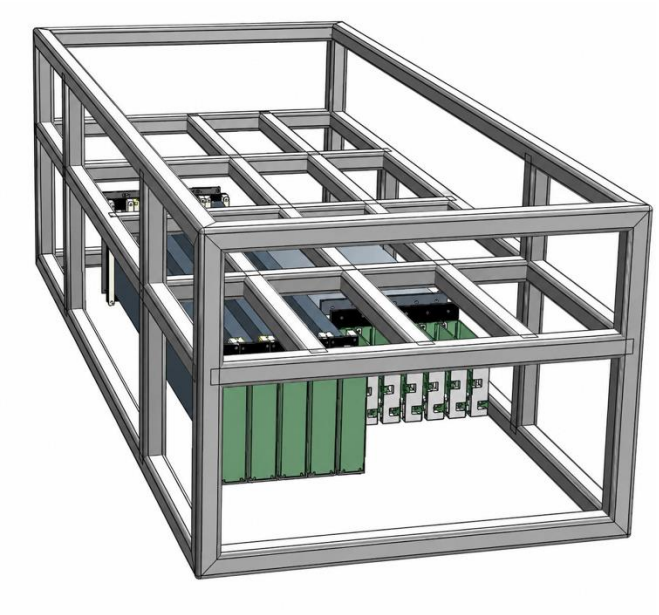


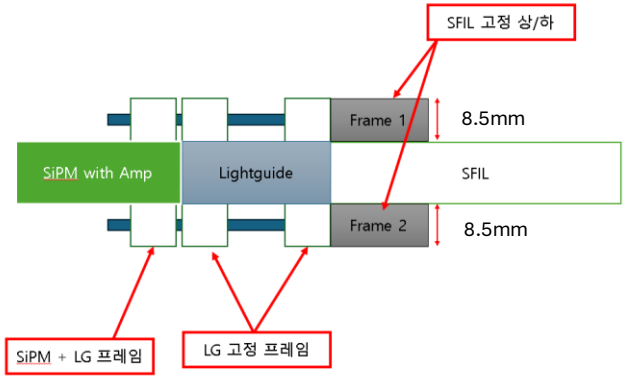
Dark box and fram

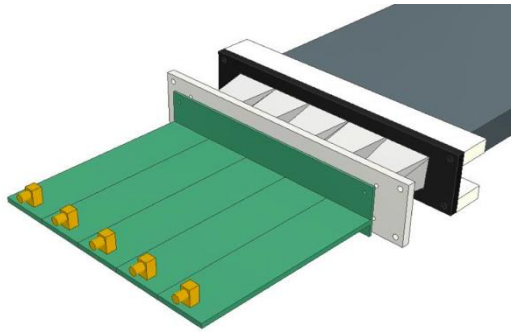


milling after cutting fiber bundle

Frame preparation (Junsub Shin)

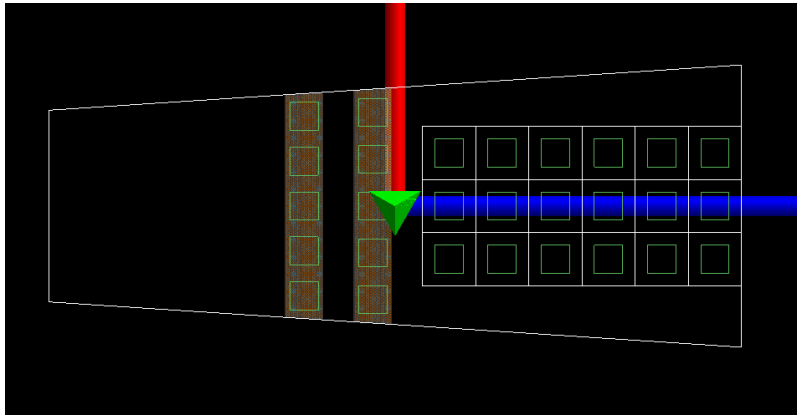


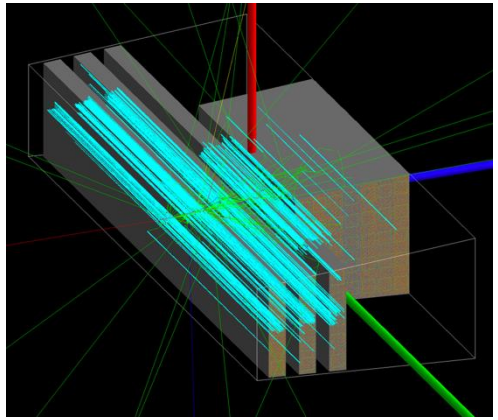


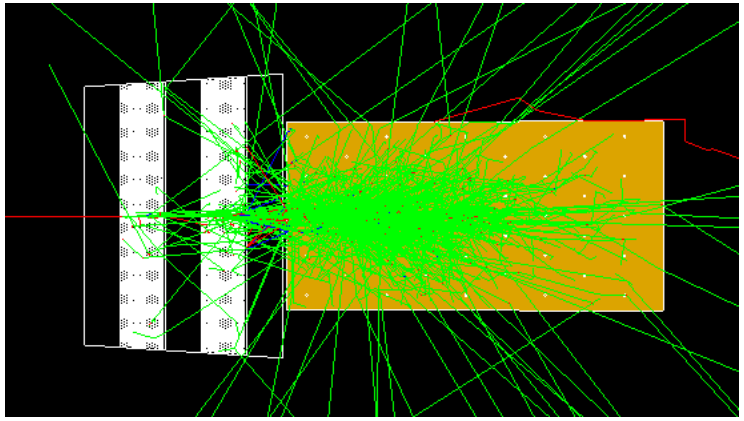


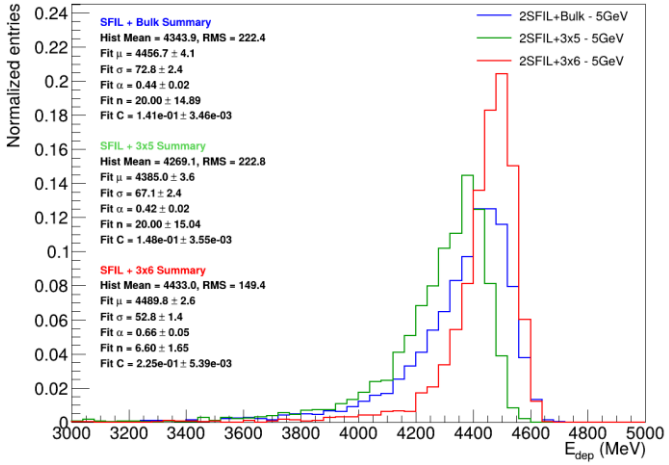
- SFIL support to connect LG, SiPM, and FEE board, as well as 32x3x3cm^3
- Frame to support
  - 5 SFILs(17mm distance) + bulk
  - H2GCROC
  - A-step and FPGA board for AstroPix

Simulation (Changhui Lee at KNU)









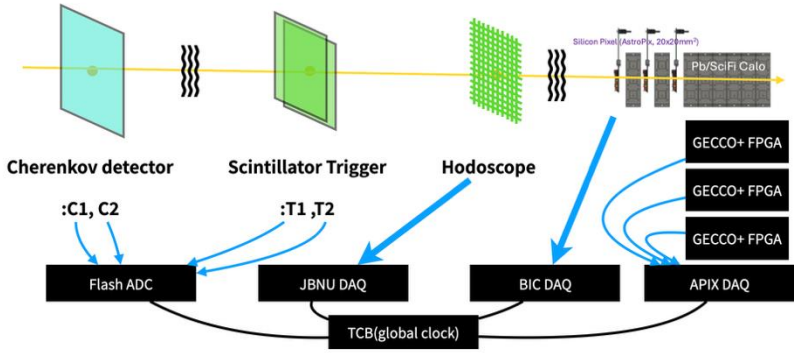
- Detector geometry were implemented. Electron energy deposit is being calculated for 2-5 SFILs

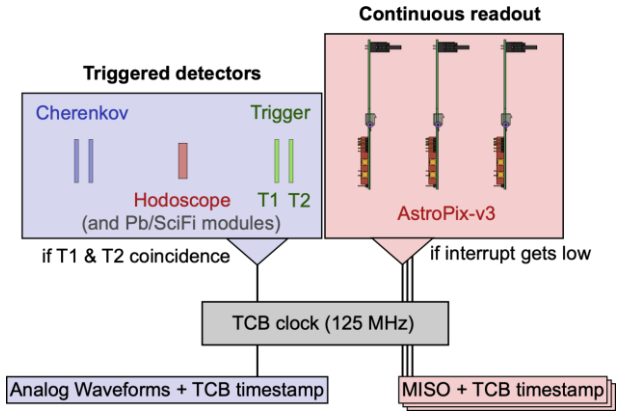
Goals

- H2GCROC data taking for the almost full depth with SFILs
- Confirm Npe for modules with exact material composition and single-clad fiber
- Confirm perfomance with FADC
- AstroPix data taking between SFILs

2. Timestamp matching at CERN

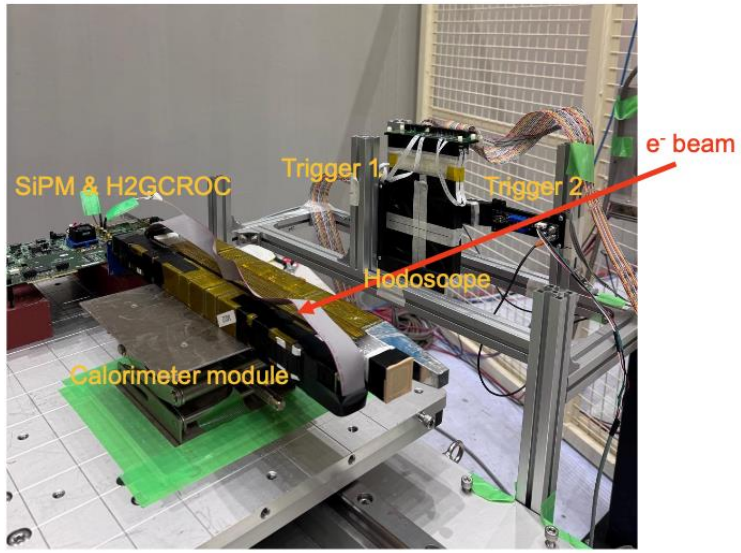
Setup at CERN in 2025

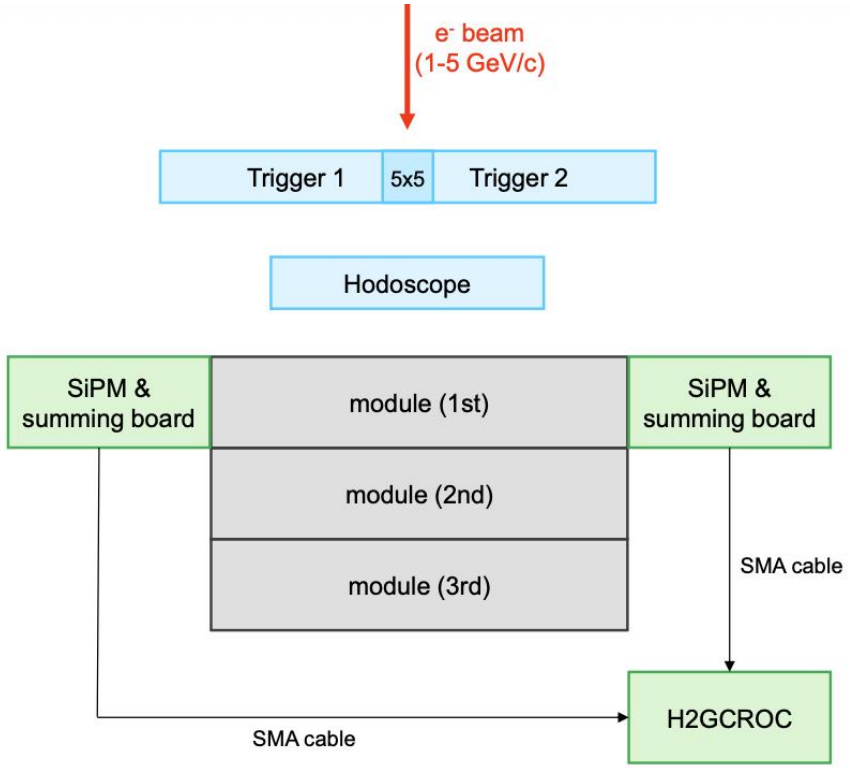




- Tested at KEK and used at CERN.
- When the interrupt signal is asserted, a dedicated DAQ module records the corresponding global timestamp from the Trigger Control Board (TCB) together with the SPI data stream.
- Not available this time
  - It was a temporary solution in 2025. A-step board interface does not support MISO, interrupt signal like last year.(?)

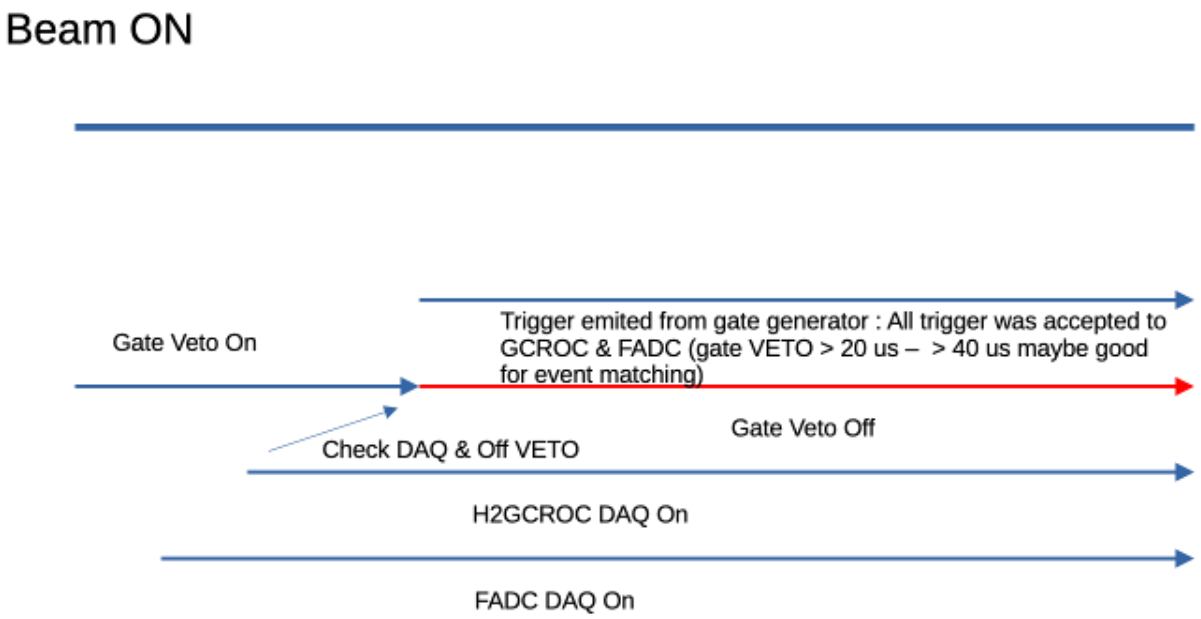
2-a) Trg-H2GCROC timestamp matching at KEK





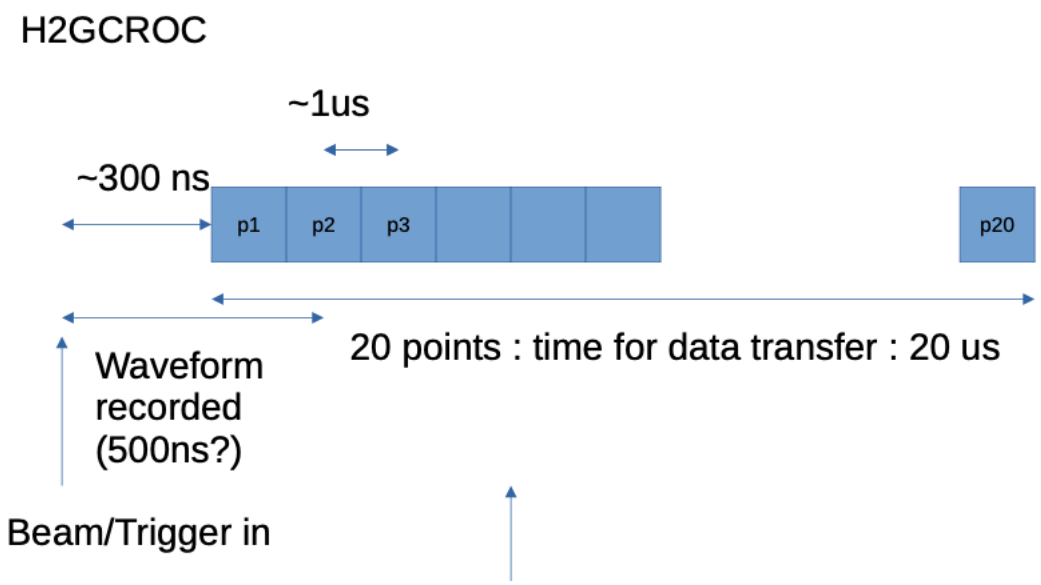
- Setup at KEK Data (Auxiliary, H2GCROC) recorded separately with common trigger.

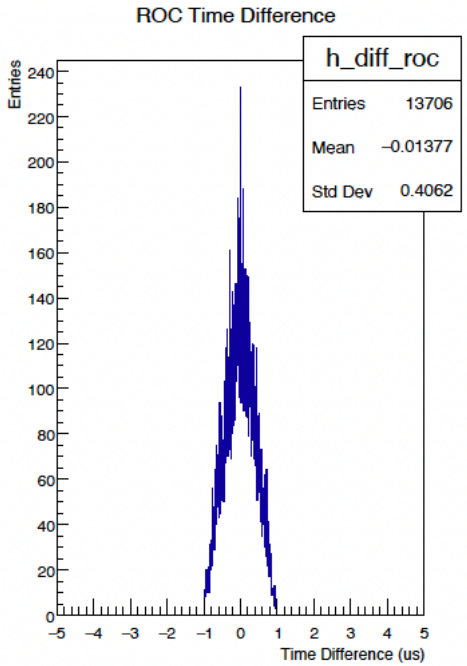
2-a) Trg-H2GCROC timestamp matching at KEK



- Using veto, we made the same starting point for the H2GCROC and FADC readout.

2-a) Trg-H2GCROC timestamp matching at KEK





- By using common trigger, we could match trigger and auxiliary detectors with H2GCROC FPGA time within +/-1 us

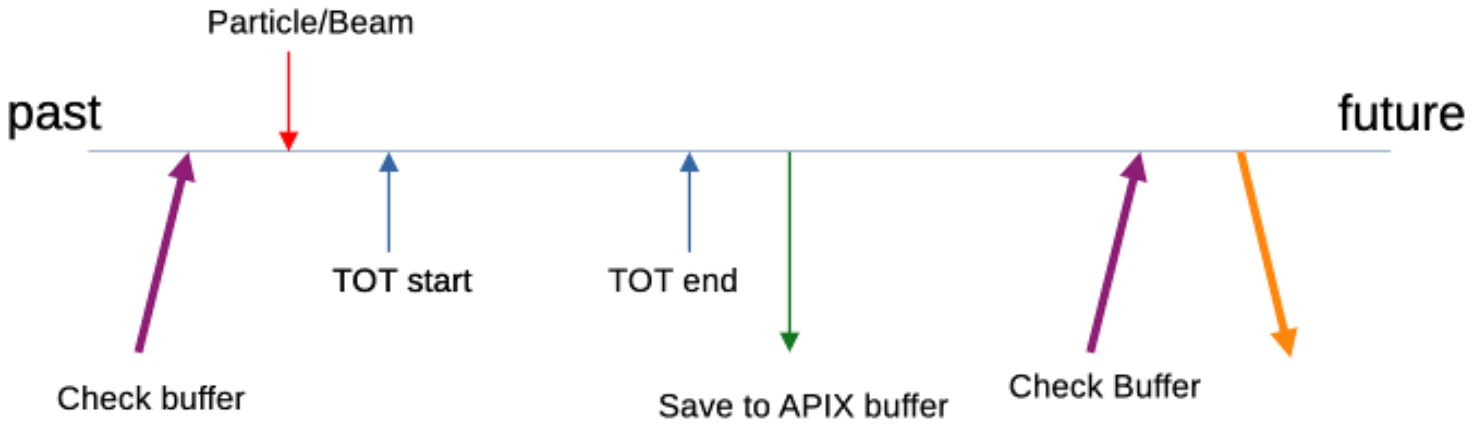
Trg time H2GCROC time

Row	(ts_nk-ts	(ts_roc-t	ts_nk-ts_	ts_nk_dif	ts_roc_di
0	0	0	0	0	0
1	2523.12	2523.1	0.02	2523.12	2461.5609
2	5518.16	5518.15	0.01	2995.04	2922
3	10531.68	10531.65	0.03	5013.52	4891.2195
4	15625.76	15625.725	0.035	5094.08	4969.8292
5	22421.216	22421.15	0.066	6795.456	6629.6829
6	46346.24	46346.125	0.115	23925.024	23341.439
7	58148.928	58148.8	0.128	11802.688	11514.804
8	60604.112	60603.975	0.137	2455.184	2395.2926
9	61754.304	61754.15	0.154	1150.192	1122.1219
10	64517.776	64517.65	0.126	2763.472	2696.0975
11	65938.528	65938.4	0.128	1420.752	1386.0975
12	78301.232	78301.05	0.182	12362.704	12061.122
13	84341.632	84341.45	0.182	6040.4	5893.0731
14	88947.44	88947.25	0.19	4605.808	4493.4634
15	103211.6	103211.37	0.225	14264.16	13916.219
16	109698.73	109698.5	0.236	6487.136	6328.9024
17	112874.97	112874.72	0.251	3176.24	3098.7561
18	119594.92	119594.67	0.253	6719.952	6556.0487
19	126591.72	126591.45	0.278	6996.8	6826.1219
20	134161.10	134160.82	0.279	7569.376	7384.7561
21	145785.10	145784.77	0.329	11624	11340.439
22	156766.04	156765.7	0.348	10980.944	10713.097
23	158141.50	158141.15	0.354	1375.456	1341.9024
24	160645.74	160645.4	0.344	2504.24	2443.1707

Type <CR> to continue or q to quit ==>

25	170304.09	170303.72	0.371	9658.352	9422.7561
26	173492.92	173492.55	0.378	3188.832	3111.0487
27	192512.65	192512.22	0.431	19019.728	18555.780
28	210208.51	210208.05	0.462	17695.856	17264.219
29	211322.20	211321.75	0.458	1113.696	1086.5365
30	211346.12	211345.67	0.453	23.92	23.341463
31	220988.11	220987.62	0.487	9641.984	9406.7804
32	226151.39	226150.9	0.492	5163.28	5037.3414
33	227338.08	227337.6	0.48	1186.688	1157.7561
34	229716.49	229716	0.496	2378.416	2320.3902
35	231441.77	231441.27	0.501	1725.28	1683.1951
36	235613.44	235612.92	0.515	4171.664	4069.9024
37	242084.22	242083.7	0.524	6470.784	6312.9512
38	243569.15	243568.62	0.527	1484.928	1448.7073
39	251617.98	251617.45	0.534	8048.832	7852.5122
40	266243.31	266242.72	0.587	14625.328	14268.561
41	278595.93	278595.32	0.611	12352.624	12051.317
42	284097.72	284097.12	0.603	5501.792	5367.6097
43	286289.88	286289.27	0.613	2192.16	2138.6829
44	293850.46	293849.82	0.639	7560.576	7376.1463
45	294036.70	294036.07	0.629	186.24	181.70731
46	299754.96	299754.3	0.66	5718.256	5578.7561
47	306722.81	299765.57	6957.241	6967.856	11
48	309632.27	306722.15	2910.122	2909.456	6786.9024
49	310491.77	309631.6	860.176	859.504	2838.4878

AstroPix data and time



- In our point of view, it seems that
- Astropix periodically checks whether the buffer is full and retrieves the data.
- FPGA time looks like the time at which data arrives at the FPGA.

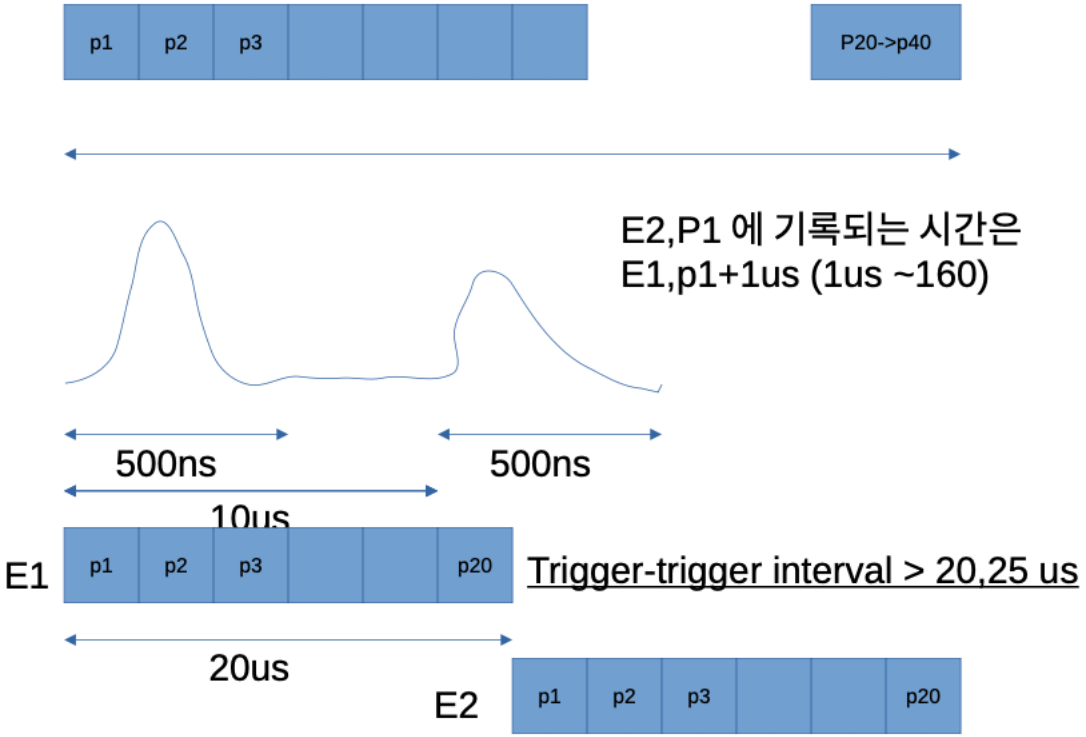
Idea for AstroPix-H2GCROC matching

- Recording the timestamp when the trigger arrives at AstroPix.
  - 0x0A[data] …. [time at trigger] …. 0x0A[data] …..
- Benefit
  - We don’t have to worry about the starting time.
  - We don’t have to worry about the non-trigger event at AstroPix

Summary

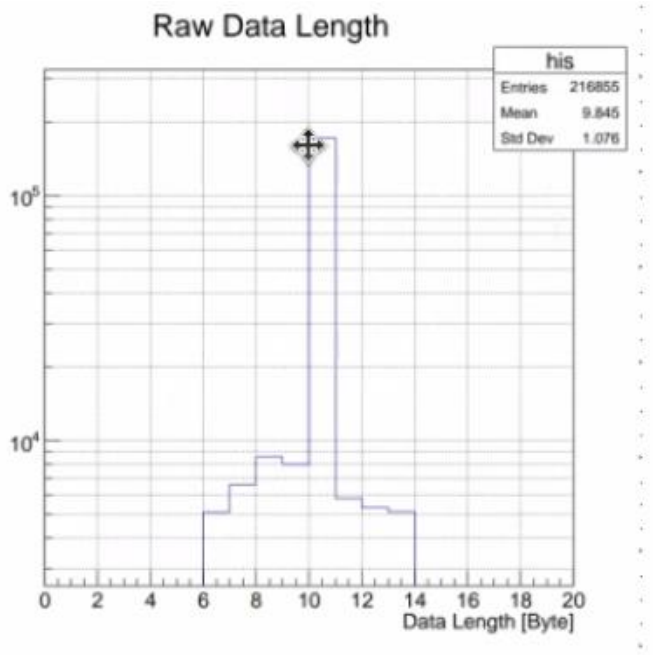
- We are being prepared for the CERN beam test
  - Pb/SciFi modules
  - Experimental setups
  - Event matching between Auxiliary detector and H2GCROC
- We need more careful approach and firmware update for AstroPix-H2GCROC synchronization

Backup: limitation in rate for H2GCROC



- When another trigger arrived while 20 points (20us in timestamp) are recorded, the next event is recorded after 20us. Maximum 50kHz, but we will keep it about a few kHz rate.

0x0A in AstroPix?



- About 20% of data are out of 10 byte length.