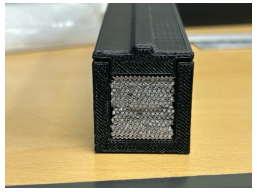
Beam Test at CERN PS T10

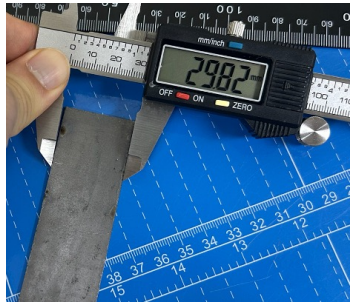
24.8.2 BIC meeting: Beam Test Plan

Jeongsu Bok (Pusan National University)

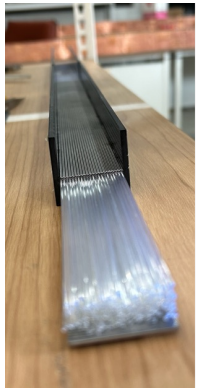
Pb/SciFi Prototype Module Production

1) Pb plate preparation



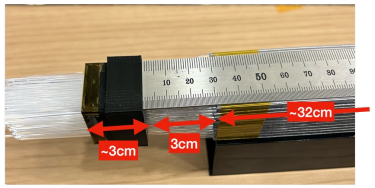


2) Stacking with fiber



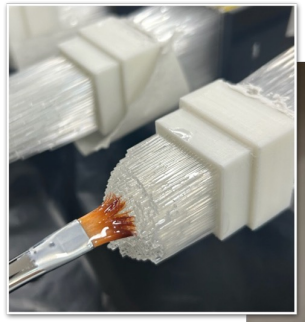
3) Cutting fiber

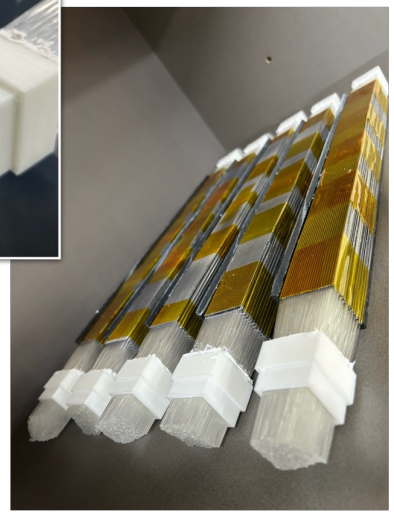
Epoxy



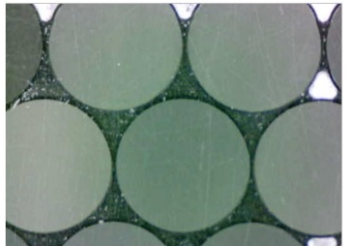
양 끝단 포함 하였을 경우, 길이 추정
: 32cm + 3cm x 2 + 3cm x 2 + α ~ 50cm
번들까지 길이 Bundle case

끝 부분 절단 후 optical cement를 붓 사용하여 도포
: 굳기까지 이틀 대기



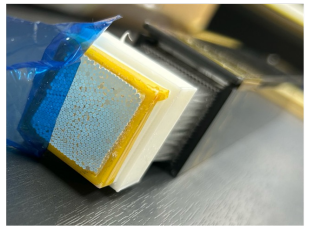


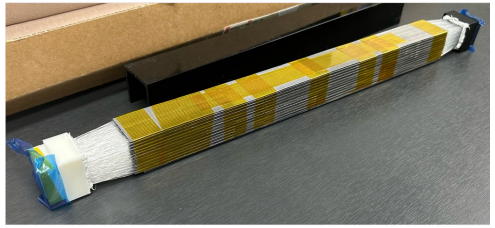
4) curing

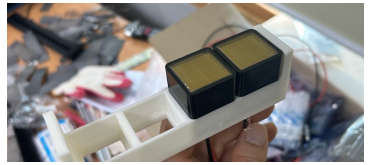


5) polishing

완성본



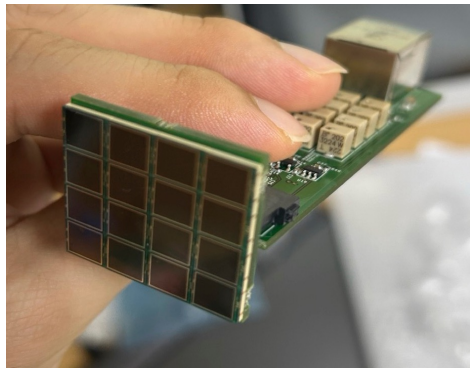




6) Connect with PMT

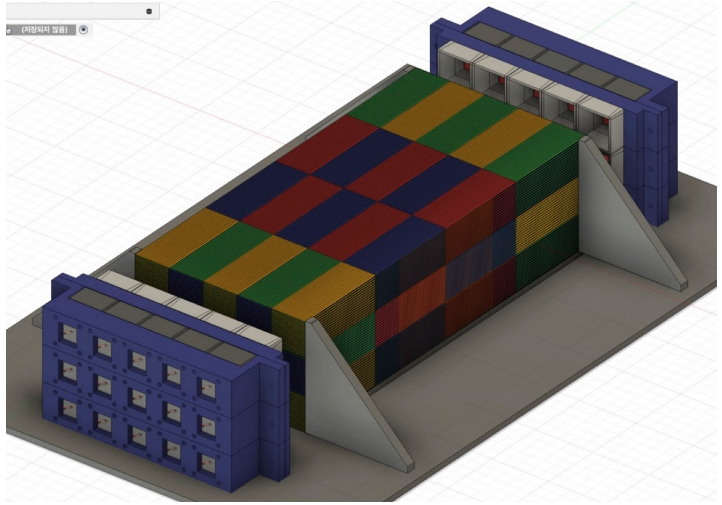
Pb/SciFi module with SiPM

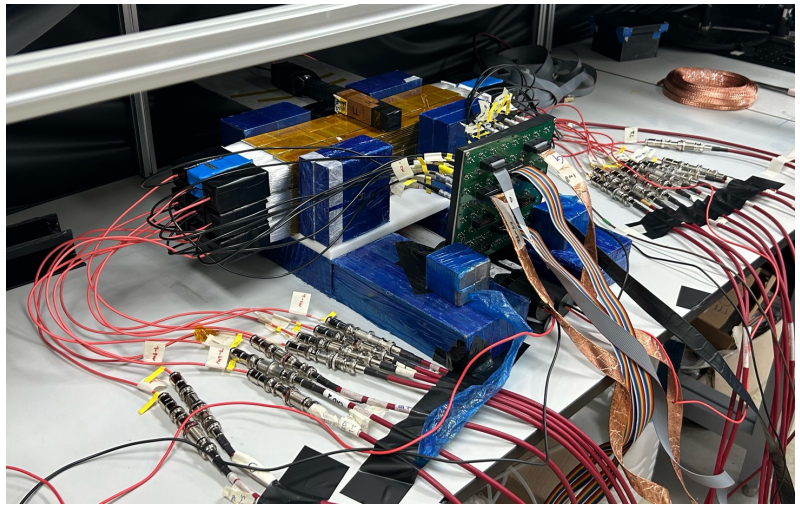
- One module is produced for SiPM readout.
- We will begin with 3x5 PMT-module setup for calibration and initial study
- Then we will include SiPM module in 4x4 setup. (other 15 modules are PMT)

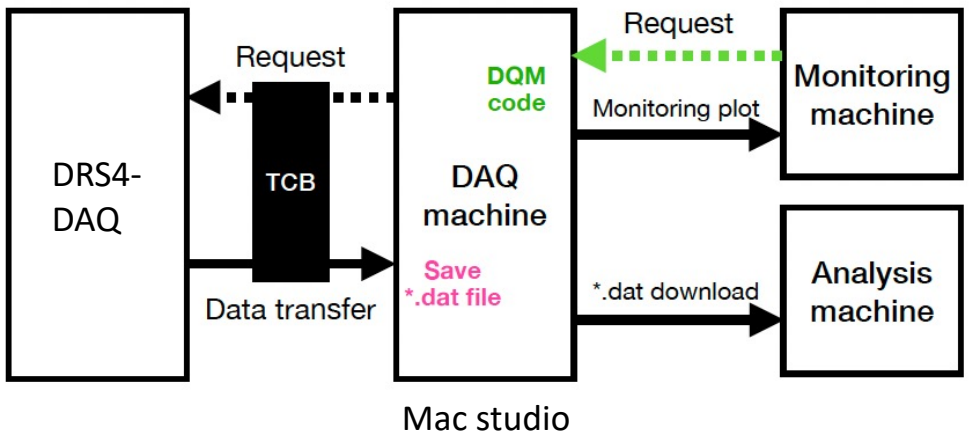


SiPM for the Pb/SciFi

DAQ test





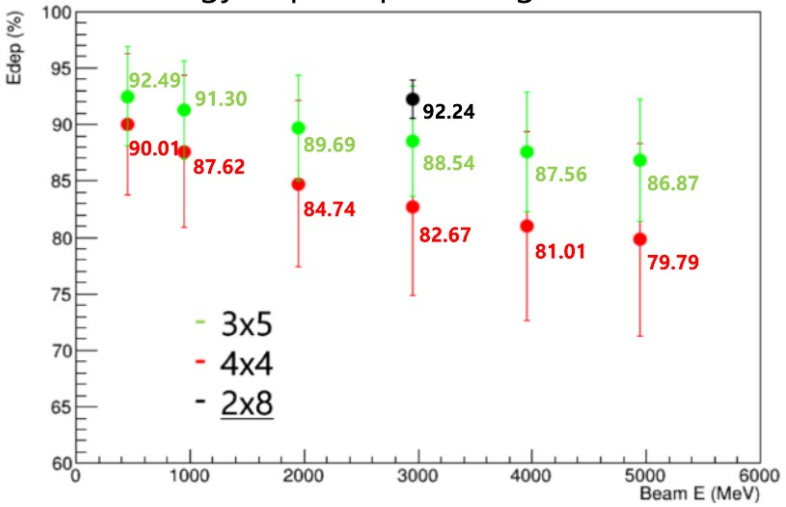


- PMT+DAQ based on DRC beam test
- Cosmic test at Yonsei was succesful
- DAQ tutorial will be at CERN before beamtest

Simulation for Beamtest

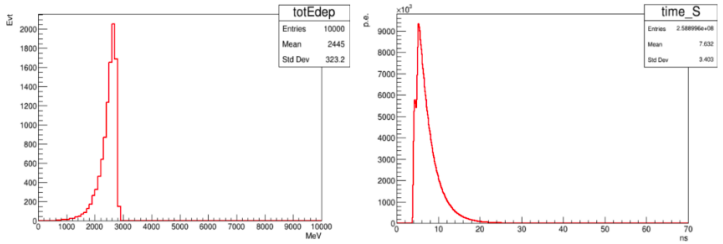
Edep using histogram mean, stddev

<Mean Energy deposit percentage for e- beam>

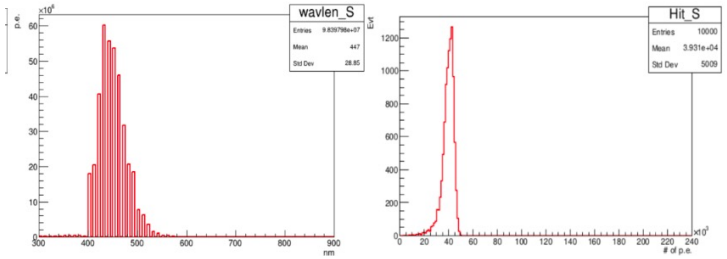


- Edep
- Time

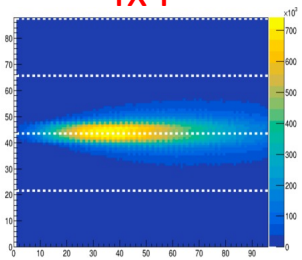
3GeV e-



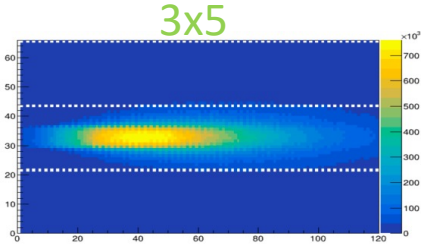
- Wavelength
- Hits



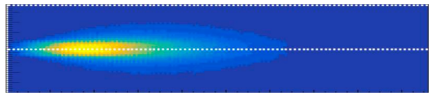
4x4



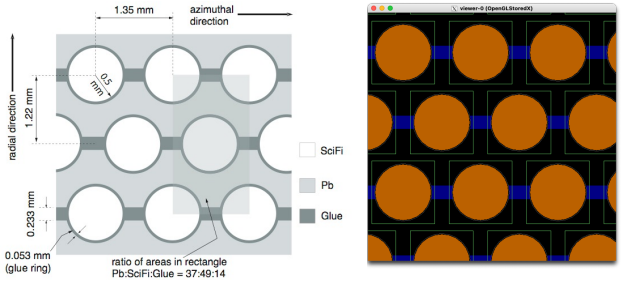
3x5



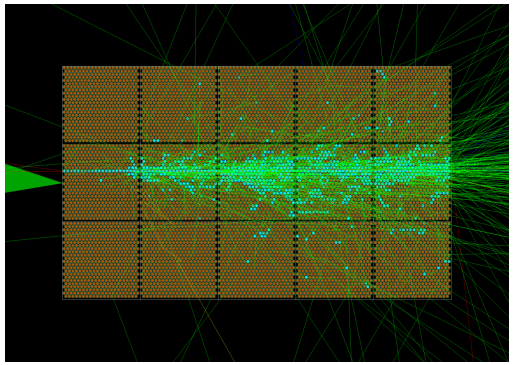
2x8



Side view



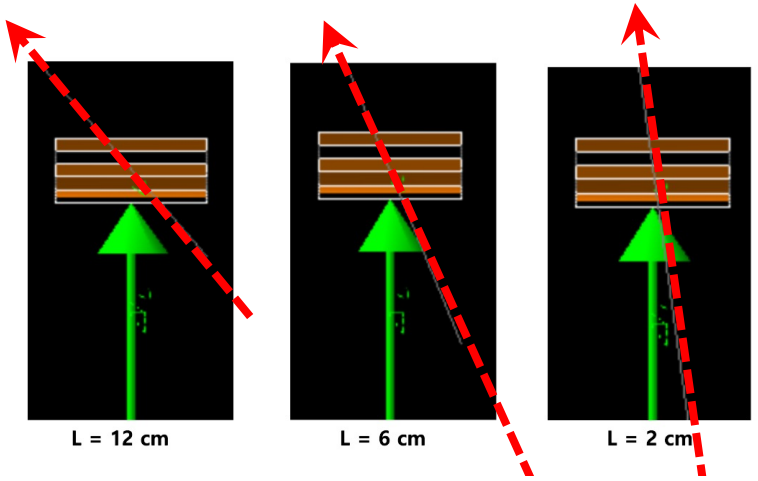
Implemented geometry based on material composition of prototype

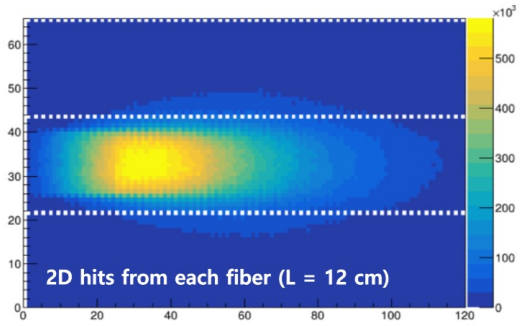


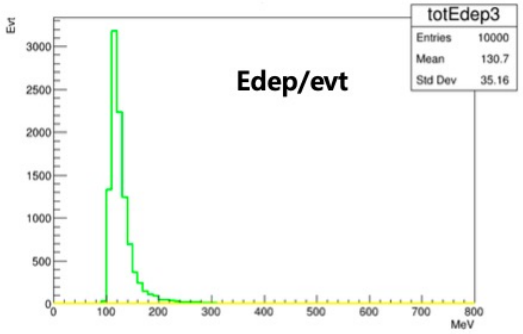
Visualization (different setup)

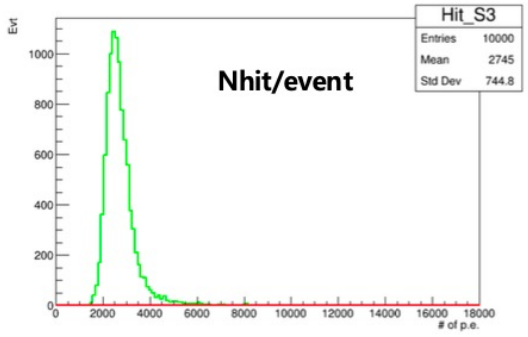
- Changhui Lee(KNU), Joonsuk Bae(SKKU), Harim Seong(SKKU)
- 10k electron 0.5~5GeV using KNU computing farm
- Implementation from DRC simulation

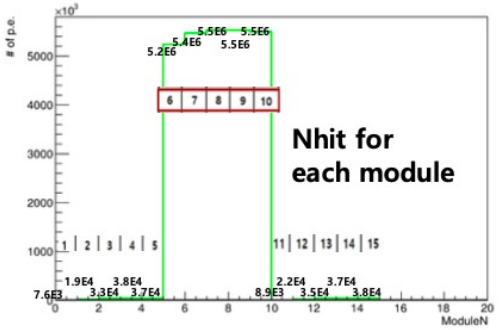
Simulation for Beamtest

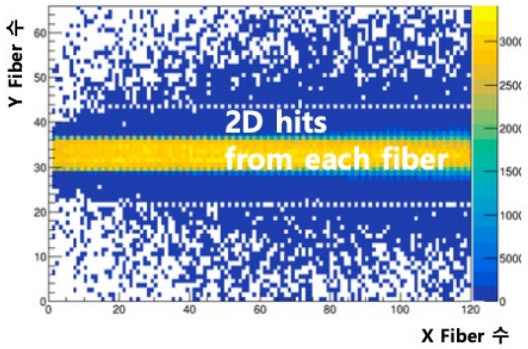




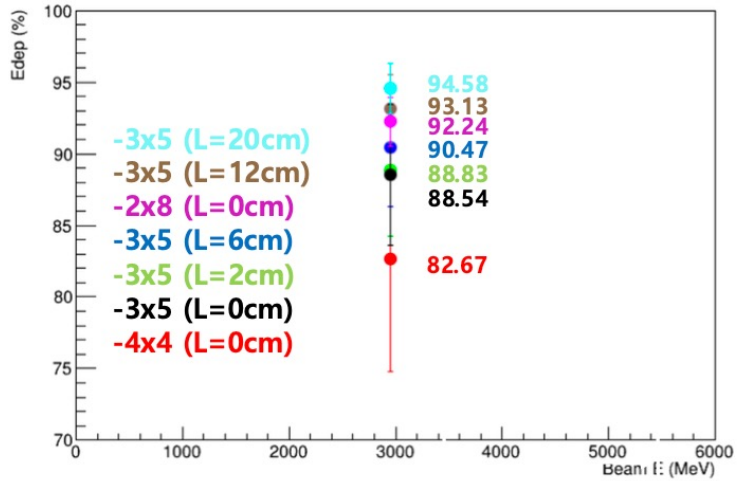








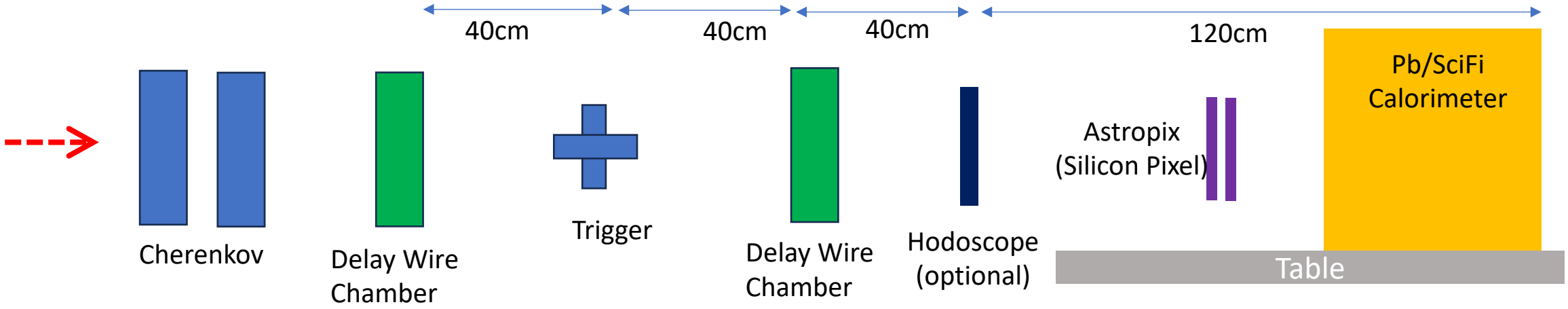
<Mean Energy deposit percentage for e- beam>



- **Value** : Edep mean *100 / Beam E
- **Err** : Edep Std Dev *100 / Beam E

- Tilted beam
  - enter +6cm from center, exit -6cm from center
  - Edep: 92.3% (larger than 2x8)
- Edge effect (in progress): beam position nearby PMT
- Muon simulation with 3GeV muon

Detector Configration

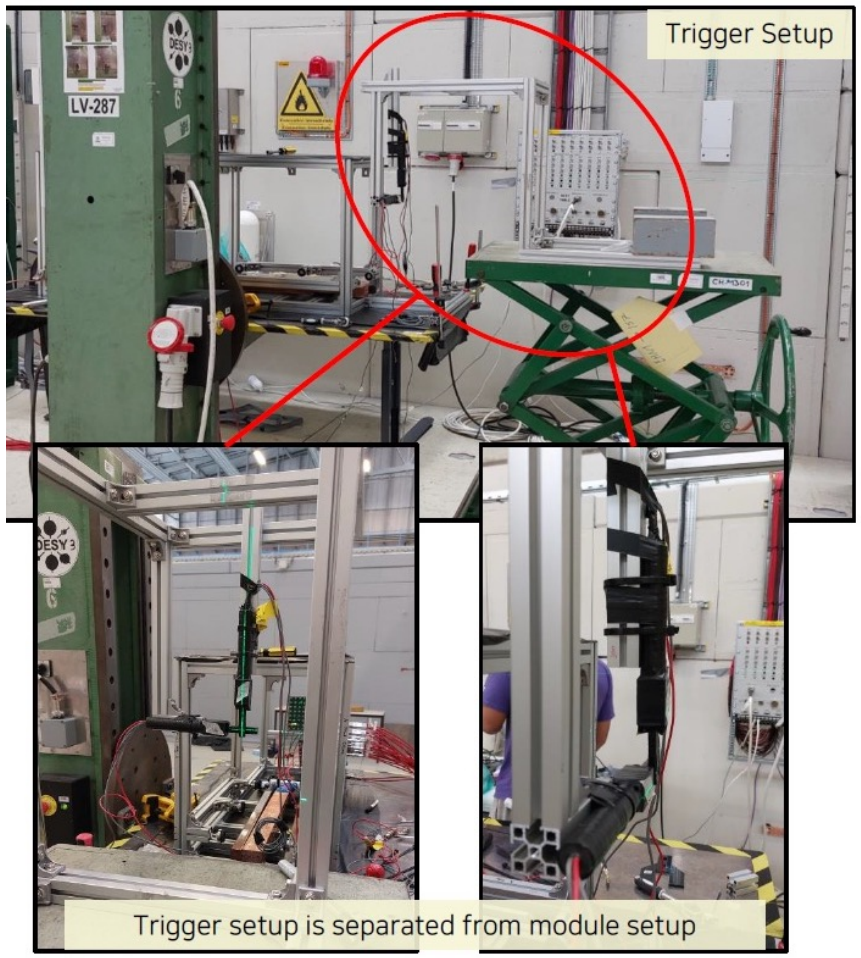


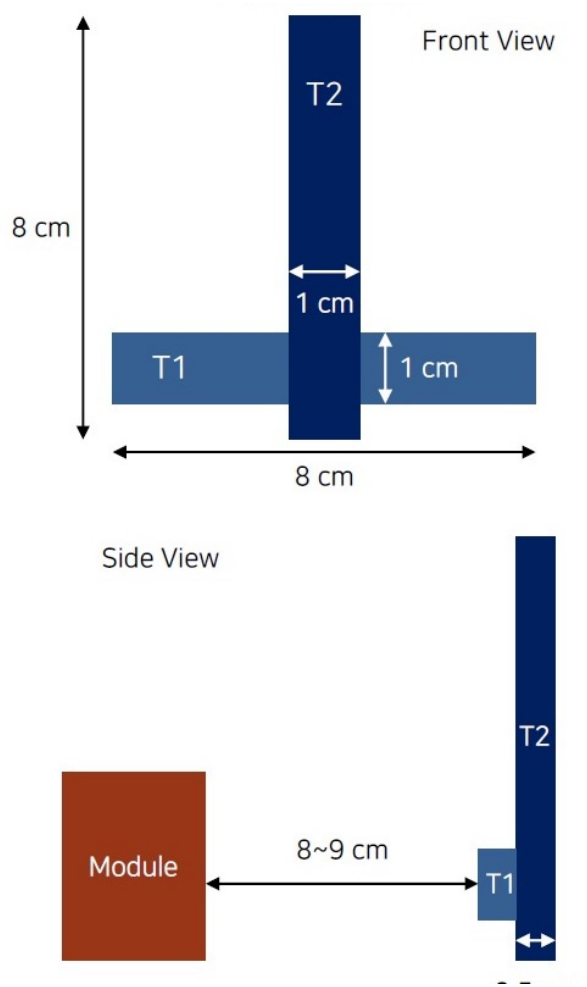
- Auxiliary Detectors
  - Trigger: ((finger) Scintillator + PMT) x2
  - Optional: SciFi Hodoscope: (1.6x1.6cm active area, 15x15cm size)
  - 2 Cherenkov Counters + 2 Delay Wire Chambers
- Setup: Pb/SciFi only → + AstroPix → + Hodoscope(optional)
- DAQ, power supply will be installed in the side of detectors

DAQ from Dual Readout Calorimeter team

Example of other team

Auxiliary detector: Trigger

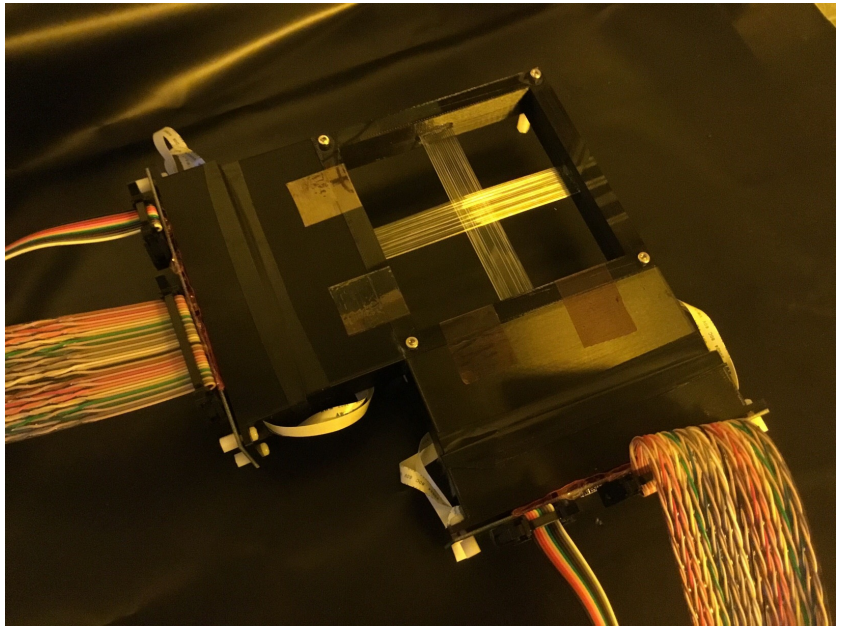


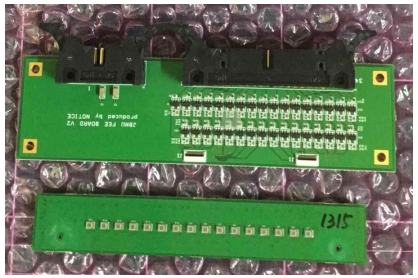


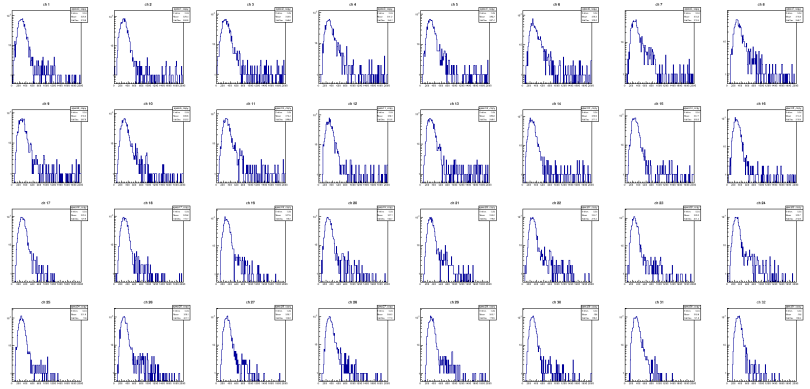
DRC beamtest 2023

- Used for DRC beam test
- Scintillator+ PMT (R2076)
- Trigger connected to
  - NIM (FIFO,Disc,Logic)
  - Trigger to TCB board of DAQ modules
  - (Raw signal to DAQ)
  - Trigger to TCB board of SciFi Hodoscope

Auxiliary detector: Fiber Hodoscope (Optional)



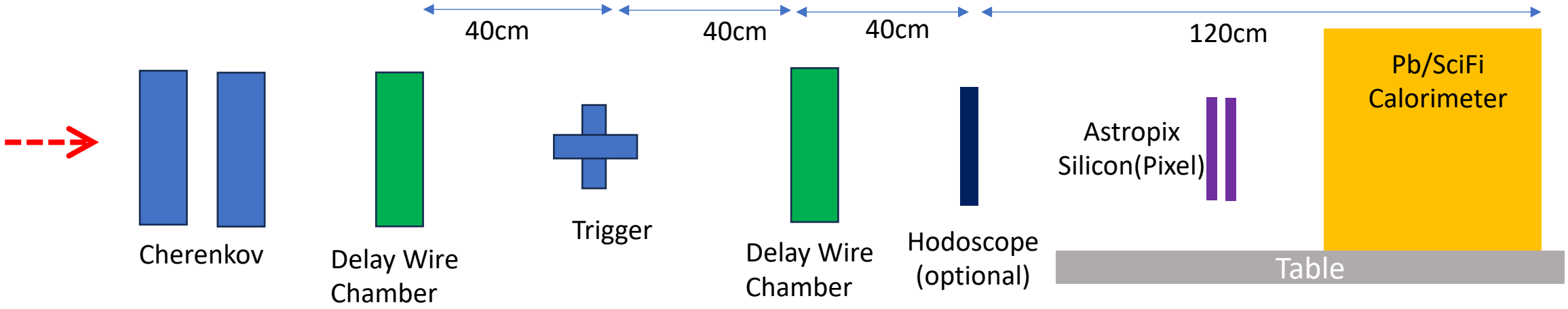




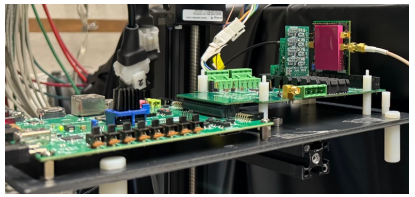
90Sr, 10s

- We will have two Delay Wire Chamber (~mm resolution)
- SciFi + SiPM hodoscope at PNU
  - 16x16mm2 using 1mm SciFi and 32 SiPMs
  - Separate FADC readout + power supply using flat cables
  - Trigger input can be used like Pb/SciFi, but TTL.

Plan for AstroPix



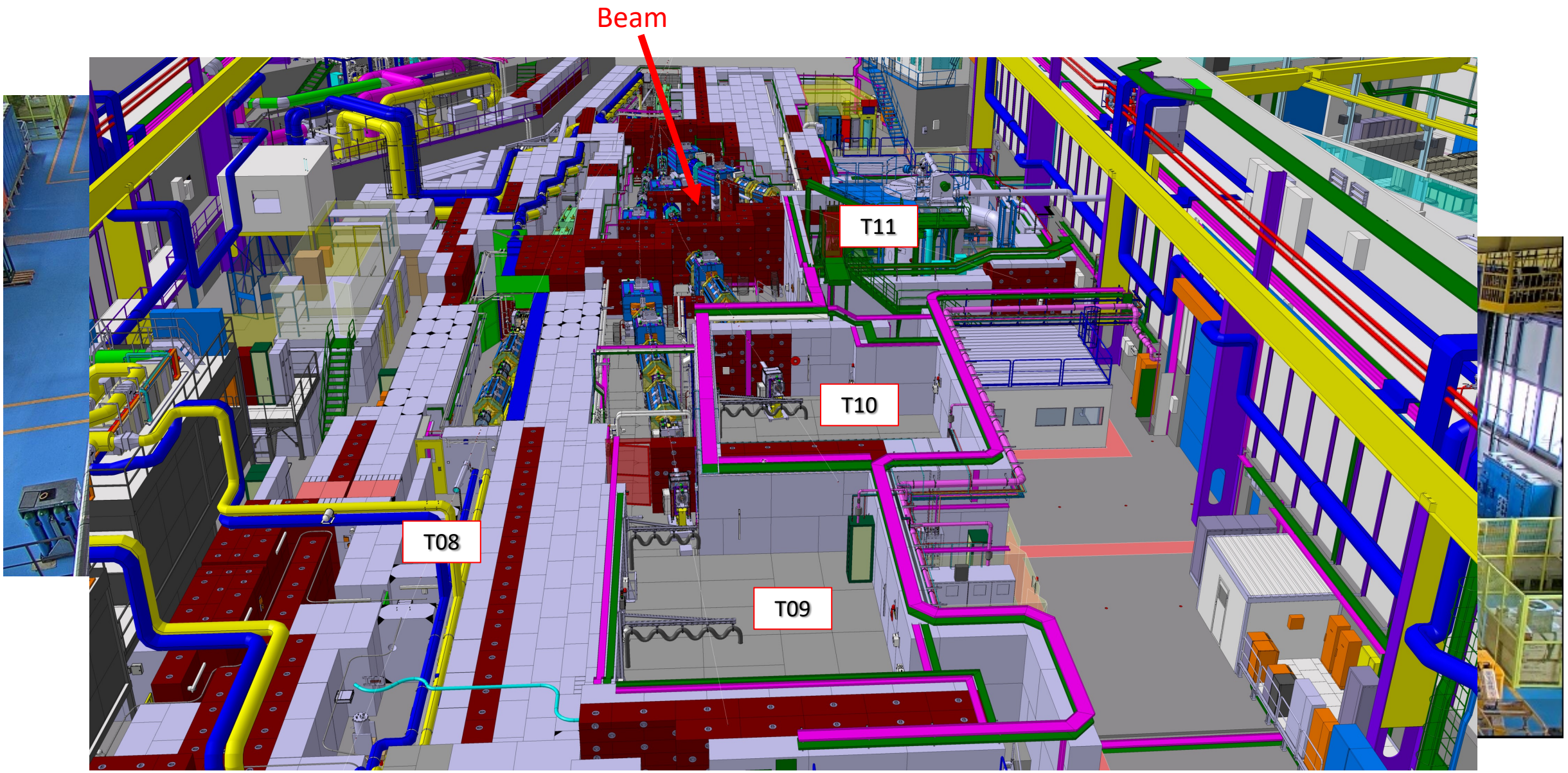
- Setup
  - Quad, single, multi layer setup by Bobae
  - DAQ laptop is from PNU (used for chip obtained in May)
  - Analog signal goes to TCB board (Trigger)



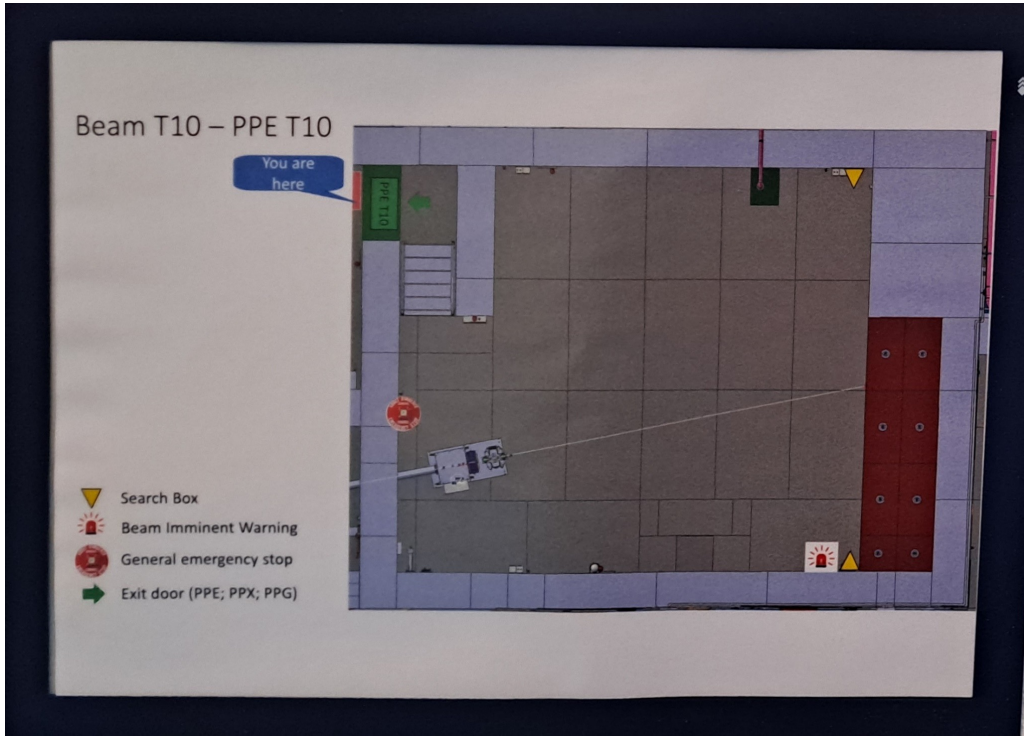
FTBF

- If calibration is succesful, **we may consider pre-shower** using three(or more) of 32x3x3cm^3 modules between astropix.
- Goal: signal from electron, muon, pion
- In future: sync time information

East Area B-157



PS T10 Beamline

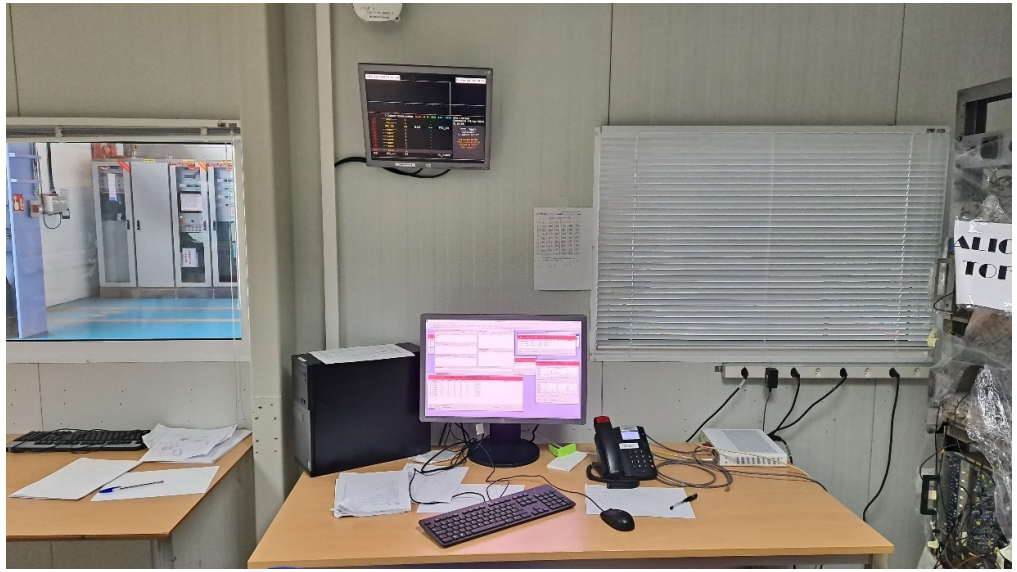


Courtesy of Sangwoo Park (SKKU)

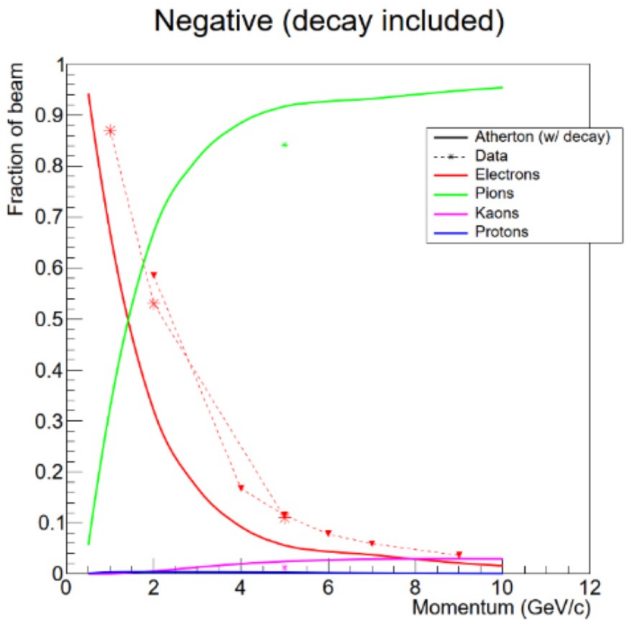
PS T10 Beamline

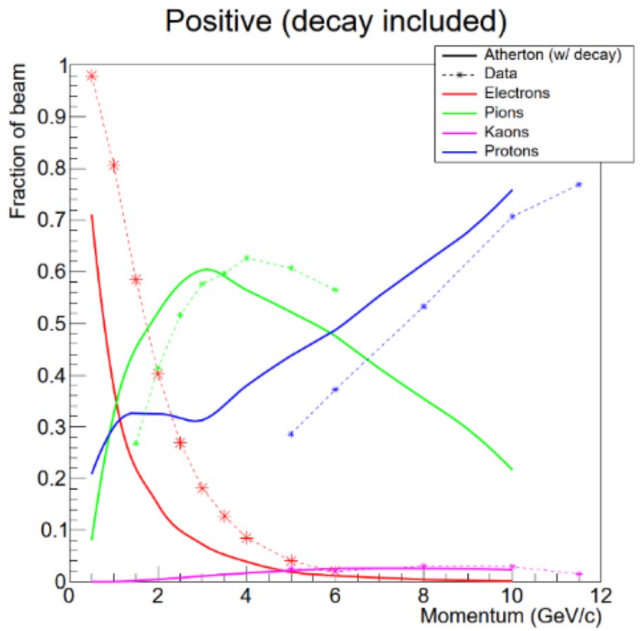
Connect beam area to control room

PS T10 Control Room



PS T10 Beam composition





- Electron
  - 50% at 2 GeV/c
  - 15% at 4 GeV/c
  - Negative is better
- Pion
  - Negative is better

Characteristics of the beams

Parameter	T09	T10	T11
$p_{\max}$ of secondary beam in $^{\mathrm{GeV}}/_{c}$	16	12	3.5
$\Delta p/p$ in %	± 0.7 to ± 15		
Maximum intensity/spill (hadrons/electrons)	10^6		
Available particle types	Pure electrons (T09 only) or mixed electrons (T10) or mixed/pure hadrons or pure muons		

Test Beam Program by Prof. Sewook Lee (KNU)

Beam Test Program

- Delayed Wire Chamber Calibration
- Find the geometric center
  - send electrons to the center module of the front face
  - position scan from left to right or vice versa
- Tower Calibration
  - send electrons to the center of the front module in each row
  - adjust HVs in accordance with energy deposits of individual modules in each row

Astropix

- Calibration with muons
  - need a good alignment between DWCs and a silicon chip
- Measurements of energy deposits and position resolution
  - electrons, pions, protons (if possible), muons: 0.5 ~ 4 (or 5) GeV/c

Pb-Fiber Modules (Standalone)

- Energy Resolution and Linearity with Pb-fiber modules
  - e^- 0.5 GeV/c ~ 4 GeV/c (or 5 GeV/c) with (0 deg., 0 deg.)
  - e^- 0.5 GeV/c ~ 4 GeV/c (or 5 GeV/c) at some angle to contain more shower
- PMT test to investigate the effect of em shower leakage
  - send electrons to one end of the center module with the highest energy of the electron beam
- Time Resolution with electrons (4 or 5 GeV/c)
  - send electrons from one end to the other (time difference of two PMTs)

Pb-Fiber + Astropix

- Energy resolution, Linearity, position resolution with the electron beam
  - e^- 0.5 GeV/c ~ 4 GeV/c (or 5 GeV/c) with (0 deg., 0 deg.)
  - e^- 0.5 GeV/c ~ 4 GeV/c (or 5 GeV/c) at some angle to contain more shower

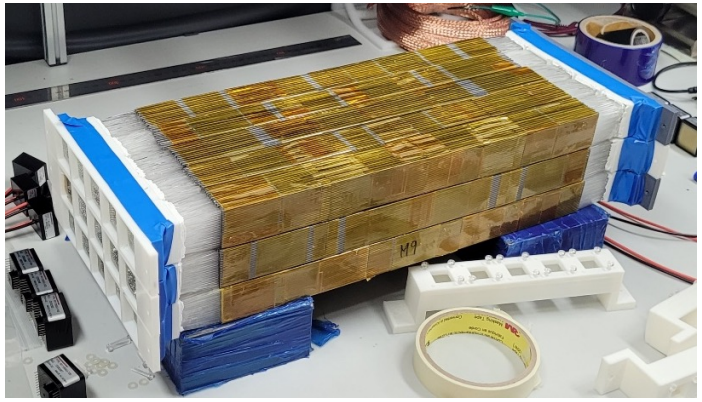
If calibration is done for both, we may consider preshower setup

backup

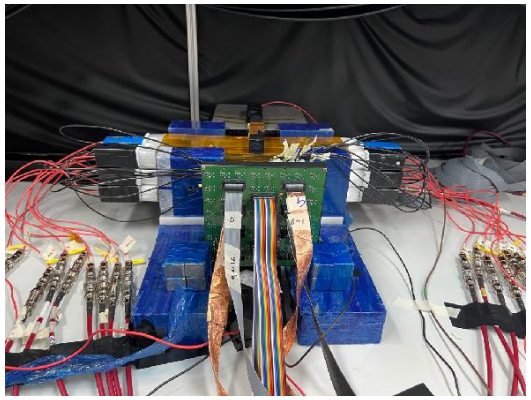
Beamtest Program (initial draft)

- Calibration study for prototype modules
  - Equalization of calorimeter modules using muon beam
  - Tuning HV for each module to get similar response
- Energy resolution and linearity study using electron beam 0.5~5GeV
  - Tilt the calorimeter to study various effect for more shower containment
  - Beam on the side of calorimeter to study edge effect (e.g. effect of shower leacakge on PMT) and effect on timing.
  - Response from pion beam
- Study of different geometry (4x4) including a module with SiPM
- Study of Astropix Silicon pixel.
  - Energy deposit and dE/dx for various energy.

Prototype of EIC Barrel Electromagnetic Calorimeter

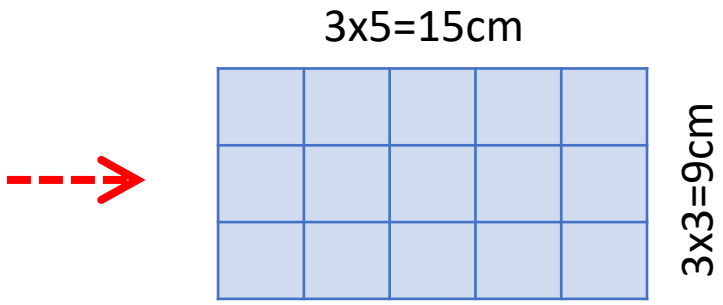


Pb/SciFi module 3x5 array

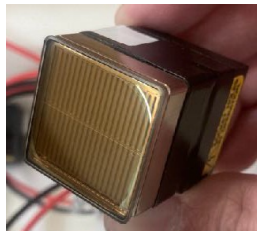


DAQ test of
Pb/SciFi module

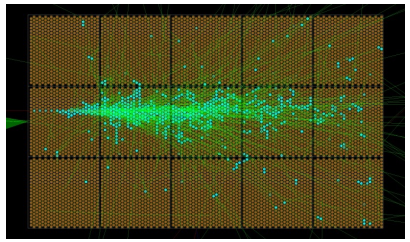
- Pb/SciFi Module
  - 3x5(4x4) of unit module(32x3x3cm^3)
  - Dimension: 32x15x9 cm^3
  - Readout with PMT (R11265-100)
  - One additional module with SiPM will be used for 4x4 setup
- AstroPix Module (Silicon Pixel)
  - Dimension: 2x2 cm
- Detectors will arrive at CERN tonight



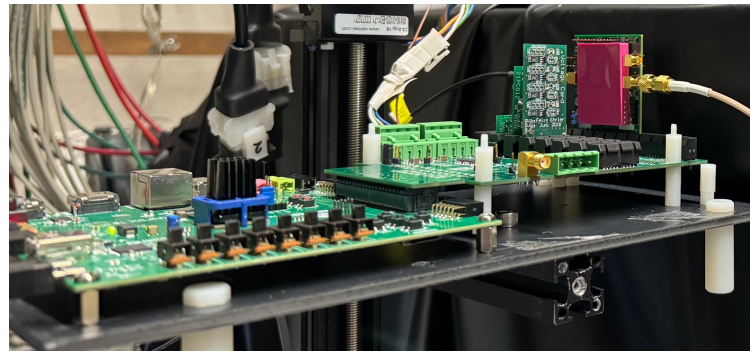
Side view



PMT



Simulation



AstroPix Chip + Carrier Board