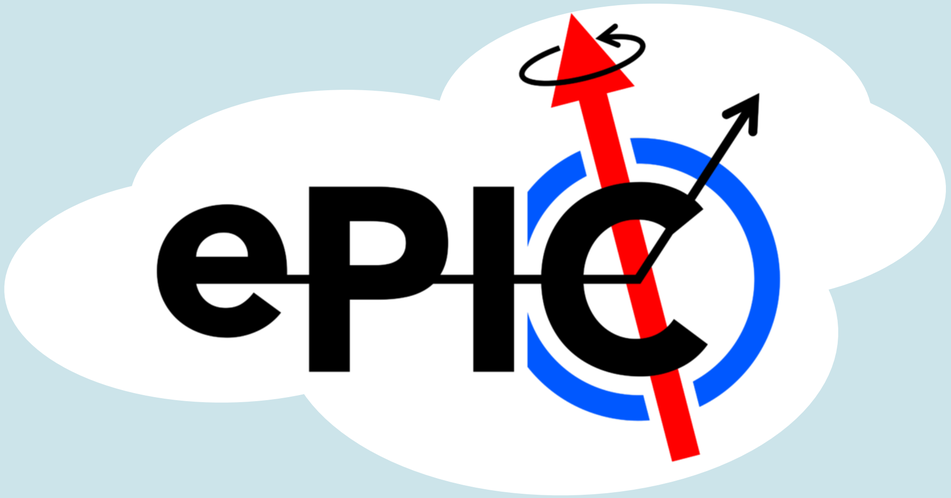
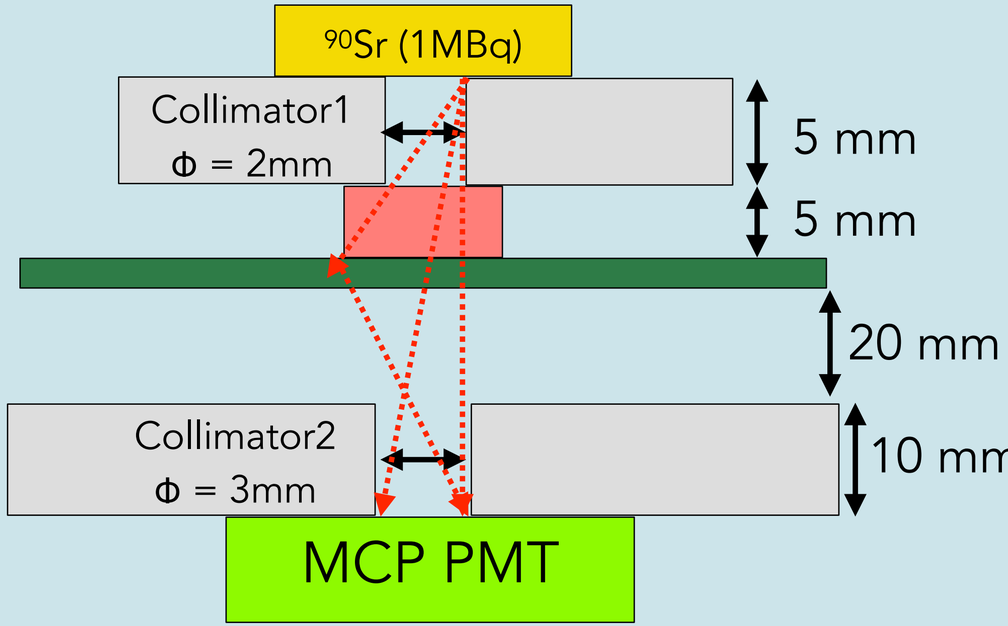


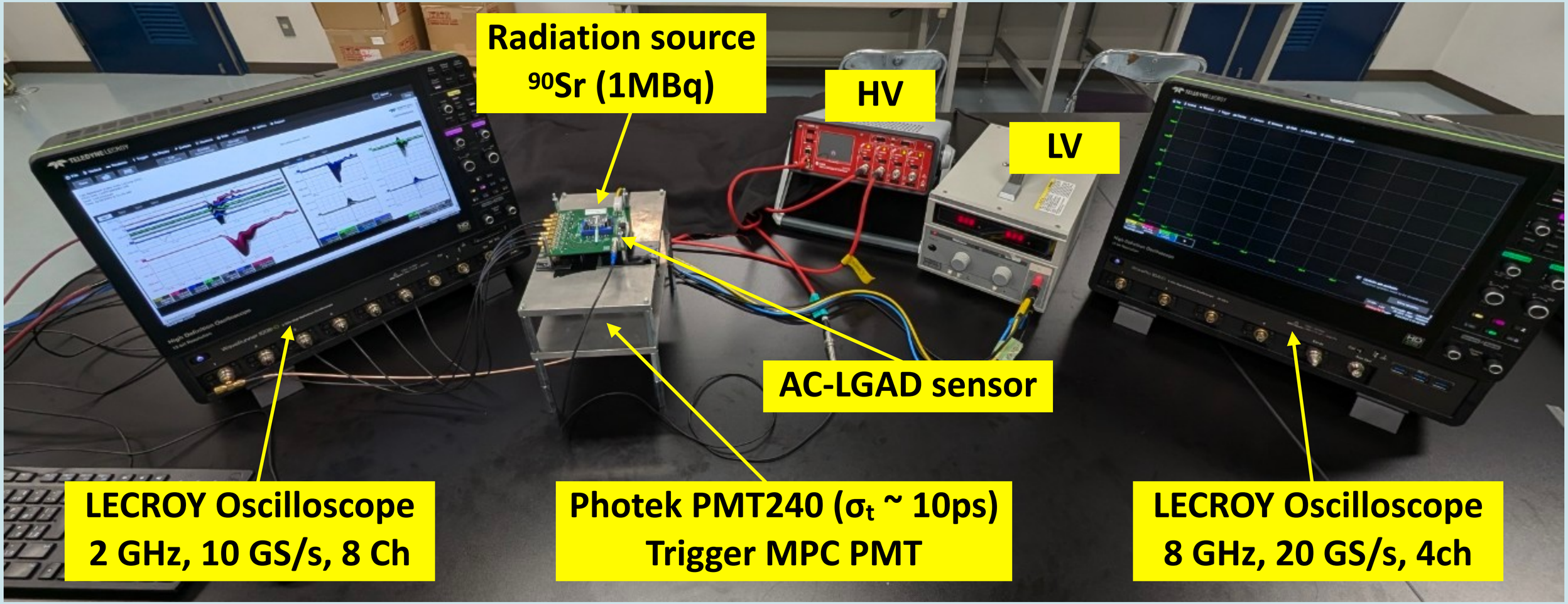
AC-LGAD activity @ HU

Satoshi Yano (Hiroshima University)

Sensor test-bench at Hiroshima University

- Goals: Studying the temperature dependence of sensor performance
  - Temperature affects to AC-LGAD sensor performance
- Peltier device fits to control temperature
  - Fine temperature control
  - applicable not only lab tests but also beam tests
- Mimic the ASIC effects on the sensor
  - Pertier device can be placed in the same location as the ASIC to mimic temperatures to reproduce conditions similar to the real thing




Radiation source
^{90}Sr (1MBq)
HV
LV
AC-LGAD sensor
LECROY Oscilloscope
2 GHz, 10 GS/s, 8 Ch
Photek PMT240 (σ_t ~ 10ps)
Trigger MPC PMT
LECROY Oscilloscope
8 GHz, 20 GS/s, 4ch

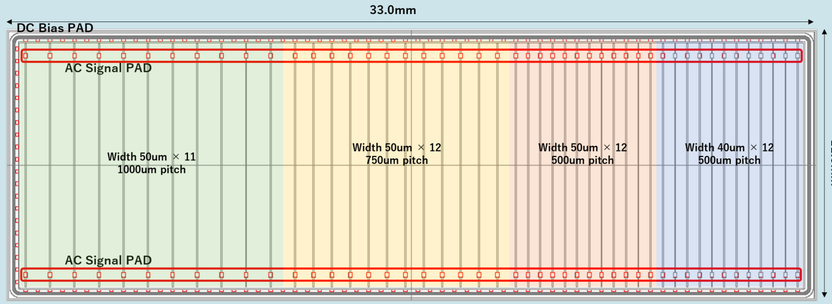
Current situation

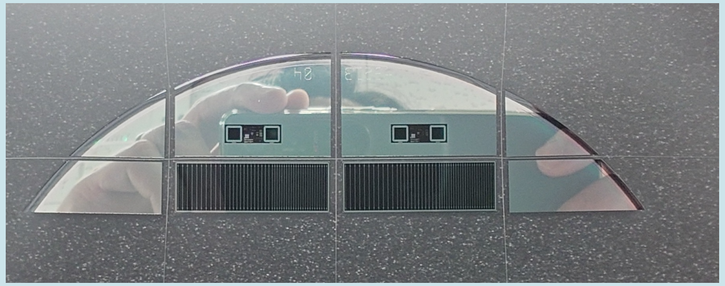
- We are in the process of making the FY25 budget available in Japan, and it will be finished soon
  - Just after the completion, we will build the temperature control system (in a month)

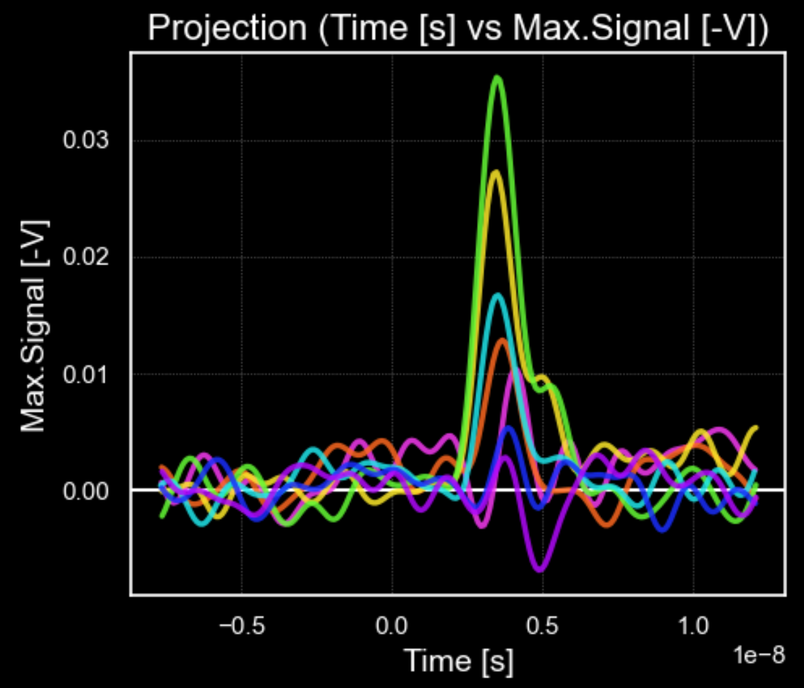
- The full-size sensor has been provided by HPK directly
  - 33 x 11 mm^2, 50um (same as the eRD112 FY24 sample)

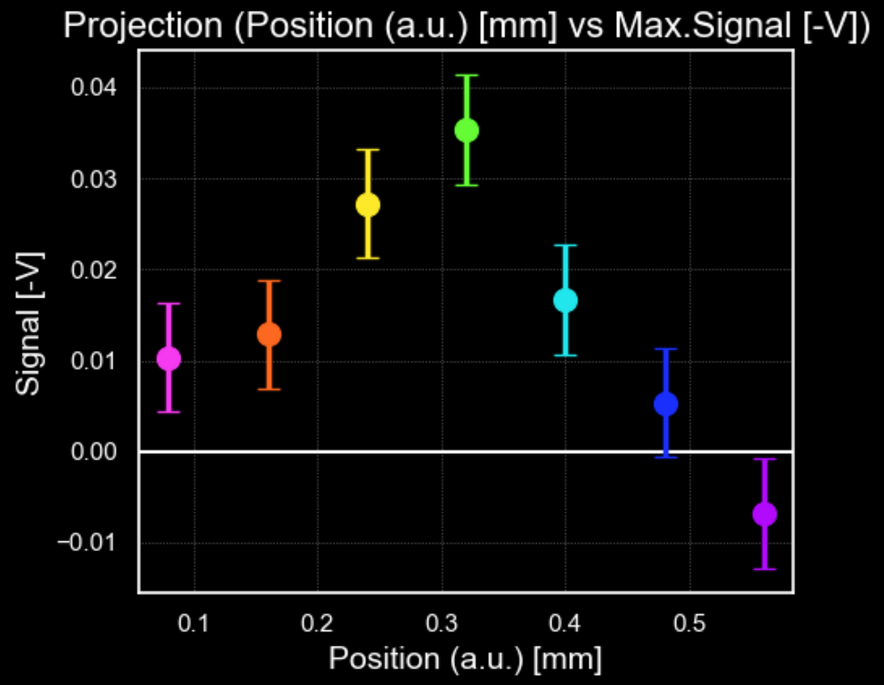
- We are looking forward to receiving boards for full-size sensor from UCSC
  - I hope they will be shipped to Japan this month

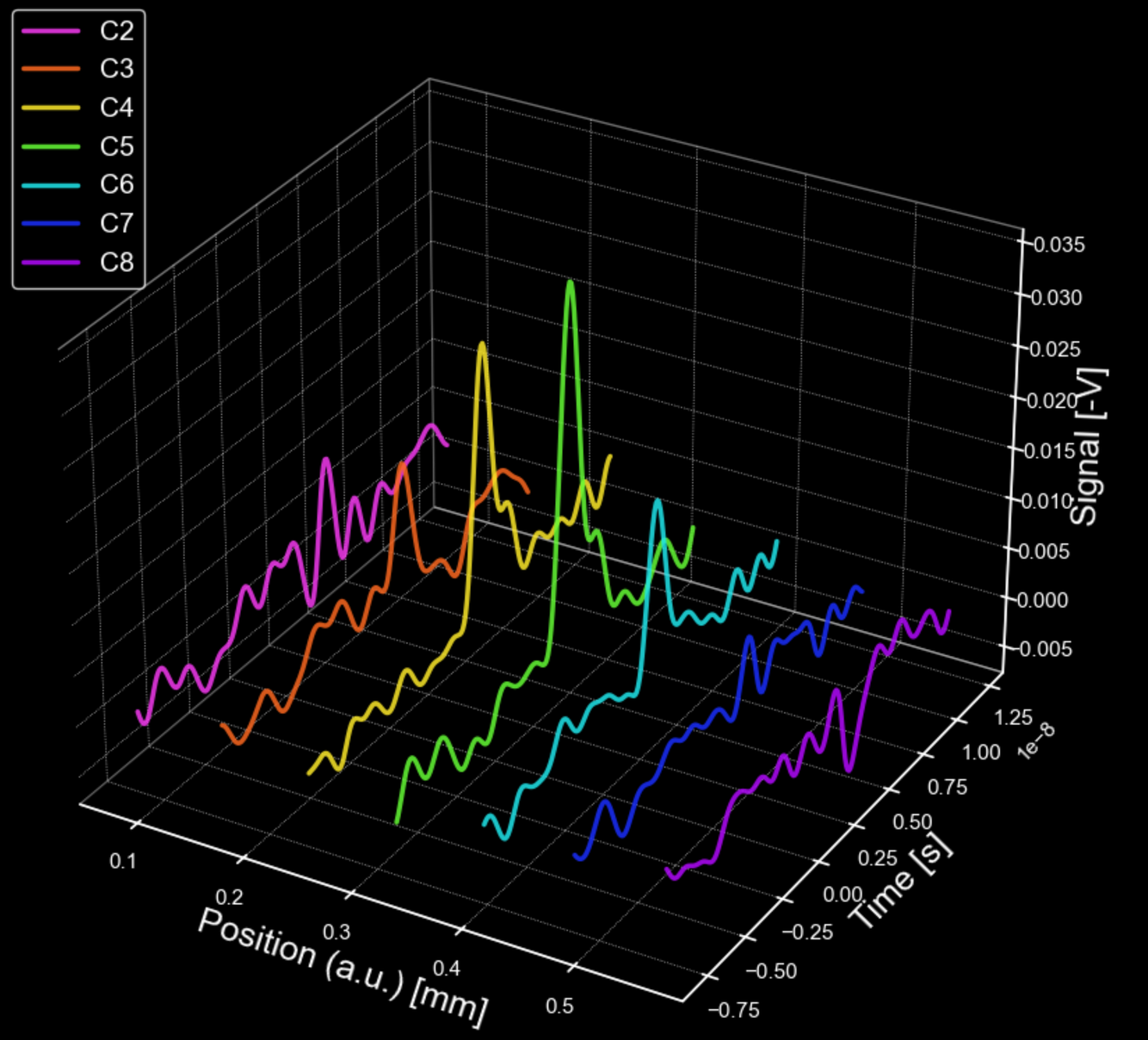
- While waiting for these things to happen, we have continued to build test benches with Sr90 as a MIP source
  - Using strip sensor+board borrowed from Koji Nakamura (KEK)
  - We are preparing to start research as soon as the board arrives





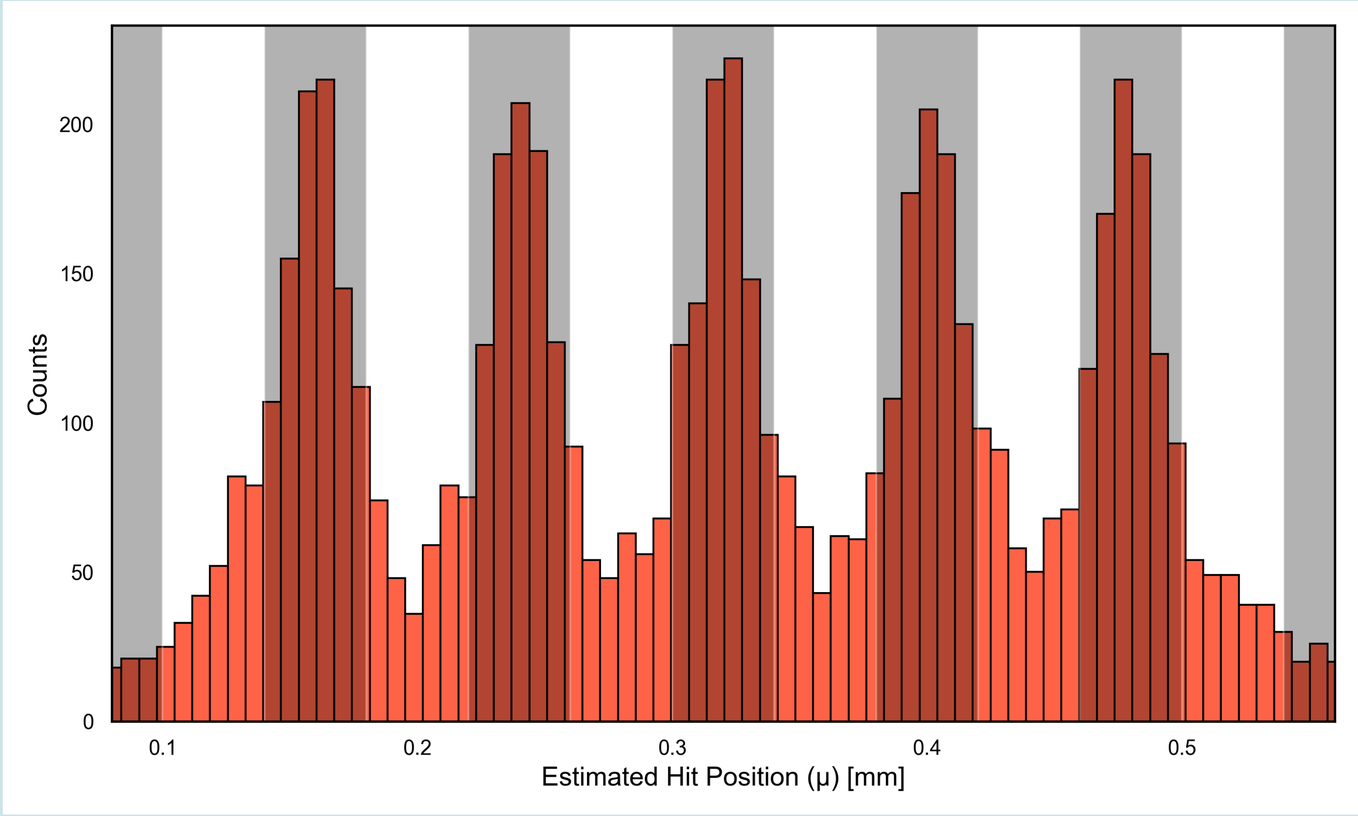

Projection (Time [s] vs Max.Signal [-V])
Max.Signal [-V]
0.03
0.02
0.01
0.00
−0.5
0.0
0.5
1.0
Time [s]
1e−8


Projection (Position (a.u.) [mm] vs Max.Signal [-V])
Signal [-V]
0.04
0.03
0.02
0.01
0.00
−0.01
0.1
0.2
0.3
0.4
0.5
Position (a.u.) [mm]


3D Waveform View - Event 00015
C2
C3
C4
C5
C6
C7
C8
Signal [-V]
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.005
Time [s]
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
1e−8
Position (a.u.) [mm]
0.1
0.2
0.3
0.4
0.5

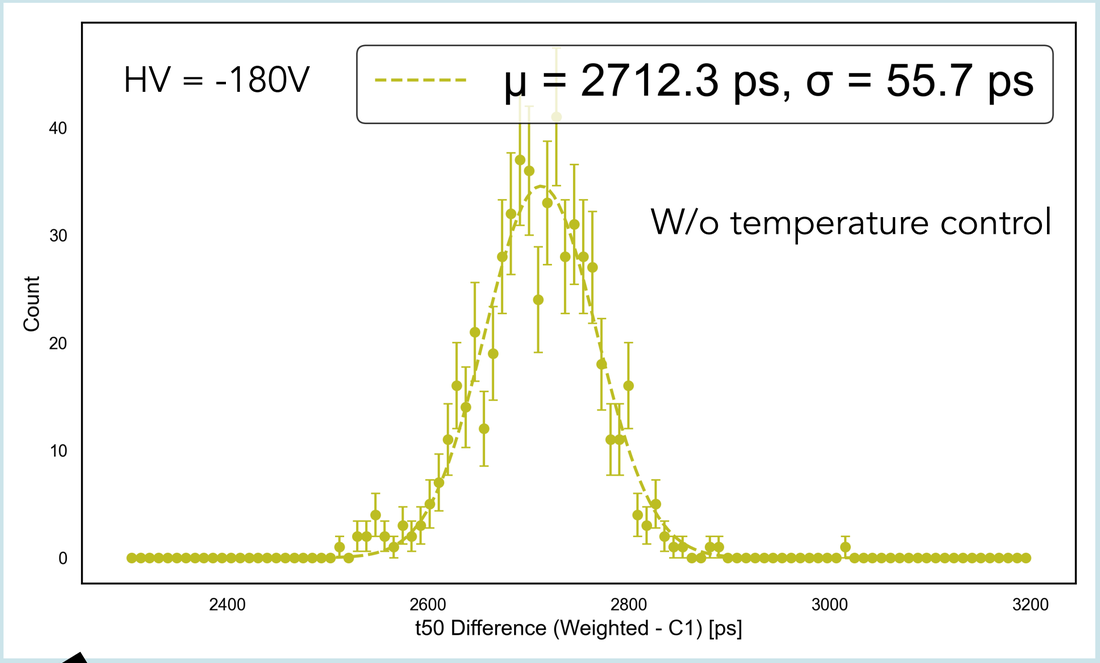
Reconstructed hit position

Gray area = Strip position (40μm width, 80μm pitch)



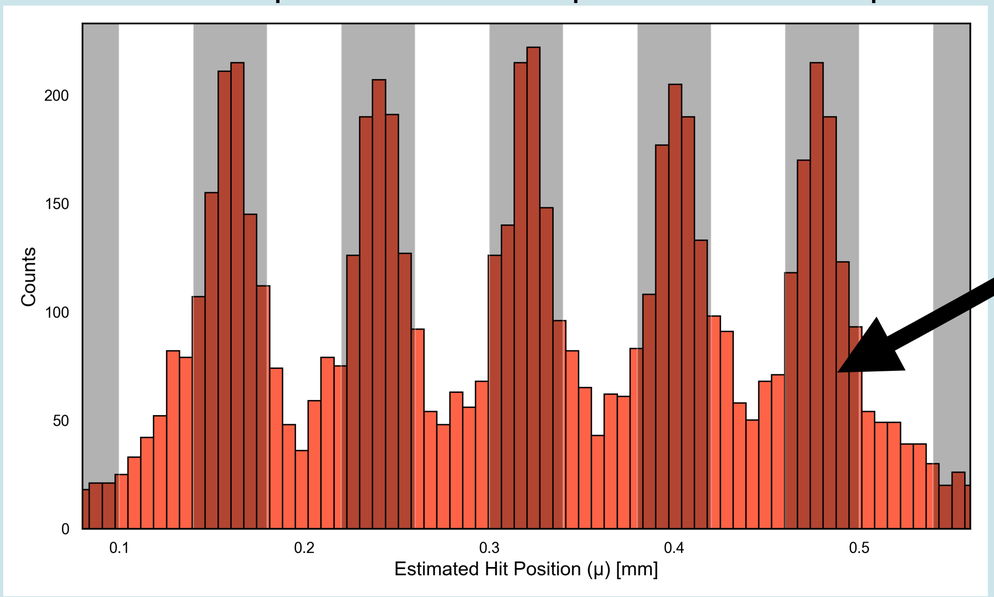
- Reconstructed hit position (fitted the signal strength of top 3 strips)
- Using 3 points decreases the efficiency between strips

Timing resolution



63.7 ps 56.4 ps

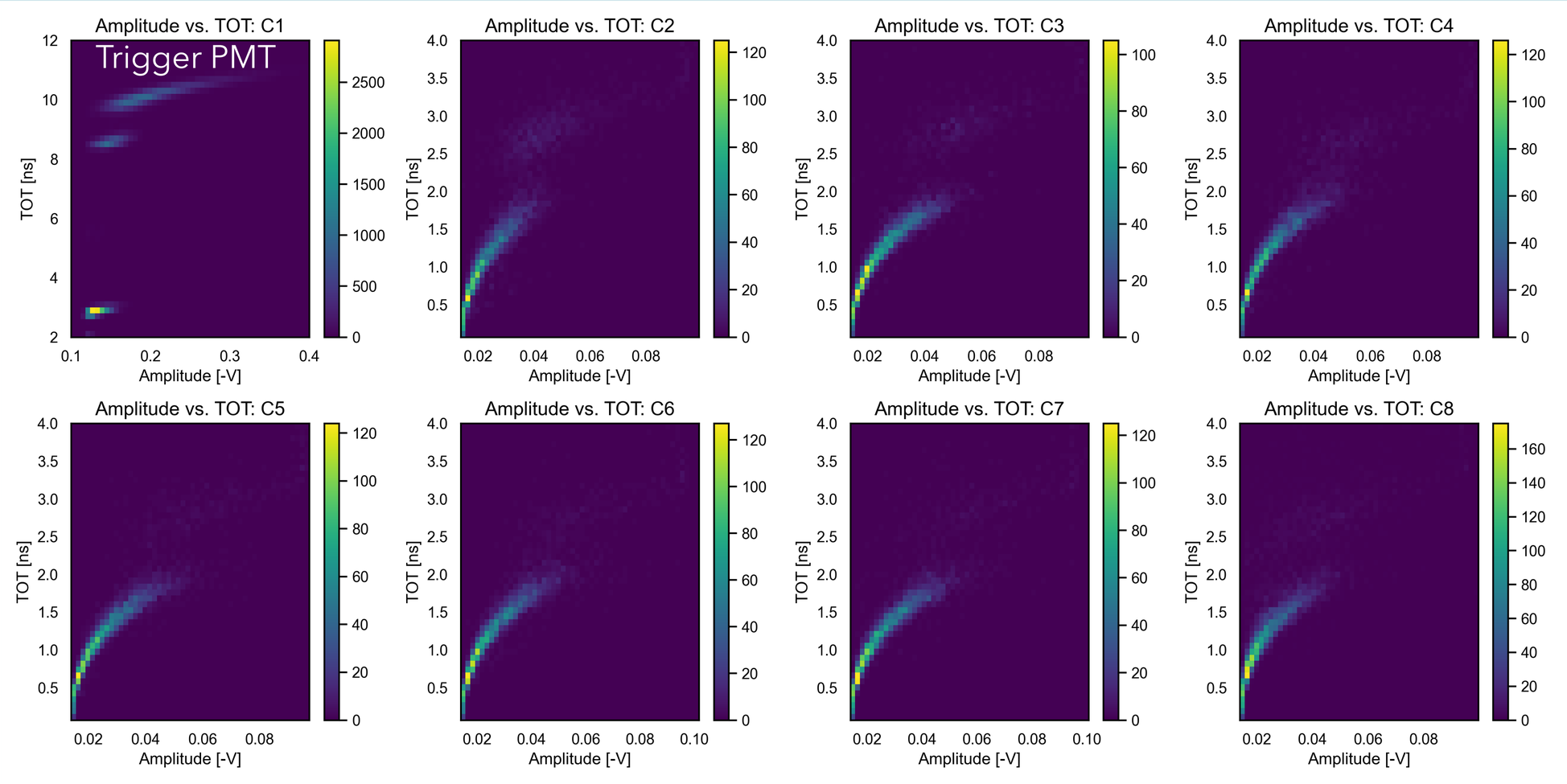
63.5 ps 59.4 ps 55.7 ps



Beta ray energy of ^{90}Sr is <1 MeV (in average), so multiple scattering can affect to enhance the path length uncertainty

Comparison of sensor and electronics performance can be evaluated by MIP (preparation for the beam test)

Signal strength v.s. TOT



We start to study if TOT (Time-Over-Threshold) can be used to measure signal

What to expect in the rest of FY25

- We will measure the timing resolution of the full-size sensor + board as soon as it arrives
  - Board made in Japan will be relesed in 2 months (main goal is checking the input capacitance matching)

- The temperature control system will be purchased and start to measure temperature dependence of sensor performance as soon as completion of the paper work

- We are preparing for the beam test in Japan (Autumn)
  - ELPH@Tohoku: 800 MeV electron beam @ 200-400 Hz
  - PF-AR@KEK: Max 5.5 GeV electron @ ~1000 Hz

- Possibly we can use RANS@RIKEN for the irradiation facility
  - 10^{12}/s Neutron with maximum 5 MeV

The sensors we are preparing

- **Baseline sensor**
  - Electrode geometry (1 type) : # channel 64x2=128 ch、pitch: 0.5 mm, size: 10 x 0.05 mm^2
  - Active thickness (2 types)：20、30μm

2 types

- **Different active layer thickness and electrode geometry for further improvement of time resolution**
  - Electrode geometry (1 type) : # channel 32x4=128 ch、pitch: 1 mm, size: 5 x 0.05 mm^2
  - Active thickness (2 types)：20、30μm

2 types

- **Double metal layer implementation**
  - Electrode geometry (2types): # channel 64x2=128 ch、pitch: 0.5 mm, size: 10 x 0.05 mm^2
  - # channel 32x4=128 ch、pitch: 1 mm, size: 5 x 0.05 mm^2
  - Active thickness (2 types)：20、30μm
  - Readout-layer (2 types)：single-side, double-side

8 types

- **Others**
  - Electrode geometry (1 type) : # channel 32x2=64 ch、pitch: 1 mm, size: 10 x 0.05 mm^2
  - Active thickness (2 types)：20、30μm

2 types