

eRD112 Updates and FY25 plans

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on behalf of eRD112 team

Introduction

- R&D is morphing into PED as we move toward the “things we will actually build” for our CD-2 baseline and CD-3 beginning of construction.
- For AC-LGADs, this means really finalizing the sensors we intend to use for the subsystems, and the finalization of the custom ASIC to read them out.

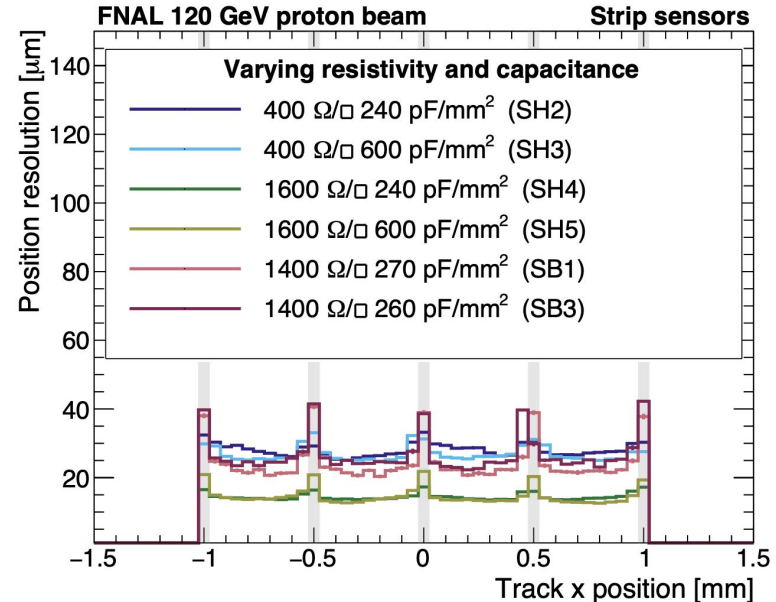
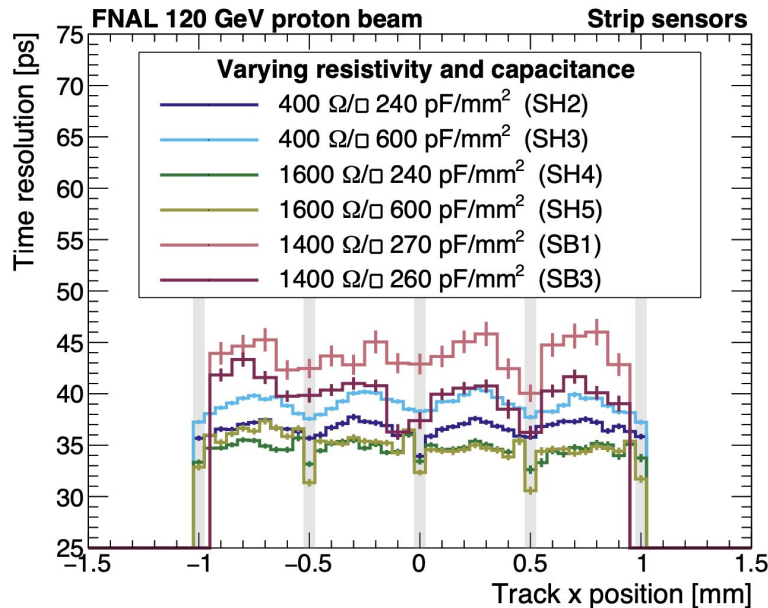
Overview of FY24 activities

eRD112 FY24

- Total budget in FY24 was \$286k, covering several activities & institutes:
 - BNL
 - Design and fabricate batches of AC-LGADs; target optimization of geometry and process parameters and pair with available ASICs
 - Testing of assemblies with custom test boards for the ASICs, and wire-bonded AC-LGADs with ASICs.
 - UIC
 - Characterize BNL and HPK AC-LGAD prototype sensors with laser and test-beam
 - UCSC
 - Characterize large variety of HPK sensors with laser TCT system
 - Redesign FNAL 16-channel board for larger sensors
 - Irradiate HPK sensors and evaluate performance
 - TCAD simulations
 - LBNL
 - Lead HPK strip/pixel production
 - Develop test-beam telescope system

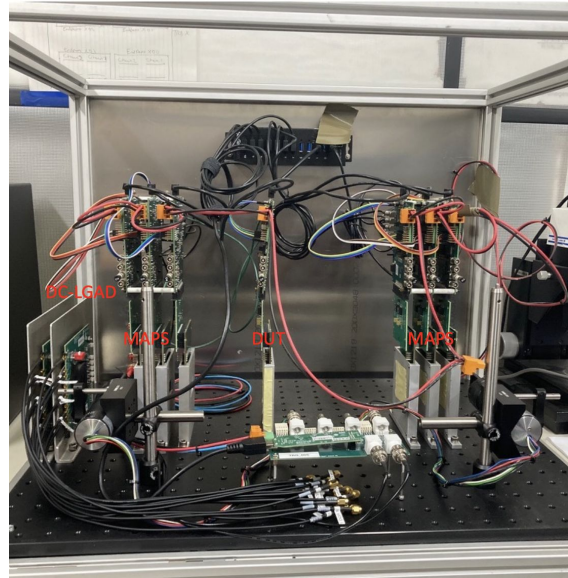
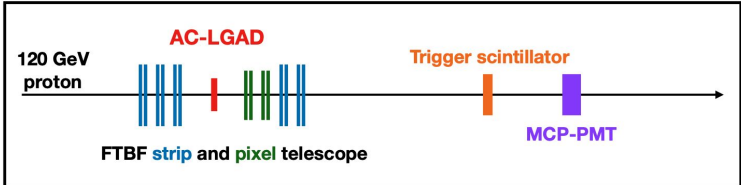
FNAL/UIC/LBNL FY24 activities

- Finalized analyses for previous test beam campaigns.
- Finalizing sensor design for FY24 HPK production (wafers in-production).
- Preparation for upcoming testbeams for new (full-size) sensor production.



Development for upcoming testing

- Developed a standalone beam telescope for future beam tests
 - Composed of Monolithic active pixel sensors (MAPS) for position and DC-LGAD planes for temporal reference; capable of providing adequate spatial and temporal references
- New large area scanning-TCT setup with infrared laser beams at FNAL



Plans for FY25

Overview of FY25

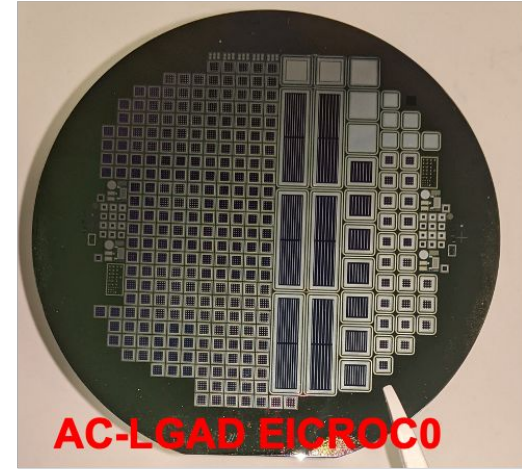
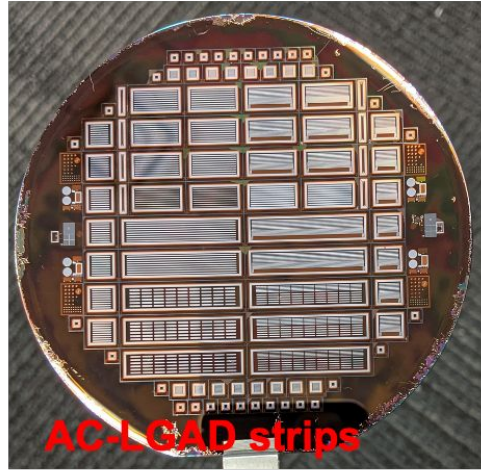
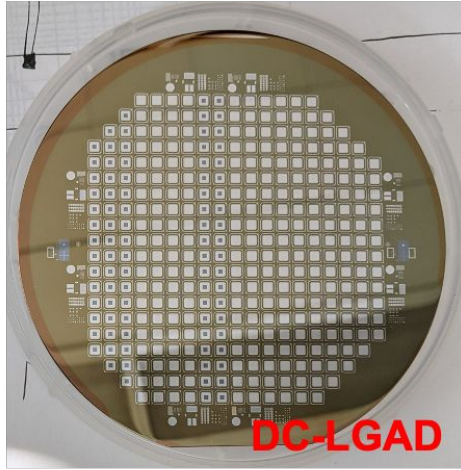
- Activities covering sensor productions, testing, and associated infrastructure
- Significant increase in budget request in FY25
 - Includes three sensor productions: HPK, FBK and BNL
 - Extensive sensor testing campaign spread across several institutes and facilities

Inst.	Sensor Production (k\$)	Labor (k\$)	M&S (k\$)	Misc. (k\$)	Total (k\$)
BNL	75	90	0	0	165
LBNL	0	75	10	10	95
LANL	0	25	10	5	40
UIC	120	13.1	10.5	8.4	152
UCSC	105	40	7	8	160
Hiroshima U.	0	0	5	25	30
Total	300*	243.1	42.5	56.4	642

BNL FY25 Plans

- Design and fabrication of AC-LGAD sensors
- Testing of AC-LGAD sensor performance
- Sensor Quality Assurance (QA)
- Assembly and testing of readout electronics.

BNL FY25 Plans



Several mask-sets available to study performance of ACLGADs vs fabrication parameters.

R&D aimed at:

- Increase the gain
- Increase the yield
- Control crosstalk

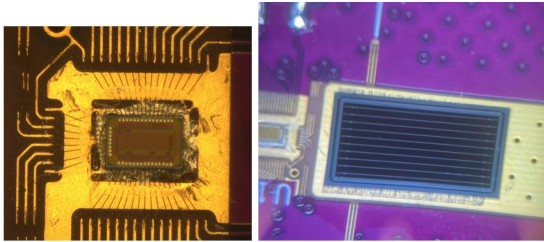
Characterization activity includes: IV,CV, TCT, gain measurements with CSA and ^{90}Sr source. Open for inputs from collaboration. Devices are distributed under request.

LBNL & UIC FY25 Plans

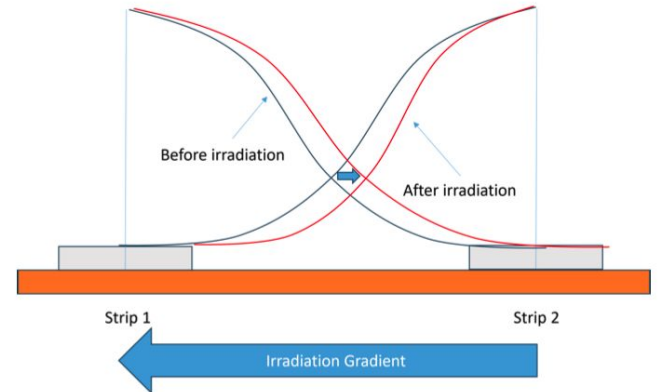
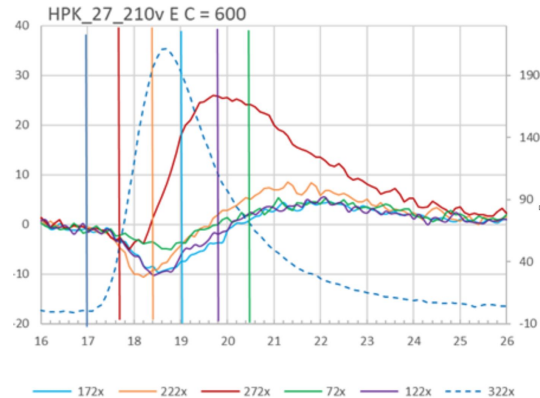
- Focus on design, construction, and commissioning of of new telescope to be used in test beam campaigns throughout FY25
- Organize & conduct test beam at FNAL using the new telescope
- UIC specific:
 - Develop a cold-box setup for operations in a temperature controlled environment and study device functionality under function of temperature
- Plan another HPK production, with funds following through UIC similar to FY24
 - Whether we proceed with this as a R&D or PED item remains to be determined
 - Depends strongly on the yield and performance of ongoing FY24 HPK production

UCSC FY25 Plans

- Support sensor characterization and development
 - Characterization of full-sized sensors with and without third-party ASICs (HPSoC, FAST, AS-ROC)
 - Continuation of TCAD simulation development
 - Supporting studies to inform and support design choices (pitch, metal width)
 - Understand mechanism for opposite polarity signal in neighbouring signals
 - Continue irradiation efforts on full-sized sensors
 - Try a graded-irradiation at LANSCE; potentially important consequences on charge sharing
 - FBK production

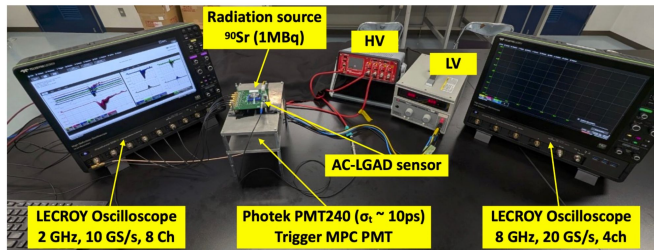


HPSoC-v2 bonded to HPK sensor



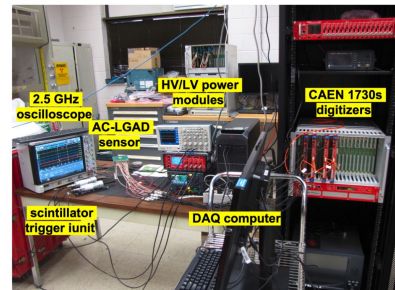
New institutes

- Two new institutes have expressed interest in joining eRD112 efforts, focusing on characterization efforts:
 - Hiroshima University
 - Establish a test-bench for AC-LGAD characterization using Sr90 source
 - Focus on studying temperature dependence of sensor performance
 - LNAL
 - Characterization of AC-LGADs using Sr90 source
 - Irradiation tests using LANL LANSCE with 500 MeV protons

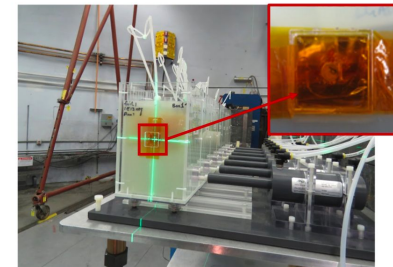


Hiroshima test bench

AC-LGAD ^{90}Sr bench test at LANL



AC-LGAD irradiation test at LANL



Conclusions

- Lots of progress has been made in FY24.
 - Analysis of testbeam data.
 - First sensor irradiation campaign + initial assessment of impact.
 - Testing of AC-LGAD + ASICs to provide feedback to ASIC designers, and to sensor productions.
 - Build-up of local testbenches and knowledge/expertise base → needed for successful implementation of subsystems.
- FY25 plans are to transition from R&D to PED as we begin testing full-size sensors, and plan for testing with the next ASIC versions, especially in Q2/Q3 FY25.
 - We hope the FY25 productions can be potentially funded with PED - our overall FY25 budget is very large, and 50% is from sensor productions.
- Potential for involvement from new vendor + in-kind also being discussed, so we are prepared to adjust our approach as this develops.