AC-LGAD Beam Test at Jlab in 2025

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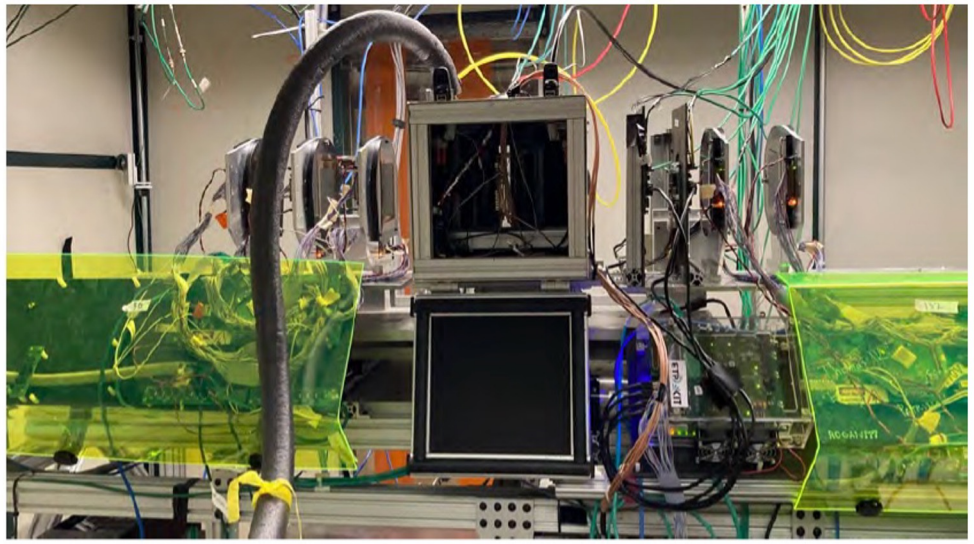
LBL

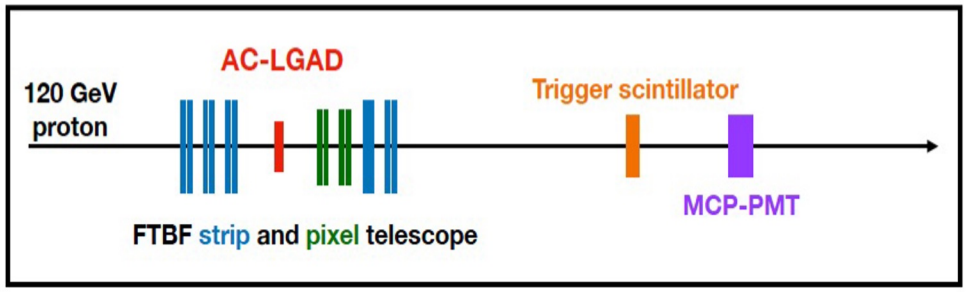
AC-LGAD Beam Tests in 2022-2023 at FTBF

- Sensors with different configurations produced by BNL-IO and HPK, and tested with 120GeV protons
  - Constrained by the availability of the FTBF telescope
  - Not straightforward to add new detectors for data taking and analysis

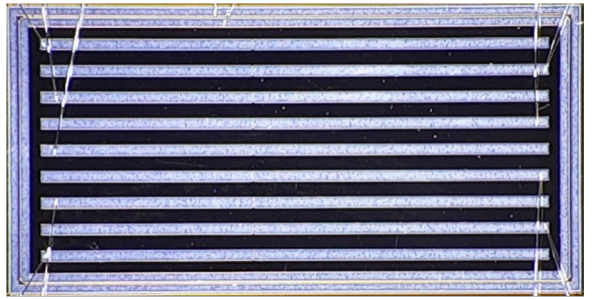
=> Assemble a movable telescope for ePIC SVT and AC-LGAD

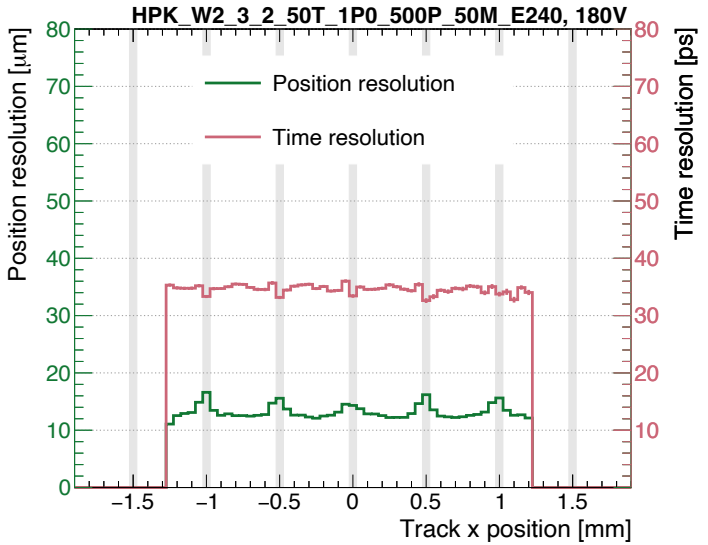
Fermilab Test Beam Setup



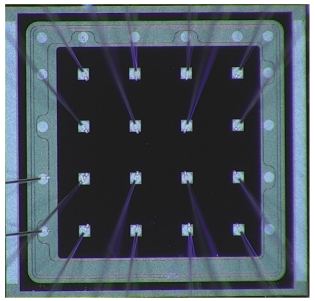


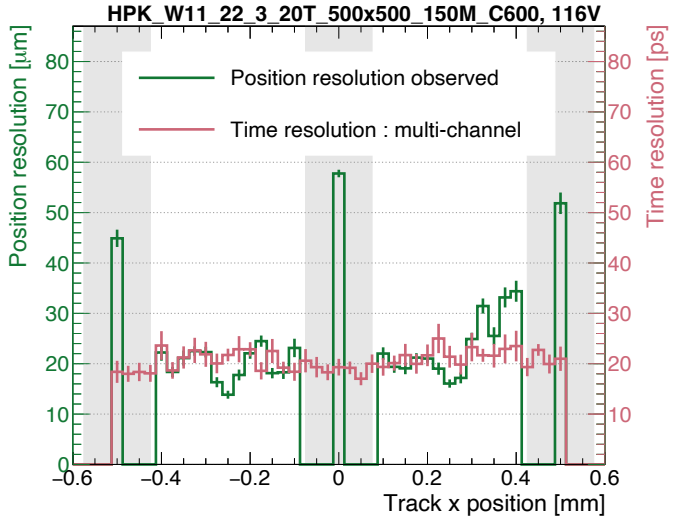
HPK Strip Sensor (4.5x10 mm²)



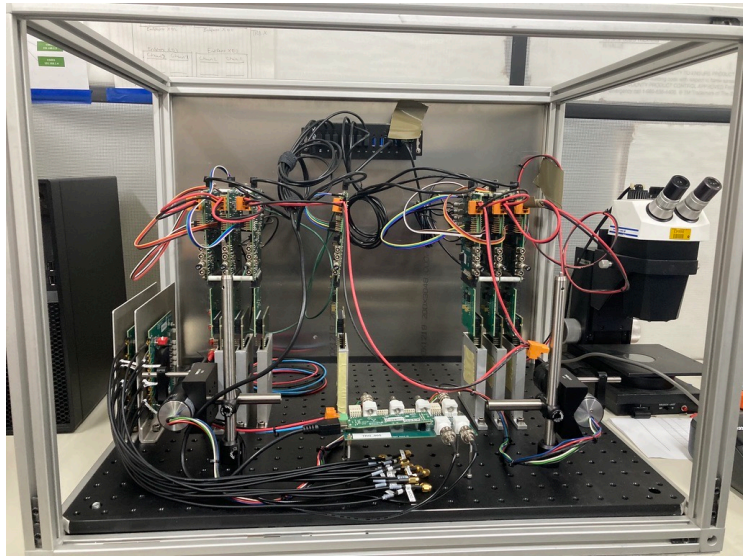


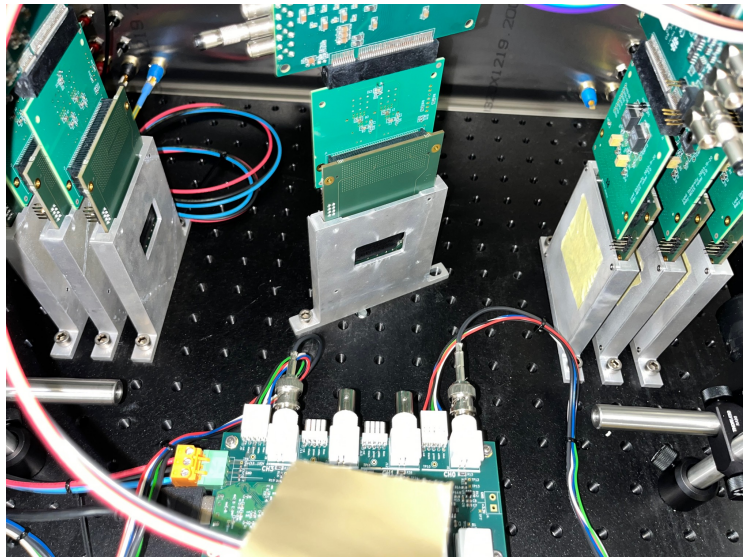
HPK Pixel Sensor (2x2 mm²)

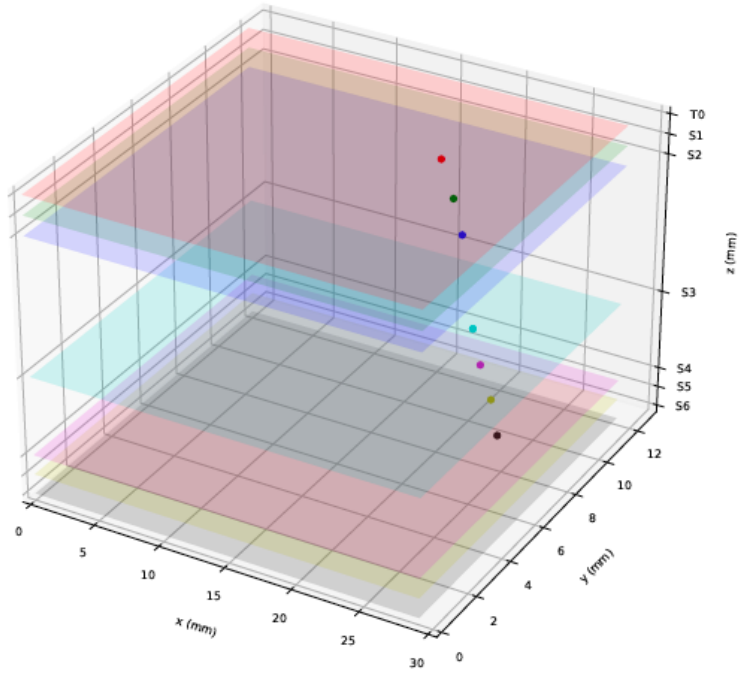


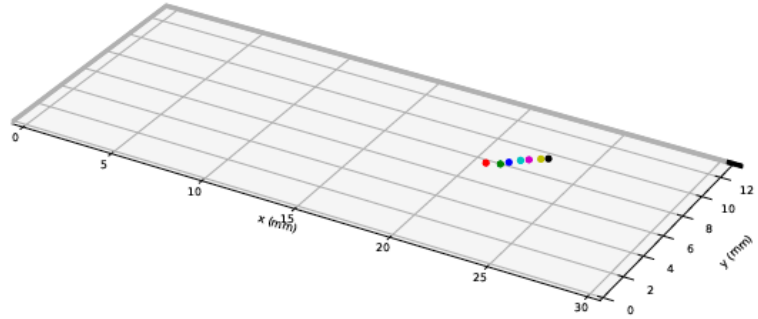


MAPS Beam Test in 2024 at FTBF



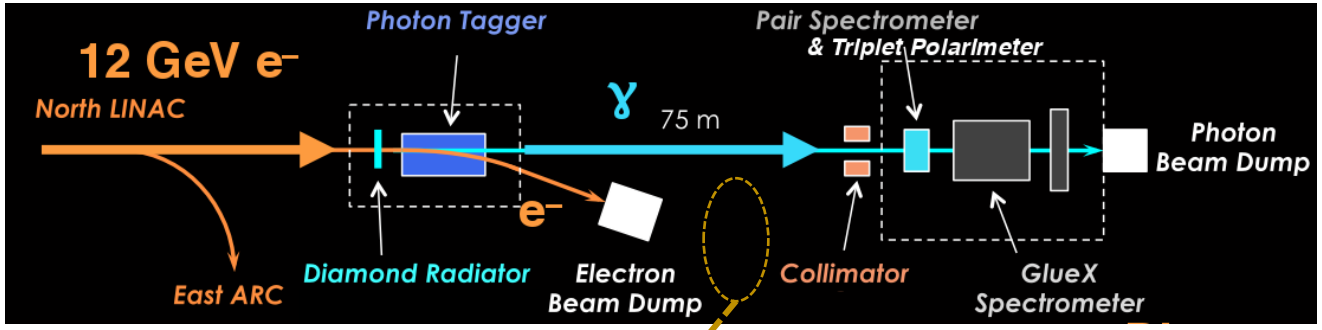


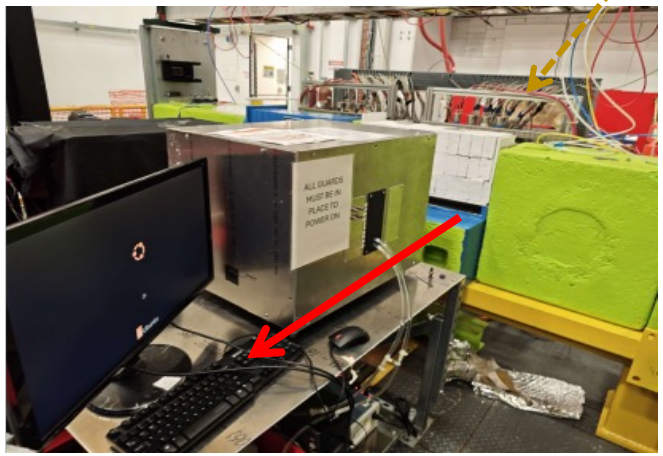




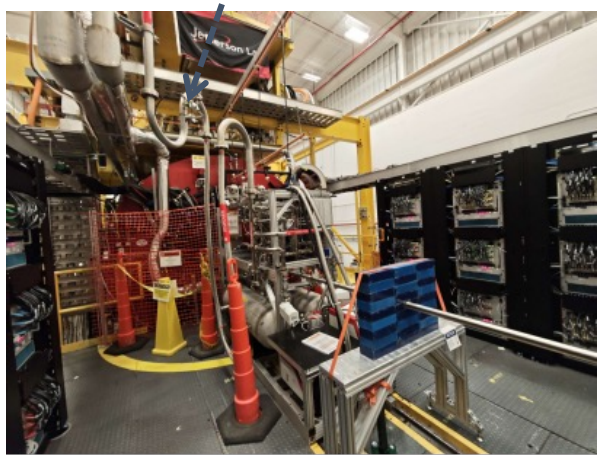
MAPS Beam Tests in 4/2025 at JLab

3~6 GeV electrons generated by Gamma beam

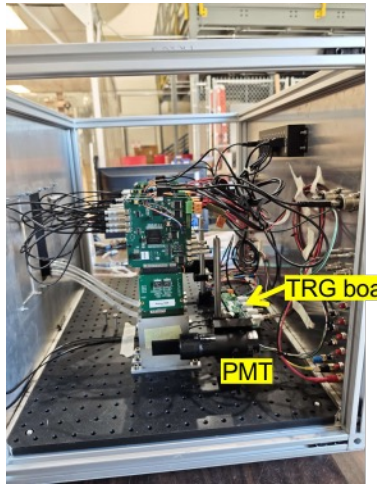


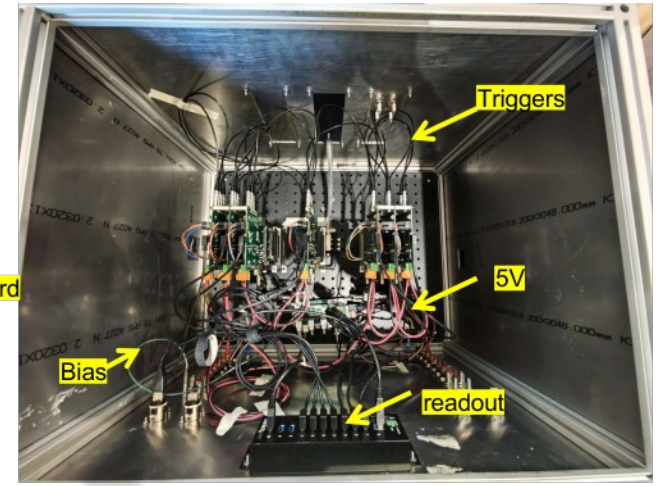


Beam direction

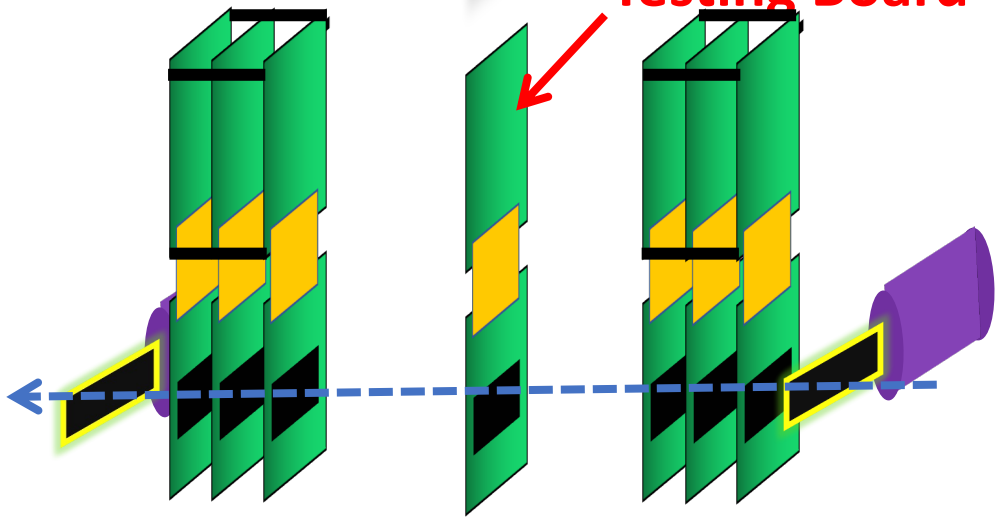


JLab Hall-D Glue X

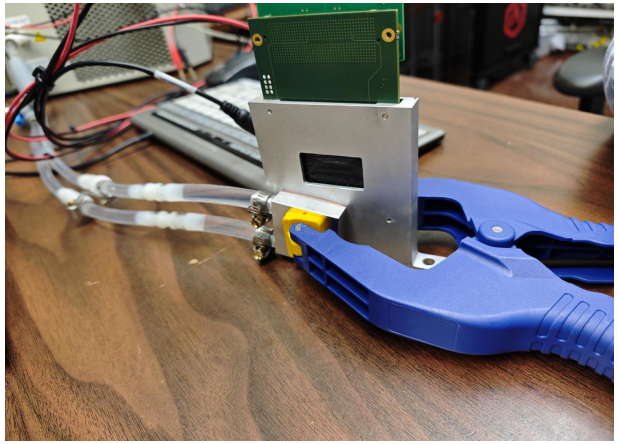




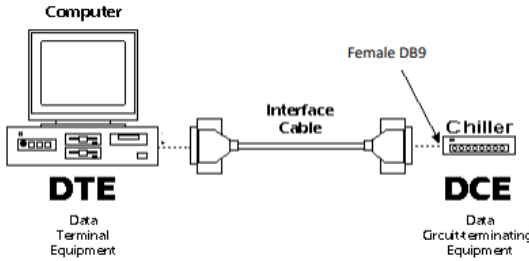
Testing Board



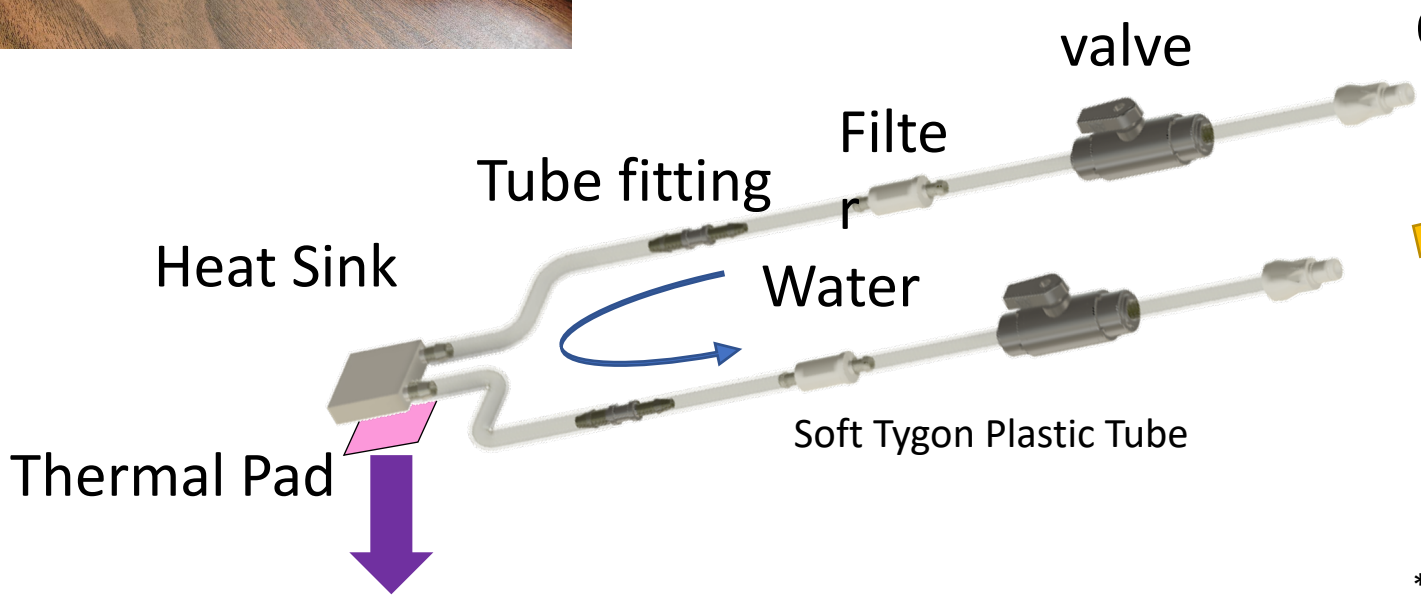
Cooling Used for MAPS Beam Tests in 4/2025 at JLab



Remote control with 8bit Hexadecimal command



RS-232



Attach to the Aluminum board holder

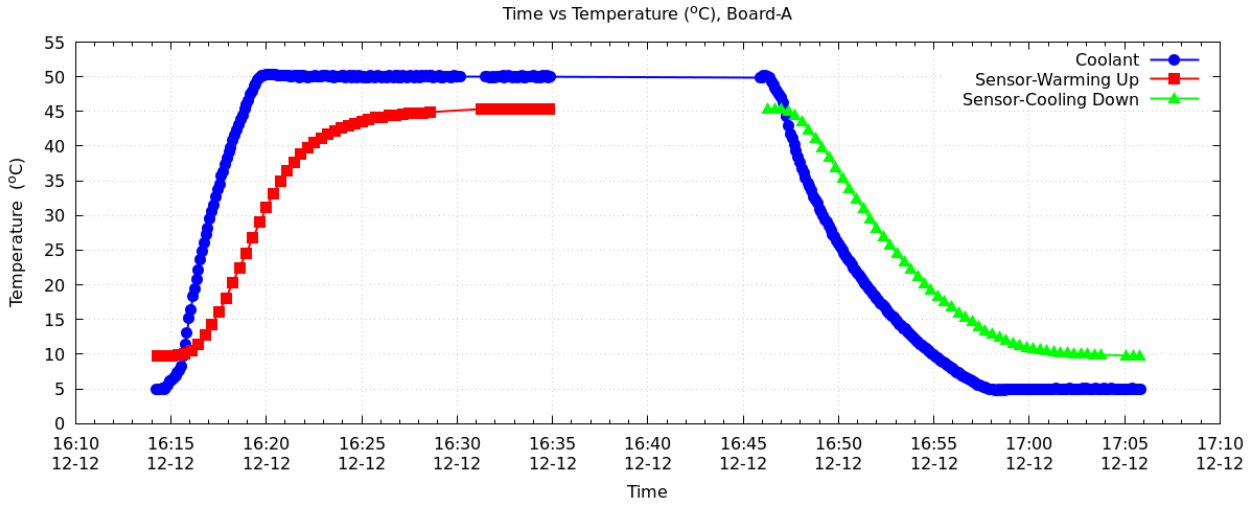
Standard: 5 ~ 50 °C

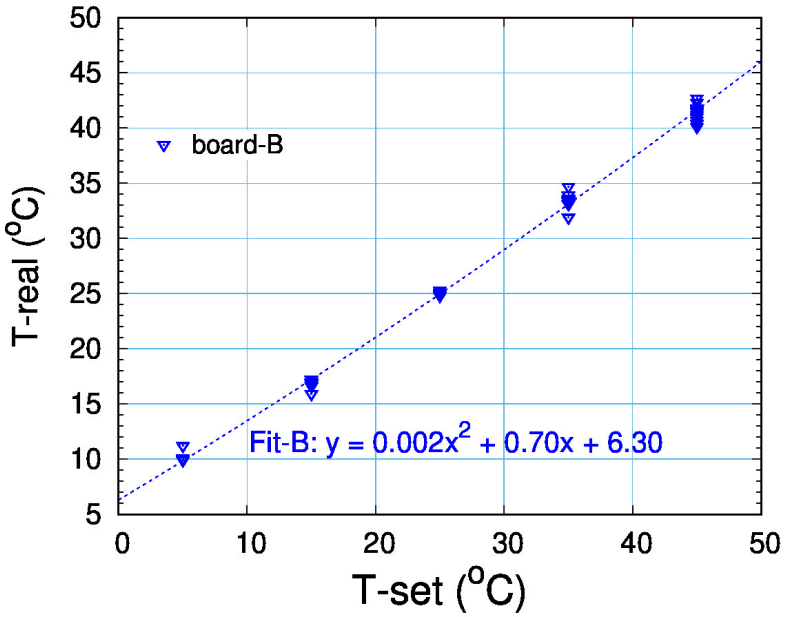
LT-HT Module: -5 ~ 65 °C

*Suggest to use Koolance (27% propylene glycol / water mix) or 27-50% ethylene glycol / water mix

Cooling Used for MAPS Beam Tests in 4/2025 at JLab

Chiller Temp (°C)	Thermistor Readout (Arb.)	Thermistor Readout (°C)
5	576	9.6
50	1344	45.2





T_{set}	$T_{measured}$
5	10
15	17
25	25
35	33
45	42

(°C)

- Thermal balance within 10 mins
- Almost linear dependents on the T_{set} and $T_{measured}$

MAPS Beam Tests in 4/2025 at JLab

Main goal:
Study **temperature** and **radiation damage effects** on the sensor performance (resolution, efficiency)

- Beam from April 6 to April 23 (17 days)
- Different beam currents during out test:
  - Commissioning: 50 nA, 100 nA
  - Highest current: ~200 nA

3 access after run started:
- Apr. 8: lower the rear side of the telescope
- Apr.11: changed to W21D4 S5 CHIP2
- Apr.16: changed to W20E1 S2 CHIP1

Total triggered events for each board:
- **W20E1 S2 CHIP3: 6.3M**
- **W21D4 S5 CHIP2: 8.1M**
- **W20E1 S2 CHIP1: 12.3M**

1 unexposed board:

W20E1 S2 CHIP3: as reference

2 exposed boards:

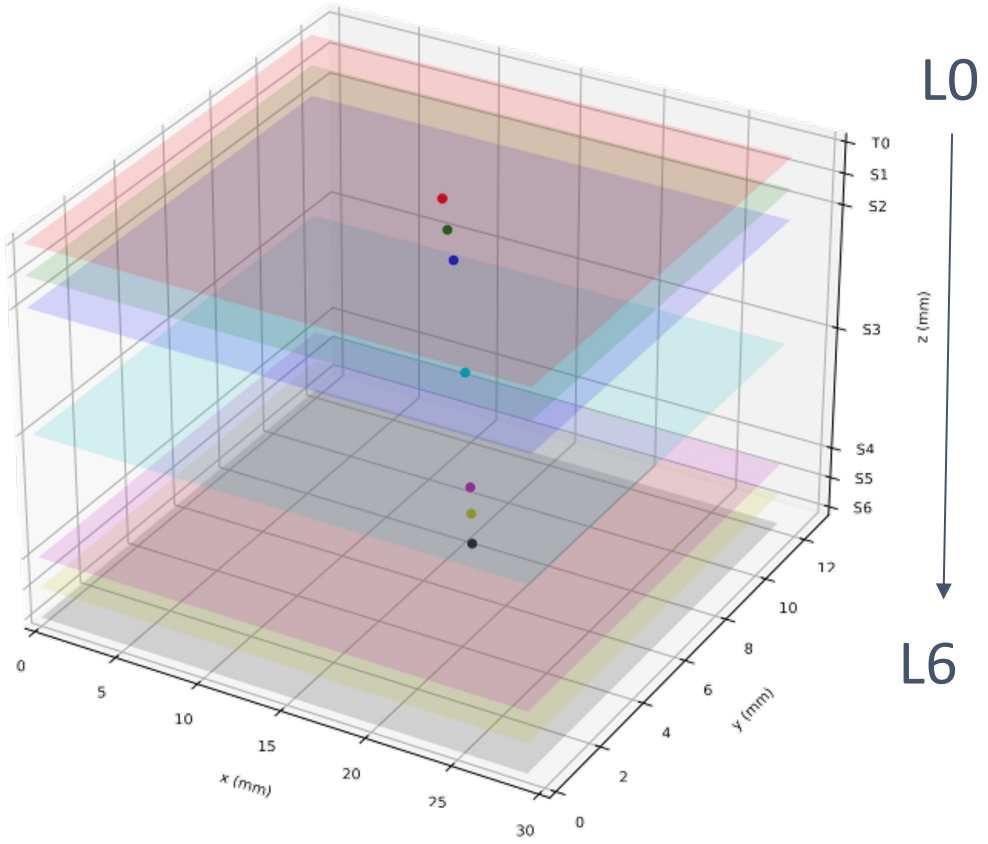
W21D4 S5 CHIP2:

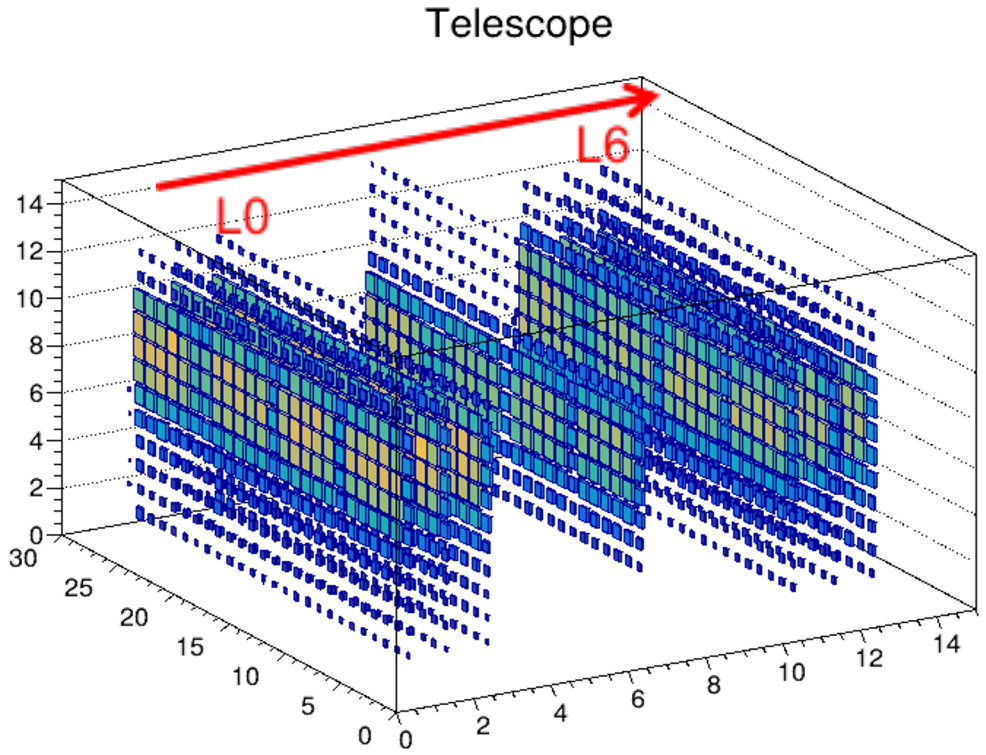
efficiency tested @Fermi Lab before the irradiation;
Irradiated w. **1 Mrad**, 10^{13} n^{1MeV}/cm^2 @ UC Davis;

W20E1 S2 CHIP1:

Irradiated w. **1 Mrad,** 10^{13} n^{1MeV}/cm^2 @ UC Davis

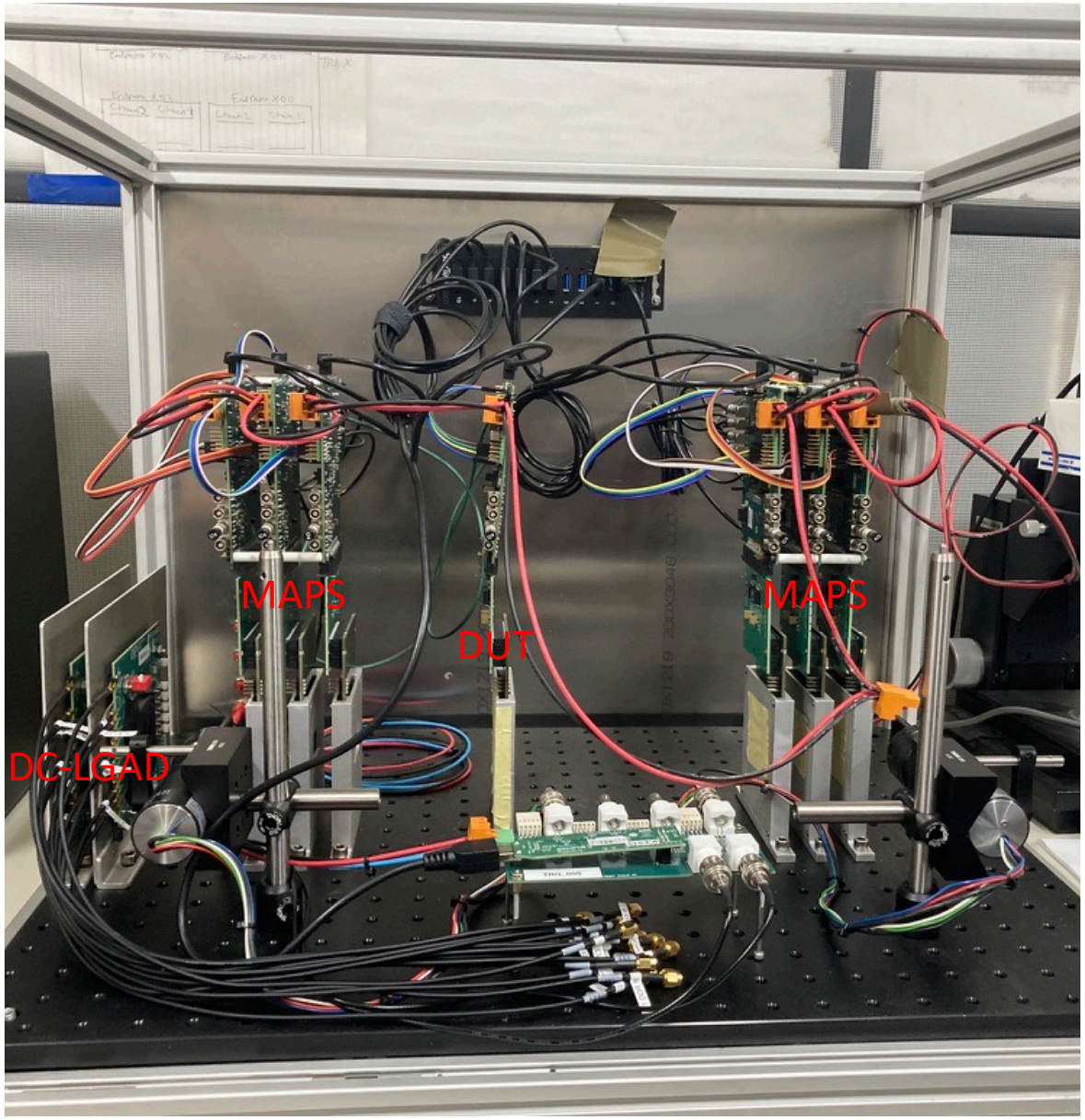
MAPS Beam Tests in 4/2025 at JLab





- Working on the alignment calibration and extract efficiencies & resolutions

AC-LGAD Beam Test at Jlab in 7/2025



- DUTs
  - New HPK sensors mounted on UCSC boards, read out by CAEN DT5742 (16+1ch), cooled to 10-40 degree C
  - Can read two DUTs at the same time, so that they can cross check with each other
- Spatial reference:
  - 6 MAPS planes, ~3um
- Temporal reference:
  - 4 DC-LGAD+ETROC2 planes, ~30 ps (TBC)

- Can only have physical access on maintenance day (Wed.)
  - Data taking will be strictly remote
  - DUTs put in must be pre-tested at UCSC
  - Specific trainings required for access
    - Online rad worker
    - In-person rad test
    - In-persona rad practical (available T/Th)
- Tentative Schedule
  - Installation 7/9/2025 (Yu, Provakar, Simone, Grigory, …)
  - Swap boards on 7/16, 7/23, 7/30 (Provakar)
  - Uninstallation 8/6/2025 (Provakar)

AC-LGAD Beam Test