LANL EIC Recent Study Overview

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UC EIC consortium meeting at UCLA

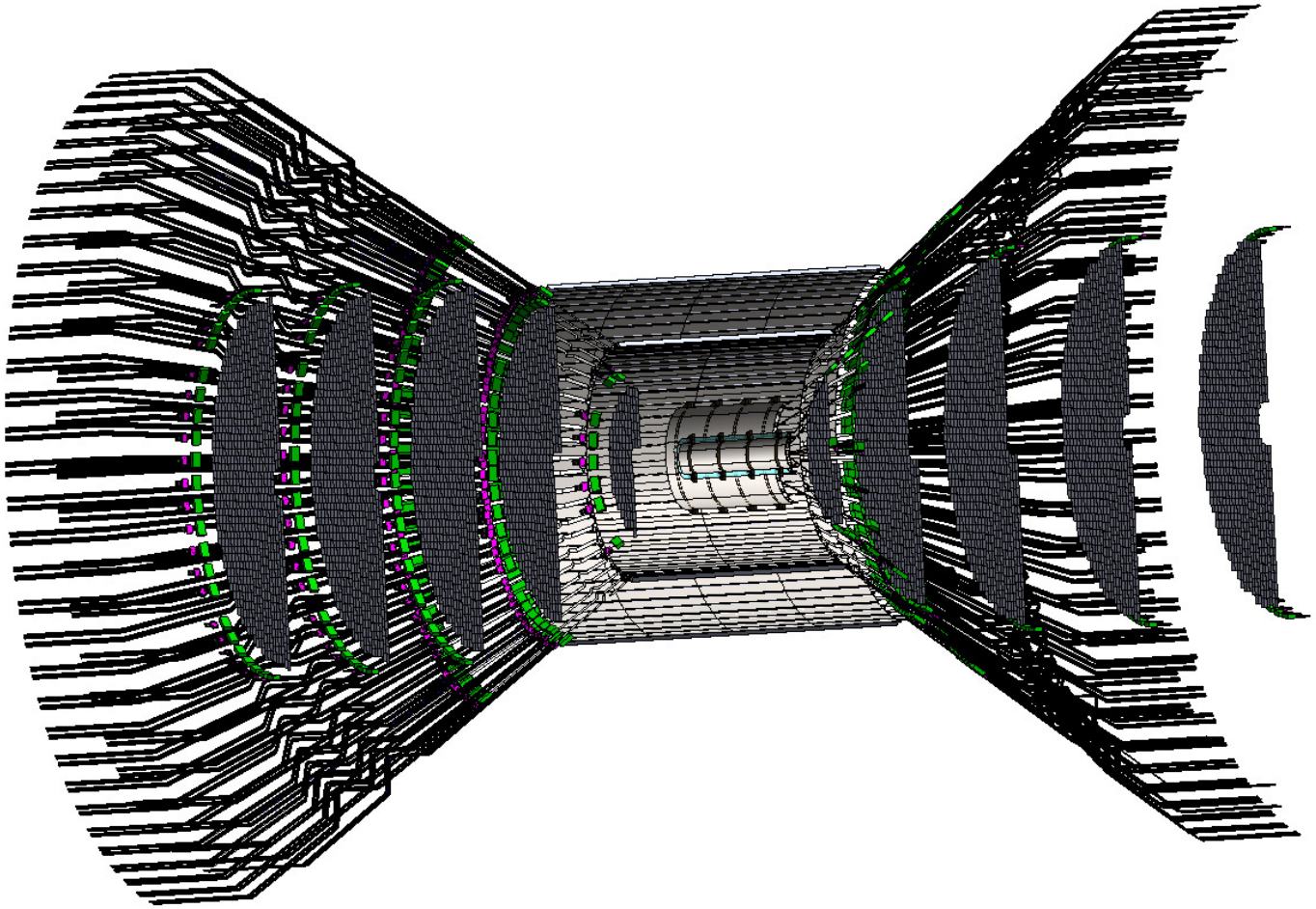
Jan. 27-28, 2023

Outline

- ePIC MAPS detector mechanical design developments
- MAPS and AC-LGAD R&D progress.
- Plan

ePIC MAPS detector mechanical design developments

- The ePIC MAPS detector mechanical design led by Walter Sondheim has been updated according to the latest ePIC detector design.



Service cables from the 3 MAPS vertex layers.
No service cables from the endcap disks

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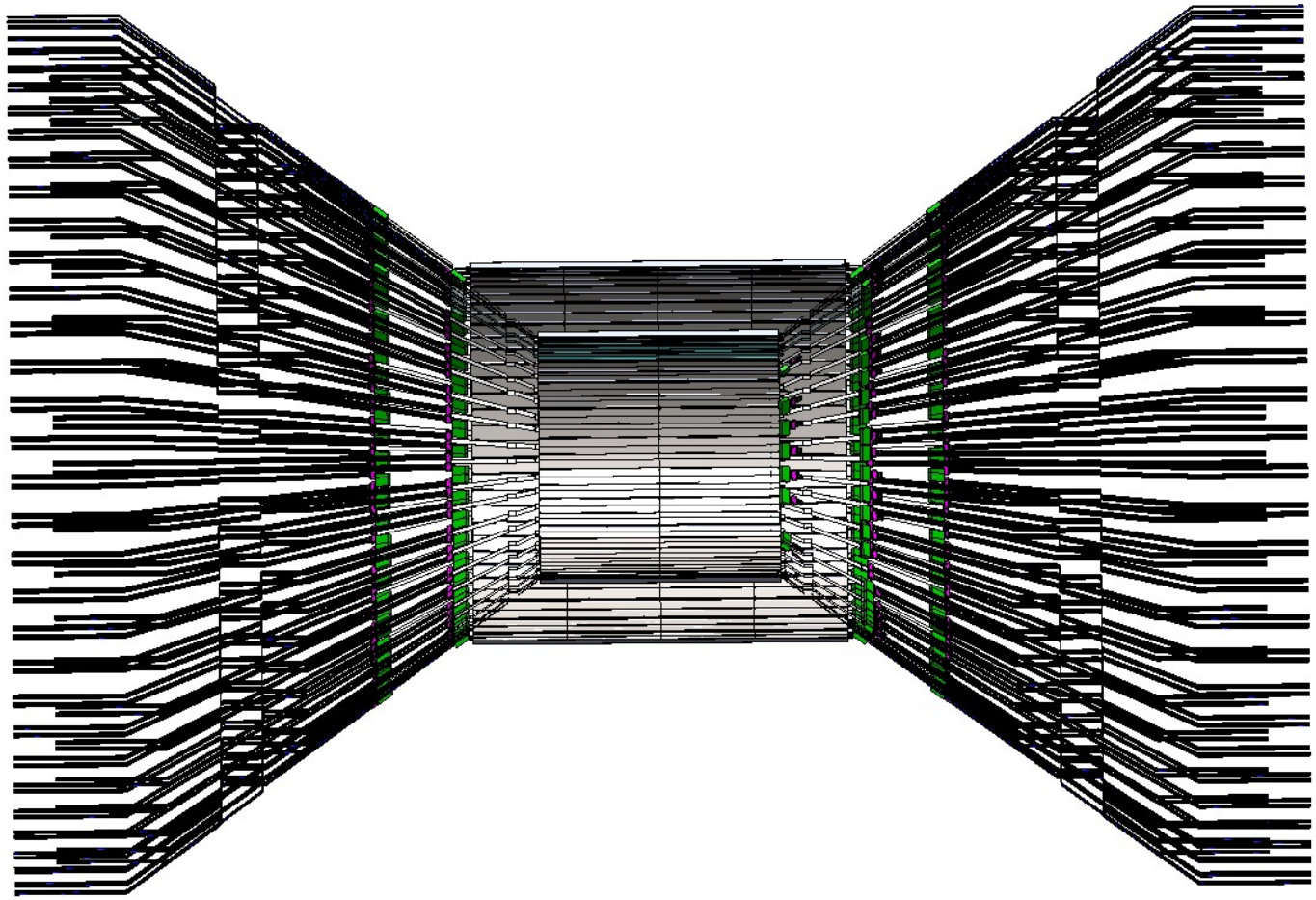


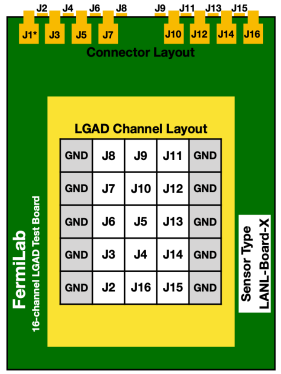
- **Service cables from the 3 MAPS vertex layers and 2 MAPS sagitta layers.**
- **No service cables from the endcap disks**

- **Will present this in the EIC SC consortium meeting for feedback and suggestions.**
- **Plan to work on the endcap disk services as well.**

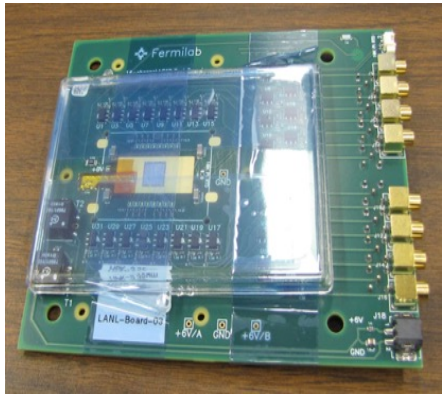
Other silicon technology candidates for the EIC silicon tracker

- Several advanced silicon prototype sensors are under characterization at LANL.

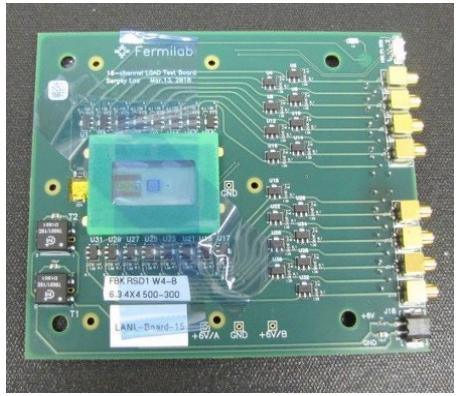
LGAD pixel map 3X5 Matrix



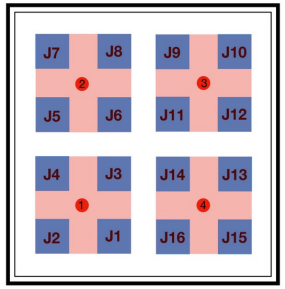
LGAD Carrier Board



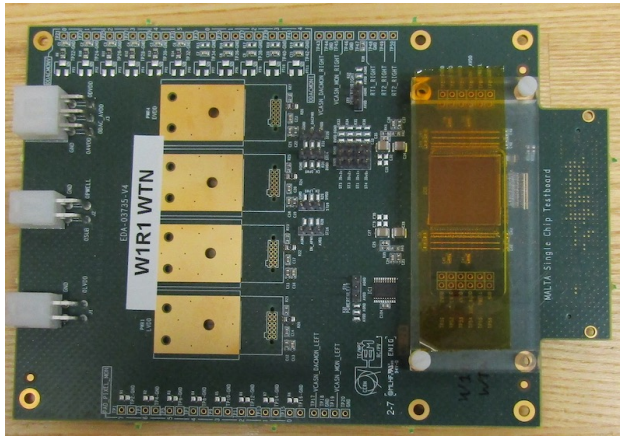
AC-LGAD Carrier Board



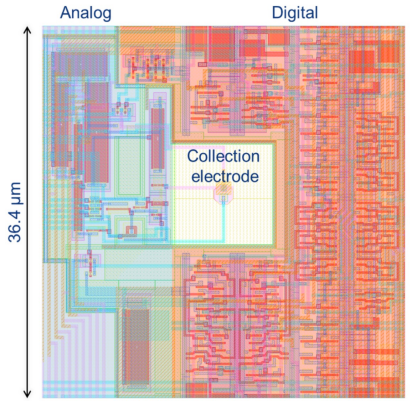
AC-LGAD pixel map 4X4 Matrix



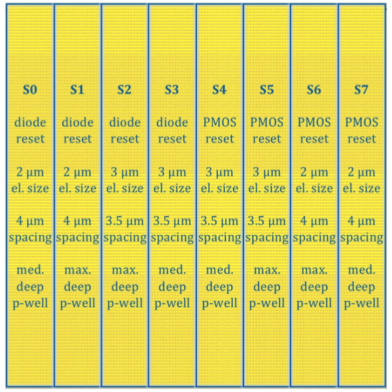
MALTA Carrier Board



MALTA Pixel diagram



MALTA sensor diagram 512X512 Matrix



Supported by the LANL 20200022DR project

Low Gain Avalanche Detector (LGAD) and AC-Coupled LGAD (AC-LGAD)

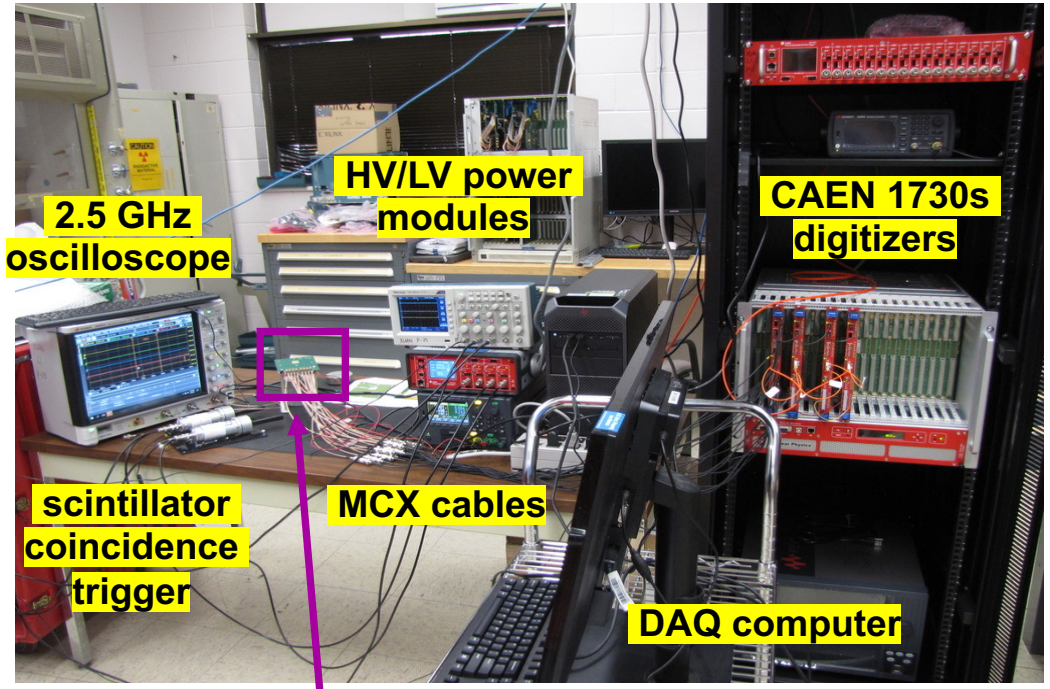
Pixel size: 0.5 to 1.3 mm
Sensor thickness: 20-50 μm
Spatial resolution: ~30 μm
Time resolution: <30 ps

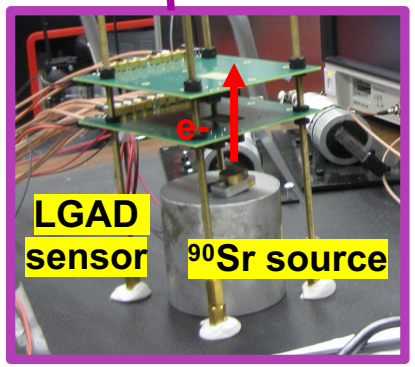
Depleted Monolithic Active Pixel Sensor (e.g., MALTA)

Pixel size: 36.4 μm
Sensor thickness: 100-200 μm
Spatial resolution: ~7 μm
Time resolution: ~2 ns

Advanced silicon technology R&D setup for EIC silicon tracker

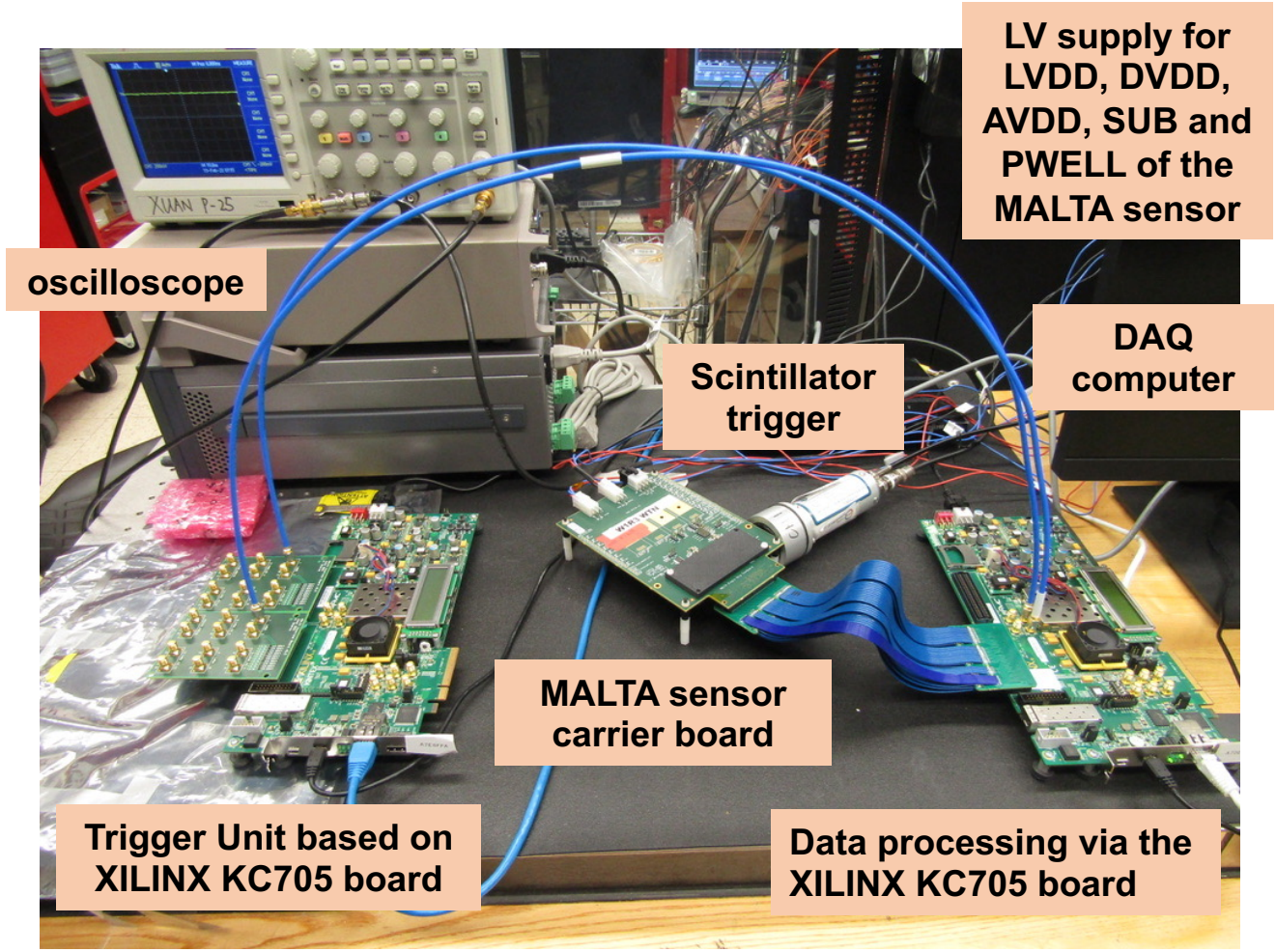
LGAD (AC-LGAD) sensor characterization with the ^{90}Sr source test





2-layer LGAD telescope

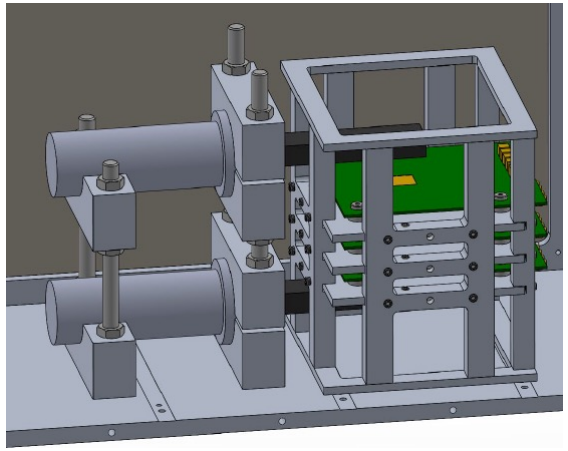
MALTA sensor characterization test bench



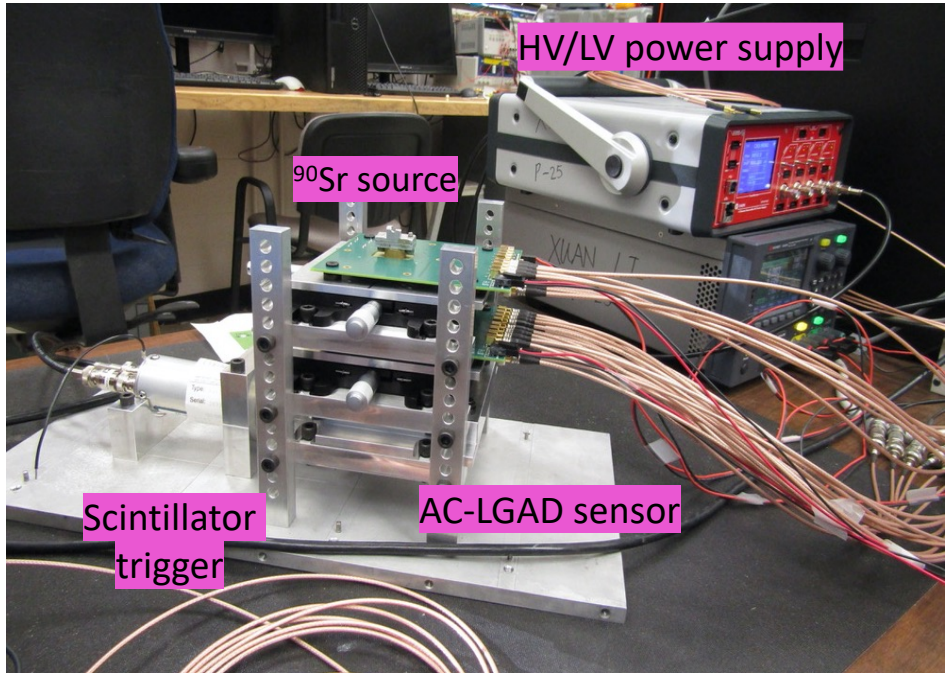
LGAD and AC-LGAD sensor R&D test results

- Feasibility tests of a two-layer AC-LGAD telescope using a ^{90}Sr source.

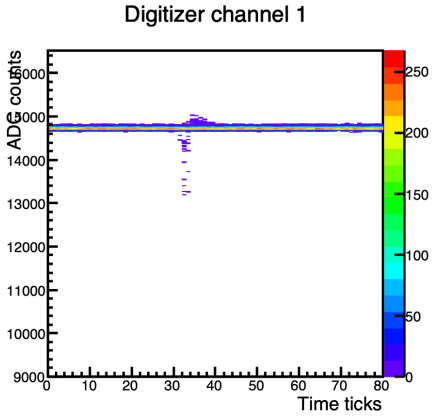
Mechanical design of 3-layer LGAD (AC-LGAD) telescope



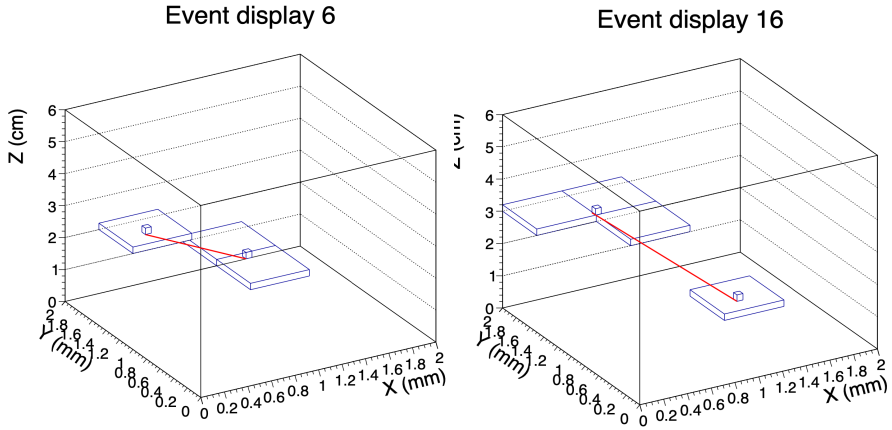
3-layer AC-LGAD telescope ^{90}Sr test setup with 2 sensors connected to the readout



Digitized pulse shape VS time tick (2ns) for individual pixel of from the ^{90}Sr source tests.



Event display of reconstructed electron tracks

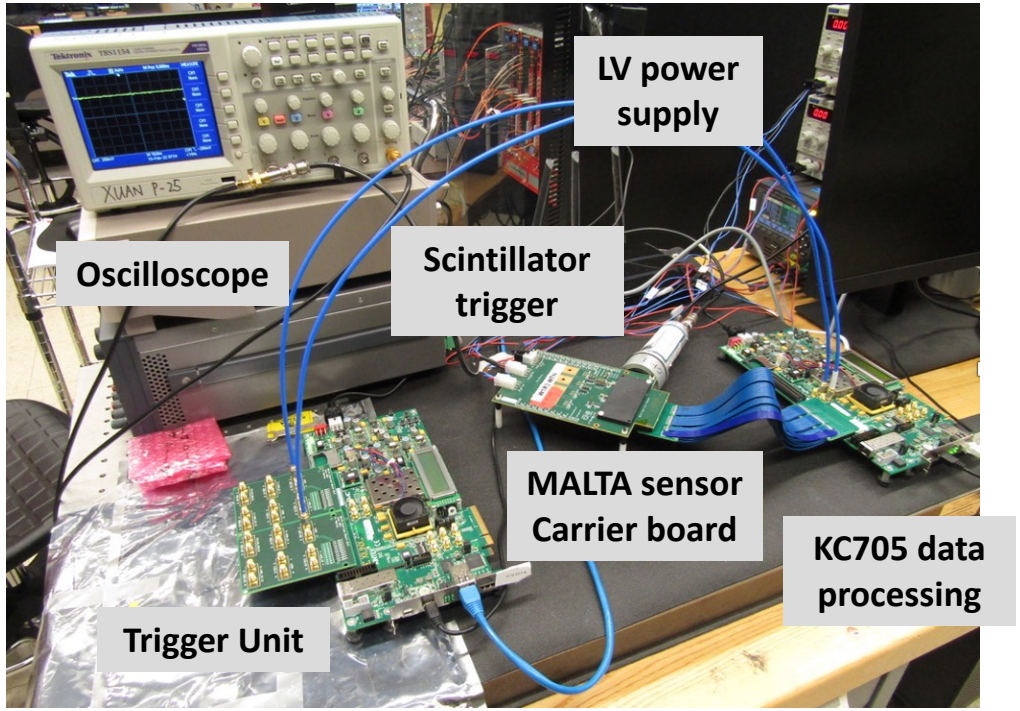


- Tracking performances such as efficiency, spatial and temporal resolutions are under study with the 3-layer telescope configuration.

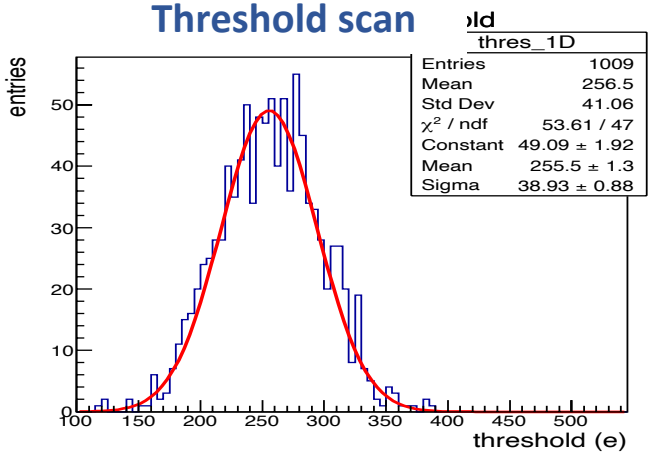
MALTA sensor R&D test results

- Threshold and noise scan has been performed.
- Successfully suppressing the noise hits with optimized DAC configuration and the hit occupancy has been studied with the ^{90}Sr source tests.

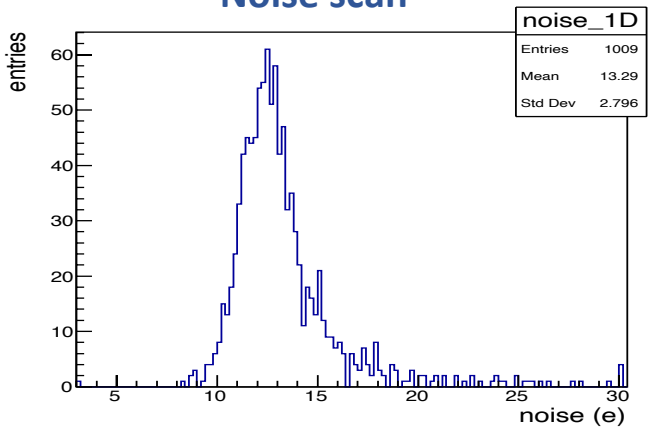
MALTA prototype sensor test setup



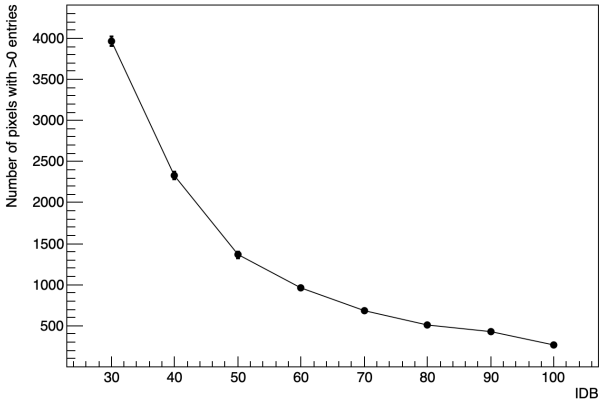
Threshold scan



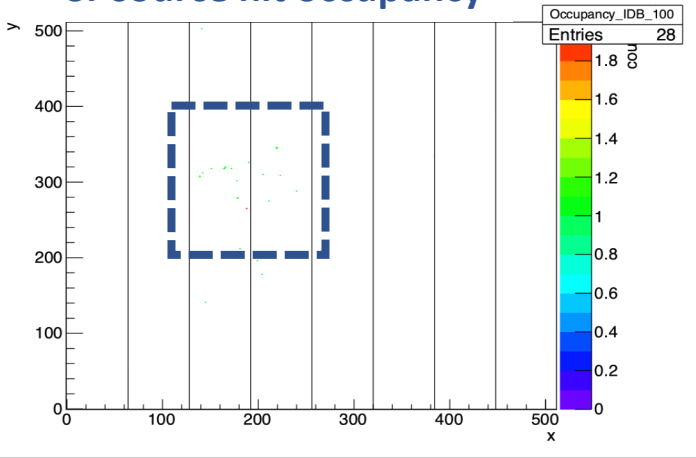
Noise scan



Noisy pixel rate VS IDB value



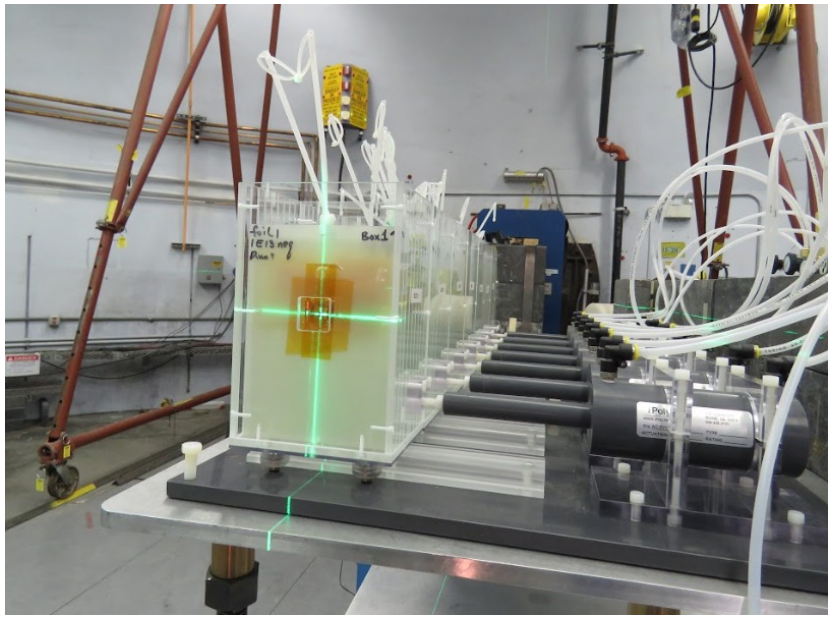
^{90}Sr source hit occupancy



Silicon sensor irradiation tests and near-term plan

- Irradiation tests performed with the LANL LANSCE facility 500 MeV proton beams to test the radiation hardness of LGAD and AC-LGAD prototype sensors with 10^{13}-10^{16} $n_{eq}cm^{-2}$ doses. Irradiative sensor characterization is underway.
- We plan to continue contributing to the ePIC MAPS vertex and tracking detector mechanical design with the eRD111 supports and look for additional funding support to contribute to the EIC MAPS prototype sensor R&D.
- If there are detector irradiation tests from this consortium, we will help submitting the user proposal and setting up the tests at LANSCE.

AC-LGAD irradiation tests at LANSCE



AC-LGAD sensor for the LANSCE tests

Plan

- Will continue work on the ePIC MAPS silicon design with the EIC silicon consortium and related eRDs.
- Will contribute to the EIC background simulation studies (see Kei Naigai's report in the last consortium meeting).
- Will update the heavy flavor hadron and jet physics studies with the latest ePIC detector design.
- We welcome UC students to visit us for EIC detector R&D related work.