

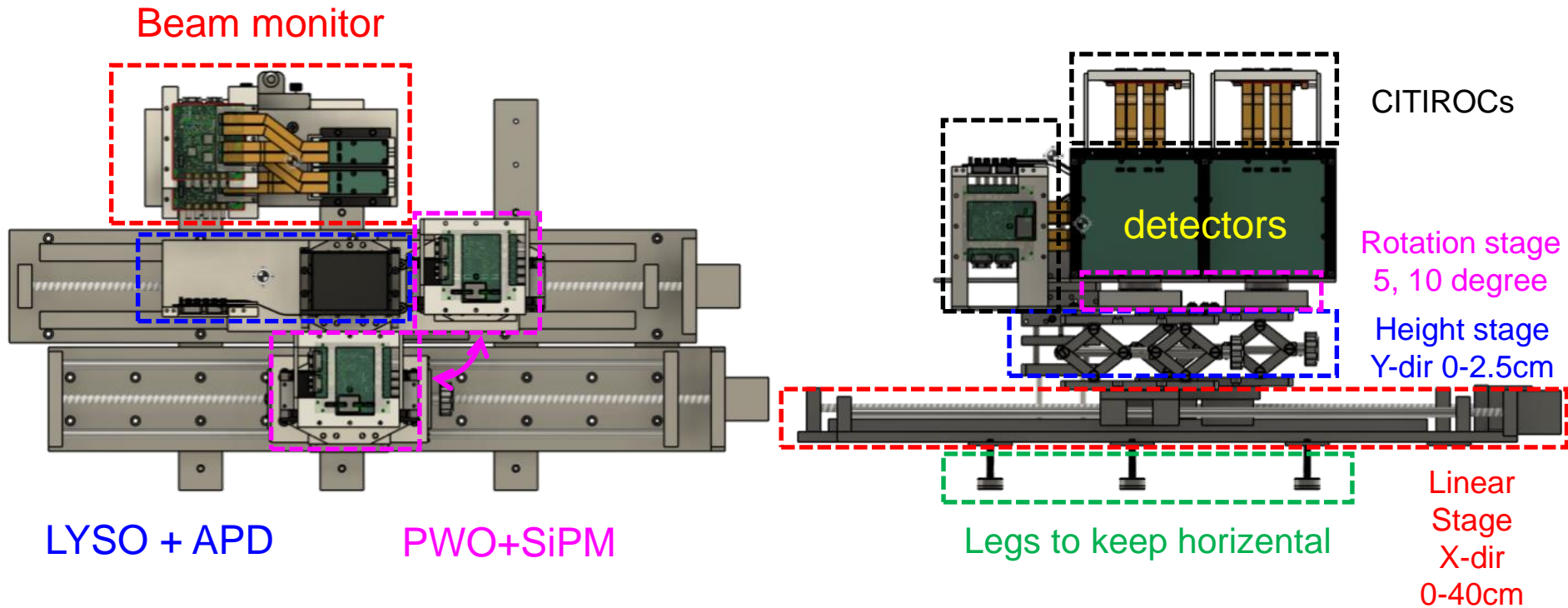


Discussion for Test Beam

Wen-Chen Chang, Kai-Yu Cheng, Tatsuya Chujo, Yuji Goto, Chia-Yu Hsieh, Motoi Inaba, Subaru Ito, Kentaro Kawade, Yongsun Kim, Chia Ming Kuo, Chih-Hsun Lin, Po-Ju Lin, Rong-Shyang Lu, Jen-Chieh Peng

2nd Prototype

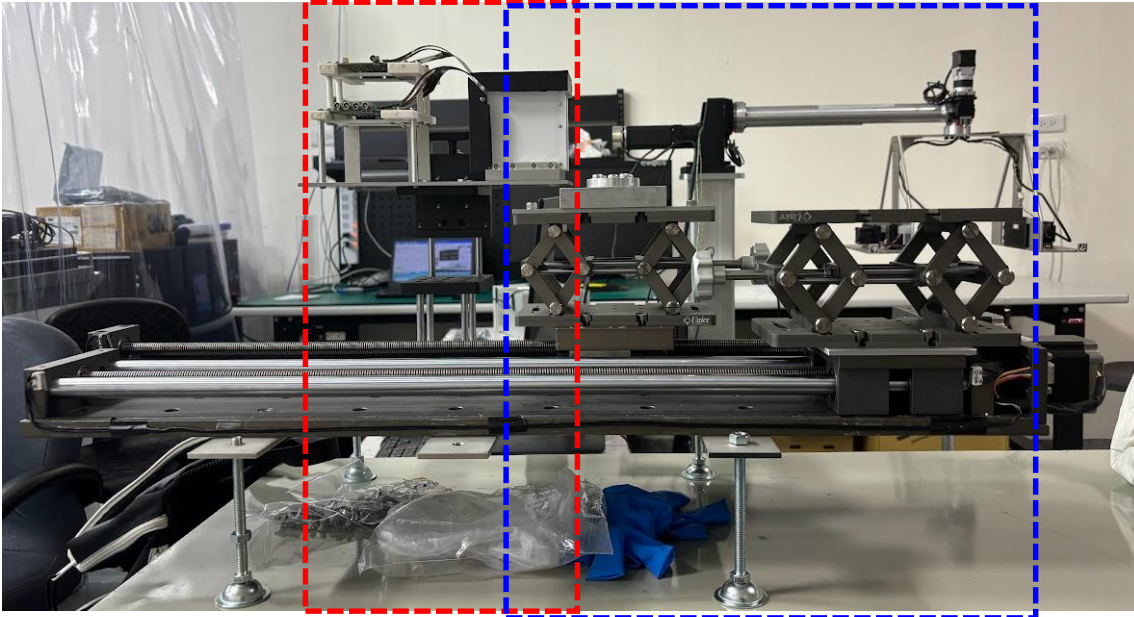
Detector	Crystal	Sensor	Size of one cell	Length	Array	Note
ZDC ECal 2 nd LYSO + APD	LYSO	APD C30739ECERH	1cm*1cm	6.6cm (6X0)	8x8	
ZDC ECal 2 nd PbWO4 + SiPM	PbWO4	SiPM MICROFC-60035	2cm*2cm	5.3cm (6X0)	6x6	Two sensors for one crystal
Beam Monitor	Plastic Scintillator	SiPM MICROFC-10010	2mm*2mm	8cm	32ch in X 32ch in Y	Two sets



Status

	Parts	Progress @2025/01/06	Progress @2025/01/24	Testing status
1. LYSO + APD 1cm*1cm*6.6cm 8x8 array	LYSO Cryatal	ready	ready	Under test
	APD (C30739ECERH)	ready	ready	
	APD Readout PCB	ready	ready	
	LYSO Housing	ready	ready	
	LYSO Base support	ready	ready	
2. PbWO4 + SiPM 2cm*2cm*5.3cm 6x6 array	PbWO4	ready	ready	Under assembling
	SiPM (MICROFC-60035)	ready	ready	
	SiPM Readout PCB	production	ready	
	PbWO4 Housing	ready	ready	
3. Beam monitor 2mm*2mm*8cm 32ch in X 32ch in Y Two sets	scintillator	ready	ready	finished
	SiPM	ready	ready	
	SiPM Readout PCB	ready	ready	
	scintillator Housing	ready	ready	
	trigger Base support	ready	ready	
4. GTM	GTM firmware	ready	ready	finished
	GTM base support	ready	ready	
	cable	ready	ready	
5. Moving stage	base plate	ready	ready	finished
	slide rail	ready	ready	
	remote control	ready	Ready	

Moving Stage



Beam
monitor

LYSO + APD
PbWO4 + SiPM



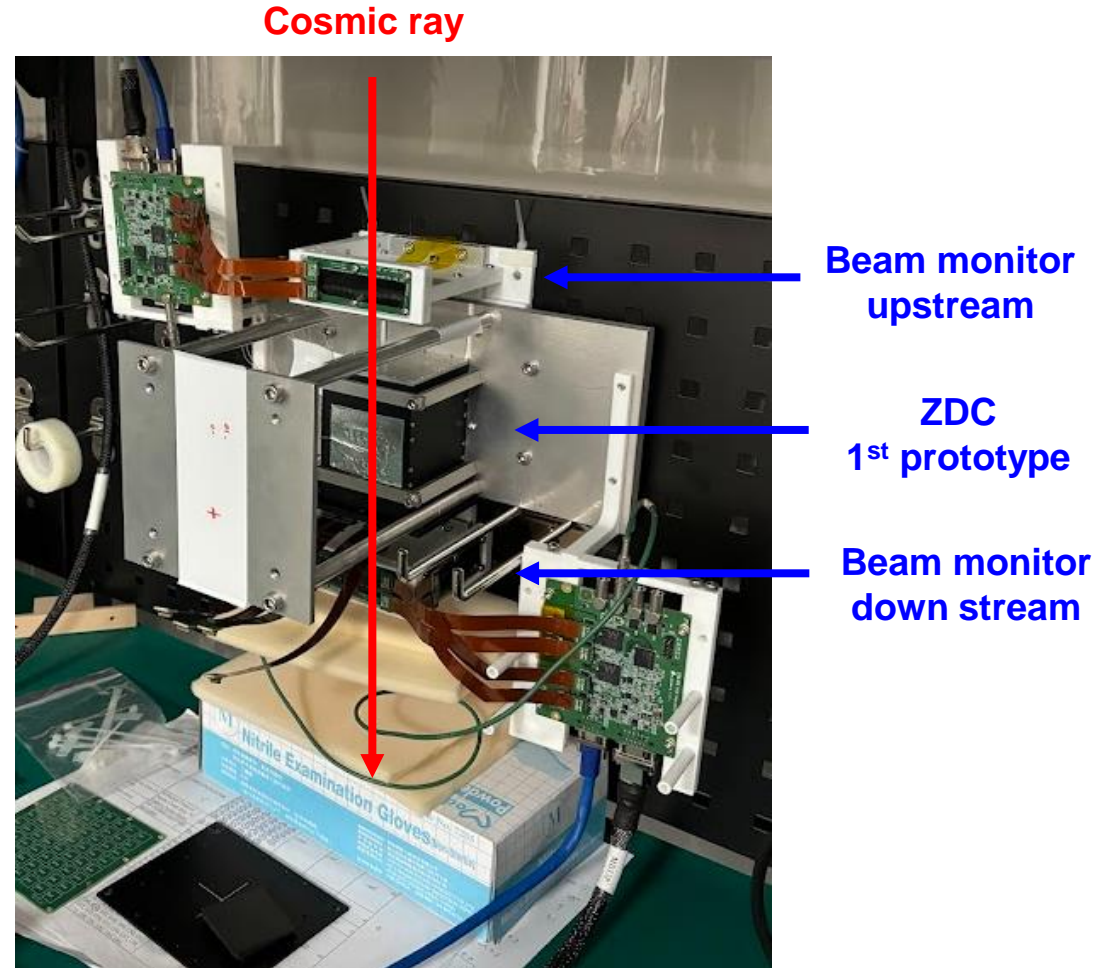
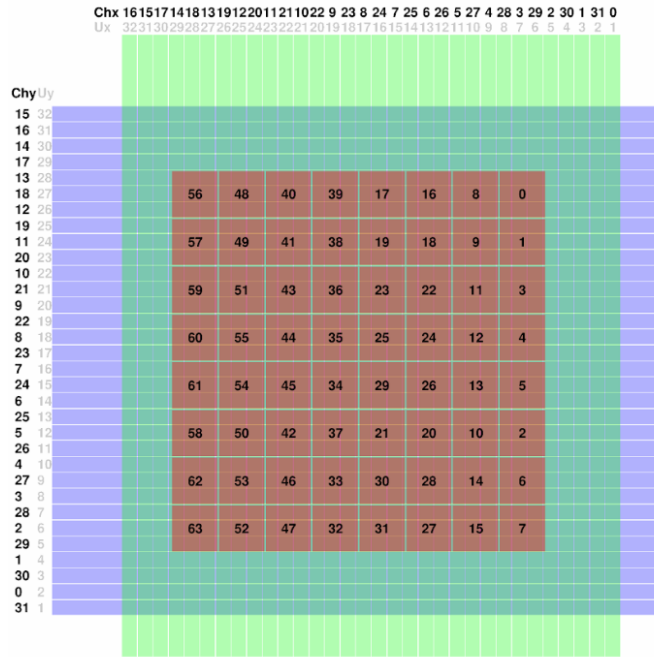
LYSO + APD
PbWO4 + SiPM

Beam
monitor

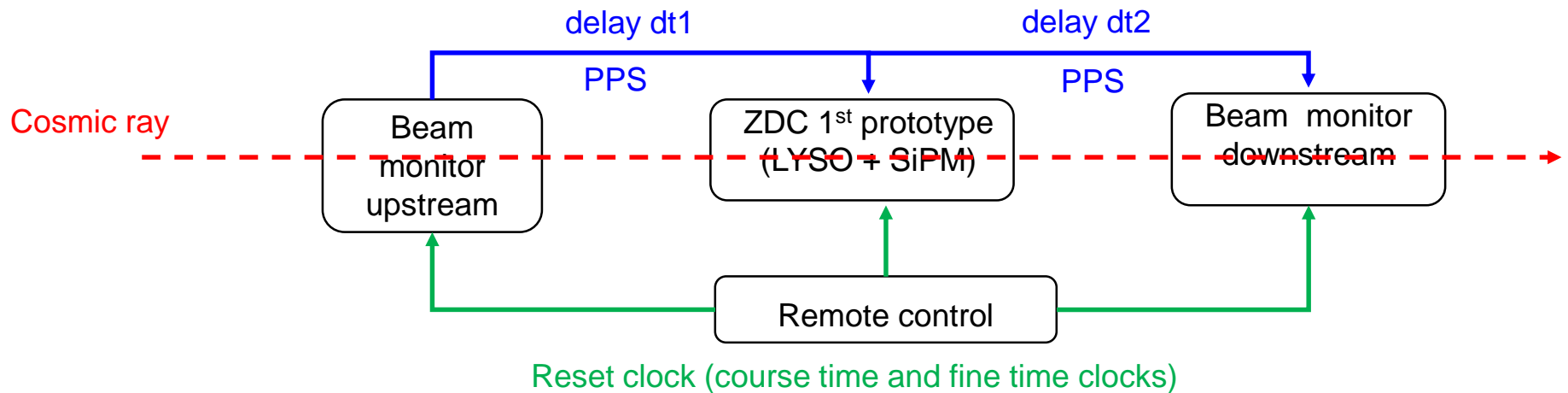
Moving stage is ready.

Lab Test of Beam Monitor

- **To do list :**
- Find pedestal level (done)
- **Synchronization between beam monitors and ZDC (undergoing)**



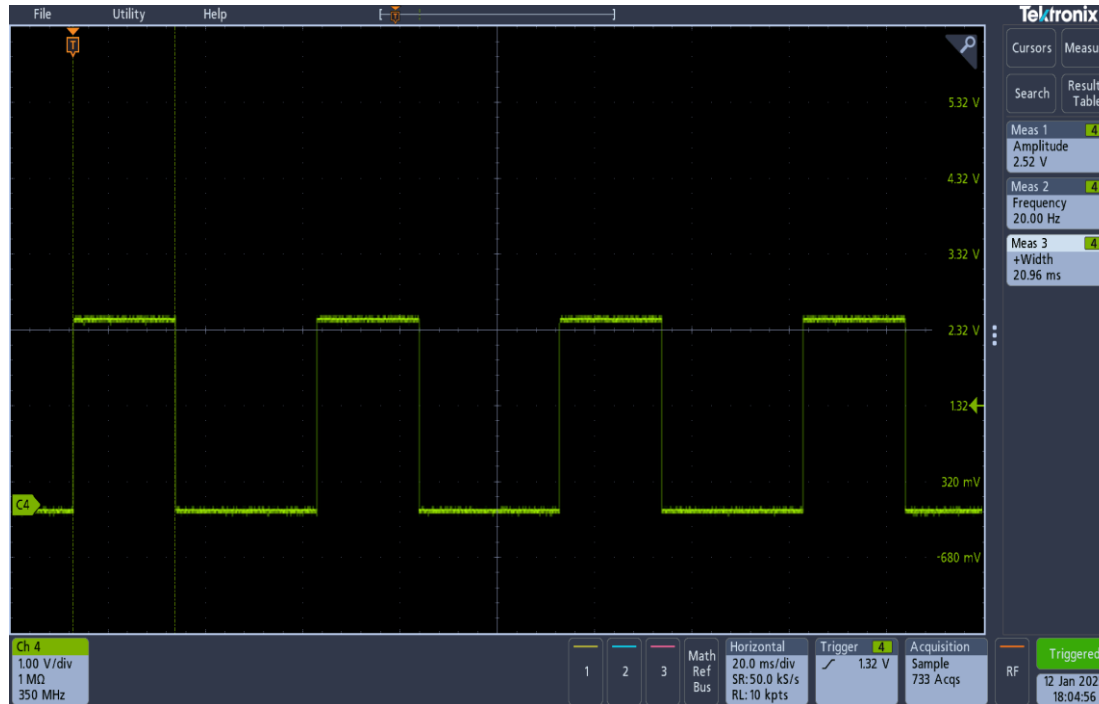
Synchronization between Detectors



- Detectors (beam monitors and ZDC ECal prototype) are all self-triggered. Trigger/event matching is done offline with PPS signals.
 - (1) Remote control set commands to reset the clock of course time (count PPS signals, 20Hz) and fine time (0.24us) of all detectors.
 - (2) PPS signal is stented from one detector to the rests.
 - (3) Event matching is done with timing matching and position matching. **We have taken some data with cosmic ray. The timing matching looks fine. Position matching is still undergoing.**

```
Common : pcnt = 4104, fcnt = 159033
Tree1 beamMonUpX : evtID: 3971, pcnt: 4104, fcnt: 159033, nHits 2, ROCID [1, 1], ch [11, 20]
Tree1 beamMonUpY : evtID: 3970, pcnt: 4104, fcnt: 159033, nHits 1, ROCID [0], ch [2]
Tree2 beamMonDnX : evtID: 2952, pcnt: 4104, fcnt: 159033, nHits 1, ROCID [1], ch [27]
Tree2 beamMonDnY : evtID: 2951, pcnt: 4104, fcnt: 159033, nHits 2, ROCID [0, 0], ch [5, 25]
Tree3 ZDC : evtID: 4988, pcnt: 4104, fcnt: 159033, nHits 4, ROCID [0, 0, 0, 0], ch [8, 9, 10, 18]
```

PPS Signal

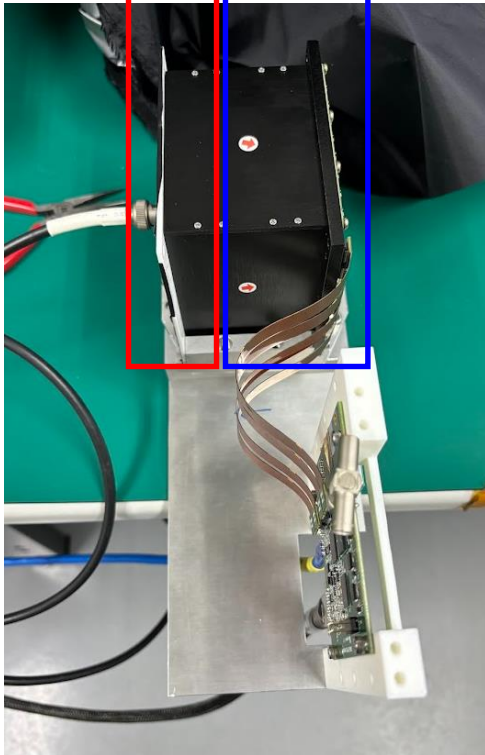


Active high pulse, 2.5V, 20 Hz, width=20.96 ms

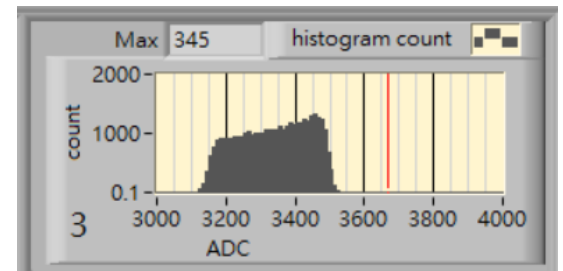
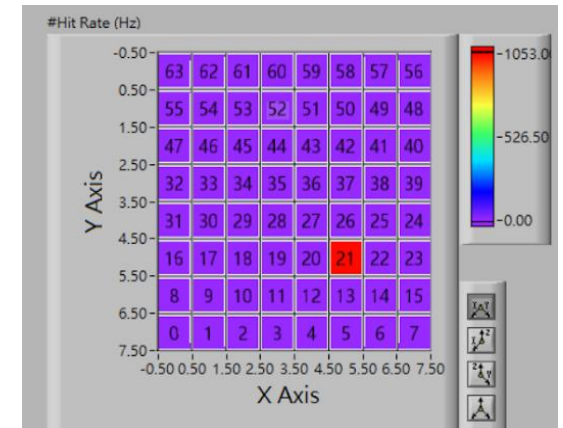
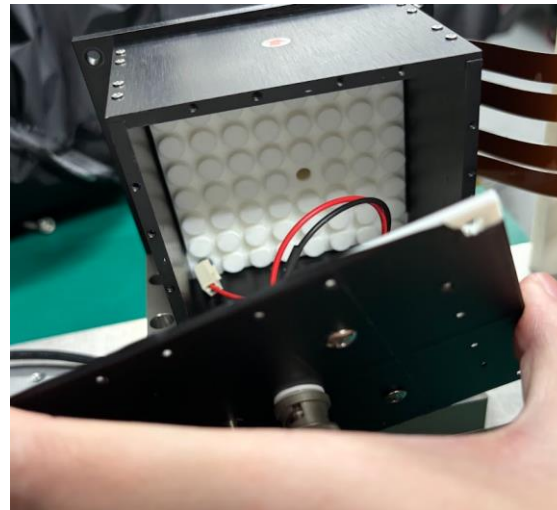
Lab Test of LYSO + APD (1) : Setting

- **To do list :**
- Find pedestal (done)
- **Gain and linearity check (undergoing) (can't be done with radiation source, so we are checking with LED)**
- Temperature Calibration (not sure if it will be done by 2/13 because of the time constrain)
- ADC to MeV mapping (not possible with radiation source, we can only do it with beam)

LED LYSO + APD



LED light is positioned at the center of each channel



Lab Test of LYSO + APD (2) : Working HV

APD working HV (absolute)

394.5	391.4	390.3	389.4	382.5	381.6	390.8	392.3
390.3	384.1	384.8	383.8	387.5	384.2	382.3	379.4
382.8	385.3	386.7	386.5	386.7	385.2	382.8	379.9
389	385.3	386.3	385.9	386.1	385.3	389.2	392.4
389.2	387.1	386.6	385.6	385.3	385.1	389.5	379.4
382.3	388.9	384.7	386.6	384.3	388.7	389.6	380.8
381	394.7	381.3	382.7	381.8	381.6	391.2	392.2
394.5	393.9	393.6	392.6	393.4	393.7	394	393.9

APD working HV (relative)

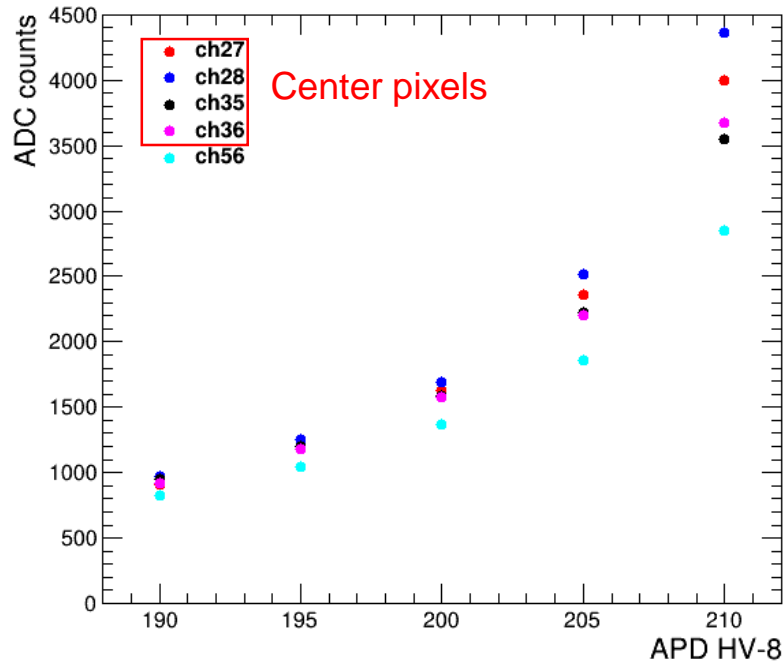
8.5	5.4	4.3	3.4	-3.5	-4.4	4.8	6.3
4.3	-1.9	-1.2	-2.2	1.5	-1.8	-3.7	-6.6
-3.2	-0.7	0.7	0.5	0.7	-0.8	-3.2	-6.1
3	-0.7	0.3	-0.1	0.1	-0.7	3.2	6.4
3.2	1.1	0.6	-0.4	-0.7	-0.9	3.5	-6.6
-3.7	2.9	-1.3	0.6	-1.7	2.7	3.6	-5.2
-5	8.7	-4.7	-3.3	-4.2	-4.4	5.2	6.2
8.5	7.9	7.6	6.6	7.4	7.7	8	7.9

In our system, the HV of APD can only be set as one value for all the channel, but the working HV of each APD is different.

We place the APD with similar working HV within 0.7V difference in the center pixels 5x5.

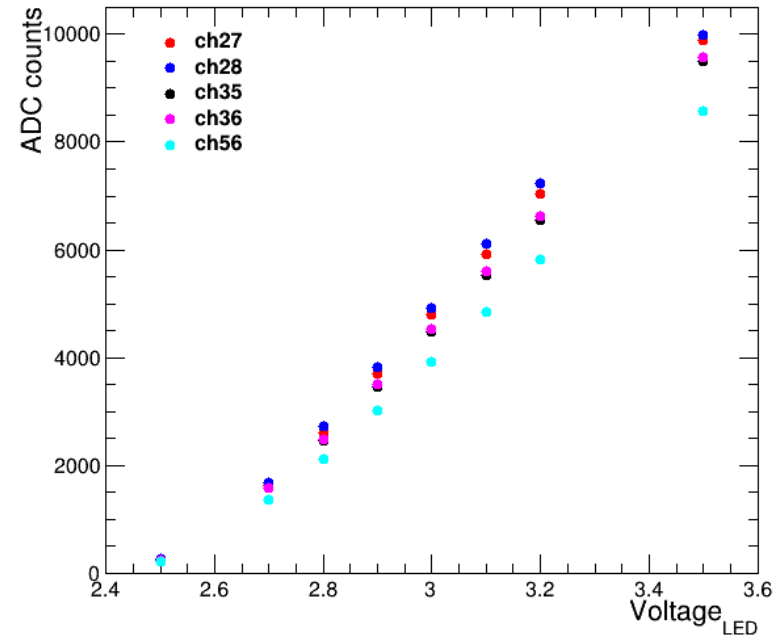
Lab Test of LYSO + APD (3) : Linearity and Gain Check

LED 2.7(V)



- We chose APD HV = 200 (DAC setting) working HV.
- As expected, the gain of center pixels are close.

APD HV-8 200



- At fixed HV of APD, we check the responds of detector (~ ADC count with the increase number of photos (~LED voltage)).
 - A linear responds is showed.
 - The gain of different channels are different.
- The same procedure will be performed again with beam at ELPH to build up the gain calibration table.

Lab Test of PbWO₄ + SiPM



- **To do list :**
 - Find pedestal
 - Gain Calibration
 - Temperature Calibration
 - ADC to MeV mapping
- **Status :**
 - **Assembling is not yet finished.**

Test Beam List

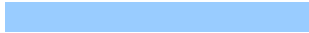
- **02/14~02/16 (preparation)**
 - Setup
 - position alignment between beam monitor and detector
 - test all the moving stages and its moving range
 - Calibration w/ PbWO4 + SiPM w/ Na22
 - Gain and temperature calibration w/ Na22
 - Cosmic ray test (check signals from both beam monitor and ZDC)
- **02/17 ~ 02/20 (beam time)**
 - LYSO + APD (PbWO4 + SiPM)
 - Gain and temperature calibration w/ beam (>50MeV)
 - Beam energy scan
 - HV scan
 - Position scan in XY
 - Rotation scan w/ 5, 10 degree

To do and Discussion

- **To do here**
 - LYSO + APD : LED light scan (expect to finish today)
 - Beam monitor event matching : position matching
 - PbWO4 + SiPM : hopefully to finish assembling today, then we will still have one week to do calibration after lunar new year.
- **Shipping :**
 - name , address, phone and e-mail of receiver?
 - Expect to send packages on Feb. 3rd
- **How to share 4 days beam time?**



Back up



Estimation of ADC Value (2024 Sept.)

//===== Gain values =====

- LYSO + SiPM : 2580/0.29 (digits/MeV)
- SiPM gain = 1e6 ~ 5e6 (here use 1e6)
- APD gain = 1 ~ 100 (here use 100)
- LYSO PDE = 25e3-35e3 photons/MeV (here use 3.0e4 photons/MeV)
- PbO4 PDE = 1e2-2e2 photons/MeV (here use 1.5e2 photons/MeV)
- Note : Polystyrene 1e4

//===== 6X0 LYSO + APD =====

- ADC digits = $[(2580/0.29)/1e6*1e2]*E_{max} = 0.89*E_{max}$
- ADC dynamic range = 11, 000
- 50MeV electron , $E_{max} = 21.5$, ADC = 19.18 => might be too low, close to noise level
- 800MeV electron, $E_{max} = 240.1$, ADC = 213.689
- 1GeV gamma , $E_{max} = 248.6$, ADC = 221.254
- 40GeV gamma , $E_{max} = 3190$, ADC= 2839.1

//===== 6X0 PbWO4 + SiPM =====

- ADC digits = $[(2580/0.29)/3e4*1.5e2]*E_{max} = 44.48*E_{max}$
- ADC dynamic range = 11, 000
- Saturation of SiPM ~ 3000 ADC
- 50MeV electron , $E_{max} = 22.43$, ADC = 997.8
- 800MeV electron, $E_{max} = 266.7$, ADC = 11862.8 => out of linear range of SiPM
- 1GeV gamma , $E_{max} = 284.0$, ADC = 12632.32 => out of linear range of SiPM also ADC dynamic range
- 40GeV gamma , $E_{max} = 4198$, ADC = 186727 => out of linear range of SiPM also ADC dynamic range