Overview of TB2023 Experiment

Seungkyu Ha

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Yonsei University

Outline

- What we did!
  - Test beam 2023 schedules
  - Beam & Setup we used

- Configurations
  - Modules
  - Ancillary detectors
  - Experimental hall setup
  - DAQ
  - DQM

- Programs
  - main
  - additional test programs

What We Did Last Summer!

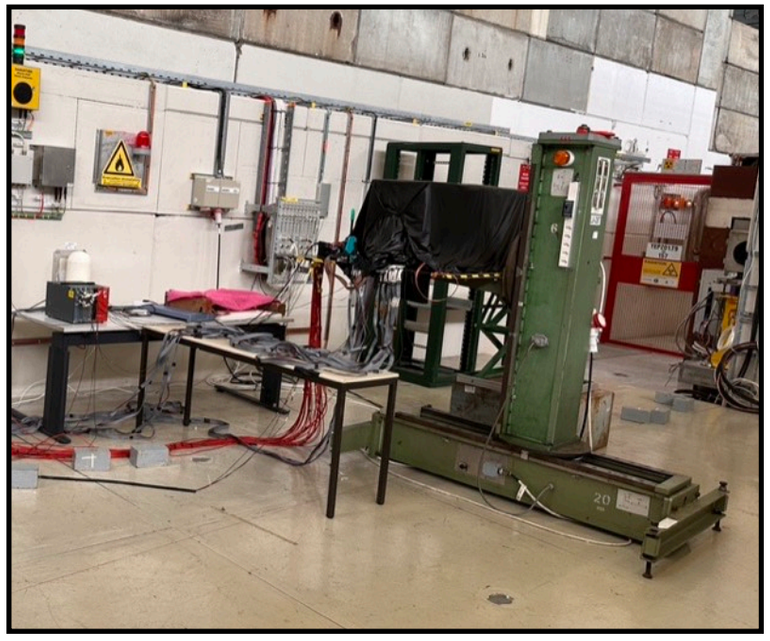
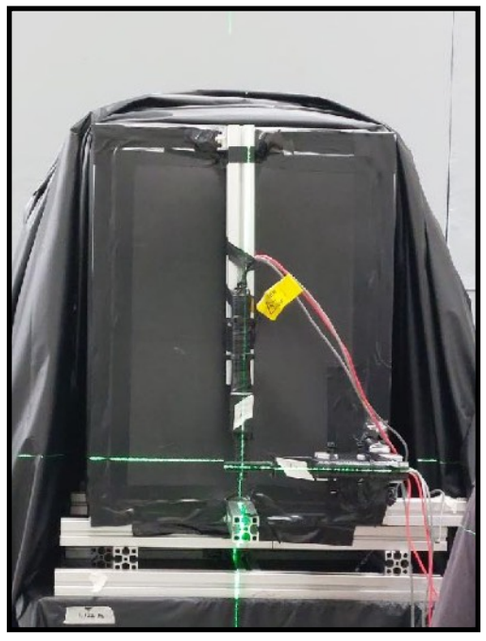
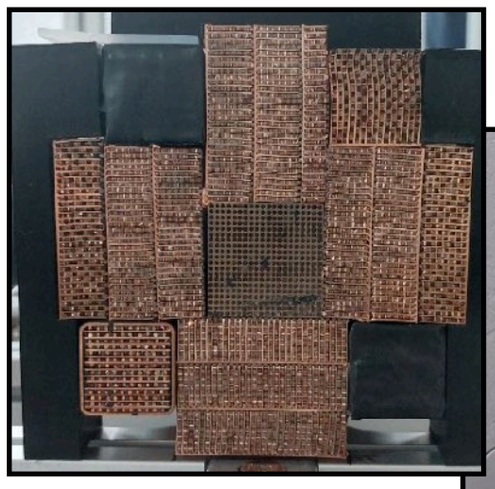
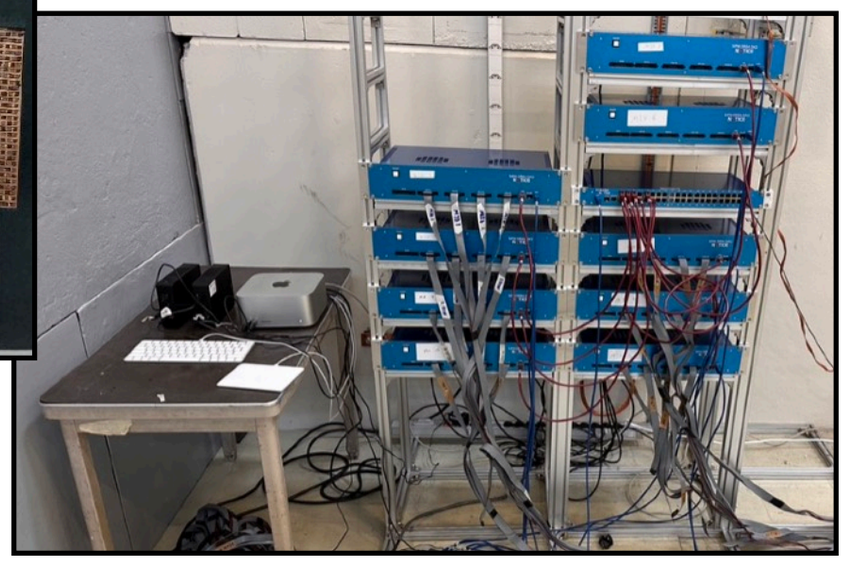
- **2023 Test Beam @ T9(CERN PS)**

  - We conducted test beam experiment DRC module at CERN east area T9 this summer

  - Test beam area with beam from Proton Synchrotron (PS), beam energy up to 15 GeV

  - From Jun 27th to Jul 13th (3 weeks)

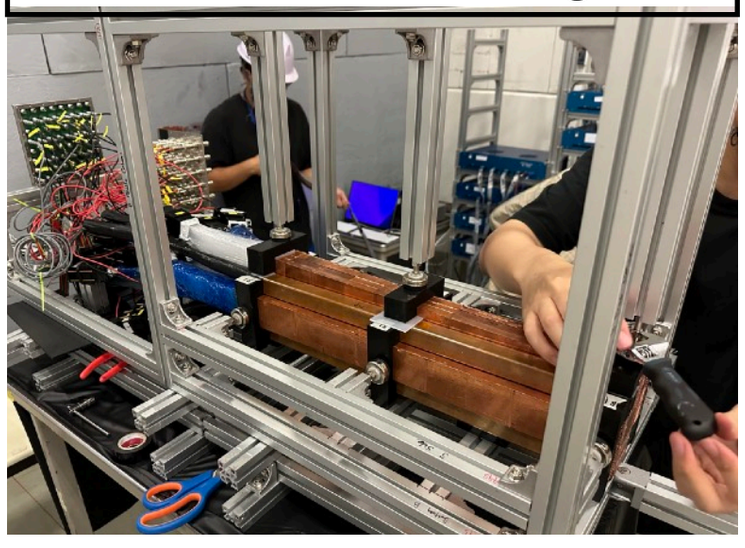
  - Total 19 people (3 faculties, 15 students including undergraduate) from YU, YU SV, KNU, GWNU

Test Beam 2023 (Schedule)

- **We had test beam Week 26 and 27**
  - Jun 28th ~ Jun 29th : Installation and Commissioning for parasitic beam
  - Jun 29th ~ Jul 5th : data taking for parasitic beam
  - Jul 5th ~ Jul 12th : Main test beam programs started & data taking

Installation & Commissioning

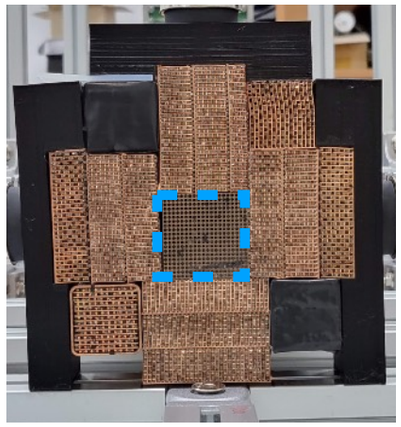


Test with parasitic beam

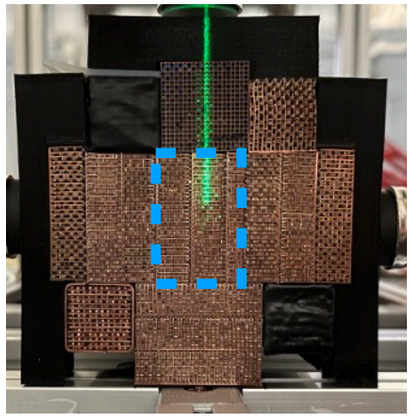
Main test beam program!

Test Beam 2023(DRC Setup& Beams)

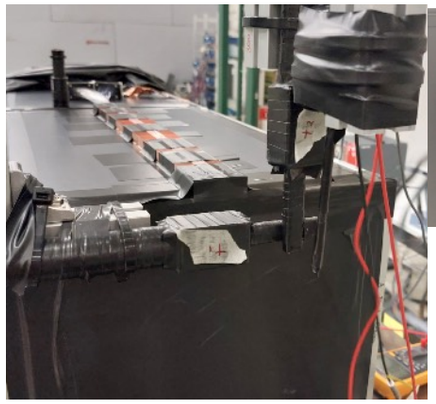
- **3 different DRC detector setup** was used for the TB in 2023

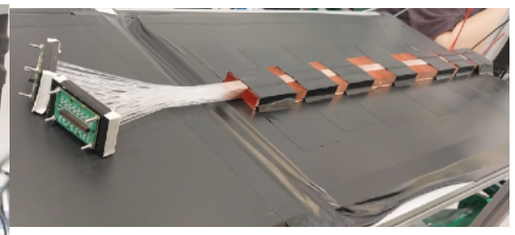


Set 1, 3 : 3D-centered



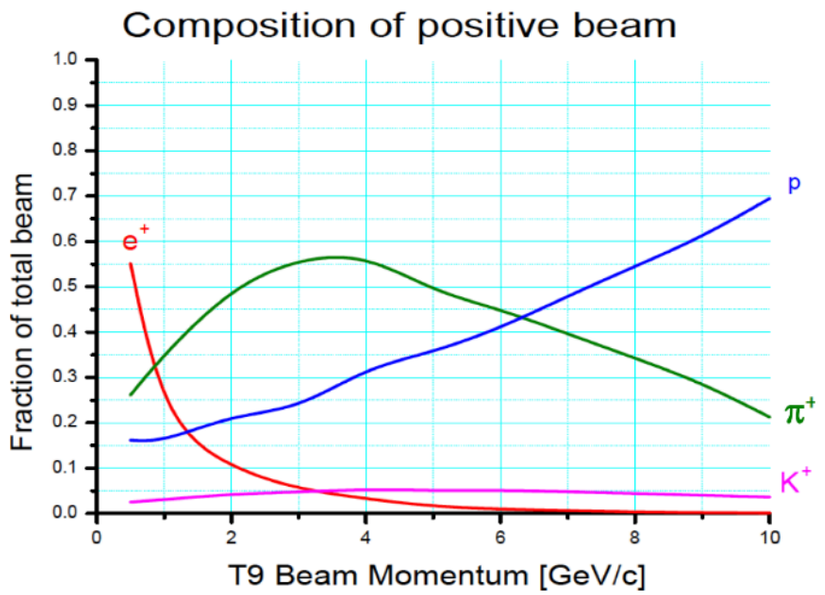
Set 2 : SFHS centered





Set 3 : SiPM module test

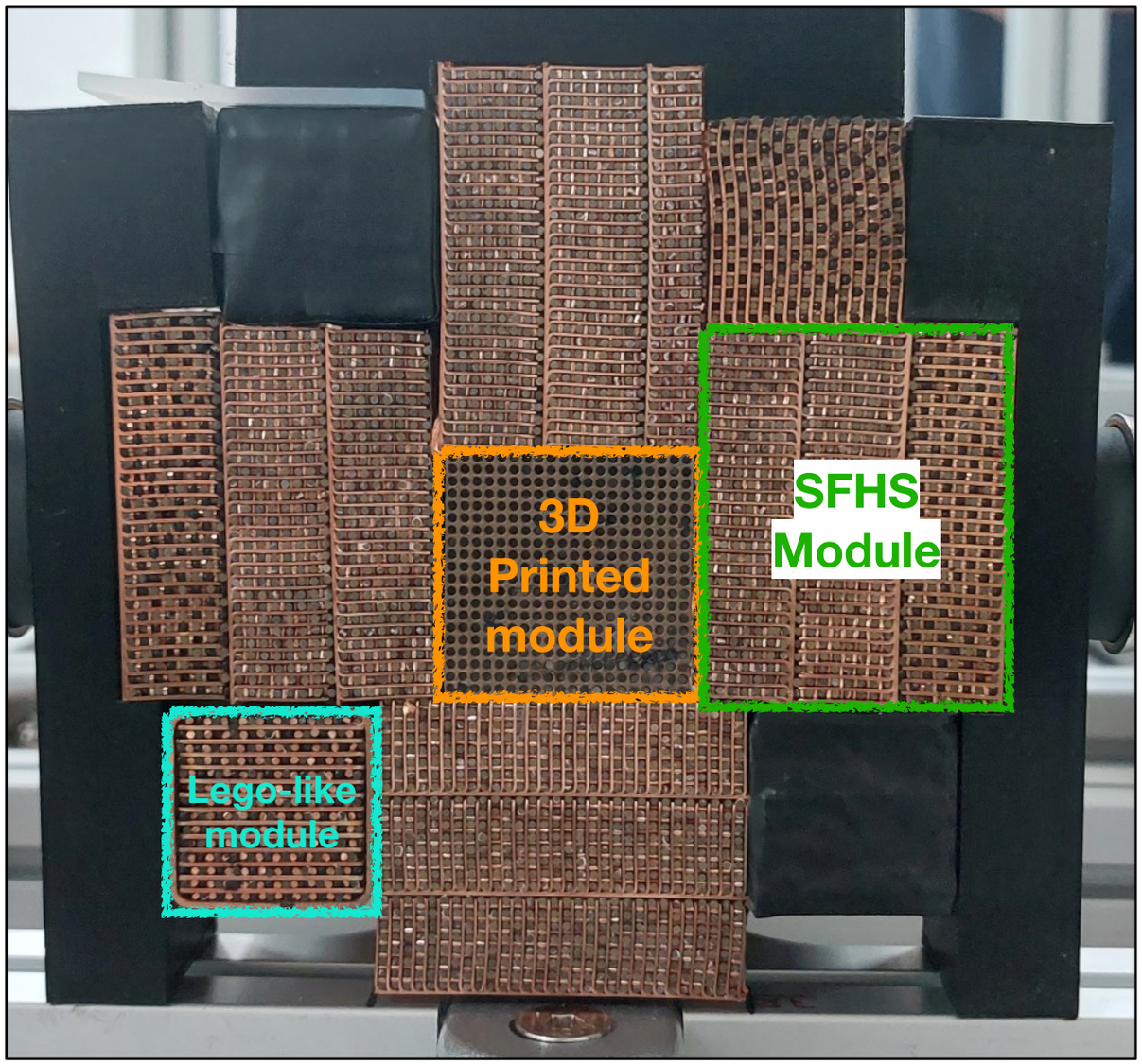
- **We conducted test beam experiments using various beams**

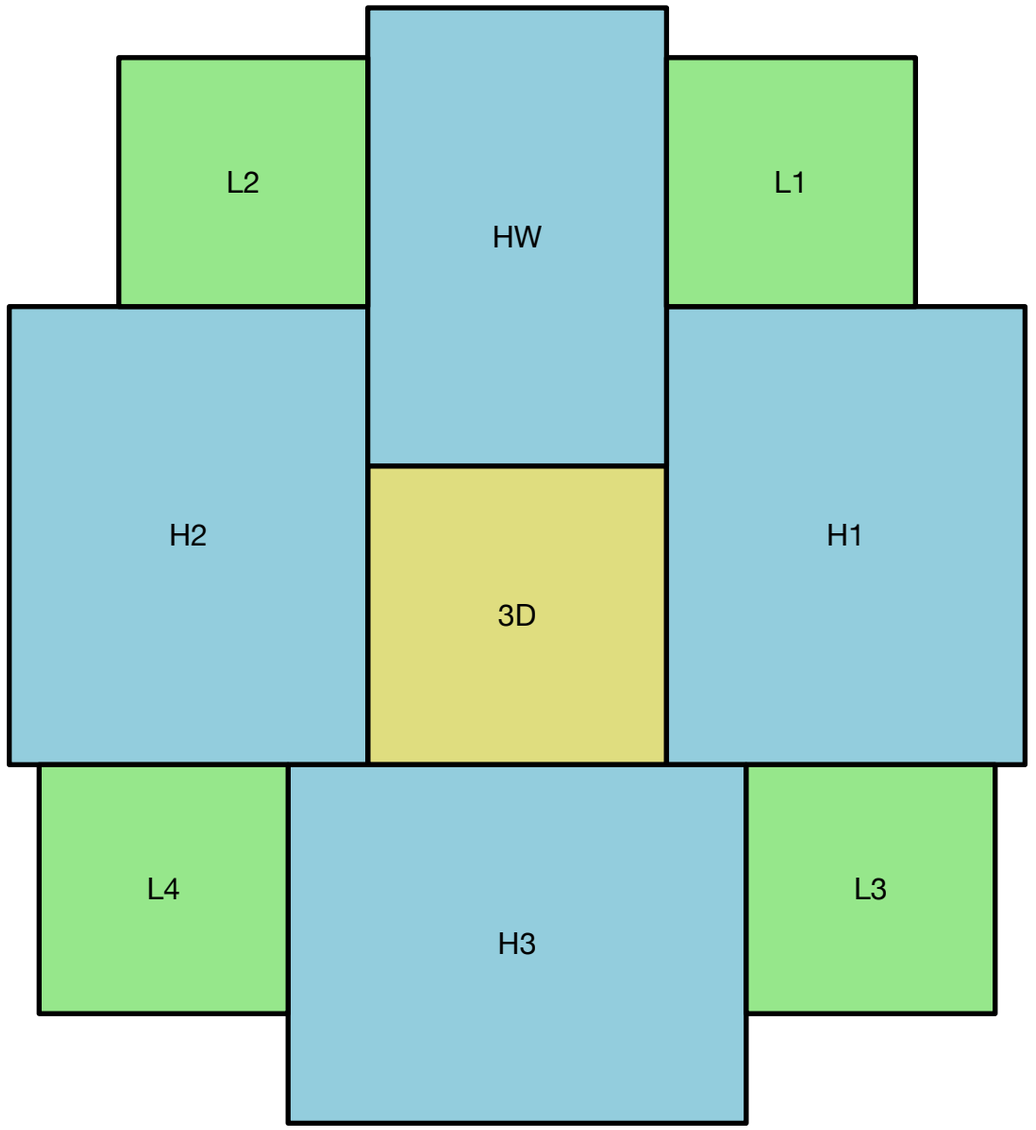


Particle	Energy (GeV)
e+	0.5, 0.75, 1, 2, 3, 4, 5
π-	3, 4, 5, ... , 10
proton	4, 5, 6, ... , 10

Module in TB 2023

- **We used 3 different types and combined modules!**
  - 3D printed module
  - Lego like module
  - HSSF module

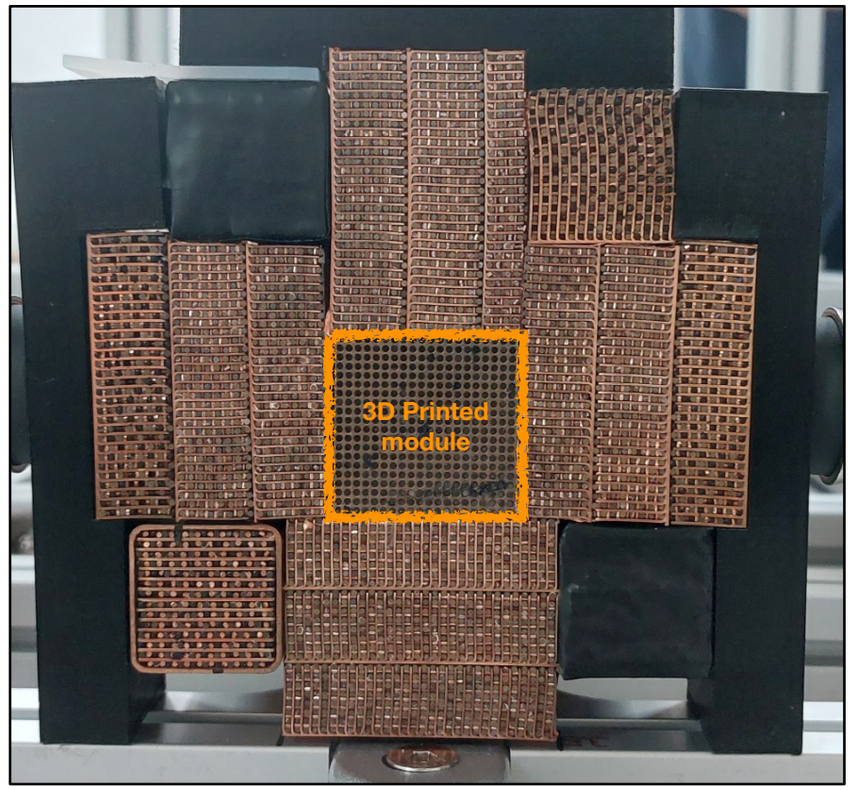


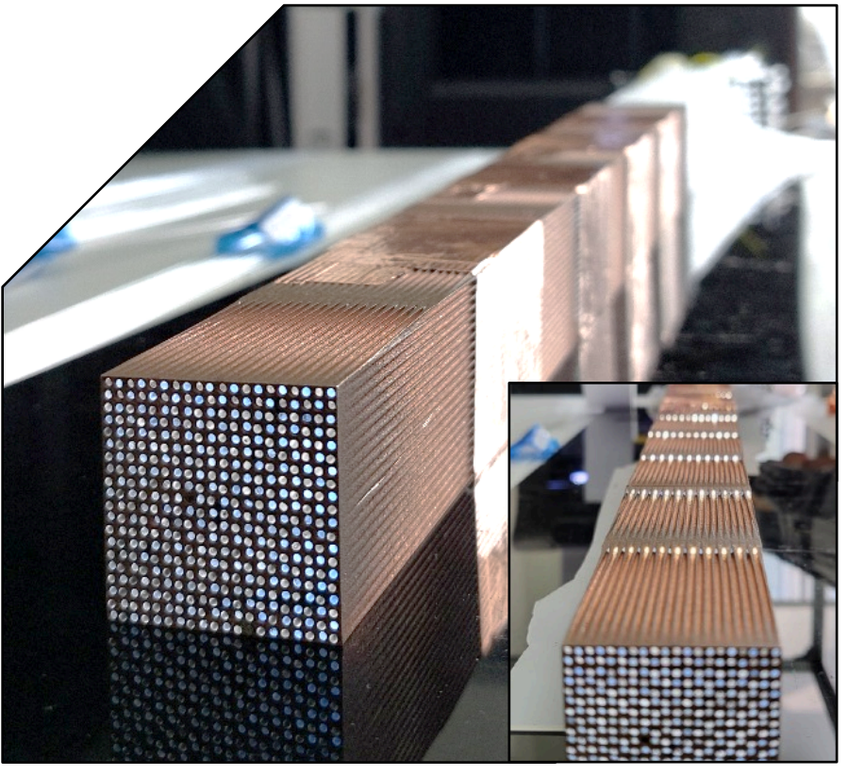


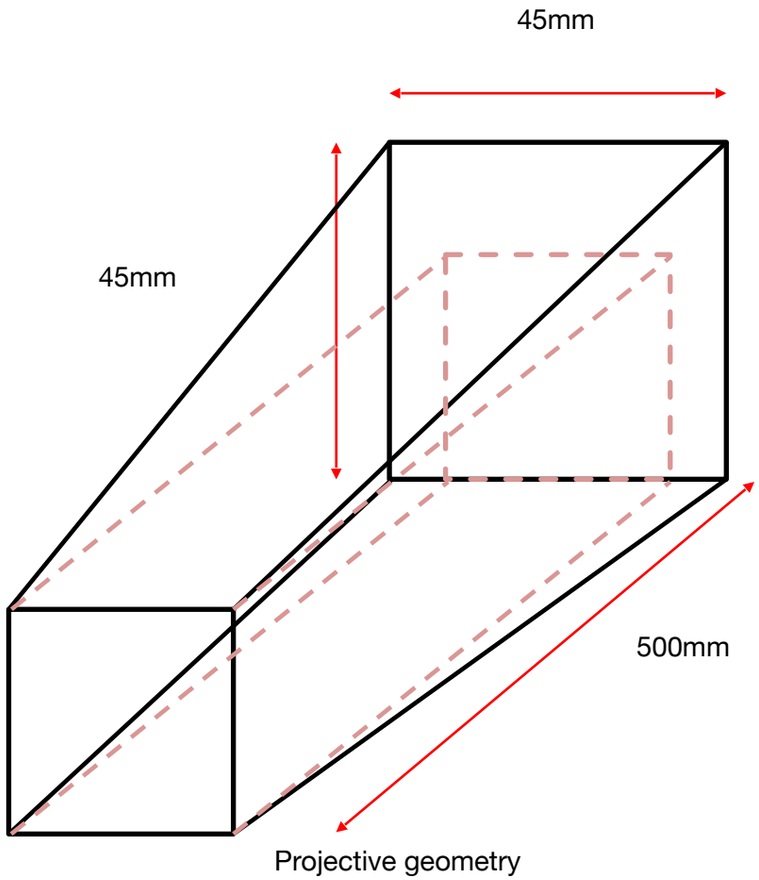
Module in TB 2023 : 3D Printed Module

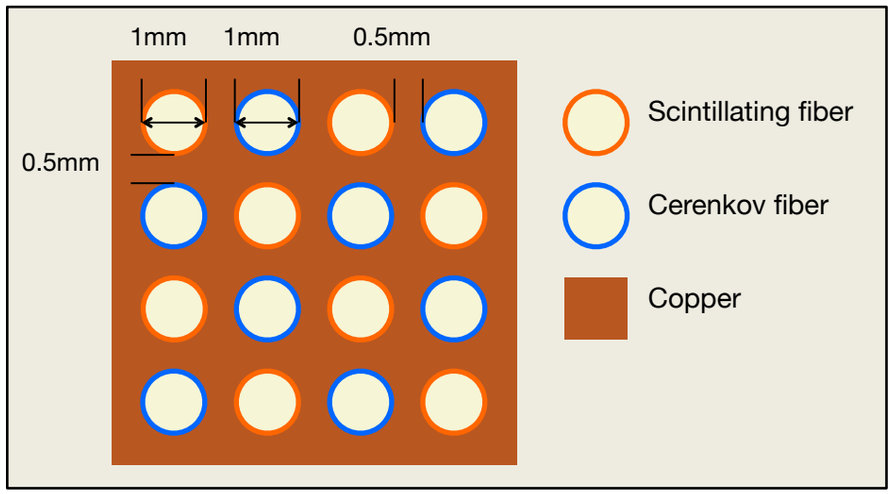
- **This is a module created by applying 3D printing technology**

  - This module is the great feature of a projective shape
  - It has amazing uniformity
  - Total 812 (S 406, C 406) fibers are implemented in copper





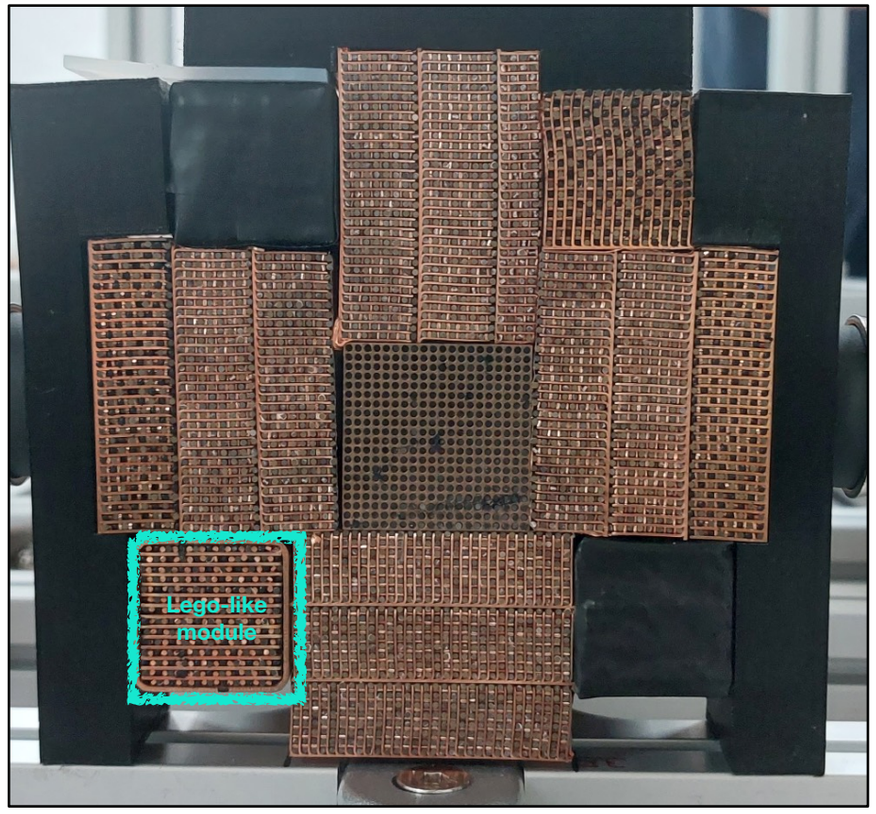


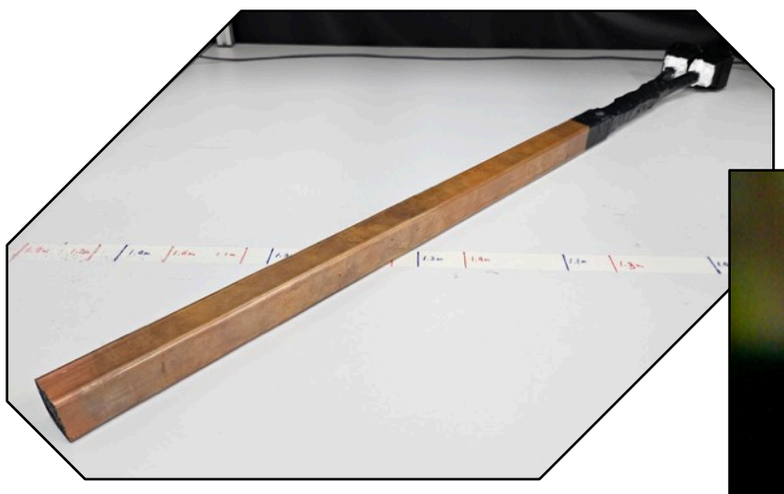


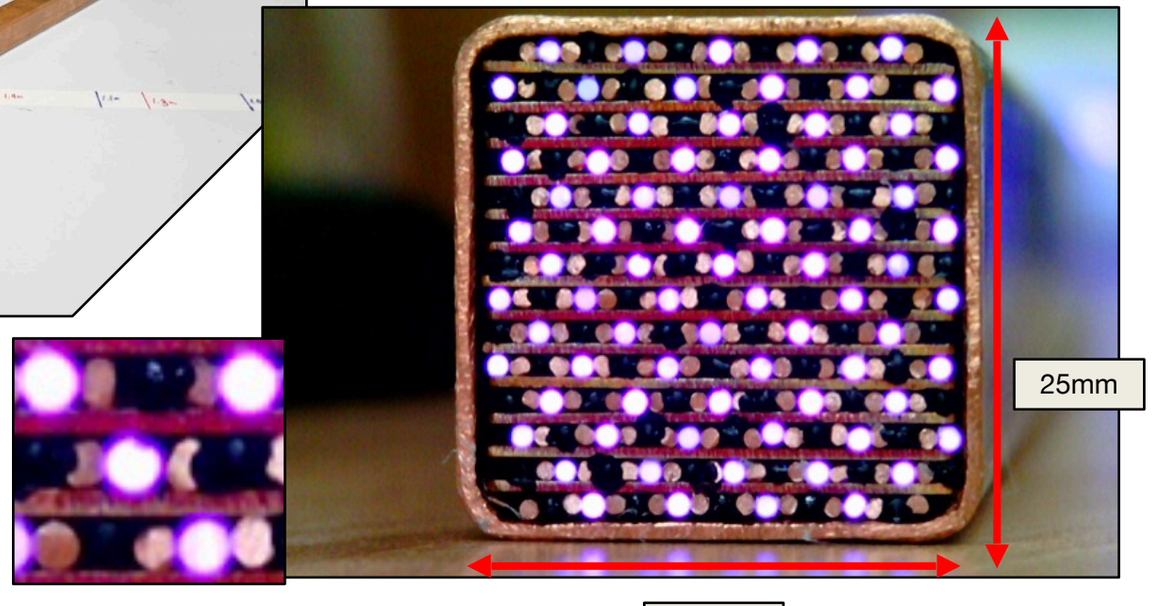
Structure of 3D-Printed Module

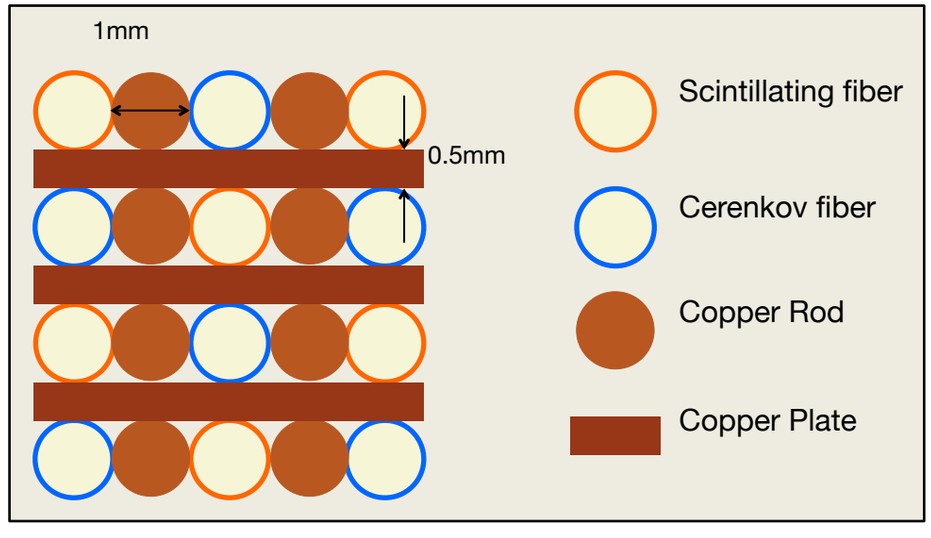
Module in TB 2023 : Lego-Like Module

- **These modules has structure of fiber & copper rods**
  - 3 Lego-Like modules used
  - This module is characterized by the convenience of assembly
  - It has good uniformity
  - Total 154 (S 77, C 77) fibers are implemented in copper









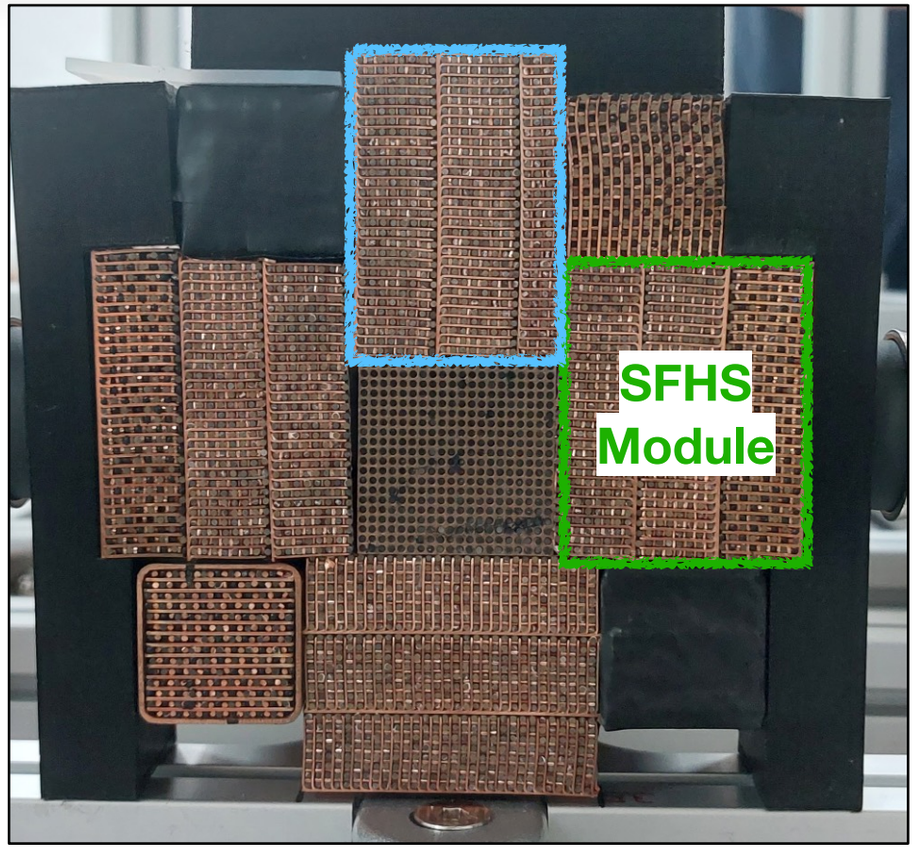
Module in TB 2023 : SFHS Module

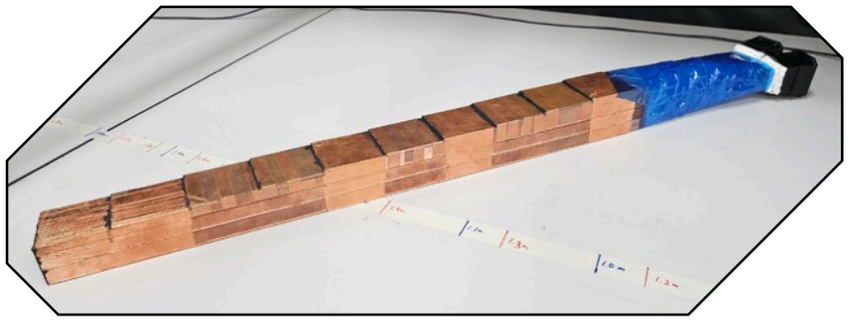
- **These modules are made of heatsink shape copper structure**

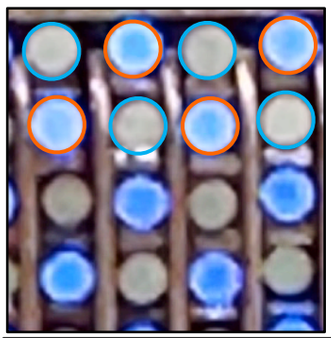
  - 4 modules used (3 cuboid shapes, 1Step type(slope geometry))

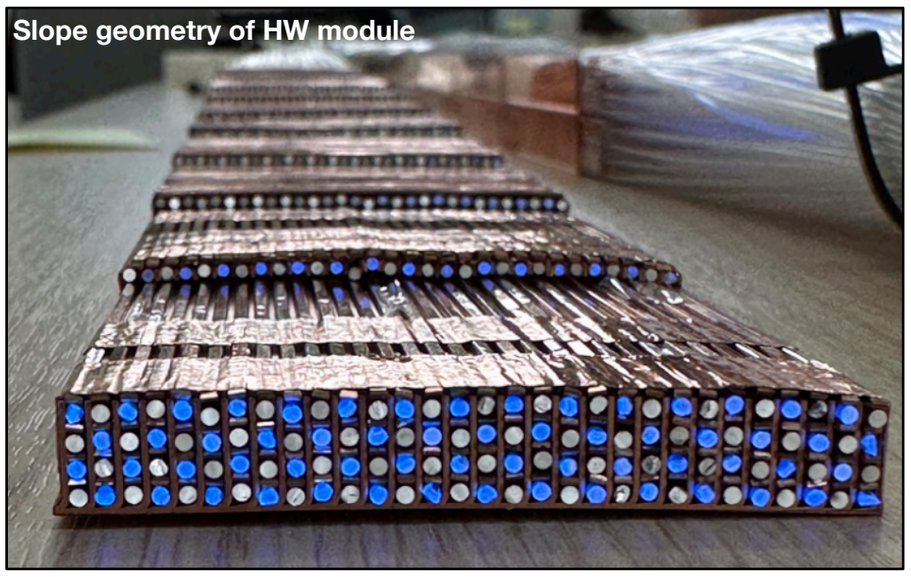
  - This module is characterized by the convenience of assembly & It has good uniformity

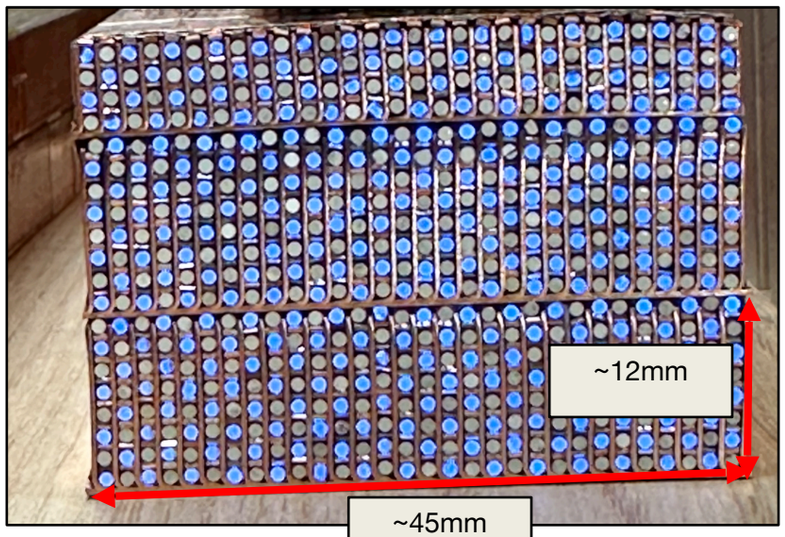
  - Total 720 (S 360, C 360) fibers are implemented in copper

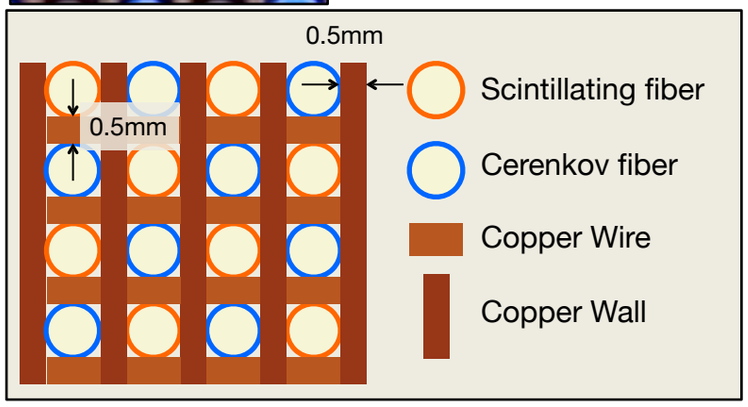






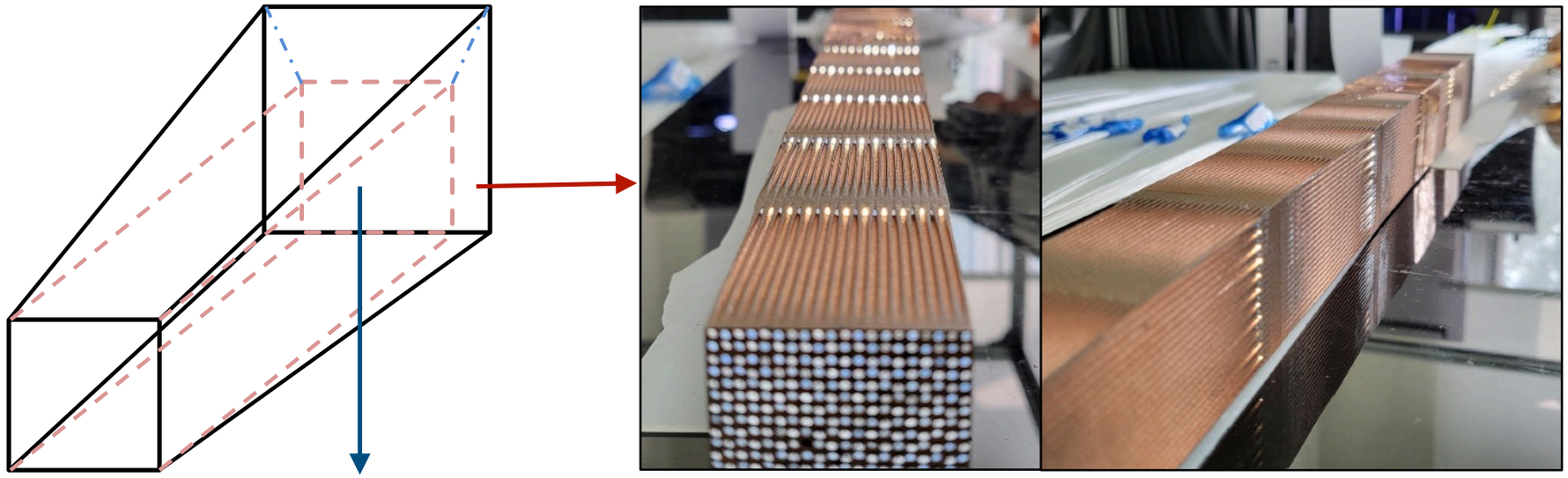


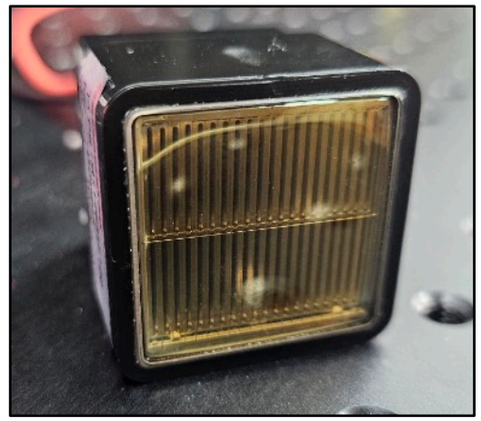




Module in TB 2023 : Readout (3D)

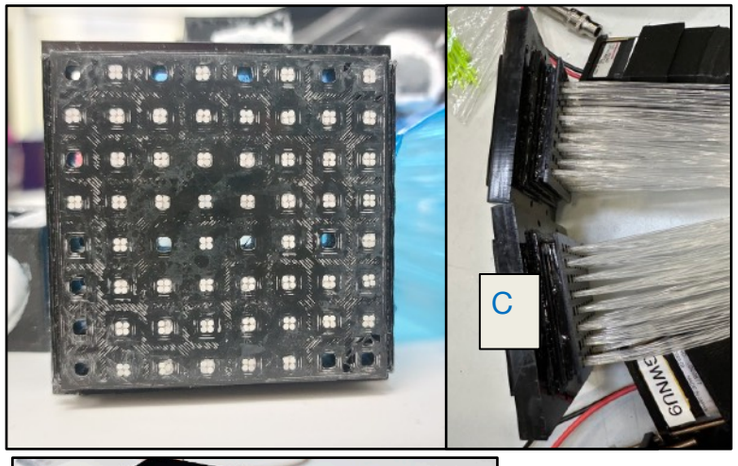
- **For 3D module, square shape PMT and MCP-PMT are used**
  - Total 106 channel (Micro Channel Plate (MCP) – PMT (100))





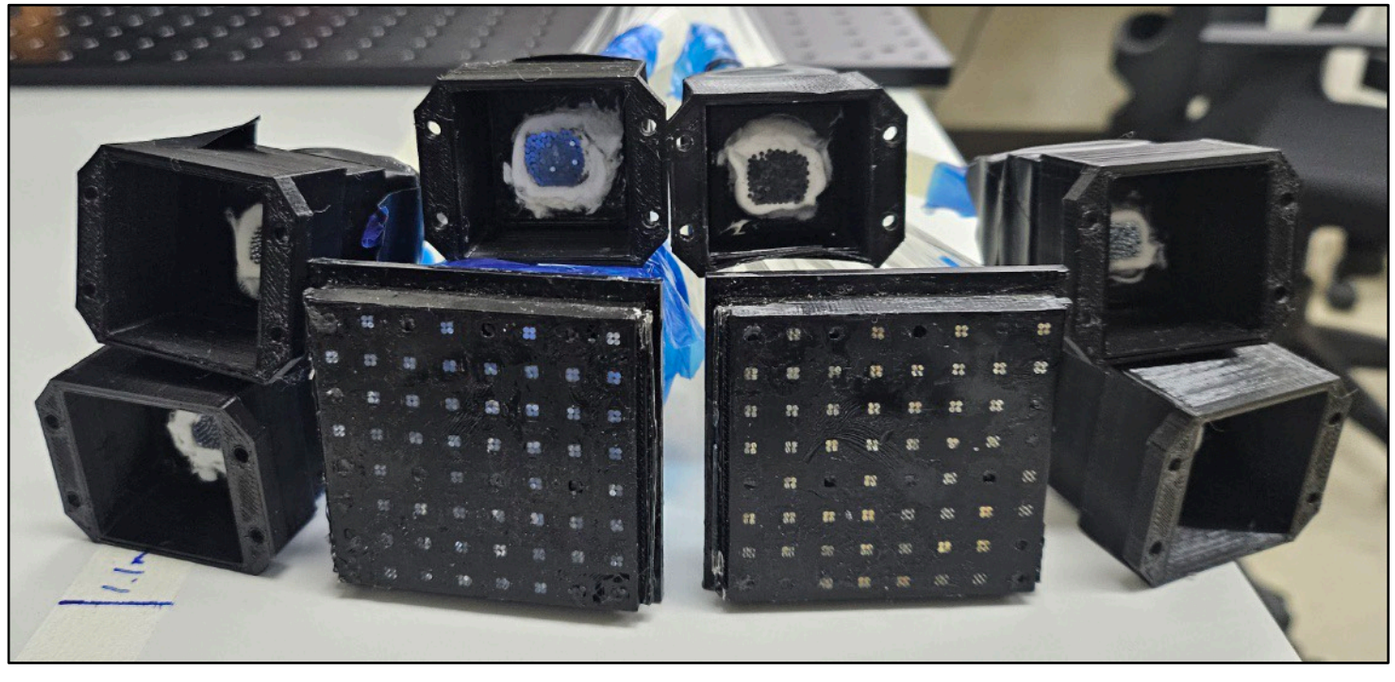
6 Square PMTs

R11265U



MCP-PMT
S(50) : XP85012
C(50) : XP85112

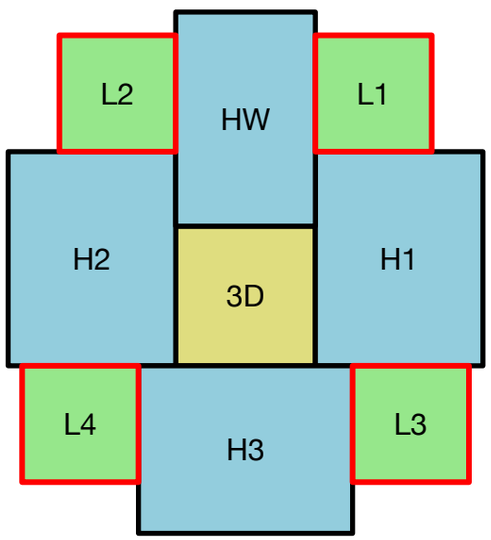
- Rear side view

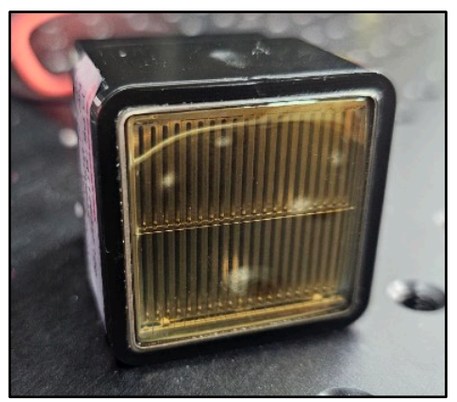


Module in TB 2023 : Readout (Lego-Like&SFHS)

- **For Lego-Like & SFHS modules , square shape PMT are used**

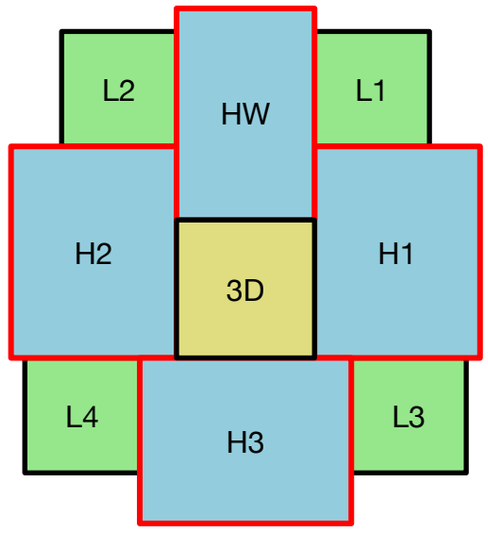
- Lego-Like module:

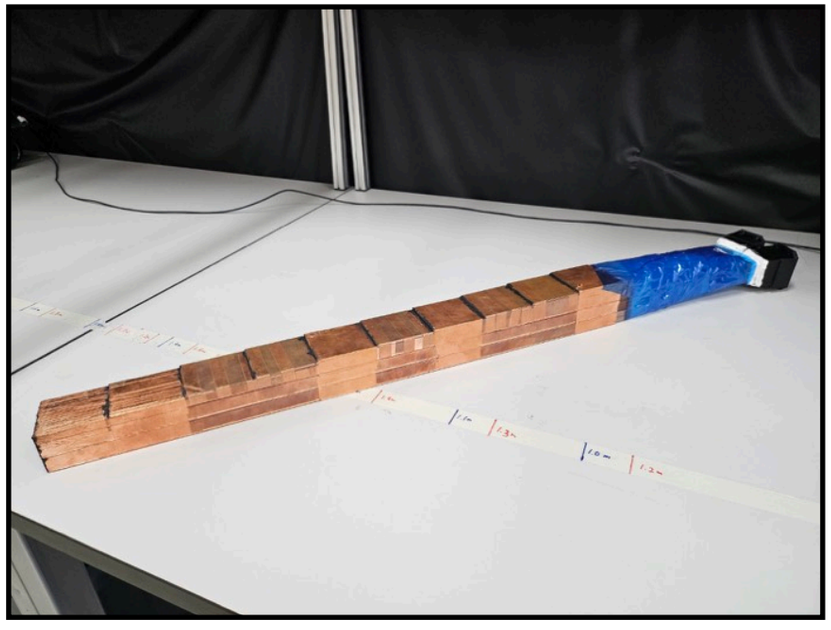


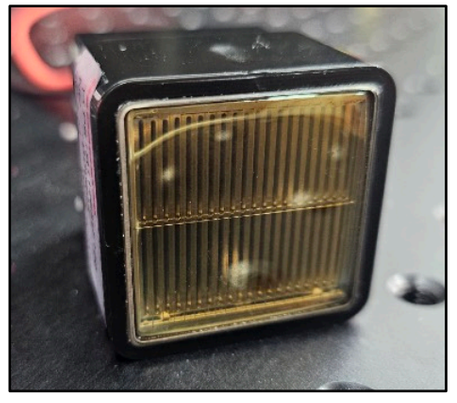


Square type PMT
R11265U
Each module has 2 ch. (S,C)
Total 2*4 = 8 ch.

- SFHS module:



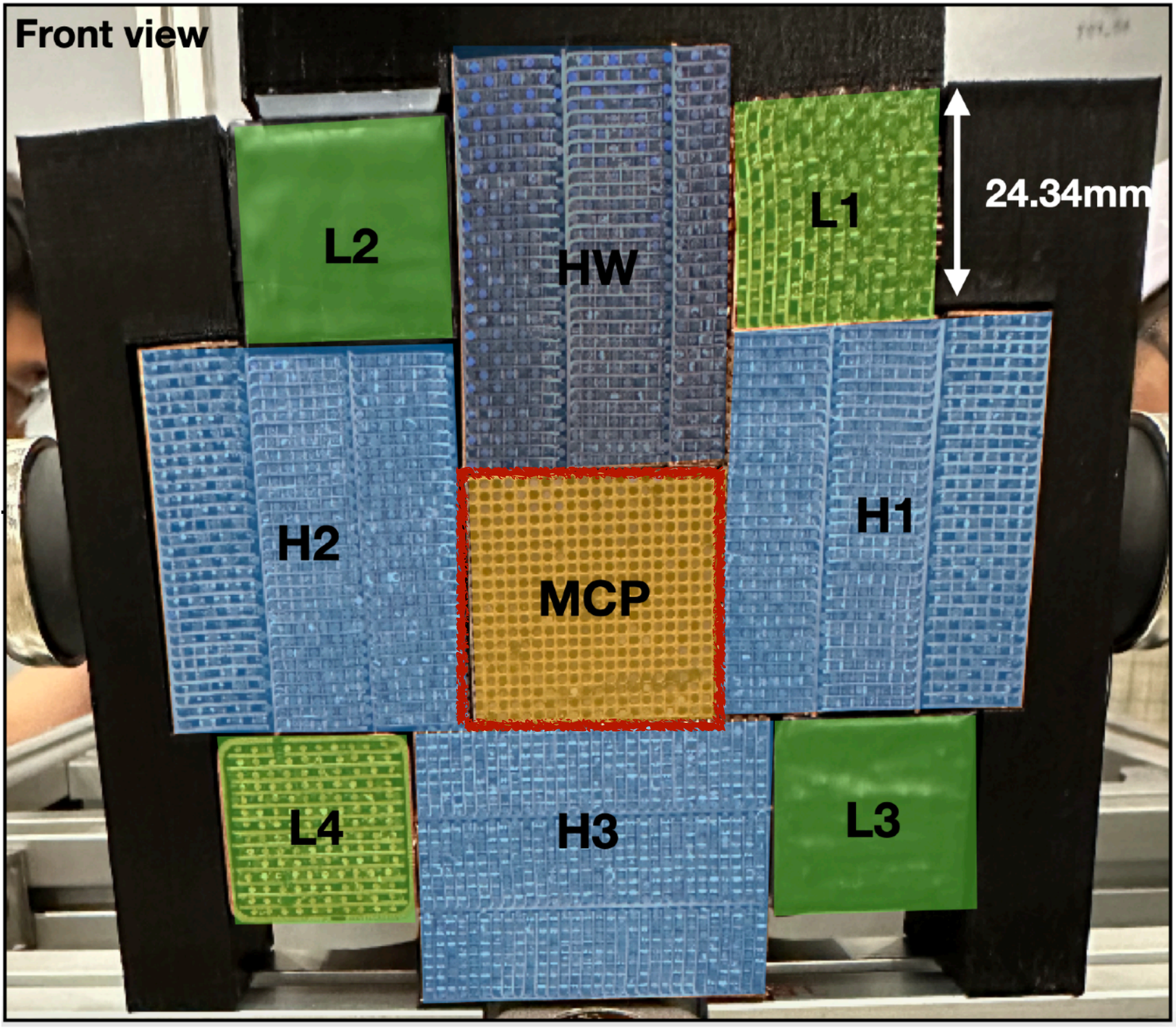




Square type PMT
R11265U
Each module has 2 ch. (S,C)
Total 2*4 = 8 ch.

Detector Configuration

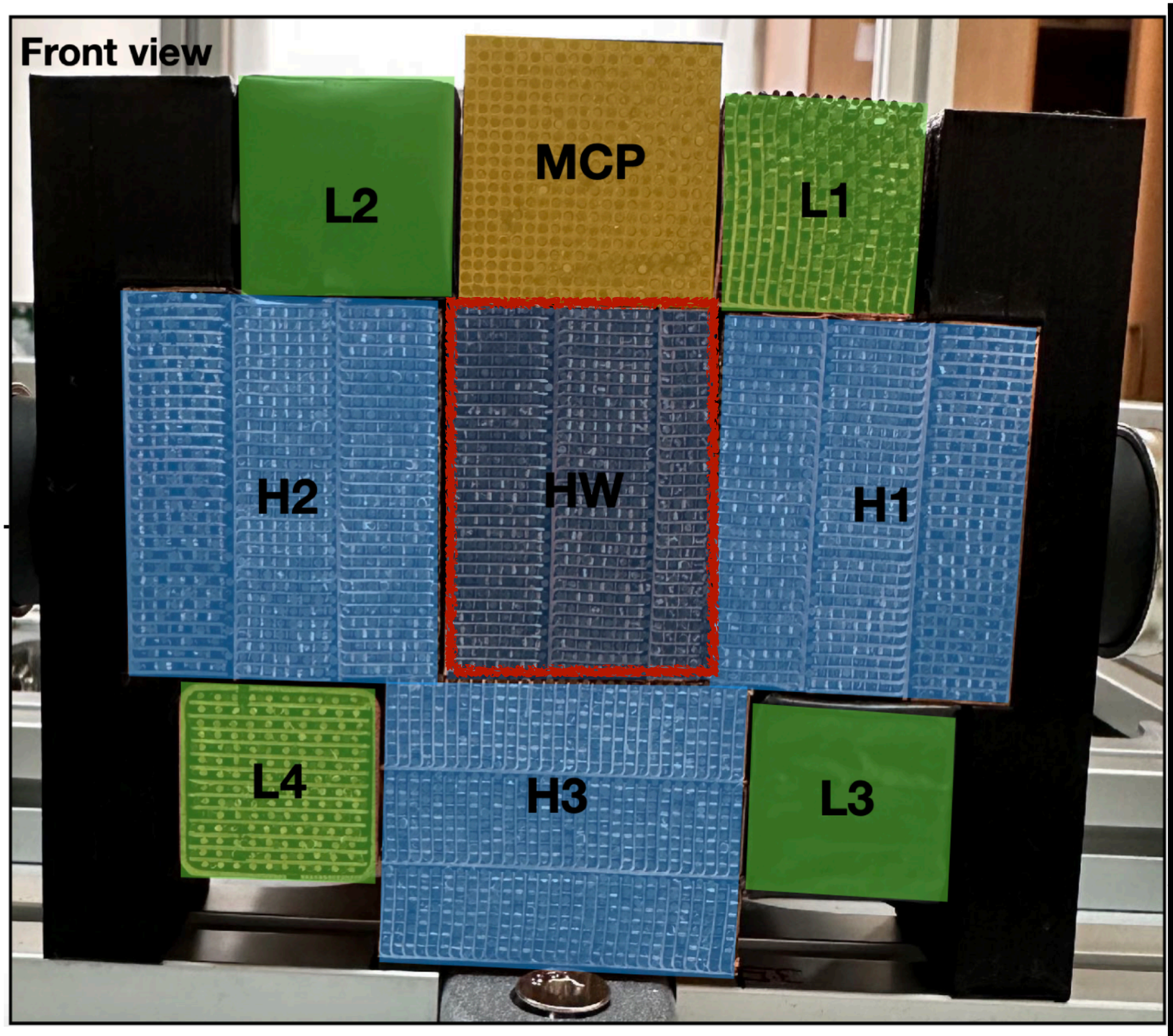
- **Set 1 : 3D Printed module (MCP-PMT) is placed at center**



	Method	Readout
L1	Heat Sink	Square PMT R11265U-100
L2	Lego-Like	Round PMT H3168
L3	Lego-Like	Square PMT R11265U-100
L4	Lego-Like	Square PMT R11265U-100
MCP	3D Printed	MCP-PMT : XP85112(S)/ XP85012(C) +PMT : Square PMT R11265U-100
HW	Heat Sink	Square PMT R11265U-100
H1	Heat Sink	Square PMT R11265U-100
H2	Heat Sink	Square PMT R11265U-100
H3	Heat Sink	Square PMT R11265U-100

Detector Configuration

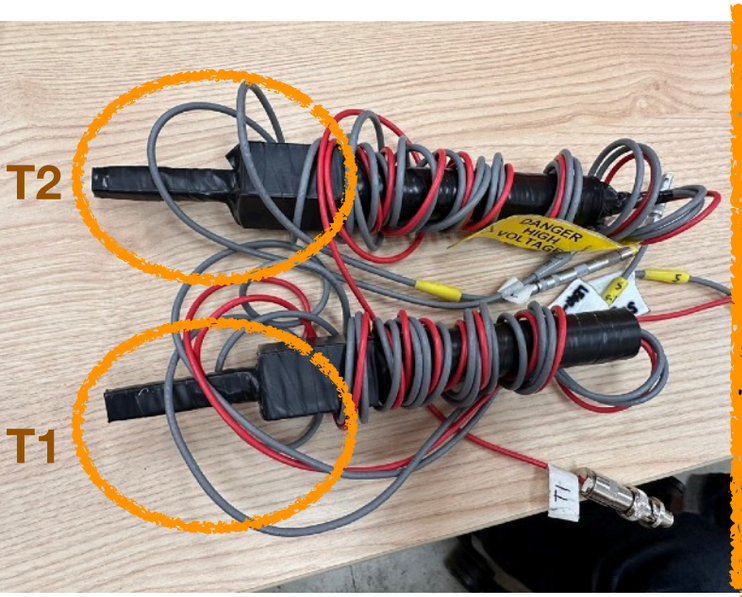
- **Set 2 : HW (Heat Sink with wing) is placed at center**

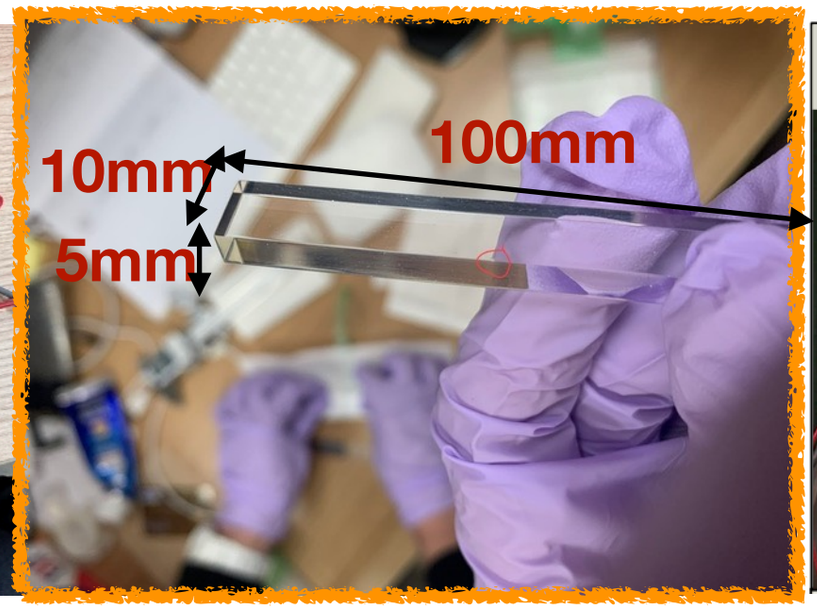


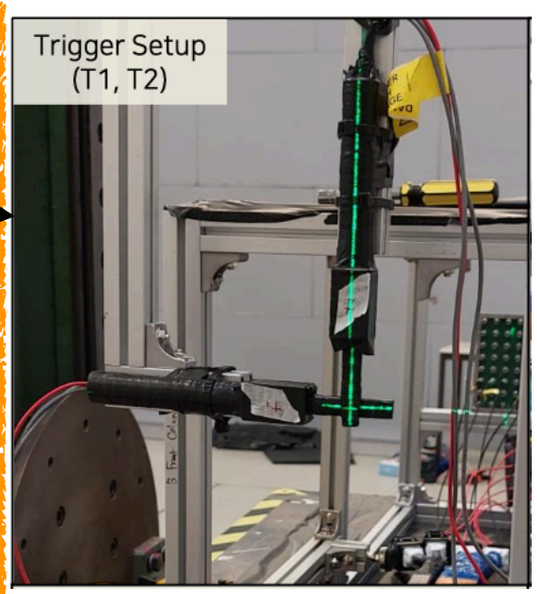
	Method	Readout
L1	Heat Sink	Square PMT R11265U-100
L2	Lego-Like	Round PMT H3168
L3	Lego-Like	Square PMT R11265U-100
L4	Lego-Like	Square PMT R11265U-100
MCP	3D Printed	MCP-PMT : XP85112(S)/ XP85012(C) +PMT : Square PMT R11265U-100
HW	Heat Sink	Square PMT R11265U-100
H1	Heat Sink	Square PMT R11265U-100
H2	Heat Sink	Square PMT R11265U-100
H3	Heat Sink	Square PMT R11265U-100

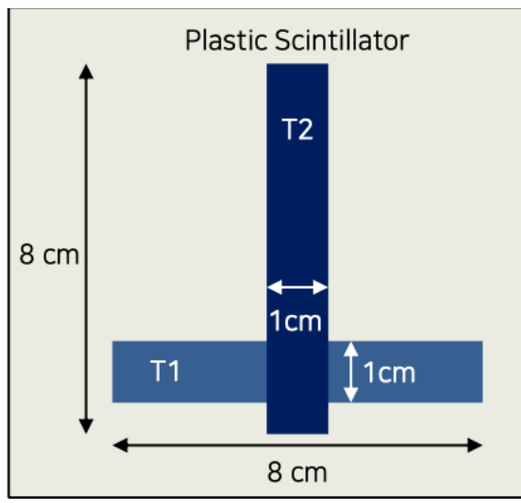
Ancillary Detector (Trigger)

- **Using 2 scintillator (10 x 100 x 5mm) , we implemented 1 cm x 1cm beam size trigger system**

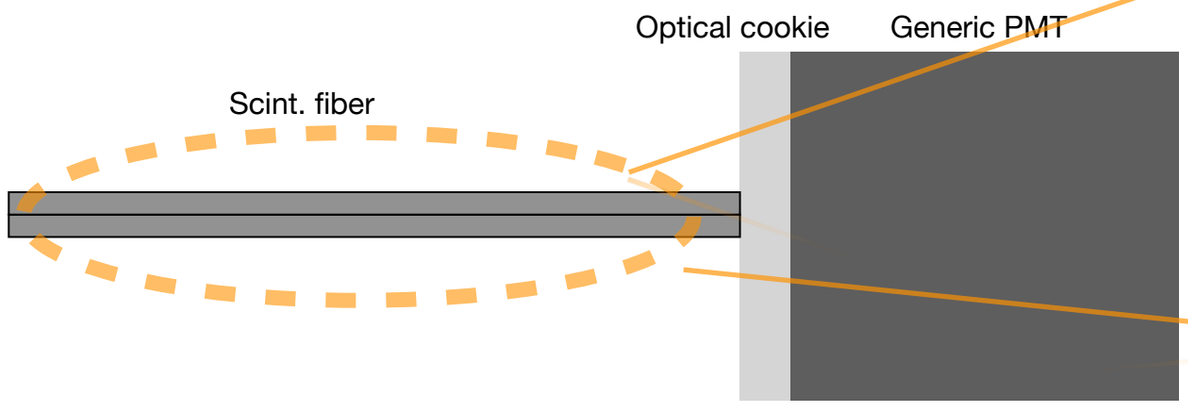


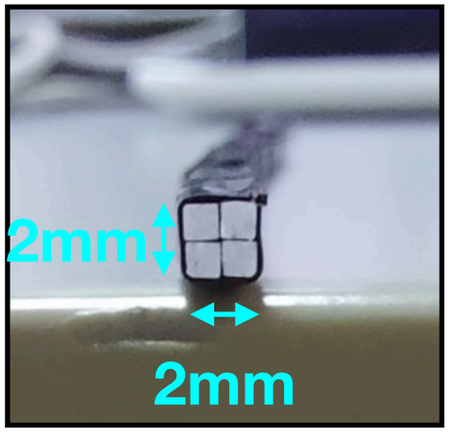






- **Using 4 square shape scintillating fibers, we additionally implemented 2mm beam size trigger system**

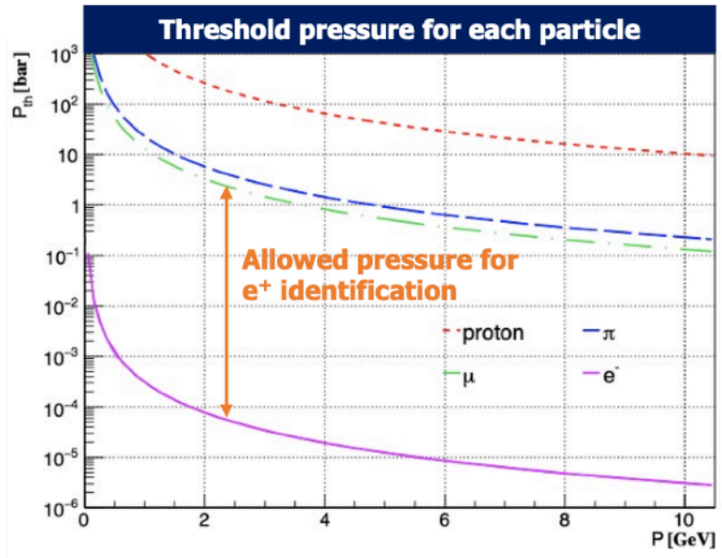




Ancillary Detector (Cherenkov Counter)

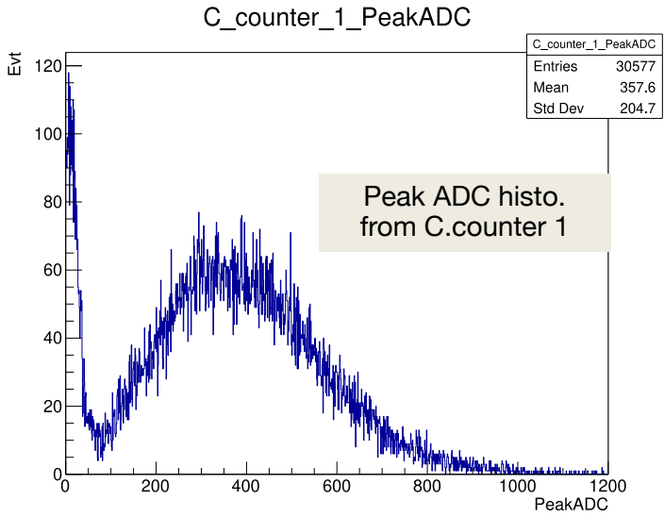
- **Threshold Cherenkov counters can obtain particle identification information for individual particles in that beamline**

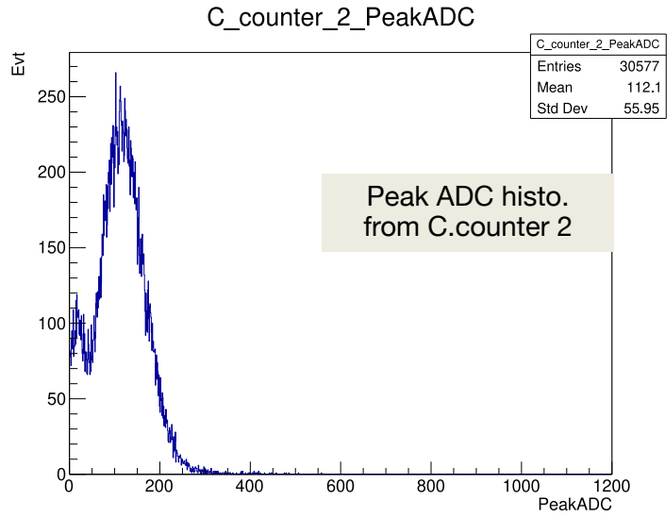
Fig. 4-30: Location of the new Cherenkov counters in the T09 and T10 beamlines.



Line	Beam aperture (mm)	Total length (mm)	Layout name after LS2	Equipment code
T09	159	3 280	T09.XCET044	XCET
T09	159	3 115	T09.XCET048	XCET
T10	159	2 975	T10.XCET040	XCET
T10	159	2 595	T10.XCET043	XCET

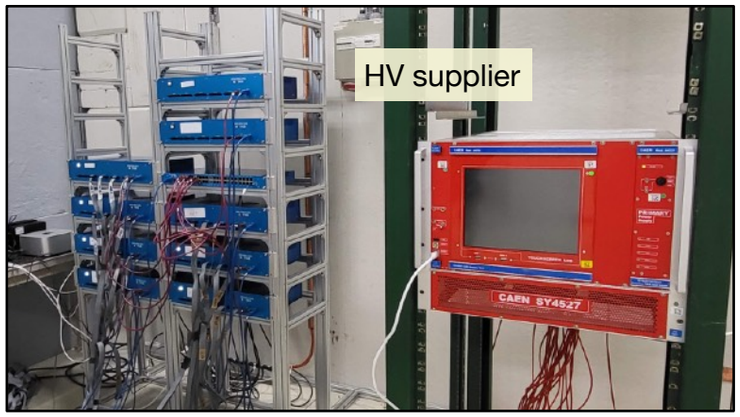
- Signal from each counter was connected to our DAQ system
- Cherenkov detector settings were controlled by CESAR at Control room

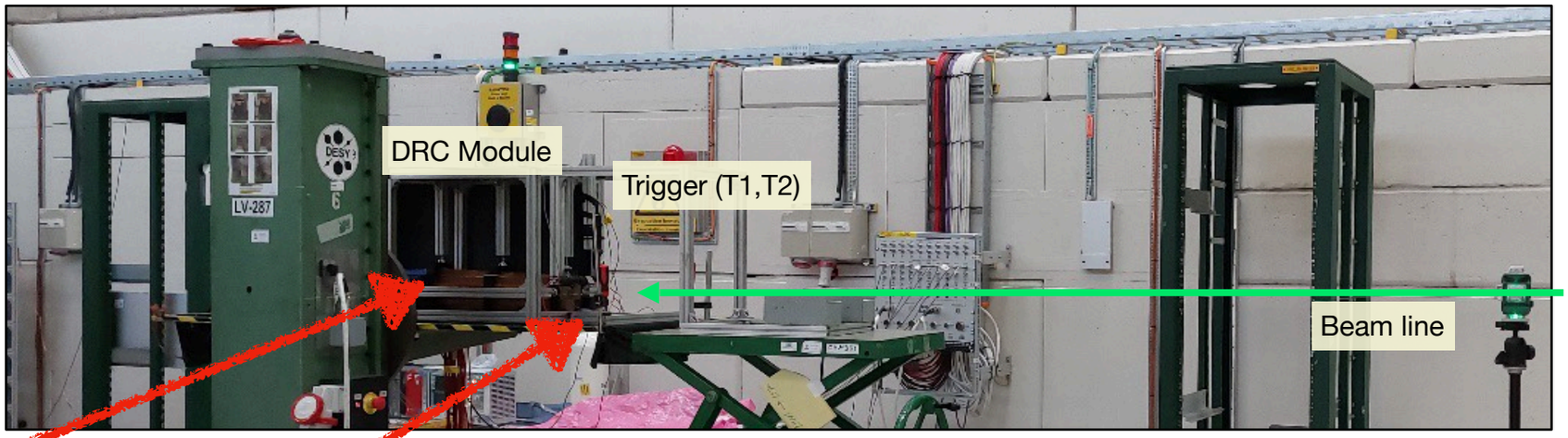


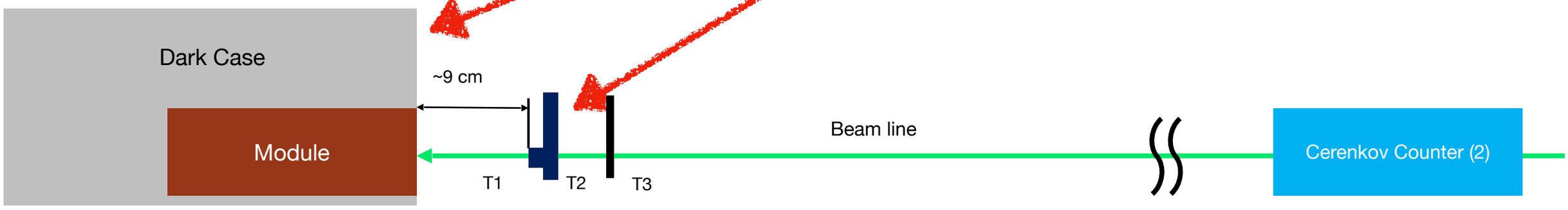


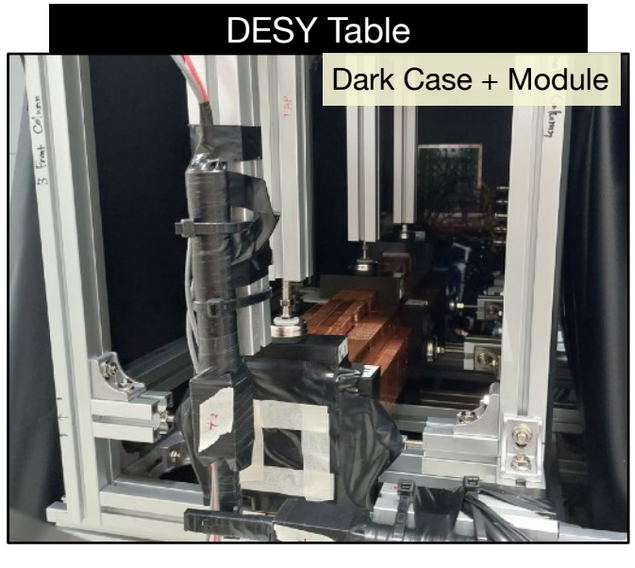
Experimental Hall Setup

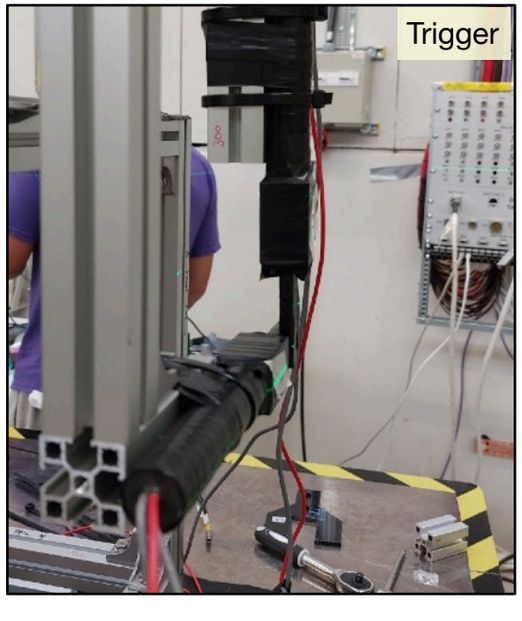
- **At CERN East area (Bulid.157), our test beam experiment are conducted**

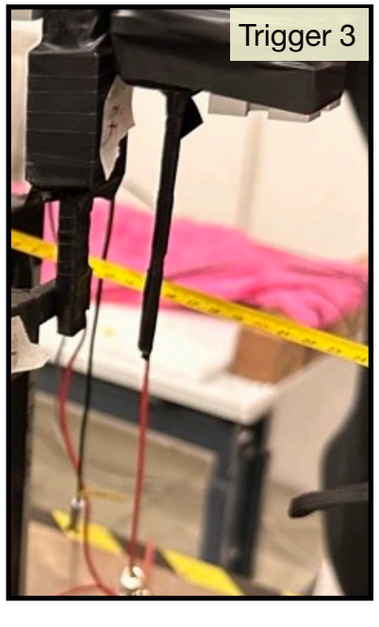








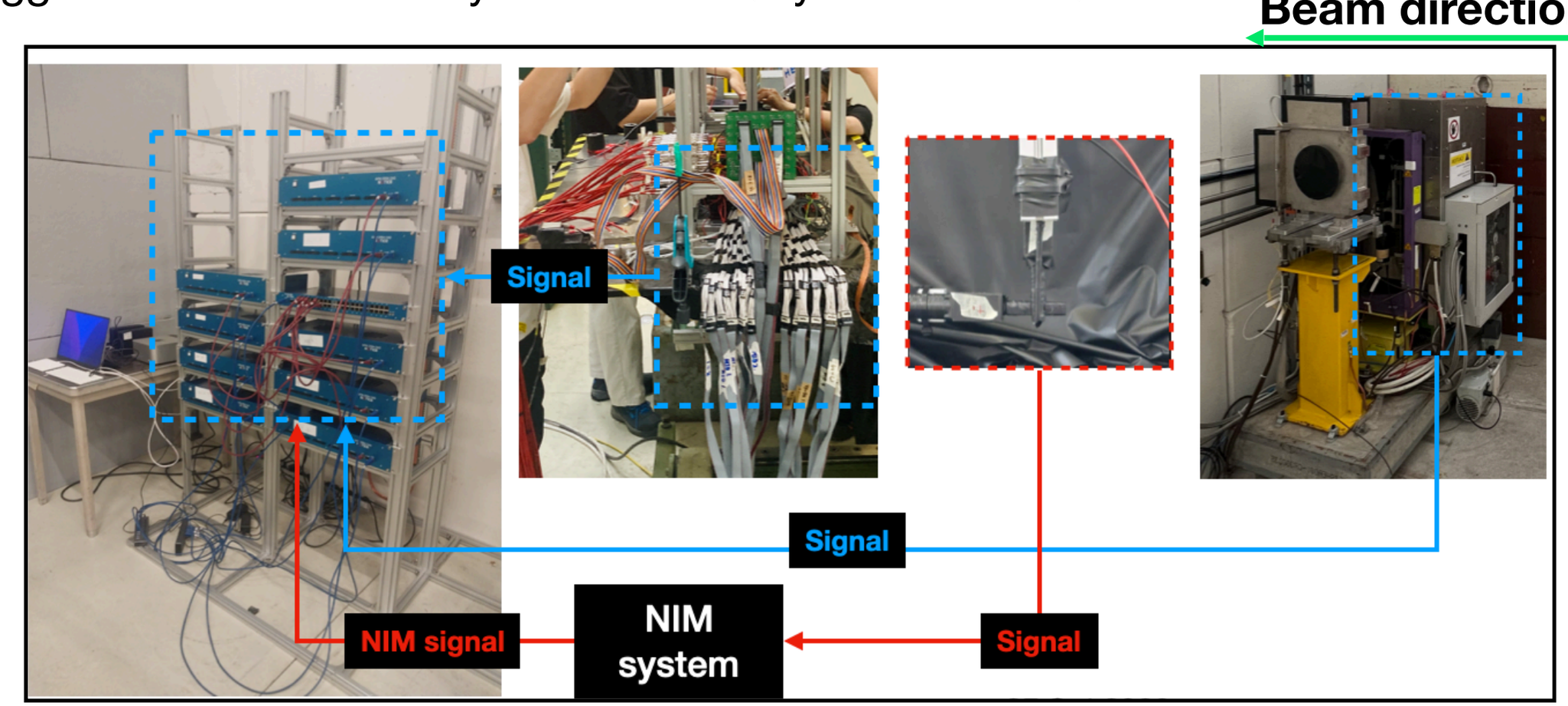




DAQ in TB 2023

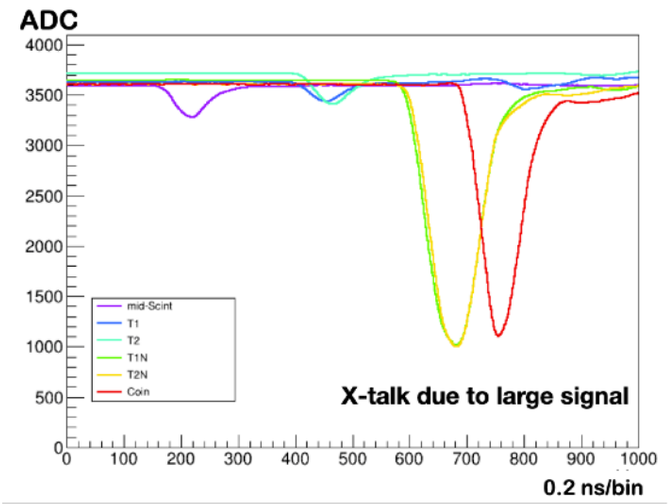
- **When received trigger signal, it records detector signals, digitize them & store it on DAQ PC**
  - 1TCB + 9 DAQ board (same as TB2022)
  - 197 channels (module + ext. trig. + Cerenkov Counter)

- **Data flow can be simply expression**:
  - DRC, C. counter readouts → DAQ system → DAQ PC
  - Trigger readouts → NIM system → DAQ system → DAQ PC



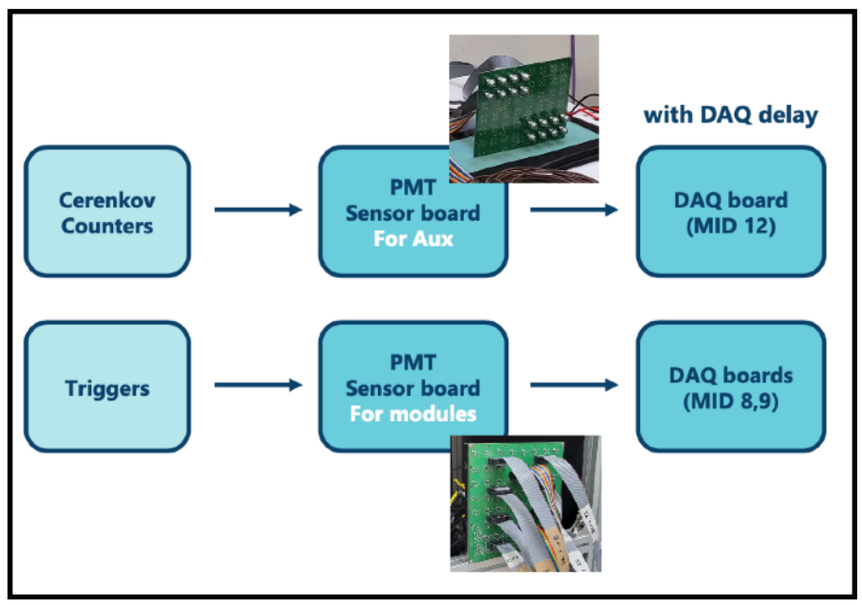
DAQ in TB 2023

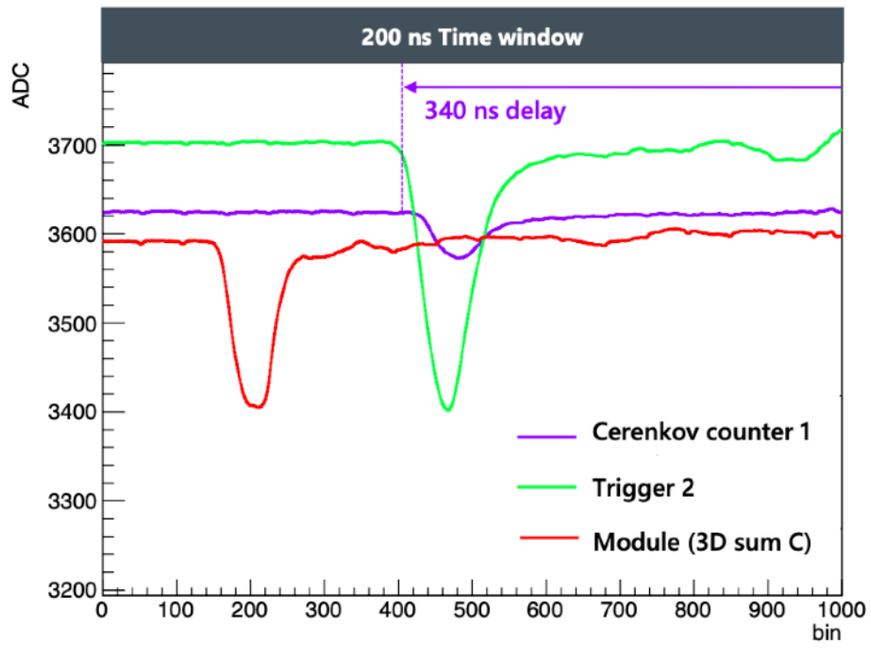
- **To avoid crosstalk between detector signals, managed signal timing by using different length of cables**



- **To achieve a 200ns time window, we separated the signals of Triggers and Cerenkov Counters**

- There about 480 ns time interval between Triggers and Cerenkov Counters
- The trigger signals were moved to the DAQ board for modules and only the Cerenkov counters were left to be delayed independently



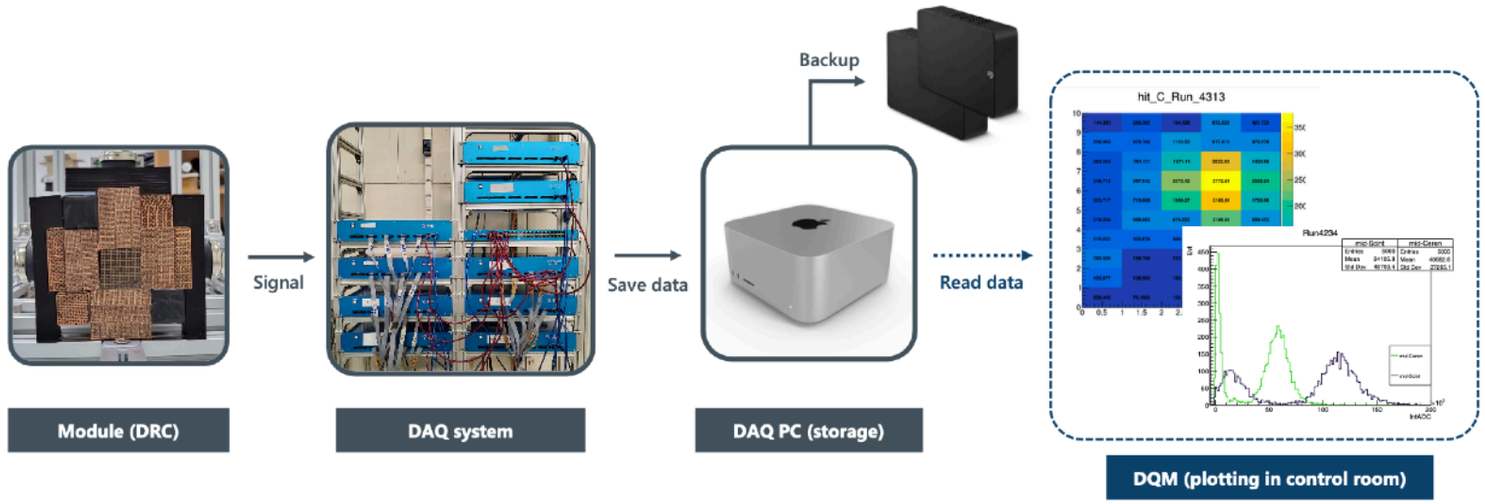


DAQ in TB 2023: Data taking

- **Under the stable DAQ setup, data taking could been carried out for 106h 40m in 7 days**

  - All data first stored in DAQ PC with 1 TB storage, and then in 16TB external HDD for backup

  - Using stored data, we could be promptly monitoring DQM plots to checkup the detector readout & DAQ system



Data taking	
DAQ running time	106h 40m
The number of runs	534
The number of events	3,523,406
Total data size	2.1 TB

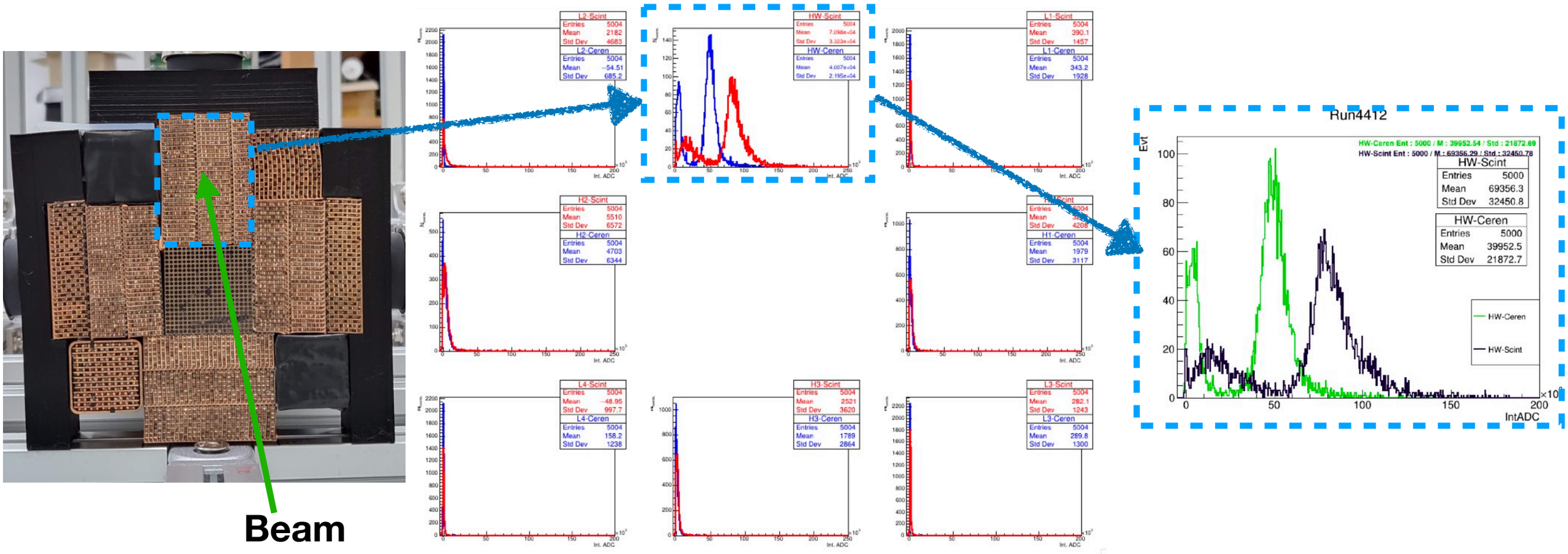
2023 DRC TB DAQ log

2023.07.11

		Time		HV		Cerenkov Counter	Position				Trigger		Beam		
Day Shifter : Haeun Jang															
4461	8k	7:12	8:08	Equalized HV is applied on all towers	T1 : 1450 V T2 : 1500 V T3 : 800 V	C1 : 0.454 bar C2 : 0.453 bar	0.897	0.748	0	0	T1, T2 (T3)	T1 & T2 : 30 mV (20 ns) T3 : 100 mV (40 ns) coin : 15 ns	e+	4 GeV	XCHV ±1.5m (momentum sp
4462		8:10	8:11	Equalized HV is applied on all towers	T1 : 1450 V T2 : 1500 V T3 : 800 V	C1 : 0.454 bar C2 : 0.453 bar	0.897	0.752	0	0	T1, T2 (T3)	T1 & T2 : 30 mV (20 ns) T3 : 100 mV (40 ns) coin : 15 ns	e+	4 GeV	XCHV ±1.5m (momentum sp
4463	8k	8:12	9:41	Equalized HV is applied on all towers	T1 : 1450 V T2 : 1500 V T3 : 800 V	C1 : 0.454 bar C2 : 0.453 bar	0.897	-0.752	0	0	T1, T2 (T3)	T1 & T2 : 30 mV (20 ns) T3 : 100 mV (40 ns) coin : 15 ns	e+	4 GeV	XCHV ±1.5m (momentum sp
4464	5k	9:42	10:16	Equalized HV is applied on all towers	T1 : 1450 V T2 : 1500 V T3 : 800 V	C1 : 0.454 bar C2 : 0.453 bar	0.897	-2.252	0	0	T1, T2 (T3)	T1 & T2 : 30 mV (20 ns) T3 :100 mV (40 ns) coin : 15 ns	e+	4 GeV	XCHV ±1.5m (momentum sp
4465	5k	10:18	10:50	Equalized HV is applied on all towers	T1 : 1450 V T2 : 1500 V T3 : 800 V	C1 : 0.454 bar C2 : 0.453 bar	-0.103	-2.252	0	0	T1, T2 (T3)	T1 & T2 : 30 mV (20 ns) T3 :100 mV (40 ns) coin : 15 ns	e+	4 GeV	XCHV ±1.5m (momentum sp
4466	1k	10:55	11:03	Equalized HV is applied on all towers	T1 : 1450 V T2 : 1500 V T3 : 800 V	C1 : 0.454 bar C2 : 0.453 bar	0.897	-2.252	0	0	T1, T2 (T3)	T1 & T2 : 30 mV (20 ns) T3 :100 mV (40 ns) coin : 15 ns	e+	4 GeV	XCHV ±1.5m (momentum sp

DQM in TB 2023

- **To ensure that the detector, readout system, and DAQ system are working well, we checked the DQM plot**
  - Overall response per tower in single plot to check the proper tower produces the signal
  - Single tower, single channel response plot can check detailed response
  - Hitmap of MCP-PMT single channel



DQM in TB 2023

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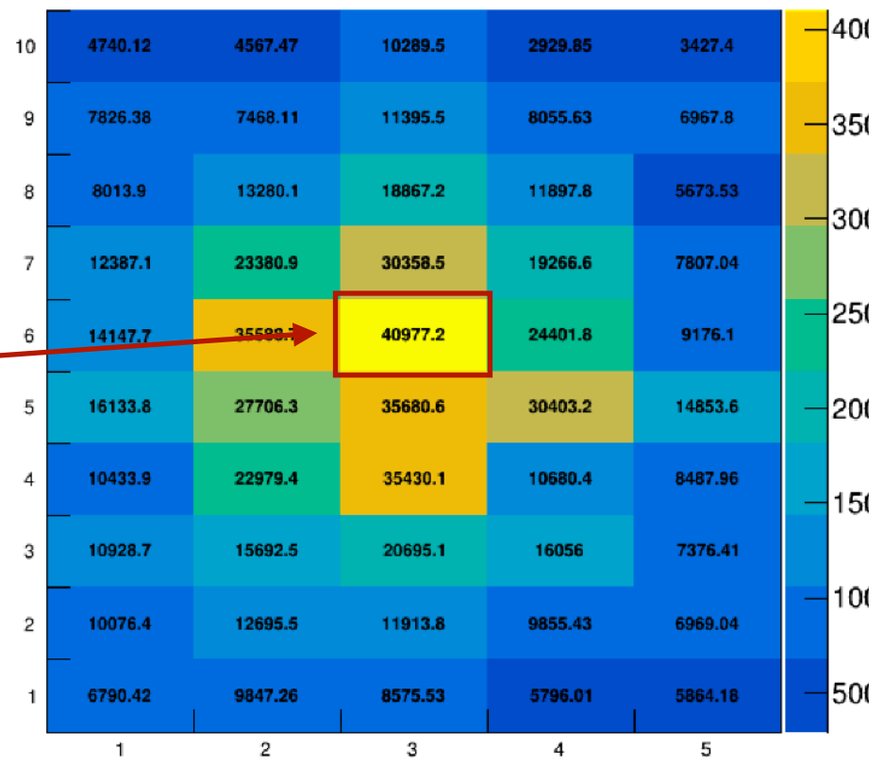
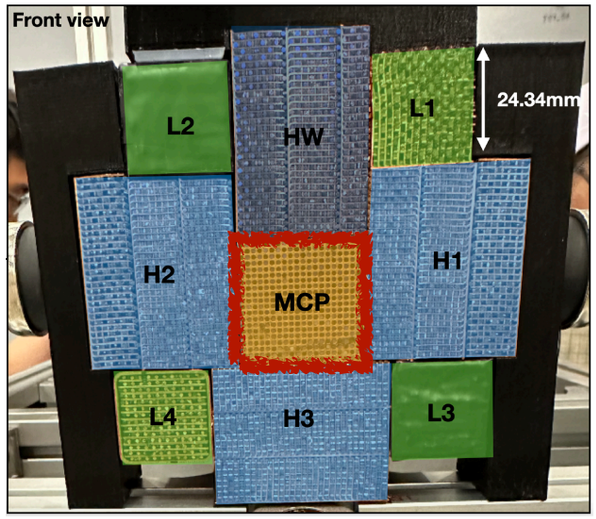
MCPPMT Hitmap (Front view)



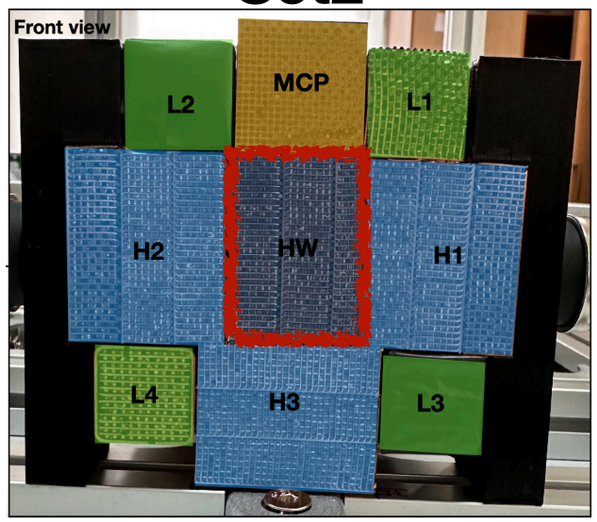
Test Beam Programs (Major)

Aim	Description	Setup
Finding towers (scanning tower position)	- Using positron beam (4 GeV) - 3mm vertical & horizontal scan - Find boundary of tower!	Set1, Set2
Gain tests	- Check signal level w.r.t. HV	Set1, Set2
Calibration	- Using positron 4 GeV, finding optimized HV (similar response ADC S and C)	Set1, Set2
Energy resolution	- Energy resolution of EM particles using positron beam (e+ 0.5 ~ 5 GeV)	Set1, Set2
Linearity	- check out linearity of detectors using positron beam (e+ 0.5 ~ 5 GeV)	Set1, Set2
Uniformity	- Using positron beam (4 GeV) - 1cm vertical & horizontal scan (9points)	Set1, Set2
Time resolution	- Check out the time resolution (MCP-PMT)	Set1
Response scan	- Check response of the projective tower at the border between towers - Using 2mm scintillating fiber trigger (T3)	Set1
EIC-Chip set (AstroPix)	- With and without AstronPix in front of our module	Set1
Position reconstruction & resolution	- Test of all 64 individual channels of MCP PMT for high granularity calorimeter	Set1

Set1

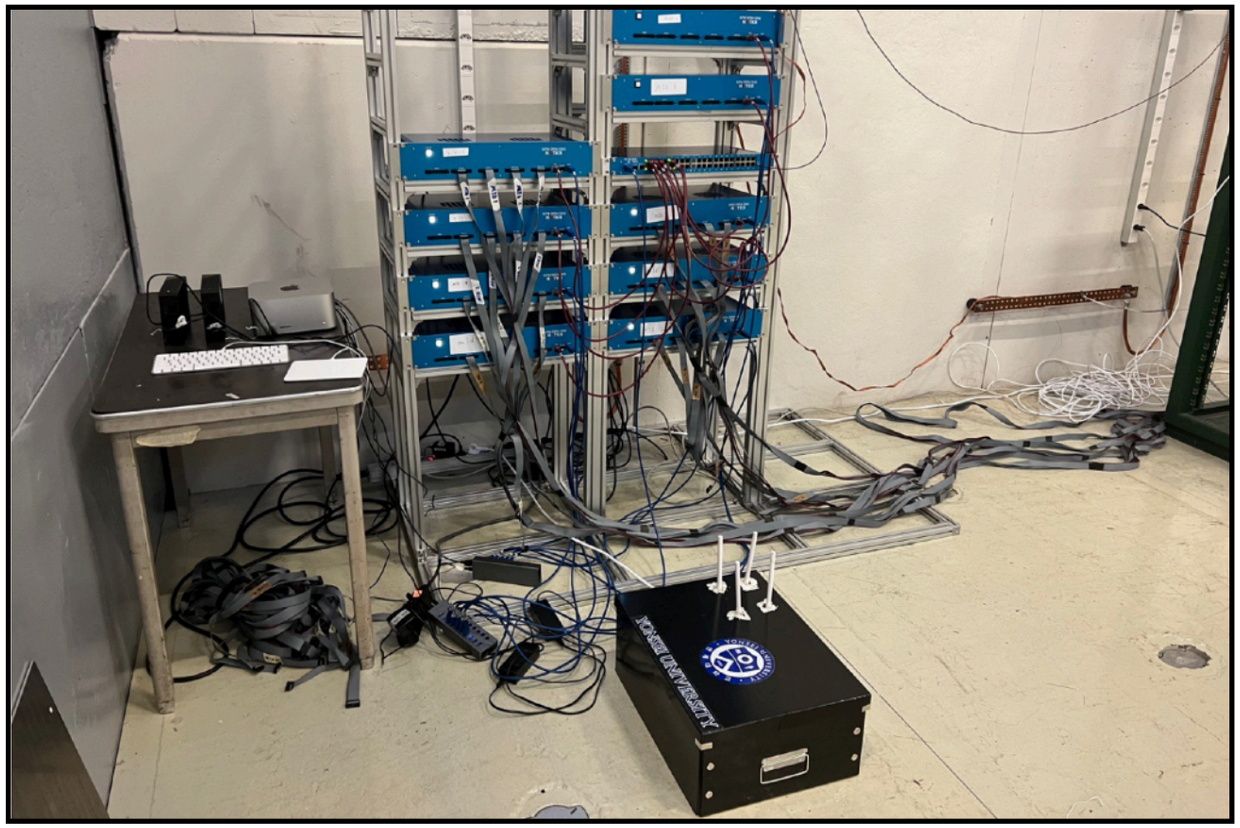


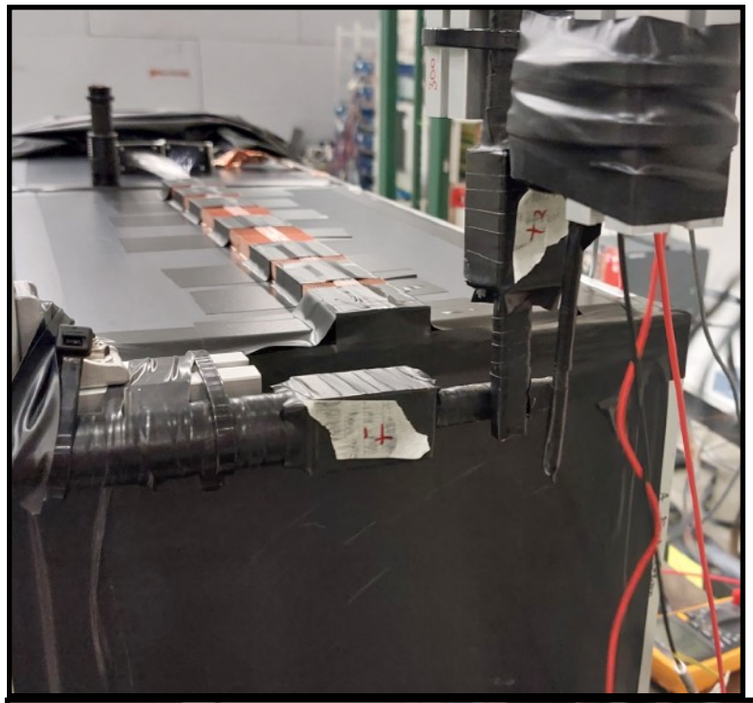
Set2

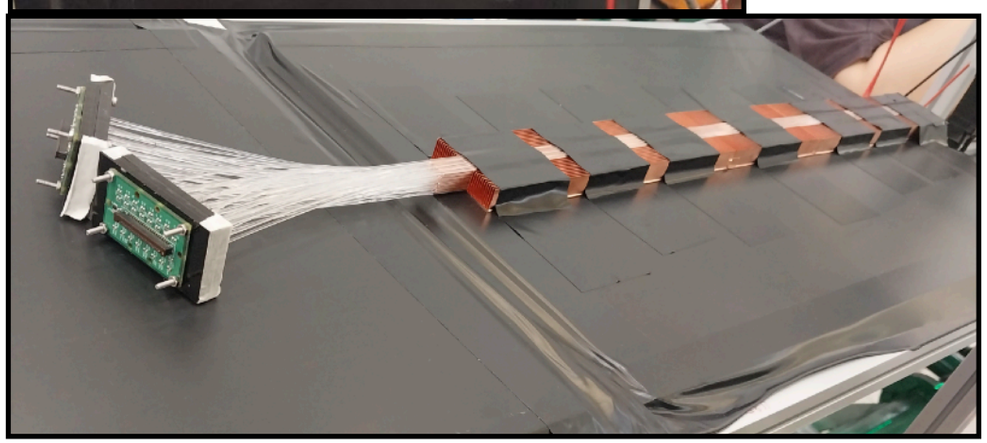


Test Beam Programs (Additional)

- **Two additional program for preparation for the new system setup (preparation for 2024 TB)**
  - Wireless DAQ system : Data transfer from DAQ to DAQ PC via wireless connection
  - SiPM gain test : SiPM readout study, which is planned to be used in the next year DRC module

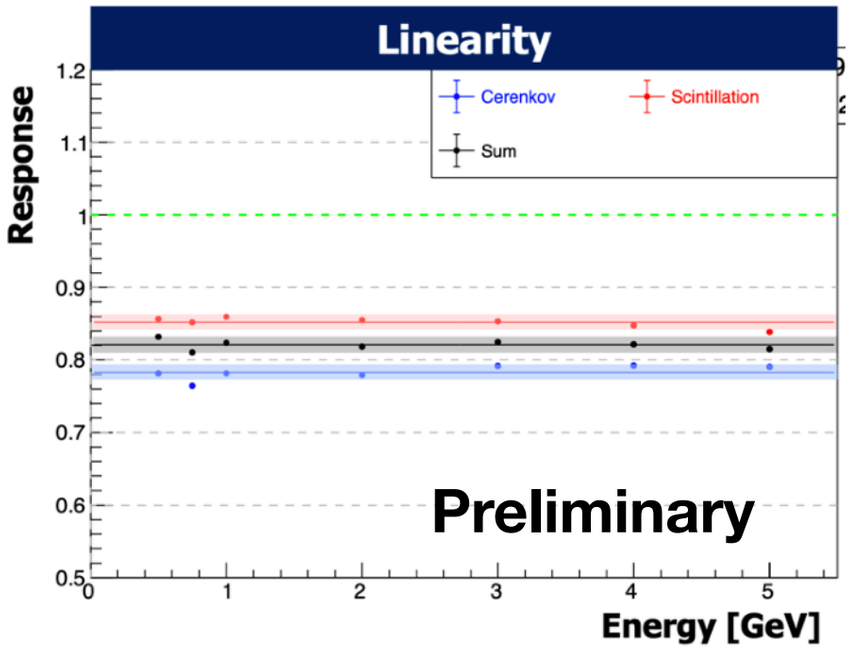


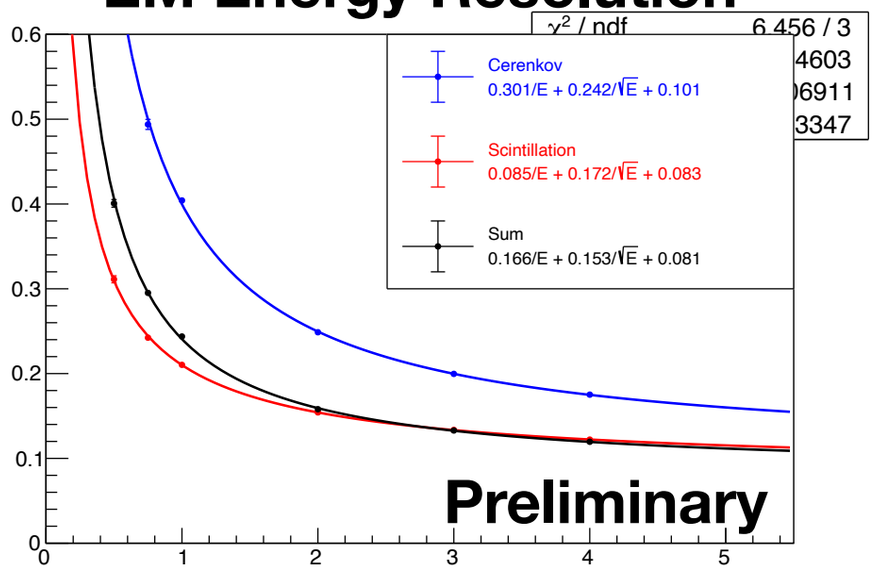




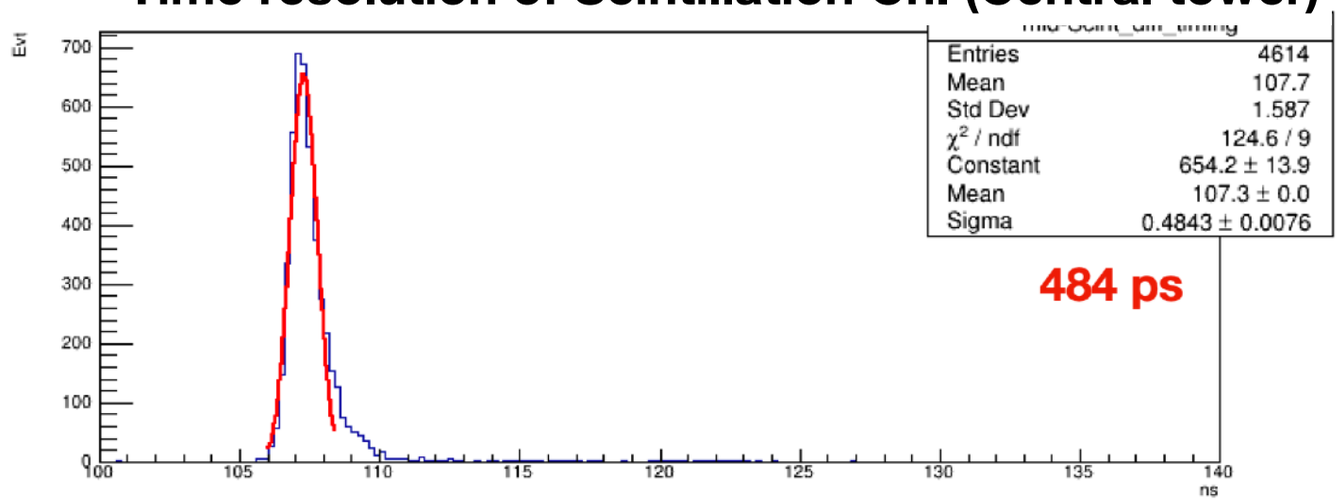
Test Beam Programs (Prompt Analysis)

- **During the test beam experiments, we conduct prompt analysis**
  - To checkup the our detector response, it is very important
  - We measured linearity & EM energy resolution (and we checked time resolution)





Time resolution of Scintillation Ch. (Central tower)



Summary

- The Korea Dual-Readout Calorimeter team performed successfully test beam in 2023
  - Take lots of useful data
  - Train next generation students

- Analysis using test beam data is on going!

Backup

Introduction: Dual-Readout Calorimeter

- The major difficulty of measuring energy of hadronic shower comes from the fluctuation of EM fraction of shower, **f_em**

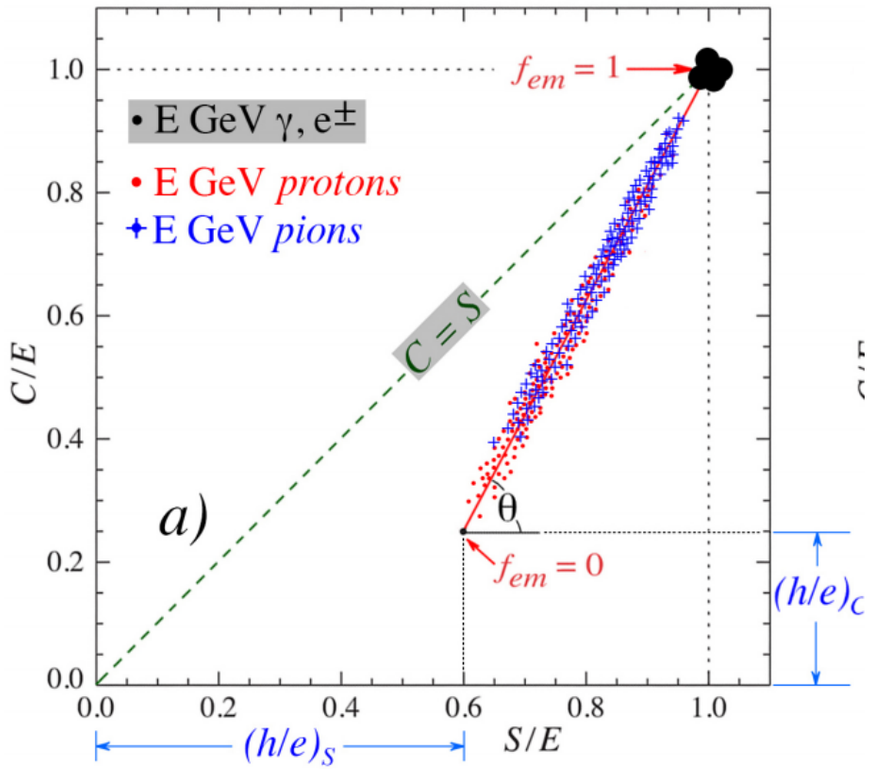
- **f_em** can be measured by implementing two different channels with different h/e response in a calorimeter

$$f_{\rm em} = \frac{(h/e)_C - (C/S)(h/e)_S}{(C/S)[1-(h/e)_S] - [1-(h/e)_C]} \qquad \cot\theta = \frac{1-(h/e)_S}{1-(h/e)_C} = \chi$$

$$S = E\left[f_{\rm em} + \frac{1}{(e/h)_S}(1-f_{\rm em})\right]$$

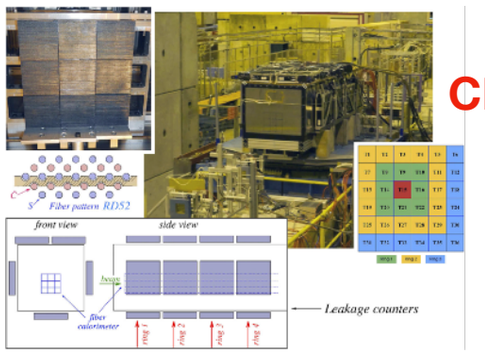
$$C = E\left[f_{\rm em} + \frac{1}{(e/h)_C}(1-f_{\rm em})\right]$$

$$E = \frac{S-\chi C}{1-\chi}$$

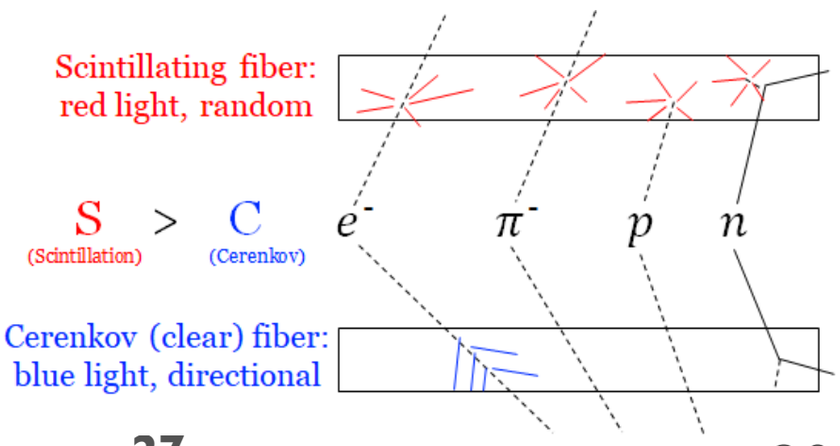


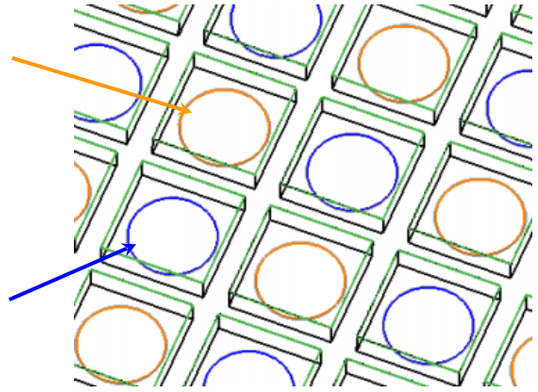
- **Dual-readout calorimeter offers high-quality energy measurement for both EM particles and hadrons**

- **Excellent energy resolution** for hadrons can be achieved by measuring f_em and correcting the energy of hadron event-by-event.



CERN RD52 experiment



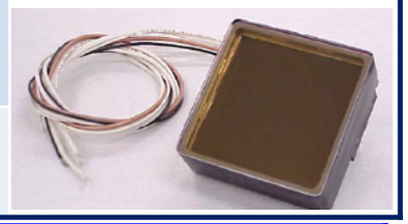


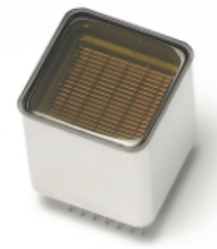
Participants

- **19 participants (15 students)**

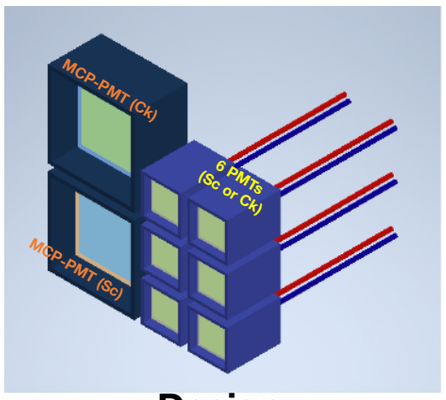
Institute	Name
KNU	Changgi Huh, Bobae Kim, Junghyun Lee, Hyunsuk Do, Sehwook Lee, Min Sang Ryu
YU	Guk Cho, Yun Eo, Seungkyu Ha, Kyuyeong Hwang, Haeun Jang, Seoyun Jang, Dongwoon Kim, Sungwon Kim, Hyesung Park, Hwidong Yoo
YU Severance	Woochan Lee
GWNU	Yoon Jun Jang, JinRyong Jeong

Readout Detectors

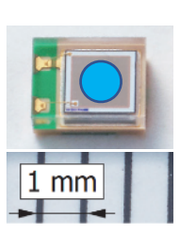
MCP-PMT	Window size	light	Quantum Efficinecy (Q.E.)	max. HV (V)	Rise time (ns)	Pulse width (ns)	photo
PLANACON XP85012	53x53 mm^2	scintillation	~7% at 550 nm	2400	0.6	1.8	
PLANACON XP85112		Cerenkov	~21% at 400 nm	2800	0.5	0.7	

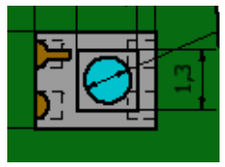
PMT	Window size	Q.E. for Ck.	Q.E. for Sc.	max. HV (V)	Time response (ns)			photo
					anode pulse rise time	electron transit time	Transit time spread (FWHM)	
R8900 series (old)	23.5x23.5 mm^2	35% at 420 nm	~7% at 550 nm	**1000**	2.2	11.9	0.75	
R11265-100 (new)	**23x23 mm^2**	**~35% at 400 nm**	**~7% at 550 nm**		**1.3**	**5.8**	**0.27**	

SiPM	photosensitive area	photo detection efficiency (PDE)		operating voltage	Gain at V_{BD}+5V	Linearity of Q.E.	number of pixels	geo. Fill factor
S14160-1310PS	1.3x1.3 (1.69 mm^2)	~15% at 400 nm	~17% at 550 nm	$V_{breaking\ Down}$ + 5 V	~1.75x10^5	~2x10^{10}/sec as incident photons	16675	31 % (0.524 mm^2)
fiber (Φ1 mm)	0.785 mm^2						~7745 (effectively)	

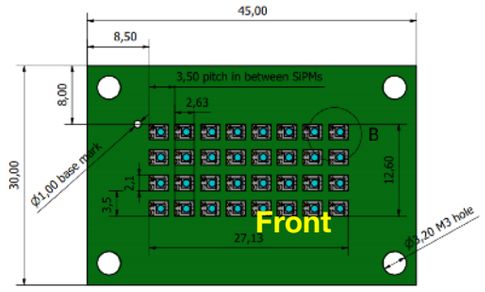


Design in real size (Module 1)

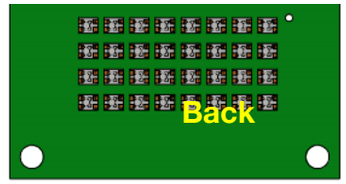




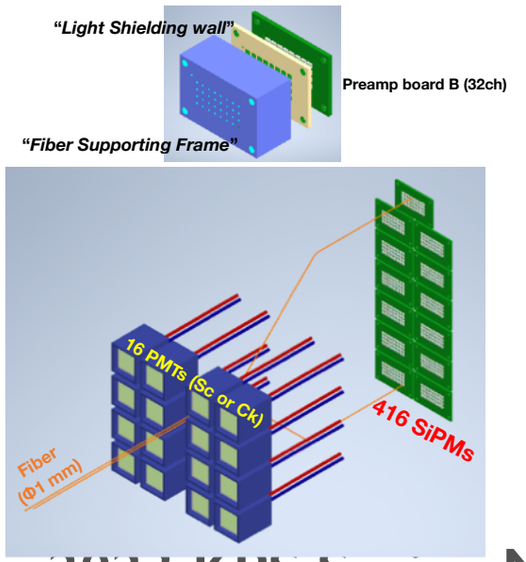
Single SiPM



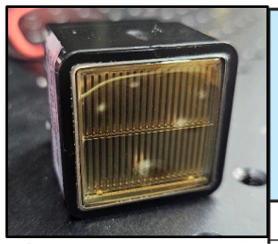
Preamp board B (32 ch)



Design in real size (Module 2)



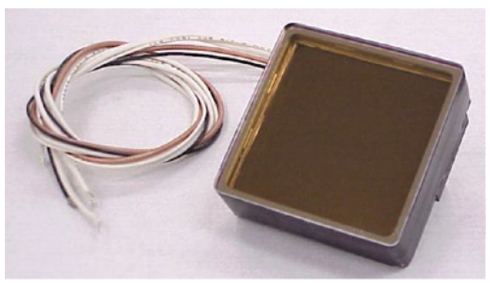
PMT & MCP-PMT Specs



Type No.	Spectral response: Range (nm)	Spectral response: Peak wavelength (nm)	Ⓐ Photocathode material	Ⓑ Window material	Ⓒ Dynode structure / stages	Maximum ratings: Supply voltage between anode and cathode (V)	Maximum ratings: Average anode output current (mA)	Cathode characteristics: Luminous Min. (μA/lm)	Cathode characteristics: Luminous Typ. (μA/lm)	Cathode characteristics: Blue sensitivity index (CS 5-58) Typ.	Cathode characteristics: Red/white ratio (R-68) Typ.	Cathode characteristics: Ⓓ Quntum efficiency Typ. (%)	Cathode characteristics: Ⓔ Radiant Typ. (mA/W)
R11265U-100	300 to 650	400	SBA	K	MC/12	1000	0.1	90	105	13.5	—	35	110

Square type PMT

23*23 Effective Area



XP85112 (Cerenkov)

MCP-PMT

XP85012 (Scintillation)

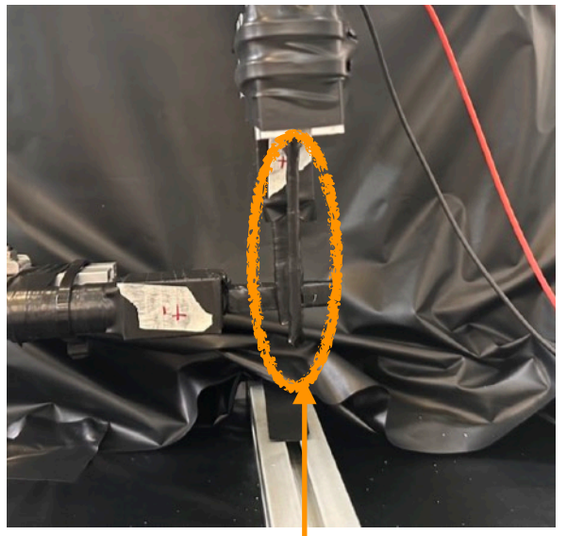
Description	
Window options	Schott 8337B or equivalent, UVFS (-Q)
Photocathode	Bialkali
Multiplier structure	MCP chevron (2), 10 μm pore, 60:1 L:D ratio
Anode structure	8×8 array, 5.9 / 6.5 mm (size / pitch)
Active area	53×53 mm
Package open-area-ratio	80%

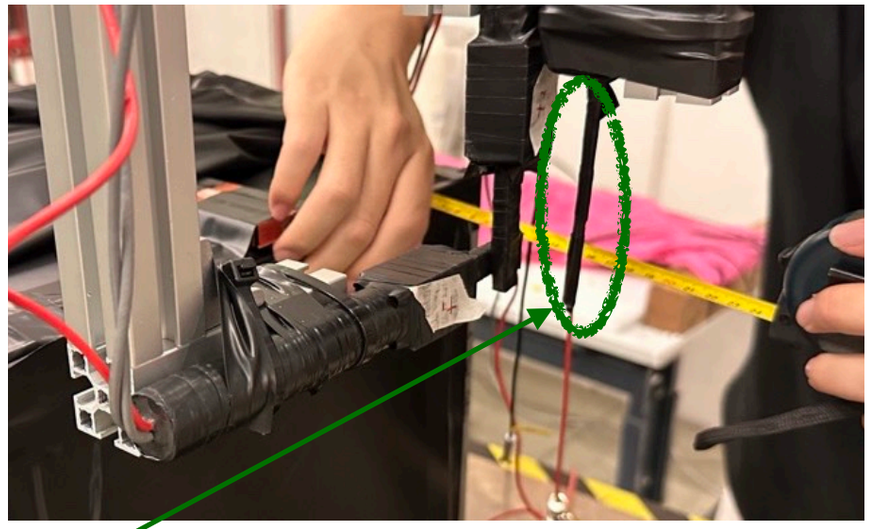
Photocathode characteristics	Min	Typ	Max	Unit
Spectral range:	200		650	nm
Peak Quantum Efficiency at 380 nm*	18	22		%
Operating Characteristics	**Min**	**Typ**	**Max**	**Unit**
Overall Voltage for 10^5 Gain *		FIG	2800	V
Total anode dark current @ 10^5 gain *		2	10	nA
Spatial Uniformity		2:1		
Rise time**		0.5		ns
Pulse width**		0.7		ns
Transit time spread (σ_{tts})**		35	60	ps
Maximum Magnetic Field Operation		2		T

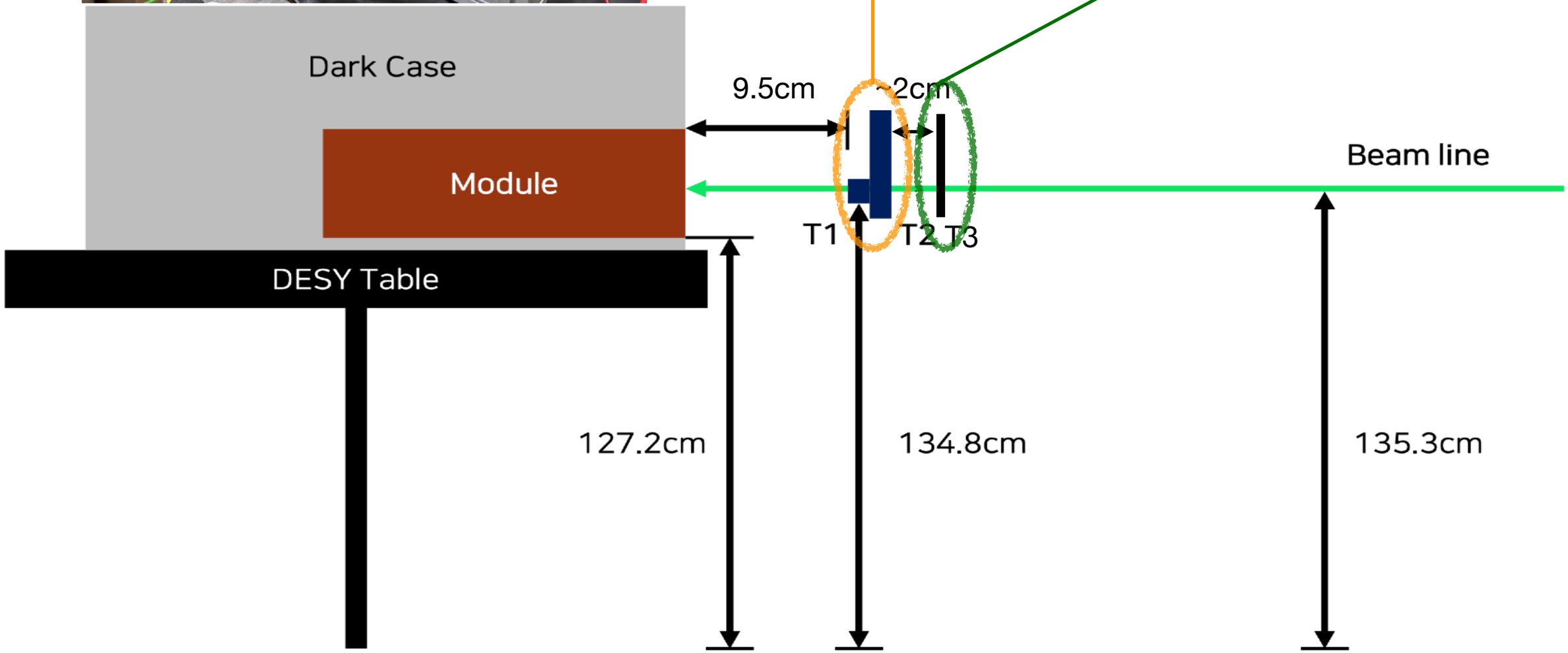
Description	
Window options	Schott 8337B or equivalent, UVFS (-Q)
Photocathode	Bialkali
Multiplier structure	MCP chevron (2), 25 μm pore, 40:1 L:D ratio
Anode structure	8×8 array, 5.9 / 6.5 mm (size / pitch)
Active area	53×53 mm
Package open-area-ratio	80%

Photocathode characteristics	Min	Typ	Max	Unit
Spectral range:	200		650	nm
Maximum sensitivity at		380		nm
Sensitivity:				
Luminous *	50	60		μA/lm
Blue *	7.5	8.5		μA/lmF
Radiant, at peak		70		mA/W
Quantum Efficiency		22		%
Characteristics	**Min**	**Typ**	**Max**	**Unit**
Overall Voltage for 10^5 Gain *		1800	2400	V
Total anode dark current @ 10^5 gain *		2	10	nA
Rise time		0.6		ns
Pulse width		1.8		ns

Geometry Setup







BEAM Energy

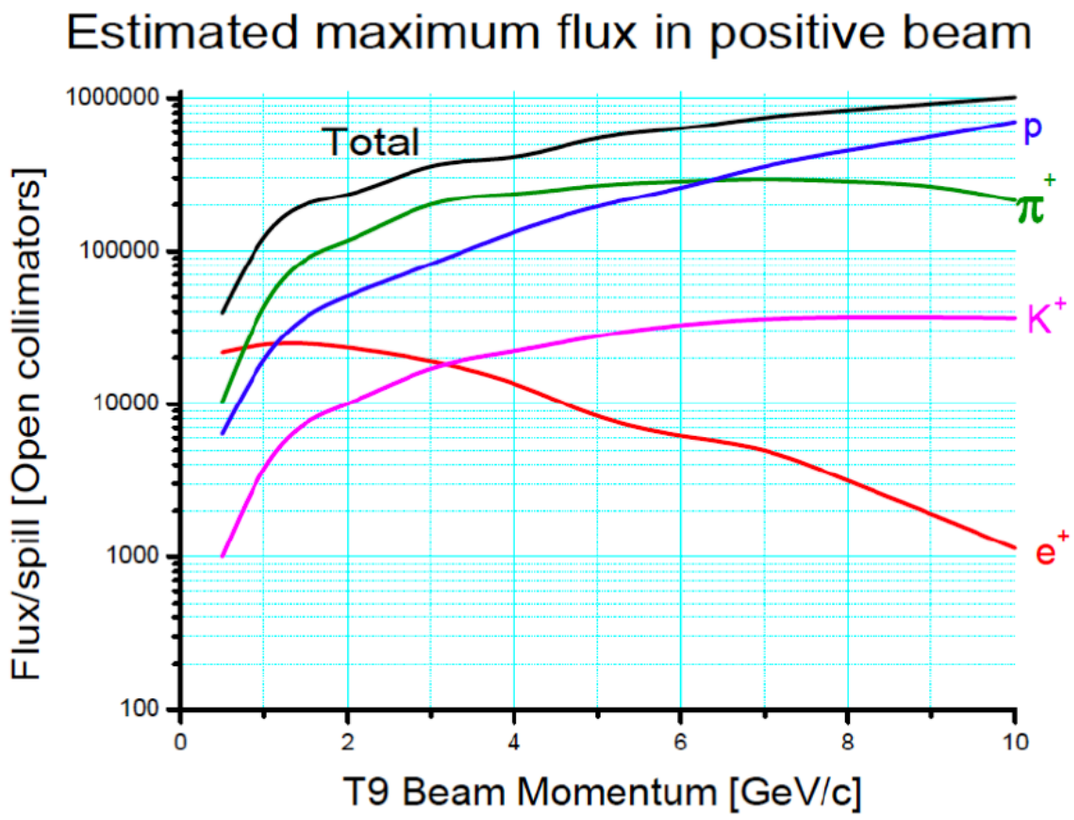


Figure 5: The Flux of positive particles present in the beam as a function of their Momentum. Please note that the flux is calculated over a time of 400 ms, and the most important information that you should retain from this plot is relative intensity of particles of different species.

https://beamlineforschools.cern/sites/default/files/Announcement_2023/Beams_Detectors_BL4S2023_new.pdf

Beam and detectors

Beamline for Schools 2023

BEAM Energy

Furthermore, there is also the possibility to have a very pure electron beam with an energy ranging from 0.5 GeV to 4 GeV. [6].
The beam has more or less a round profile, known as cross section. In the focal plane, the beam spot has a diameter of about 2 cm. Similar to what happens with light, the

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[5]Please note that these plots stop at 10 GeV but the beam can reach an energy of 15 GeV. The reason is that this testbeam facility has been upgraded in 2020/2021 and an updated version of the plot is not available yet. Nevertheless, the data shown by the plots are still valid.

[6]To create a pure electron/positron beam the secondary beams of charged particles are deflected away with two bending magnets and only the neutral gammas rays (Gamma rays are photons with energies above 0.5 GeV) are selected. Following this, a converter consisting of 5 mm of lead is placed in their path and convert them into electron/positron pairs. Finally, the beamline is tuned to select either the electrons or positrons of energies ranging between 0.5 GeV and 4 GeV. Using this method, at energies <3 GeV the electron purity is $> 90\%$

Cerenkov Counter

Threshold Cherenkov counters can obtain particle identification information for individual particles in that beamline (will be used)

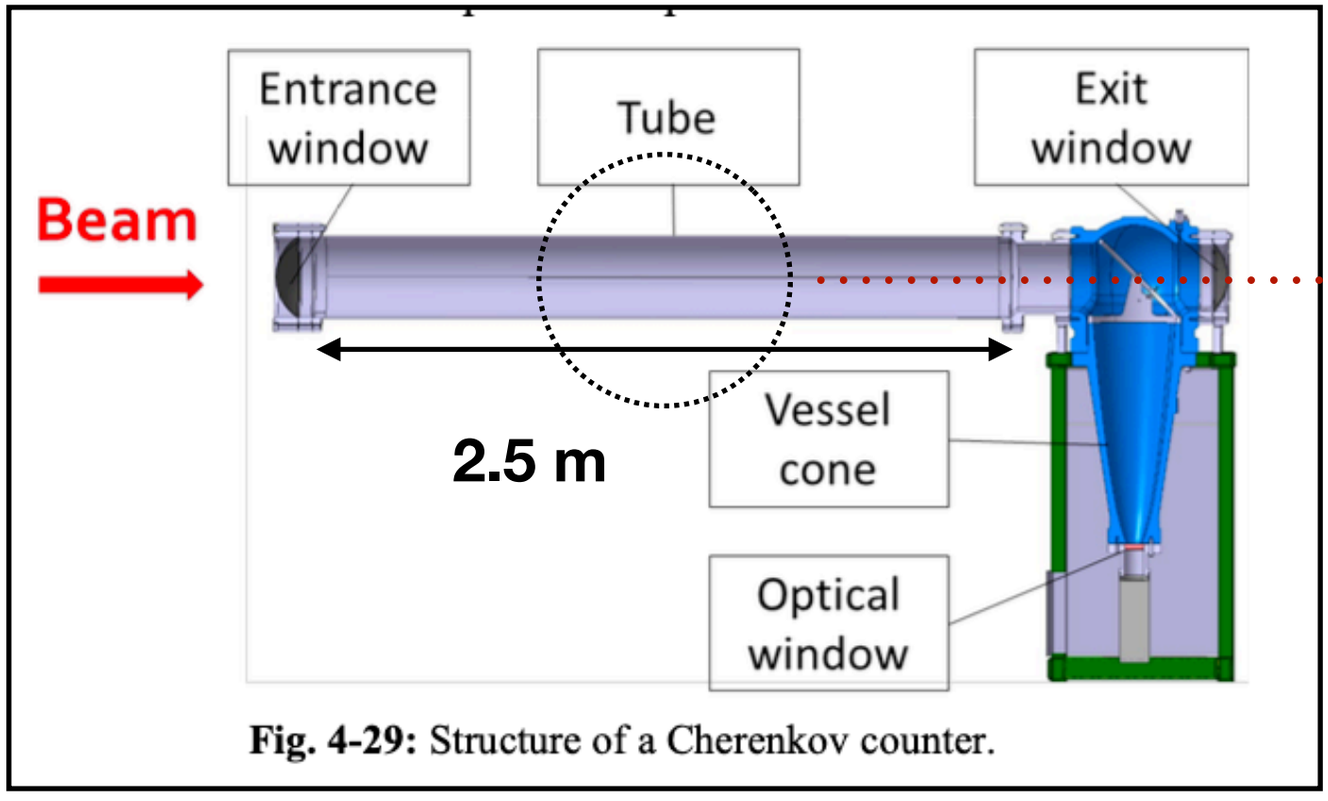


Fig. 4-29: Structure of a Cherenkov counter.

CO_2, N_2, R218, R134a
- maximum gauge pressure of 15 bar

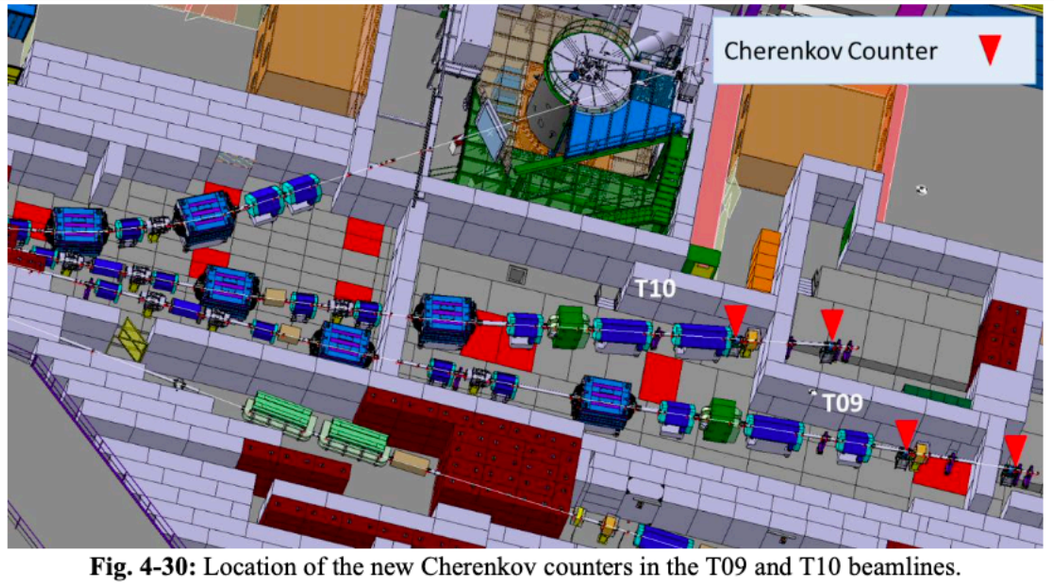


Fig. 4-30: Location of the new Cherenkov counters in the T09 and T10 beamlines.

Cerenkov Counter

Threshold Cherenkov counters can obtain particle identification information for individual particles in that beamline (will be used)

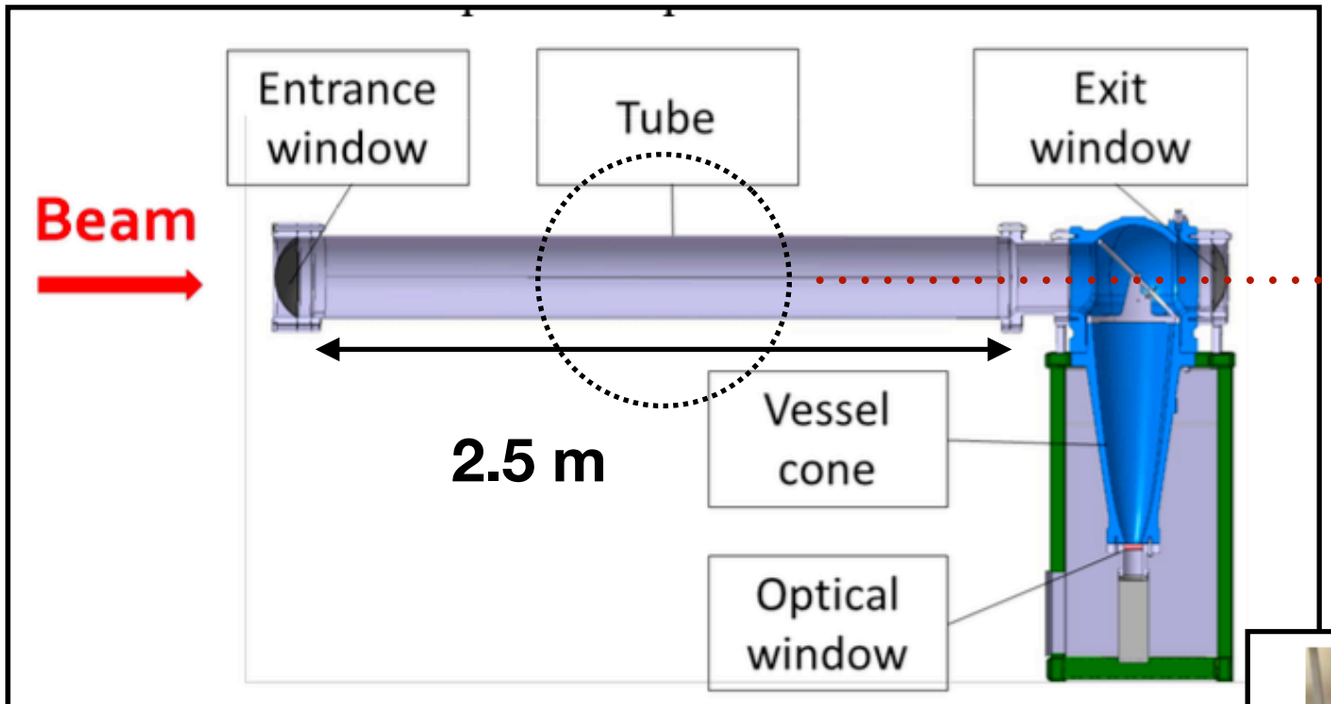


Fig. 4-29: Structure of a Cherenkov counter.

Table 4-15: Technical details of the four new Cherenkov counters of the East Area.

Line	Beam aperture (mm)	Total length (mm)	Layout name after LS2	Equipment code
T09	159	3 280	T09.XCET044	XCET
T09	159	3 115	T09.XCET048	XCET
T10	159	2 975	T10.XCET040	XCET
T10	159	2 595	T10.XCET043	XCET

CO_2, N_2, R218, R134a
- maximum gauge pressure of 15 bar

After renovation, CO_2, N_2 will be filled
- pressure of 15 bar

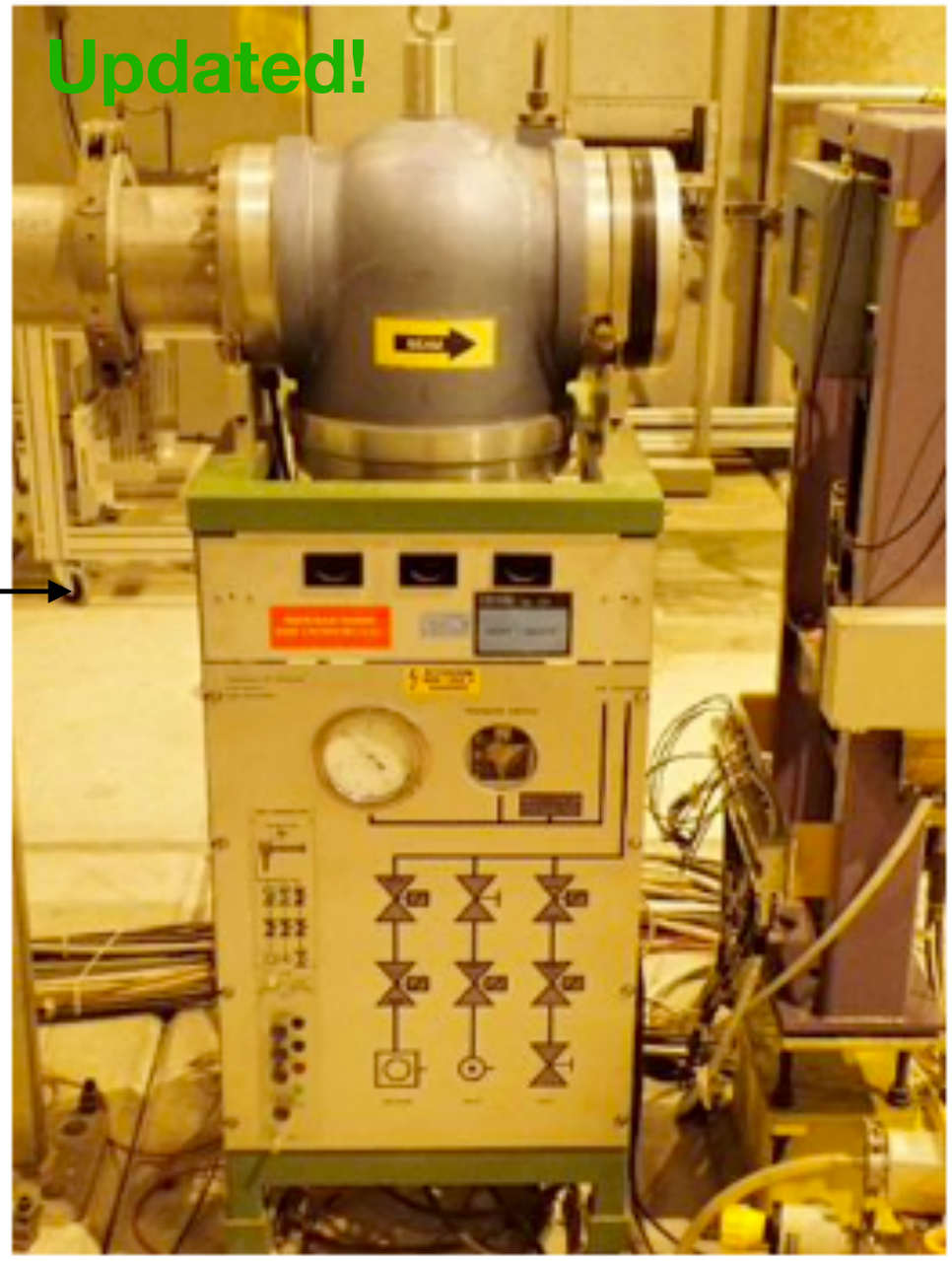
Fig. 4-31: New Cherenkov counter. Left: body; centre: conical part; right: complete assembly.

Cerenkov Counter

- **The detector settings will be done by CESAR**

actual manual gas control panel

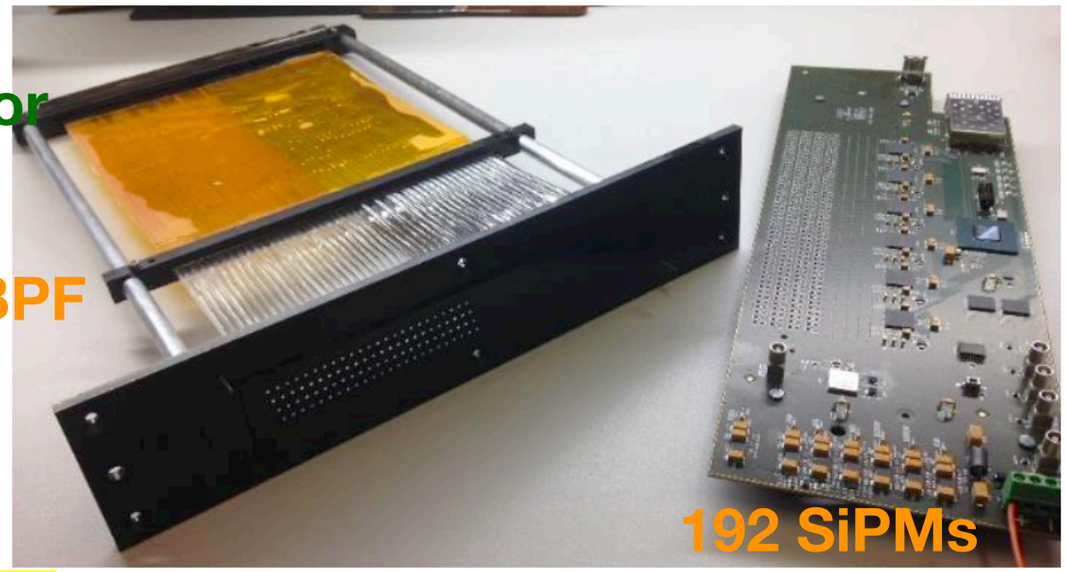
remote control interface for Cherenkov counters



Beam Profile Fiber Monitor (XBPF)

The experimental beam profile fibre monitor (XBPF) is a scintillating fibre detector recently developed at CERN for the measurement of the profile, position, and intensity of secondary beams

- It has 100 or 200 scintillating fibres



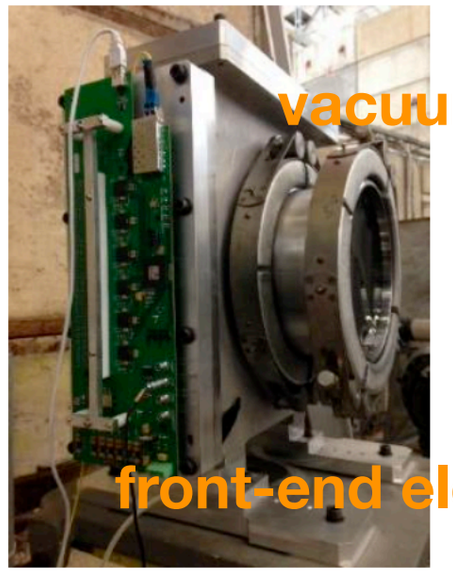
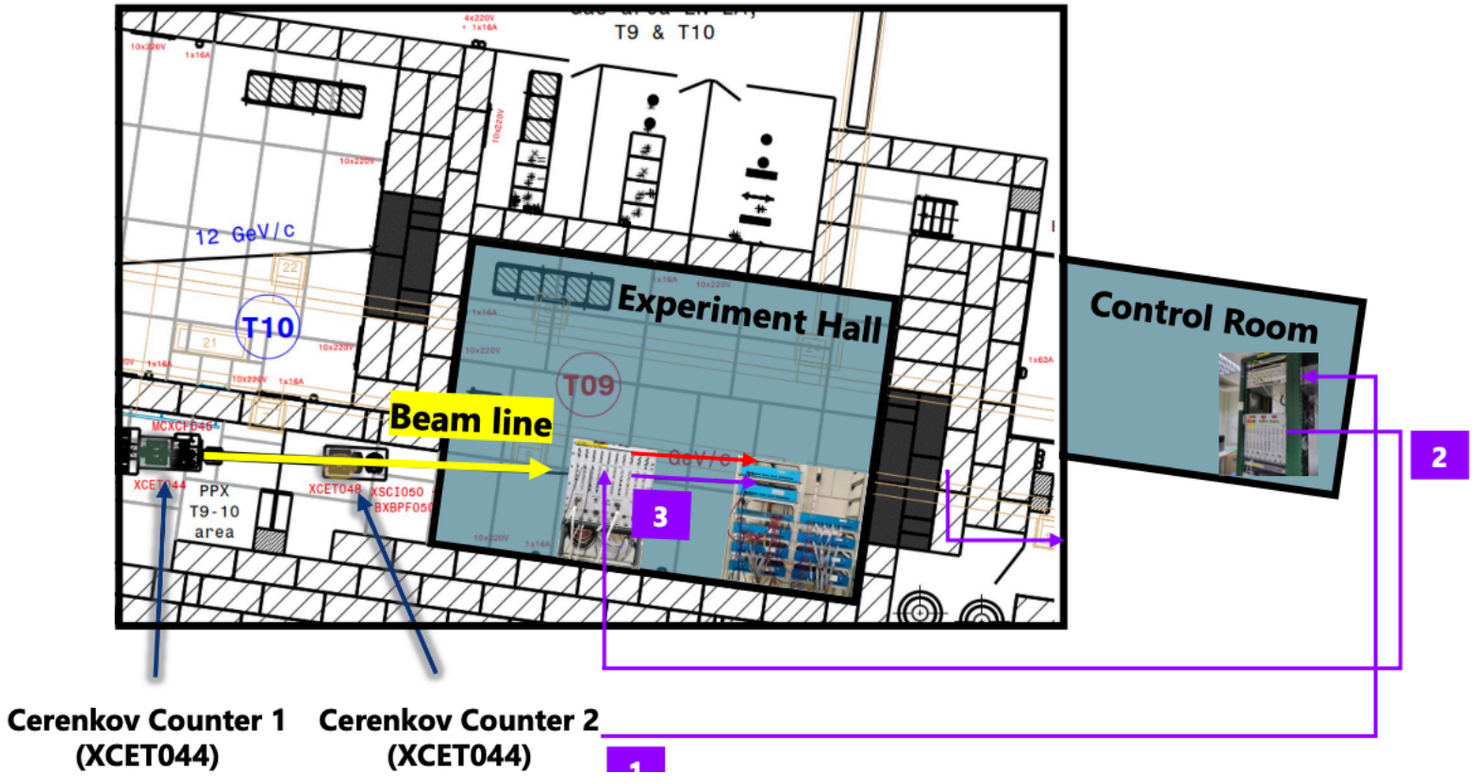


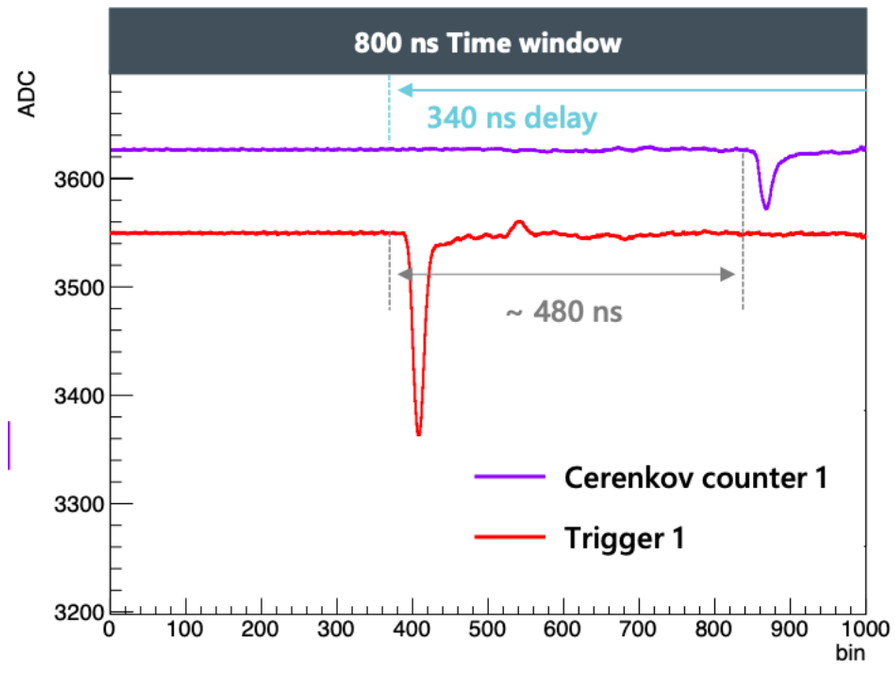
Table 4-19: Upgrade of beam profile monitors after LS2.

Line	Changes after LS2	Equipment code	Comment
ZT09	Removed	XDWC	Storage
ZT10	Removed	XDWC	Storage
ZT11	Removed	XDWC	Storage
T09	T09.XBPF041	XBPF	New, 10 cm × 10 cm
T09	T09.XBPF050	XBPF	New, 10 cm × 10 cm
T10	T10.XBPF045	XBPF	New, 10 cm × 10 cm
T11	T11.XBPF022	XBPF	New, 20 cm × 20 cm

DAQ - Time Window

- **Time window**
  - Since Cerenkov Counters are with the beam line, so that there is inevitable delay by cables.
  - There about 480 ns time interval between Triggers and Cerenkov Counters.
  - In this case, they couldn't be in the same 200 ns time window.





R&D : Timeline

Tasks	Details	5. 21-27	5. 28- 6. 3	6. 4-6. 10	6. 11-6. 17	6. 18-6. 24	6. 25-26
SFHS module	Assembly + polishing bundle	**Assembly Done, Bundling(Epoxy)** →					
3D Printed Module	Assembly (fiber)+ polishing bundle	**Assembly Done, Bundling(Epoxy)** →					
PMT Assembly			**Done** →				
Bundling + Readout Frame			**Frame design completed, Acrylic is printing** →				
Dark Case + Bottom base	Shielding Light (포맥스)		**Done** →				

DAQ : Timeline

Tasks	Details	5. 28- 6. 3	6. 4-6. 10	6. 11-6. 17	6. 18-6. 24	6. 25-26
PMT Sensor board test	Single & Multi (cross talk)	→				
TCB	Need to update firmware	**Vist Notice @ Monday**		**Done!**		
Fast mode timing/		**Vist Notice @ Monday**		**Done!**		
PMT sensor board		**Vist Notice @ Monday**		→		
Cable for MCP-PMT	Production cable for MCP-PMT	**Cable production completed!**				

DQM : Timeline

Tasks	Details	5. 21-27	5. 28- 6. 3	6. 4-6. 10	6. 11-6. 17	6. 18-6. 24	6. 25-26
Code Test (using DAQ PC)	cvmfs install + Bulit DQM codes		**After Severance test** →				
Hodoscope & cerenkov counter		→					