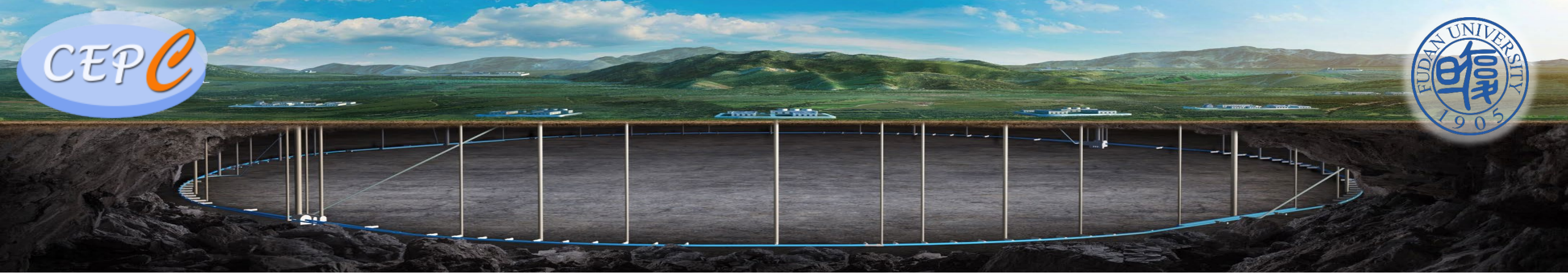
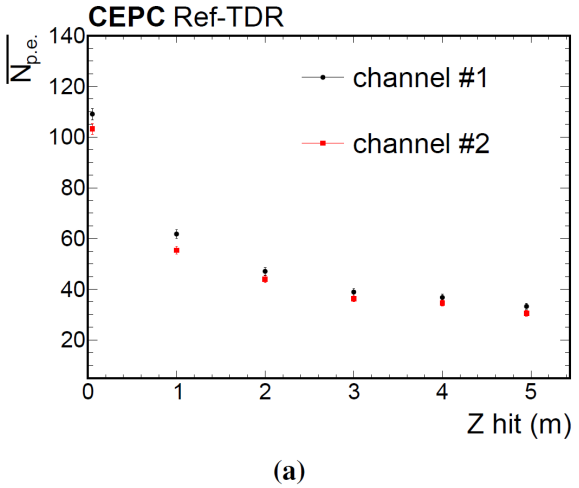


R&D for Muon Detector and HMPID

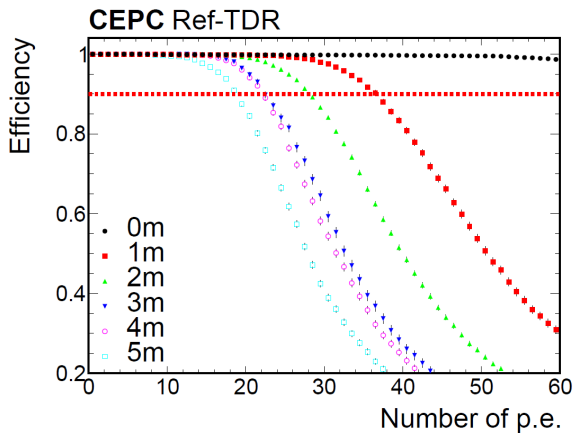
Xiaolong Wang
Fudan University
Dec. 10th, 2025

Performance of full size PSU prototype

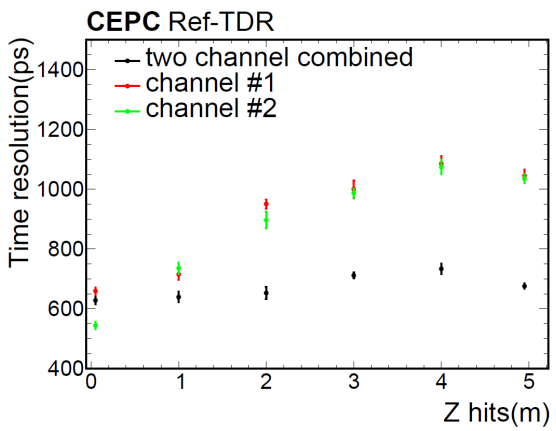
- Prototypes with $5m$ PSUs in CR tests, using $2.0mm$ diameter Kuraray WLS fiber.
- nPE was calculated according to pulse-height. But this takes into account neither the decay time of scintillator and WLS fiber, nor the reflections of the photons inside the fiber.
- Instead, we count nPE based on charge.



(a)



(b)

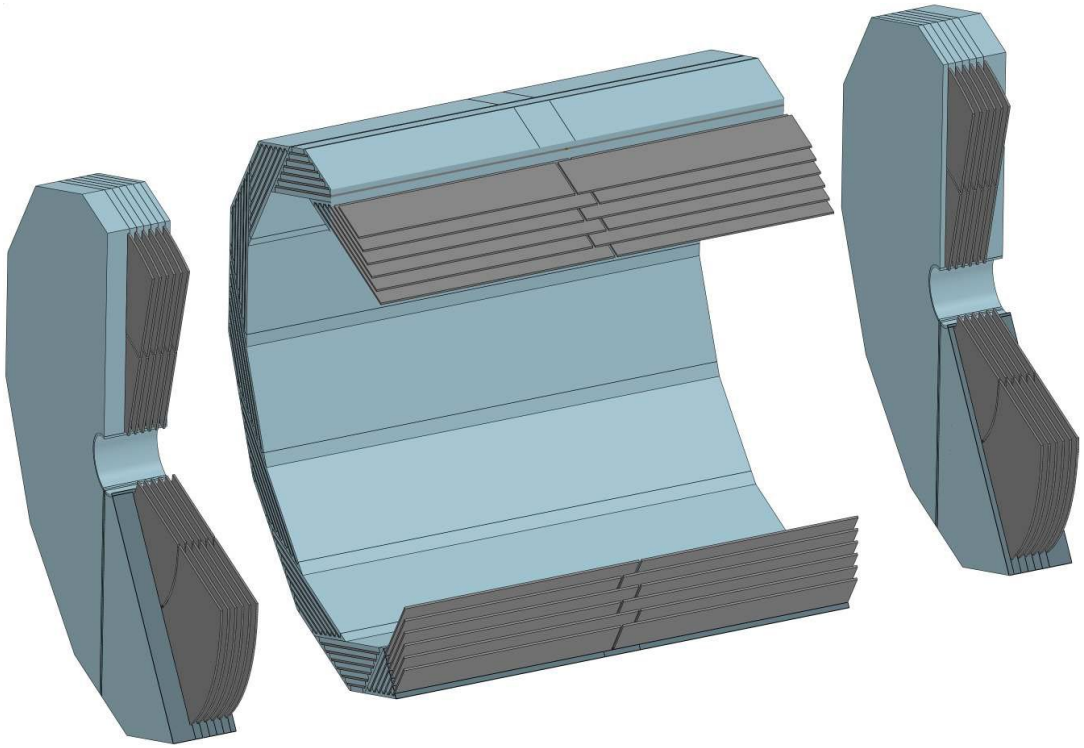


(c)

Fig. 9.12

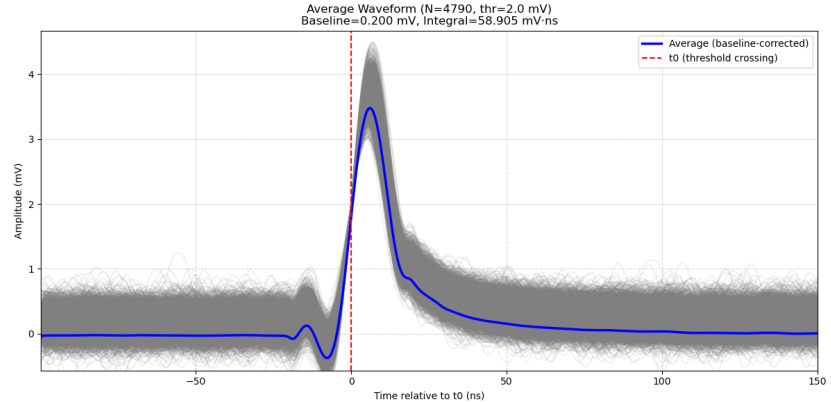
5m PSU prototypes under CR tests.

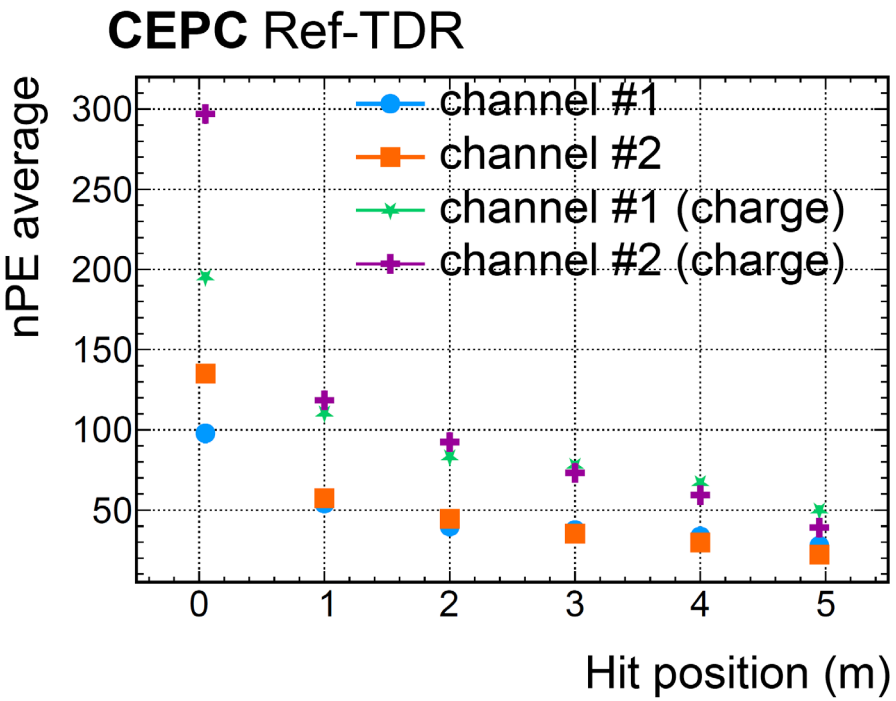
- Muon Detector



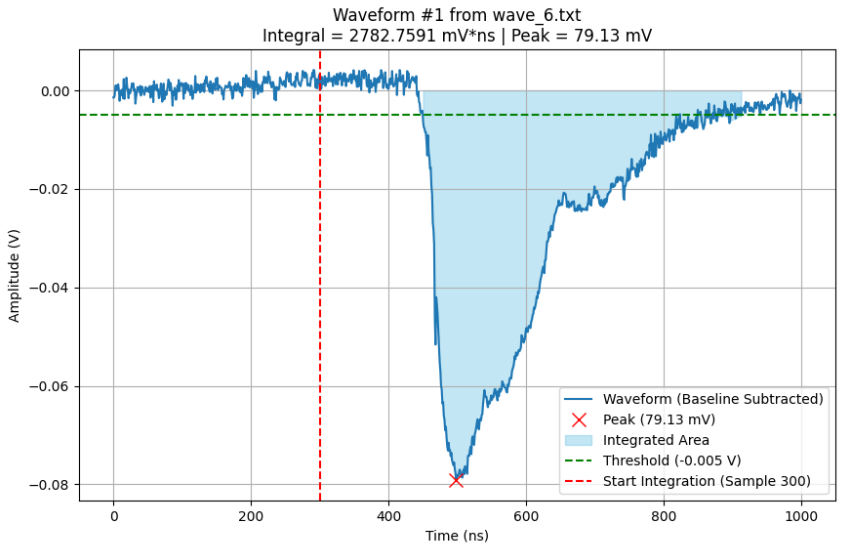
Charge of single p.e. signal

- Average of single p.e. signal based on >4,500 pulses: $58.9\ mV \cdot ns$
- Pulse widths of signals from far-end are much larger than the single p.e. signal.
- Compare the nPE calculations based on pulse height and charge.





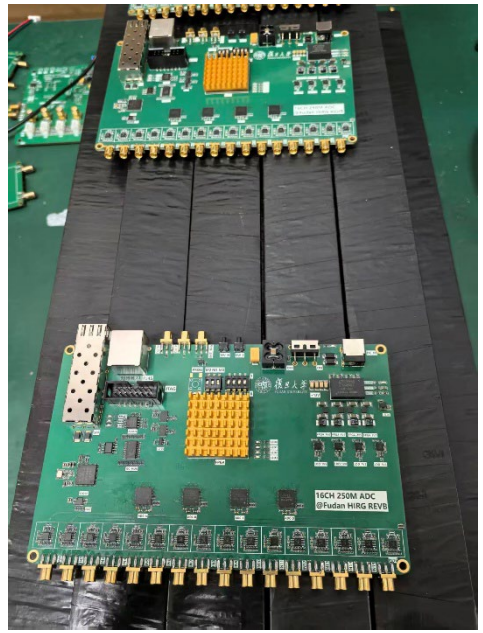
nPE is increased by a factor of two!

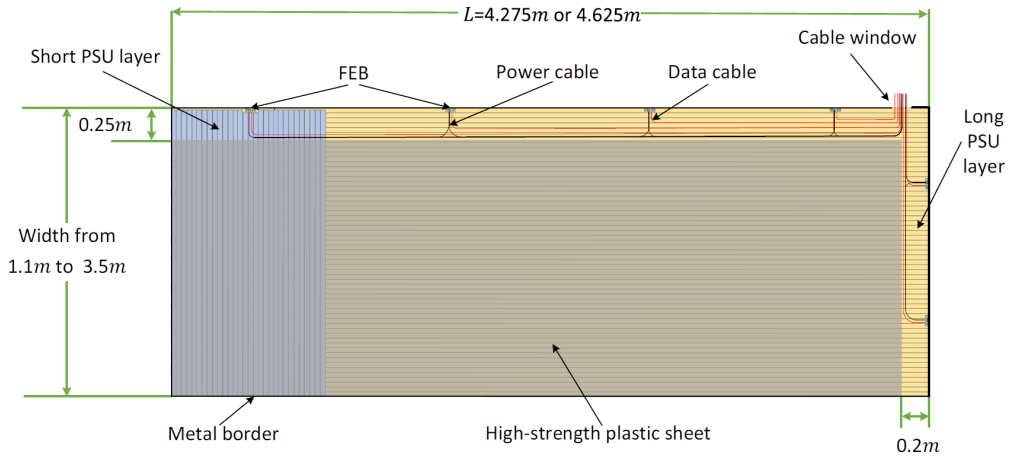


Large pulse widths of the far-end signals.

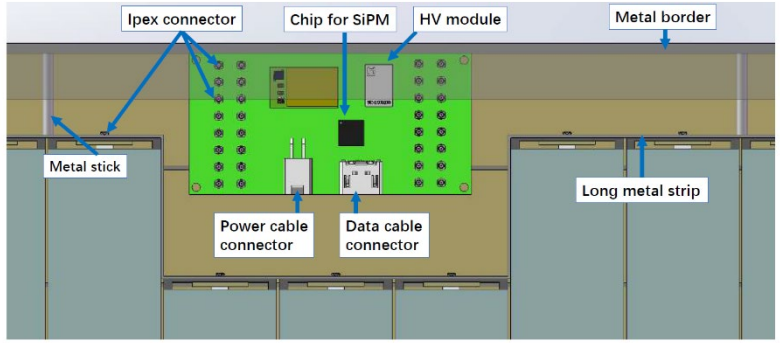
Plan for a prototype module

- Most of the R&D work is mature: PS bar, WLS fiber, SiPM and preams…
- We are working on DAQ based on 250M ADC at Fudan, 16ch each board. We can design a preliminary FEB using such ADC chips.
- In principle, we can make a module.
- Previous R&D based on 80M ADC.

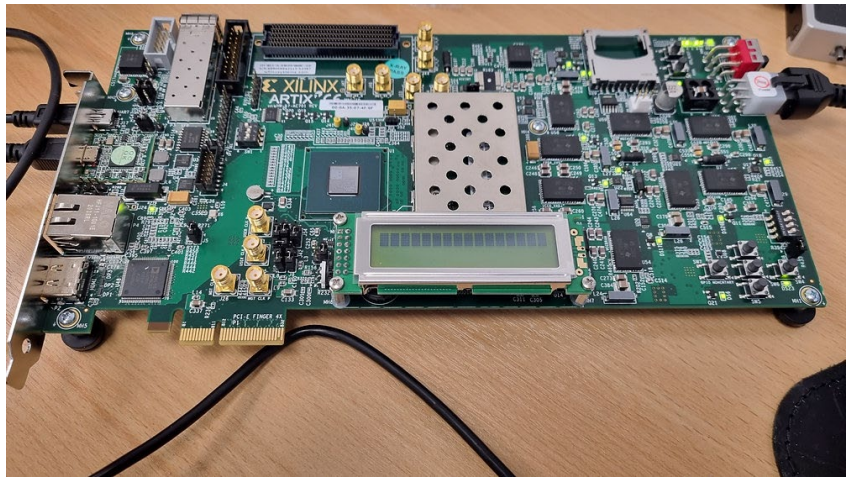


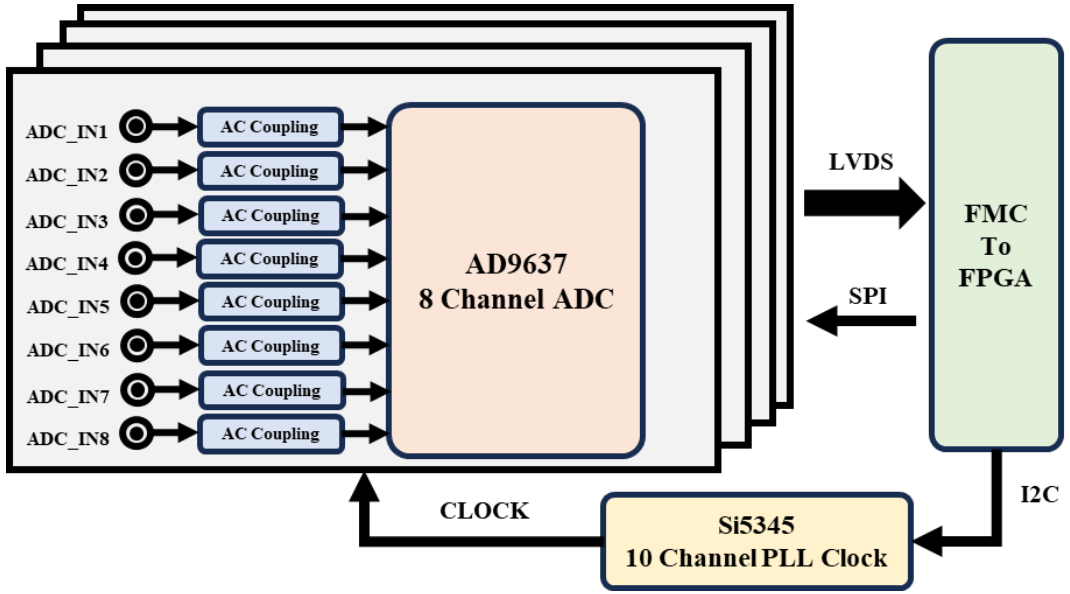


Barrel Module



Previous work





ADC Chip： AD9637 × 4

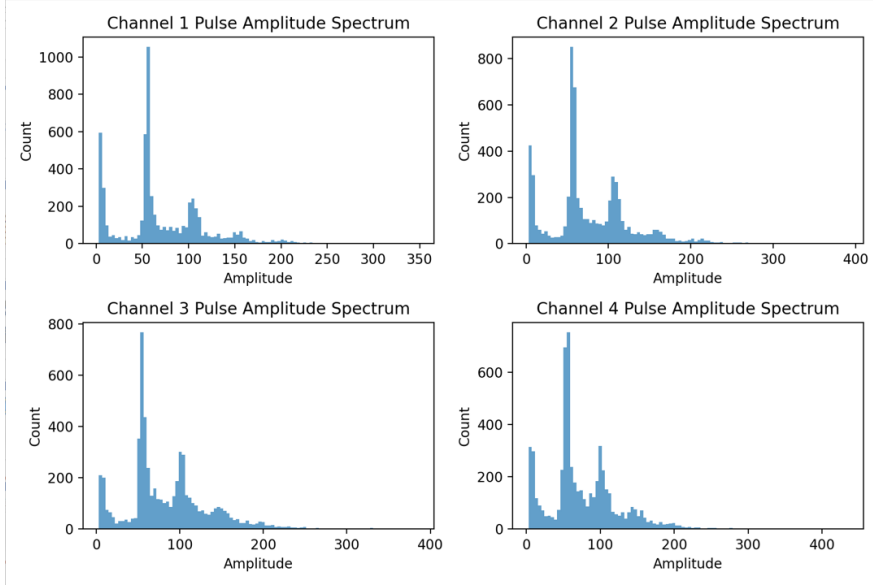
Channel： 32通道

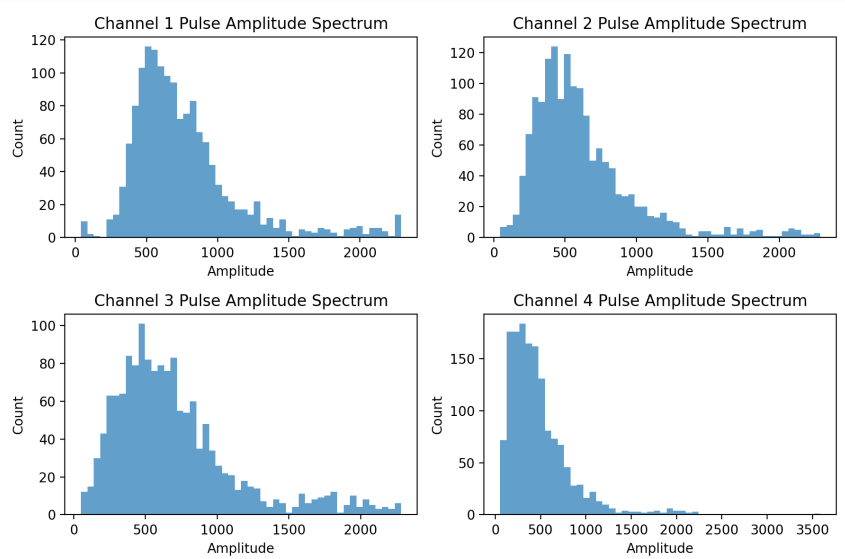
Rate： 80 MSPS

Bit Depth ： 12bit

Serial LVDS

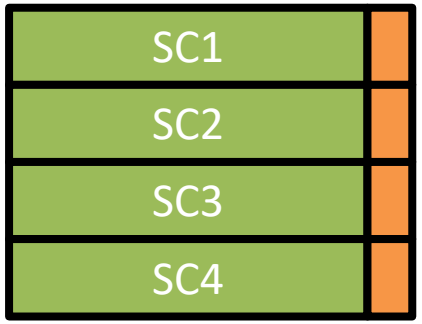
Performance in CR test





Mean of pulse height from CR: 300mV

Clear p.e. spectrum from dark counting

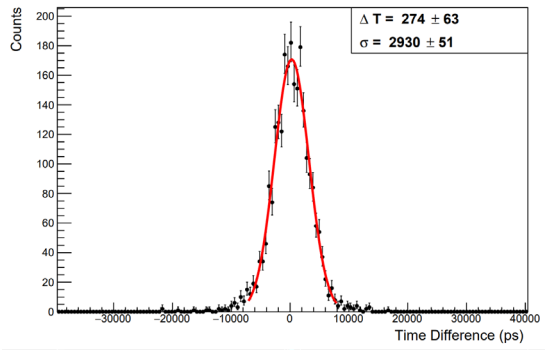


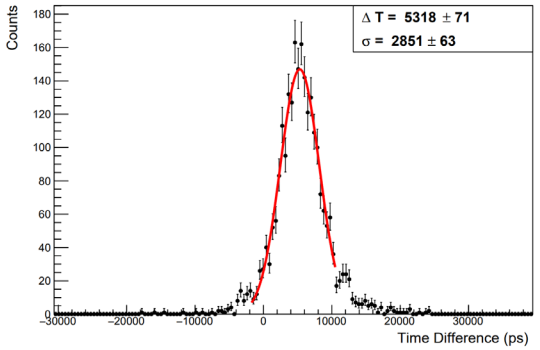
T1

T2

T3

T4





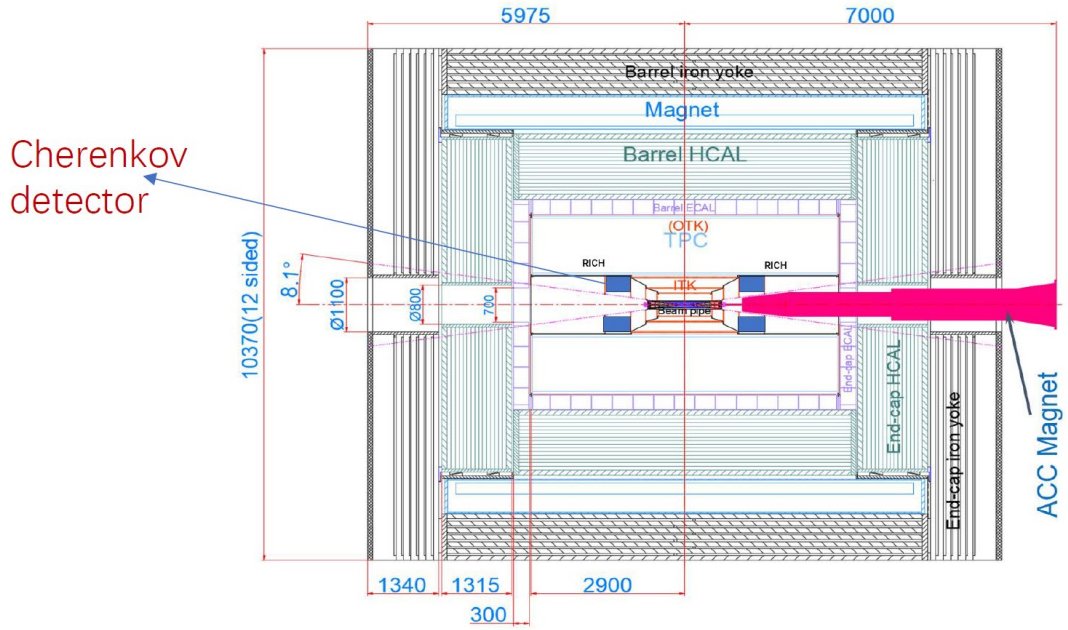
Time resolution: ~1.9ns

Plan for a detector module

- Should we build prototype module(s) in the near future?
- It will be good to demonstrate the R&D for CEPC detector.
- If so, how large should it be? Using 5m PS bars?
- Where to have such large module(s)? Space is an issue.

HMPID: High-Momentum PID

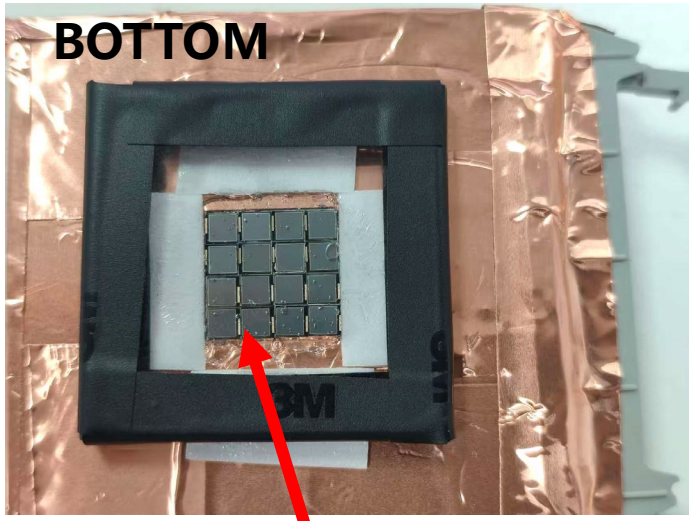
Preliminary consideration of a Cherenkov detector at CEPC

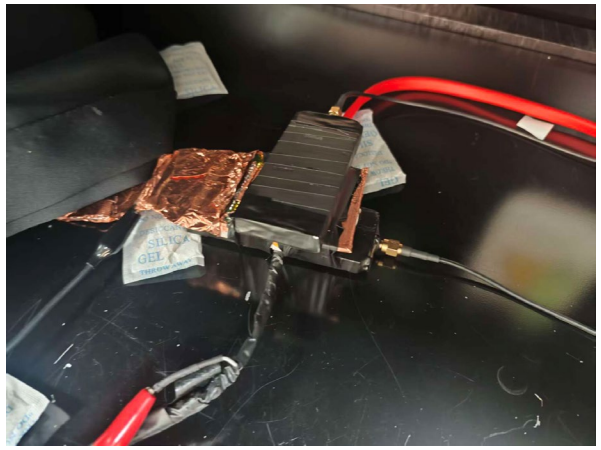


Zhonghua Qin, IHEP

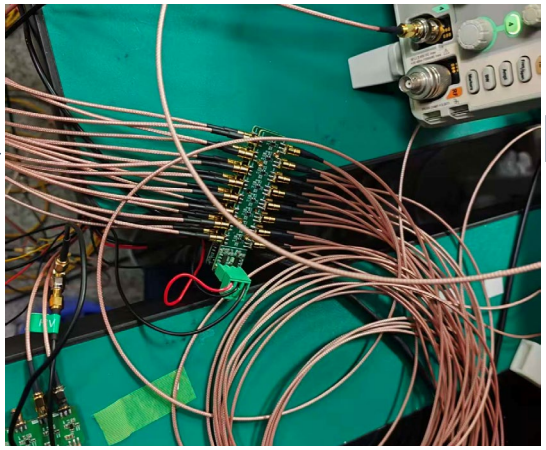
CEPC Workshop, Nov.9, 2025

Using SiPM to detect Cherenkov photons

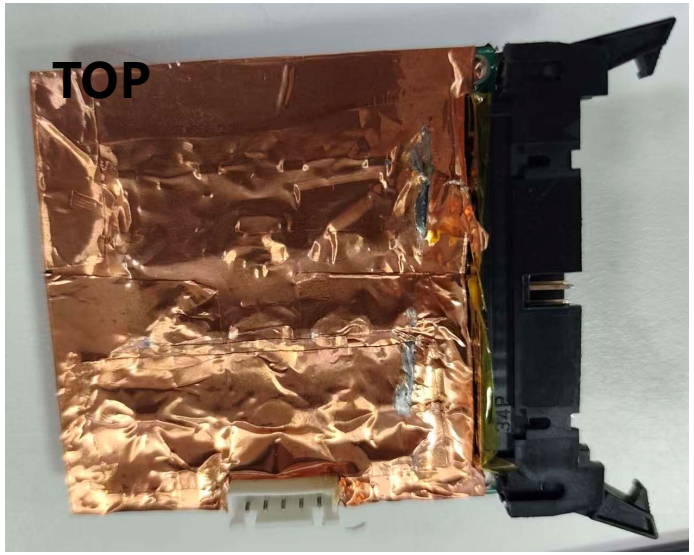


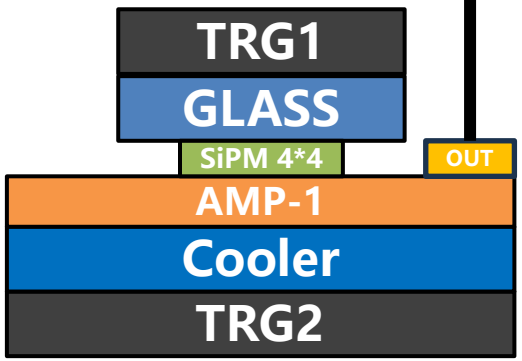


16ch

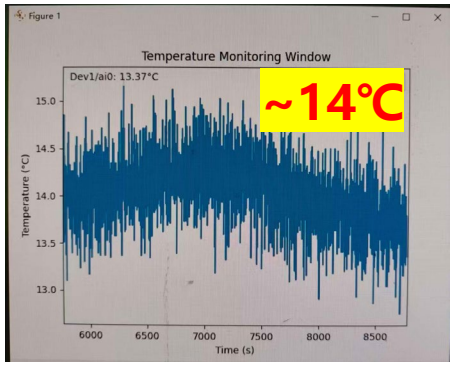


DAQ: DT5742





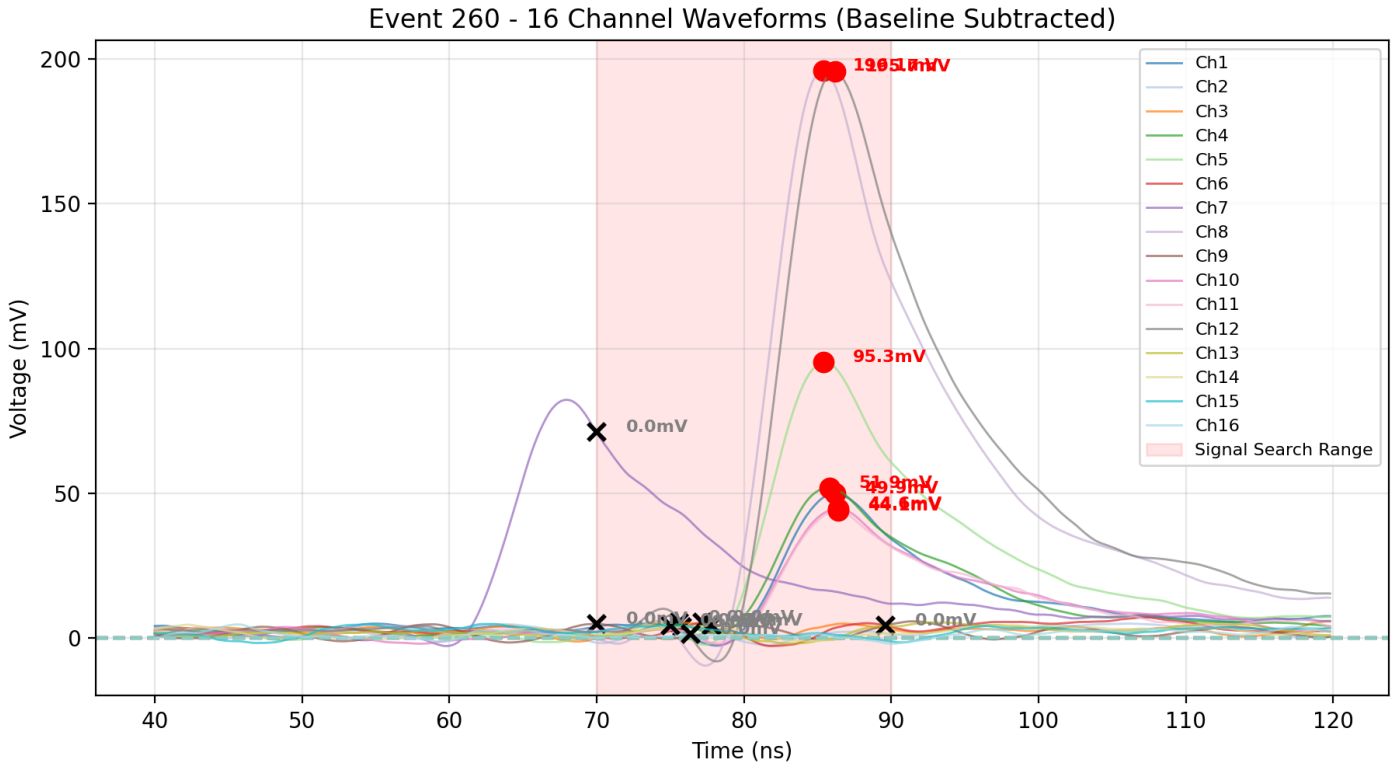
Temp Mon

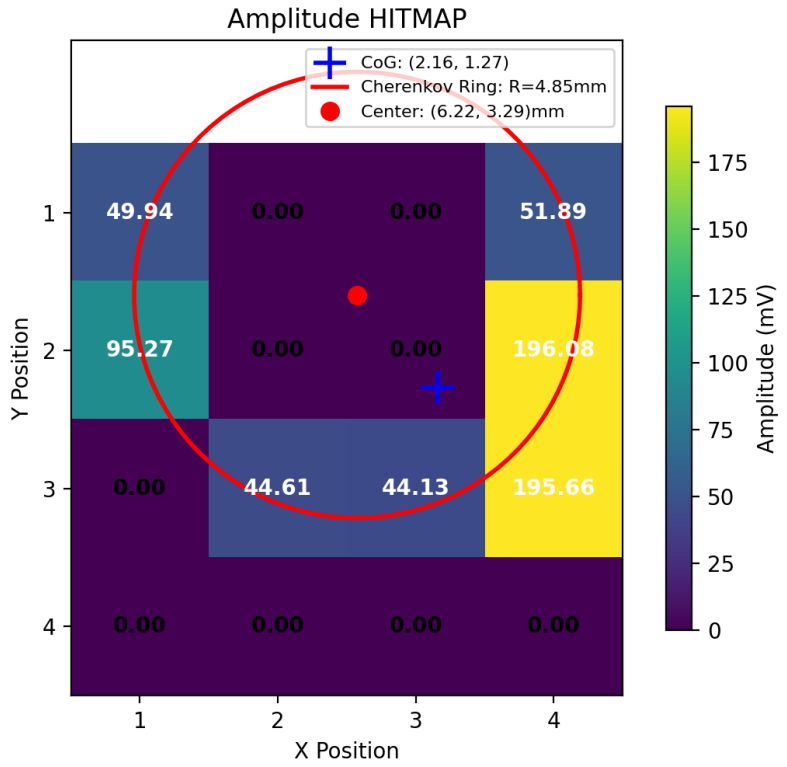


AMP-2 ×10

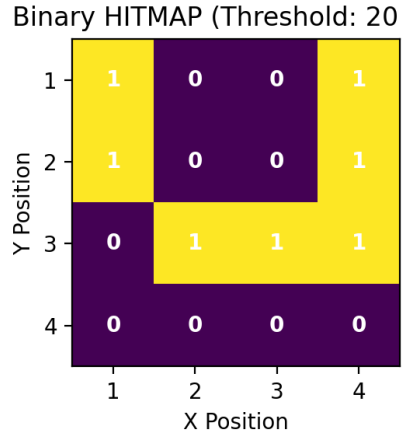
Digitizer

Signals of Cherenkov ring

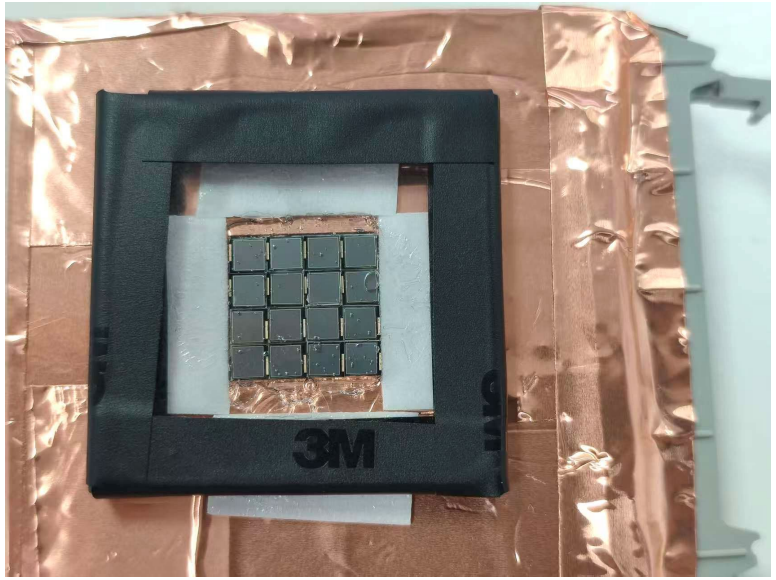


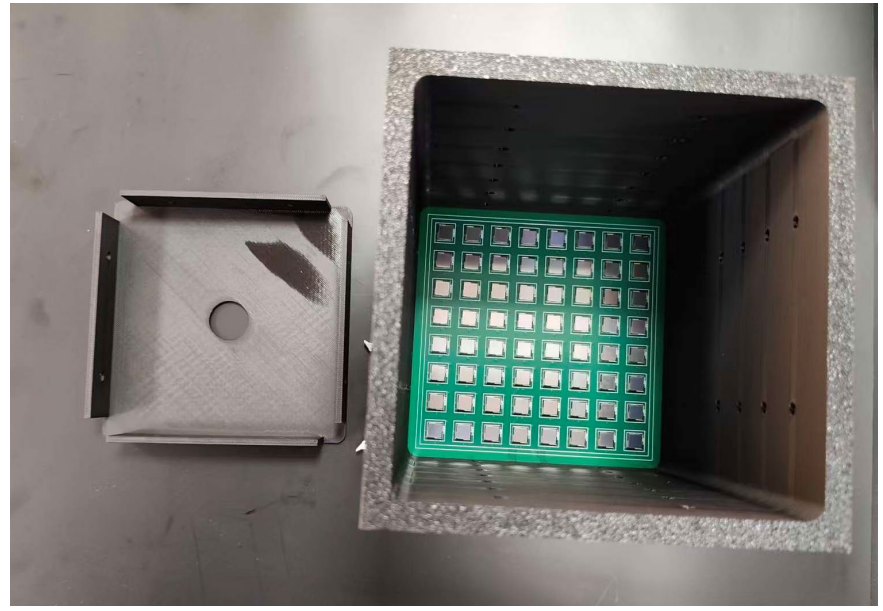


介质	厚度	内部切伦科夫角	出射角	出射光斑半径
石英	4.8mm	44.4°	78.1°	**22.7mm**
气凝胶	20mm	5.3°	5.33°	**1.87mm**



Improvement of R&D for HMPID

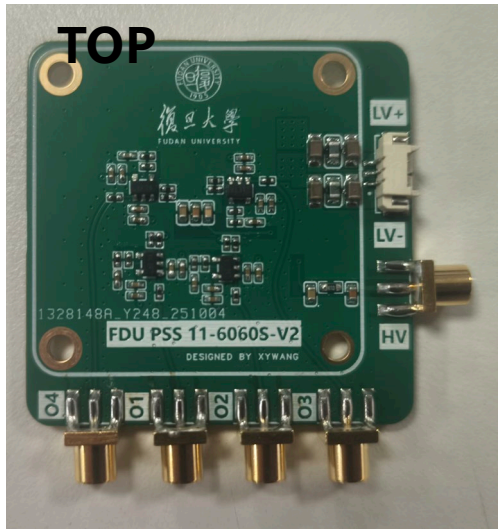


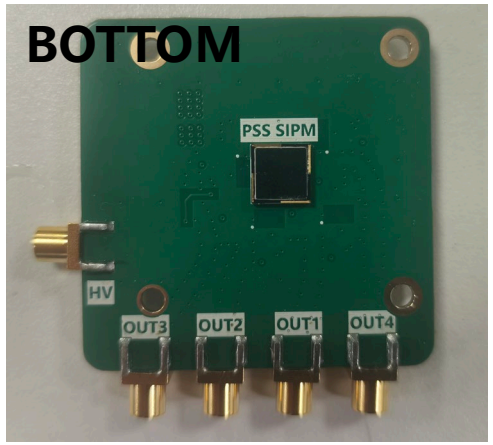


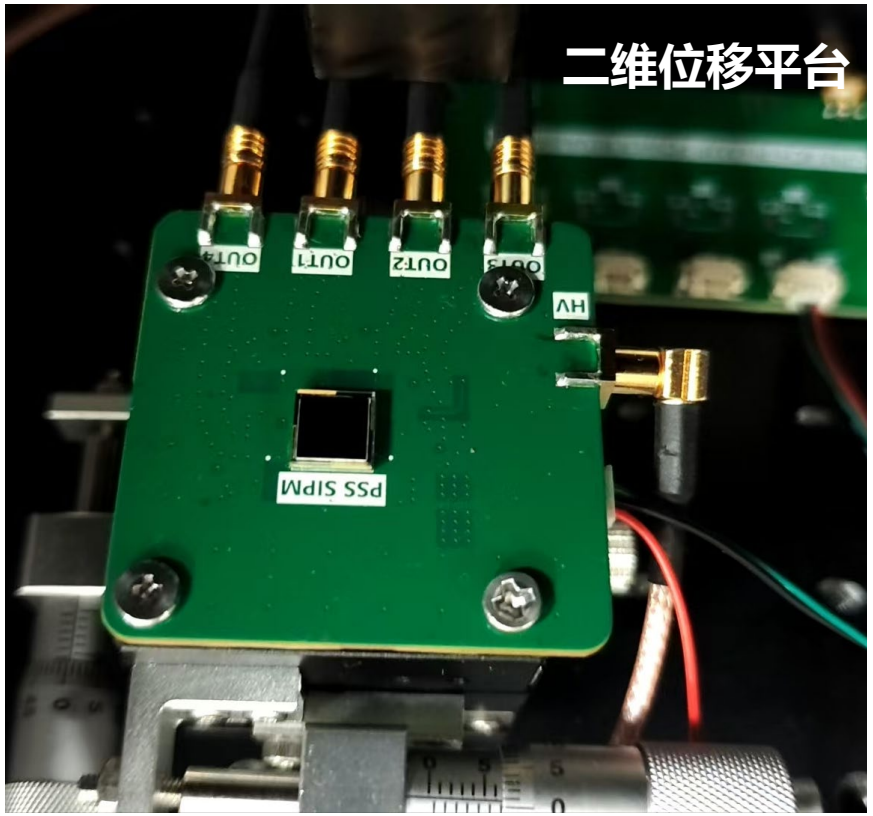
16 * 3mm SiPM Array

64* 6mm SiPM Array

Test on Position Sensitive SiPM (PSS)



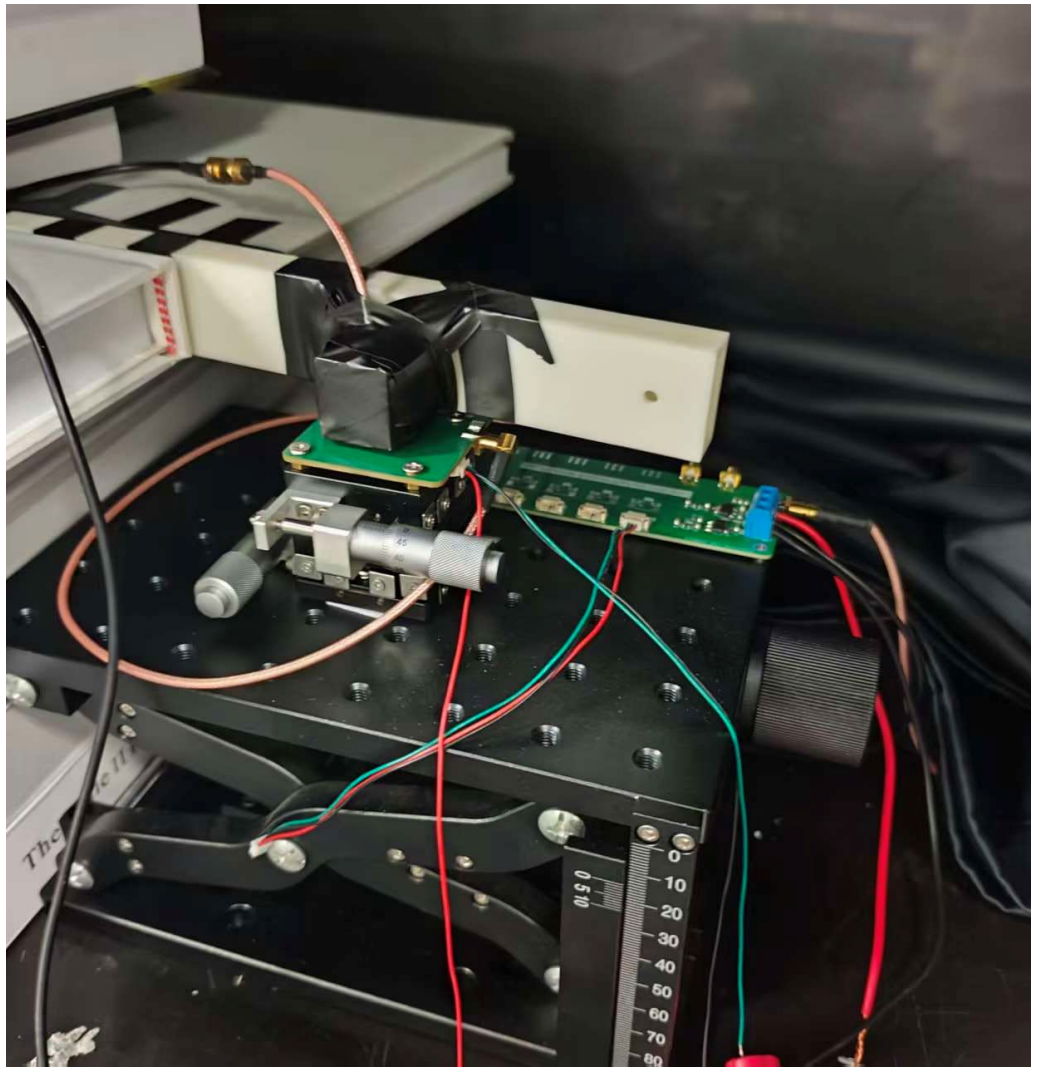




$$x_c = \frac{L}{2} \cdot k \cdot \frac{(Q_2 + Q_3) - (Q_1 + Q_4)}{(Q_1 + Q_2 + Q_3 + Q_4)}$$

$$y_c = \frac{L}{2} \cdot k \cdot \frac{(Q_3 + Q_4) - (Q_1 + Q_2)}{(Q_1 + Q_2 + Q_3 + Q_4)}$$

L is the length of the active area. Q_i (i = 1, 2, 3, 4) is the shared charge of the corresponding anode. k is the calibration factor.



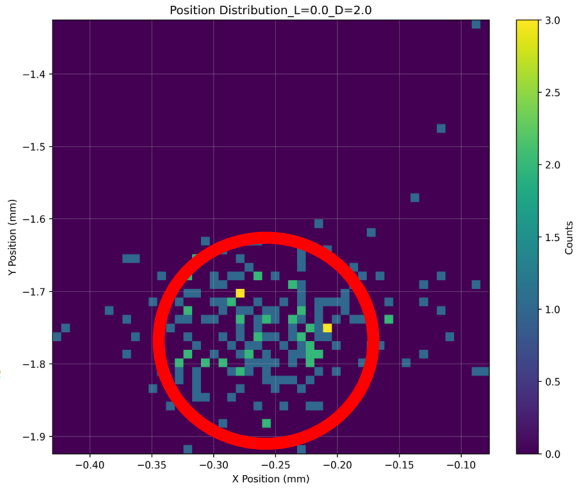
Fix the LED, move SiPM_PCB

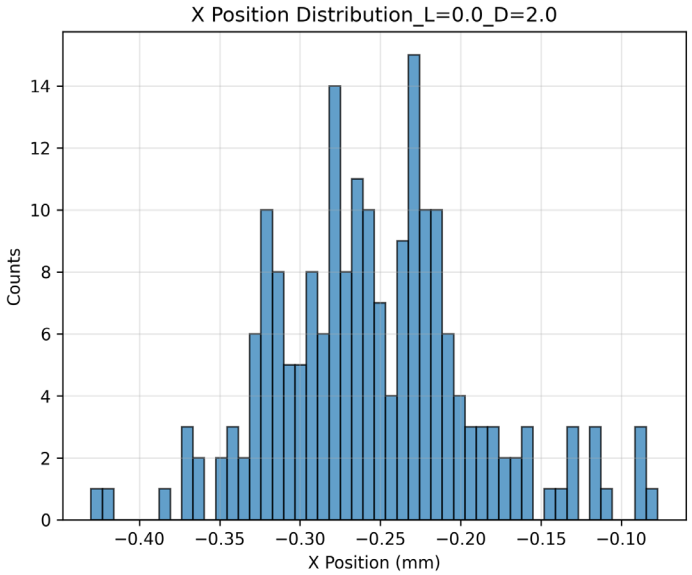
Reconstruction of single position

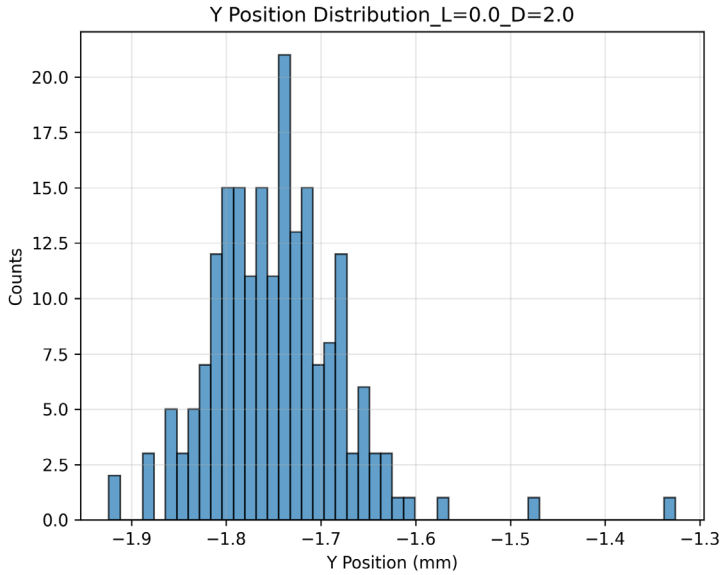
$$x_c = \frac{L}{2} \cdot k \cdot \frac{(Q_2 + Q_3) - (Q_1 + Q_4)}{(Q_1 + Q_2 + Q_3 + Q_4)}$$

$$y_c = \frac{L}{2} \cdot k \cdot \frac{(Q_3 + Q_4) - (Q_1 + Q_2)}{(Q_1 + Q_2 + Q_3 + Q_4)}$$

L is the length of the active area. Q_i (i = 1, 2, 3, 4) is the shared charge of the corresponding anode. k is the calibration factor.







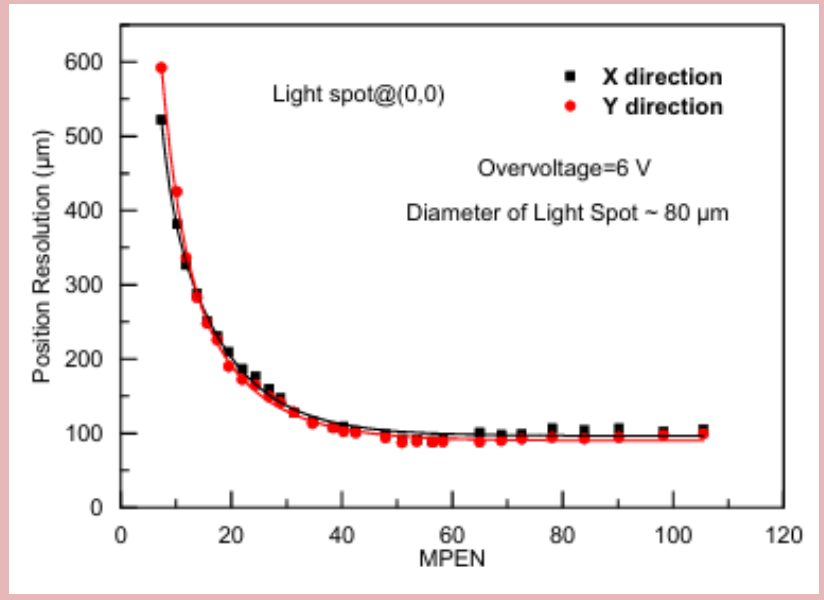
$\sigma_X = 0.062mm$

$\sigma_Y = 0.070mm$

R of light spot~200um

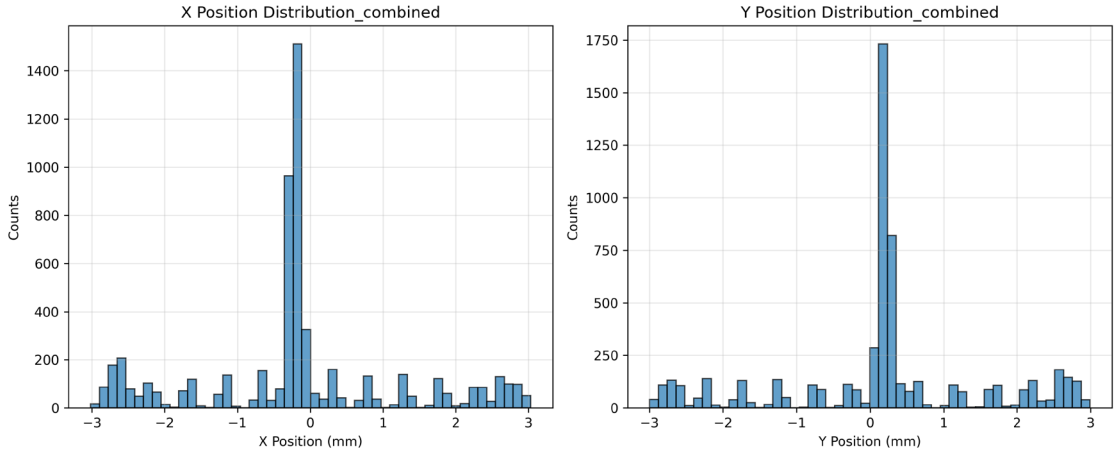
Position resolution~70um

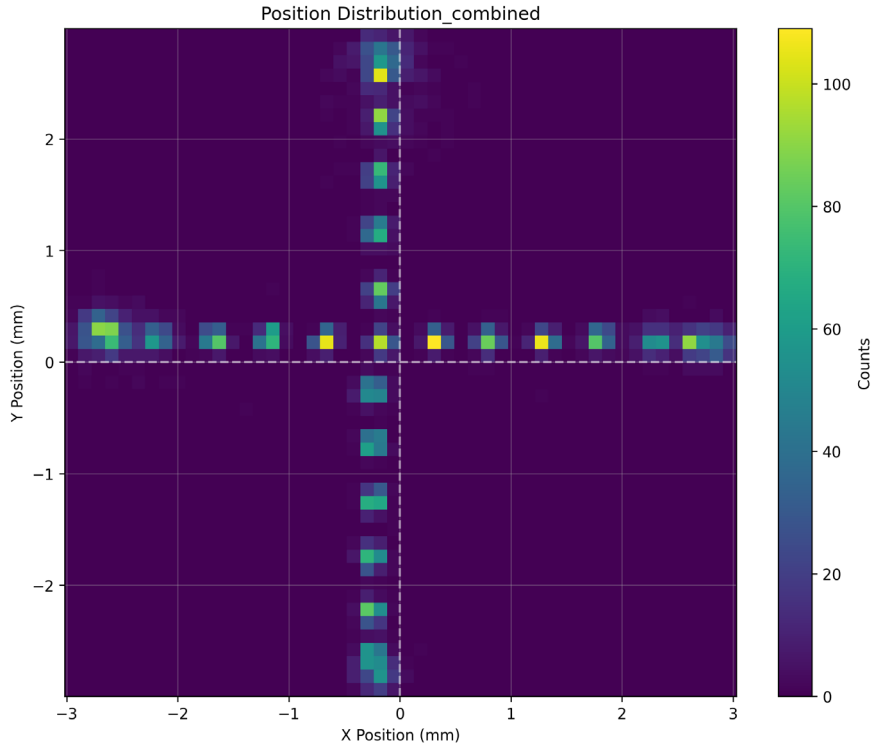
Results depend on the R of light spot

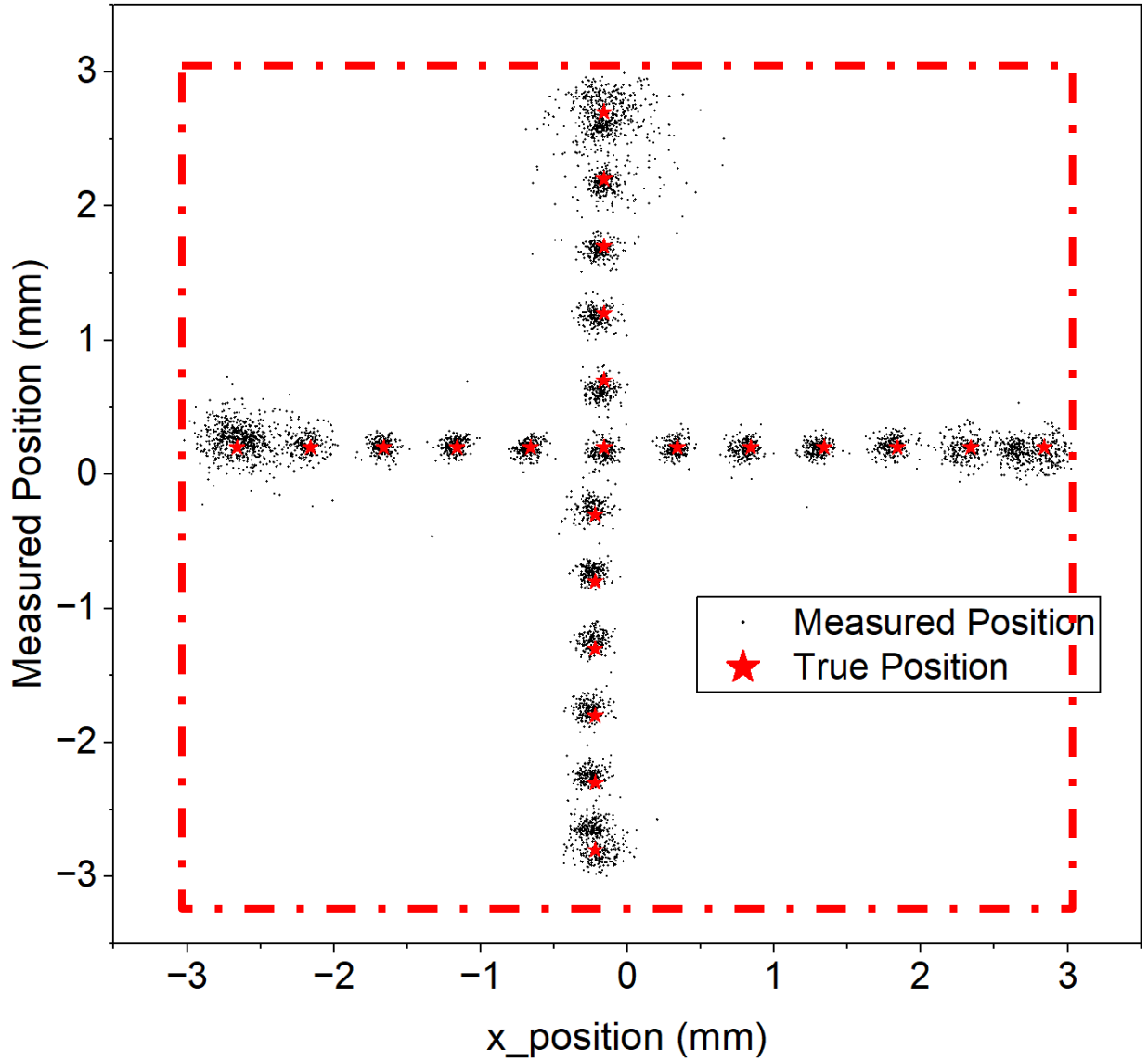


PSS datasheet: spatial resolution vs nPE

Reconstructions of multiple positions







Spatial resolution reduces near the boarders.