

# eRD112 FY24 Proposal

- AC-LGAD Sensor
  - Productions by BNL IO, HPK and FBK
  - Sensor characterization in the lab/beam
  - TCAD simulation
  - Irradiation test
- Sensor/ASIC integration
  - Interposer to connect pixelated ASICs with strip sensors, or pixel sensors with various pitch
- Mechanical structure
  - Light-weight structure for FTOF

Further optimize sensor design and produce prototypes that meet ePIC requirements, including timing and spatial resolution, irradiation tolerance, and reasonably large size for module assembly

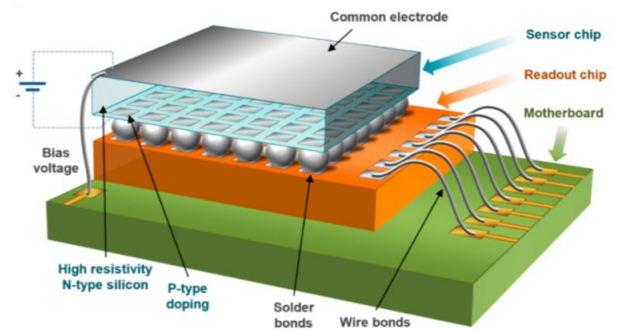
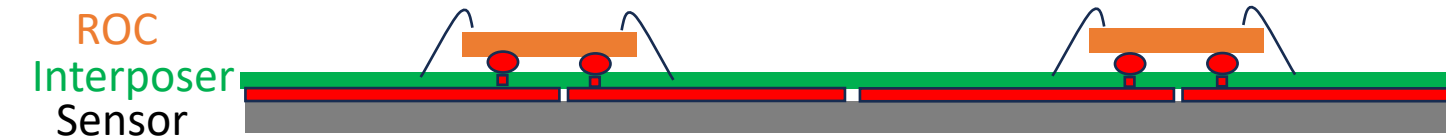
Investigate reliable and cost-effective mechanical and electrical sensor-ASIC connections with interposer

Develop light-weight mechanical structures for FTOF

Sensor + ASIC demonstrator (prototype module) for EIC and testing with particle beam

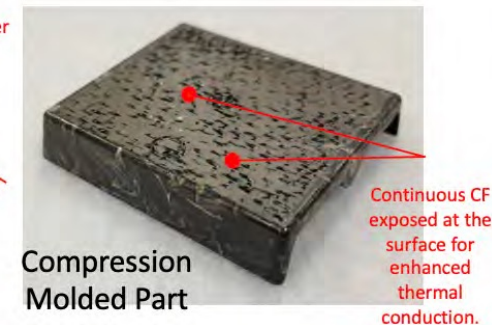
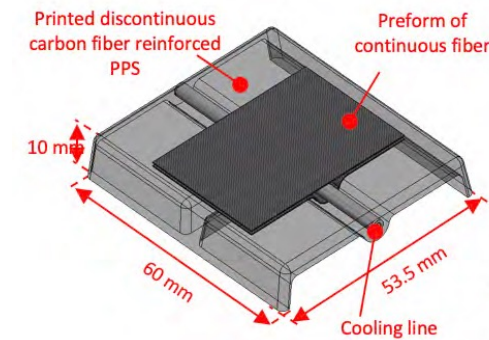
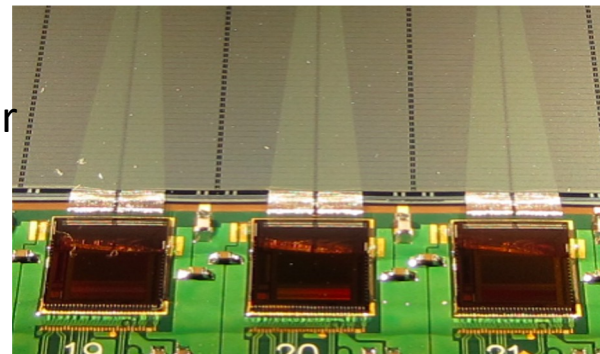
# eRD112 FY24 Proposal

- Sensor (346k) further optimize sensor design, determine final size and yield, verify radiation tolerance
  - TCAD simulation and sensor irradiation test (20k)
  - Sensor production and characterization: BNL IO (75k+46k), HPK (80k+40k), FBK (70k+15k)
- Sensor/ASIC integration (15k)
  - Interposer to connect pixelated ASICs with strip sensors, or pixel sensors with various pitch
- Mechanical structure (53k)
  - Light-weight structure made from CF composite materials using compression or injection molding for FTOF



Sensor

ROC



Compression Molded Part

# eRD112 FY24 Deliverables

- Optimized sensor design and final prototypes that meet ePIC requirements, including timing and spatial resolution, irradiation tolerance, and reasonably large size for module assembly
- Prototypes of interposer for mechanical/electrical connections between strip sensor and ASIC
- Prototypes of light-weight module mechanical structures for both barrel and forward TOF
- Sensor + ASIC demonstrator for EIC applications and testing with particle beam.

**eRD112 (414k)**

- Sensor R&D (346k\$)
  - BNL, HPK/FBK productions
  - TCAD, lab/beam/irradiation tests
- Sensor/ASIC integration (15k\$)
  - Interposer
- Mechanical structure (\$53k)
  - Light-weight structure with cooling

**eRD109 (Fernando’s talk)**

- Frontend ASICs
  - EICROC, FCFD
- Frontend electronics
  - Low Jitter Clock
  - Low-mass flexible PCB
  - Service hybrid

**EPIC Simulation**

- Geometry model, digitization and reconstruction
- Requirements on spatial, timing resolutions, and material budget

**Project Engineering Design**

- Engineering design for pre-TDR
- Integration & services

## eRD112 – AC-LGAD -1-

- This project is dedicated to advancing the AC-LGAD technology, intended for implementation in multiple crucial subdetectors: the main detector of TOF, as well as in the far-forward and far-backward instrumentation along the beam line adjacent to the main detector. Large efforts are proposed to be made on not only the fabrication of AC-LGADs but also the readout electronics including ASICs. Many institutions involved in the project and made their own progress due to a well-organized R&D proposal.
- By FY23, both BNL and commercial vendors have produced prototypes of the sensor, substantially reducing risks. The beam testing at Fermilab on these sensors are ongoing, and achieved some positives. The timing resolution and position resolution of the pixel sensors produced by HPK have reached 20ps and 20um respectively. The development of the first prototype of the low-mass mechanical support structure has been completed. There are plans to continue further testing of sensor prototypes and to develop multiple versions of the mechanical support structure. Additionally, the possibility of introducing another vendor, FBK, will be considered."
- Compared to FY22, significant progress has been made in this project, especially in the development of the sensor. So far, the results look promising and are in line with the project timeline. Clearly, continuing the research on sensor production options is still crucial, whether at BNL or with commercial vendors. The current US-Japan collaboration may benefit on the scheduling in mass production at HPK. These will mitigate risks.
- According to simulations based on the latest simulation framework, the material budget requirements for the forward TOF and the spatial resolution requirements for the B0 tracker have both been significantly enhanced. The research team plans to continue the study of a common design to reduce costs and risks. At the same time, attention should also be given to whether the original design can meet the significantly improved performance requirements of these individual detectors. More detail checks are suggested to see if there are other requirement changes.

## eRD112 – AC-LGAD -2-

- Since there are several commercial vendors involved, ensuring enough funding contingency is something that needs to be considered due to the fluctuations in the international supply chain prices.
- Continue the study on sensor fabrications options in various vendors.
- Using the latest simulation frame, further check if there are crucial performance requirements changed in related individual detector to meet the goals of ePIC.
- Continue the material budget study based on whole system including sensor, bounding base, supporting structure and other integration materials.

## eRD109 – ASICS/Electronics

- Combination of multiple development efforts
- Delay due to difficulty in setting up contracts hindered FY23 progress
- Close attention should be made to ASIC development schedule, especially with regard to chip availability for use in detector component testing/development as well as the availability of expert support
- Scope of R&D activities has expanded since last year's proposal, including well-motivated EICROC and HGCROC modification
- Fully explore the cost and timescale of packaging, especially for future productions
- High priority projects with large impact to the EIC effort/performance

# ePIC AC-LGAD Workfest at ANL in January 2024

- Proposed to ePIC spokespersons a ~1.5-day AC-LGAD workshop at the ePIC Collaboration Meeting at ANL on January 9-13, 2024
  - Title: AC-LGAD Detectors at ePIC
  - Description: bring people working on AC-LGAD detectors at ePIC together, to review the detector requirements and design status, and establish a closer collaboration among the different detector DSC's to work on common challenges in R&D, detector design and construction
  - Organizers: Alessandro Tricoli, Alexander Jentsch, Wei Li, Zhenyu Ye
  - Estimated number of attendees: 15-20
  - Length of the workshop: 1.5 days, avoid scheduling conflict with parallel sessions on PID and FF
  - Workfest schedule (inputs are welcome):
    - Session 1 Detector requirements and design status
    - Session 2 Sensor
    - Session 3 ASIC and interconnect
    - Session 4 Electronics
    - Session 5 Detector Module

# eRD112/LGAD Consortium Meeting



Tuesday 26 Sep 2023, 08:00 → 12:15 America/Chicago

Alessandro Tricoli (Brookhaven National Lab) , Wei Li (Rice University) , Zhenyu Ye (University of Illinois at Chicago)

**Description** This is a joint meeting of the eRD112 and the LGAD Consortium

Zoom Meeting

<https://uic.zoom.us/j/82195681594?pwd=V3JXdHZQbE5vMVIKS045SHphSWdSdz09>

Meeting ID: 821 9568 1594

Passcode: eRD112LGAD

**08:00** → 08:10 **News**

🕒 10m



**Speaker:** Zhenyu Ye (University of Illinois at Chicago)

**08:10** → 08:25 **Update on Sensor Production at BNL-IO**

🕒 15m



**Speaker:** Gabriele Giacomini (BNL)

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**08:25** → 08:40 **Updates on the EICROCO testing at BNL** ⓘ

🕒 15m



**Speaker:** Prithwish Tribedy (BNL)

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**08:40** → 08:55 **Update on ASIC Studies at UCSC**

🕒 15m



**Speaker:** Simone Mazza (University of California - Santa Cruz)

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**08:55** → 09:10 **Status of Low-Mass Flexible PCB Development at ORNL**

🕒 15m



**Speakers:** Mathieu Benoit (ORNL), Oskar Hartbrich (Oak Ridge National Lab)

**09:10** → 09:25 **Report on Recent AC-LGAD R&D Activities by EIC-Japan**

🕒 15m



**Speaker:** Satoshi Yano (Hiroshima University)