

# News – 03/12/2024

- **EIC Project Detector R&D**
  - **FY24 plan (p2);** contracting in progress, mid-year report due Feb 29, 2024
  - **Detector R&D Day on [March 25, 2024](#),** Detector R&D annual review in August 2024 with deadline for submission July 1, 2024
- **ePIC TOF Project Engineering Design**
  - **Mechanical engineering on support structure and cooling:** [Mechanical PED](#)
  - **BTOF (and FTOF?) module prototyping in preparation**
- **ePIC TOF Simulation**
  - TOF geometry: **Zhenyu updated TOF according to [latest geometry database in DD4HEP #564](#)** Wei: will update the FTOF design
  - TOF in tracking – Nicolas et al.: **re-check FTOF material budget impact**
  - TOF PID reconstruction – Oskar et al.: **TOF reconstruction, validation plots, and PID LUT (code frozen in May/June?)**
  - TOF digitization – Souvik/Adam: **charge sharing and detector noise (model on standalone, help on digitizer needed)**
  - TOF service in simulation – TBD: **implement the missing material for mechanical support structure, cooling and cabling**
- **ePIC TOF DSC**
  - Working with CAMs to understand/update the TOF cost and schedule – **in-kind contributions and FTOF labor spreadsheet**
  - **[Reform TOF DSC ORG with new leadership team and working group structures \(p5\)](#)**
- **Upcoming Reviews**
  - **Incremental Design and Safety Review on July 5-6, 2023:** [Presentations](#); [Review report](#); answers in preparation (p3/4)
  - **PDR2 in Summer 2024?; CD2/3 in Winter 2024?**
  - **pre-TDR/TDR planning (p6/7):** [see Silvia's slides at TIC on Feb 19, PID discussion on Feb 23, and presentation at TIC on \[March 4\]\(#\)](#)

# New time slot

- Three time slots:

|                |    |
|----------------|----|
| Wednesday 10AM | 13 |
| Friday 10:30AM | 10 |
| Friday 11AM    | 10 |
- Wednesday collides with ORNL group meeting  
Friday, most of Asian colleague not available

# AC-LGAD FY24 R&D Proposal

- 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 forward TOF~~
- Prototypes of frontend ASICs
- Functional and full size low-mass Kapton PCB
- Low-cost interconnect for sensor-ASIC hybridization
- Service hybrid prototype

## eRD112 (414k->286k\$)

- Sensor R&D (346k->261k\$)
  - BNL, HPK/~~FBK~~ productions
  - TCAD, lab/beam/irradiation tests
- Sensor/ASIC integration (15k\$)
  - Interposer
- ~~Mechanical structure (\$53k)~~
  - ~~Light weight structure w. cooling~~

## eRD109 (435k->390k\$)

- Frontend ASICs
  - EICROC (85k\$)
  - FCFD (40k\$)
  - ~~3<sup>rd</sup> Party ASICs (45k\$)~~
- Frontend electronics
  - Low-mass Kapton PCB (30k\$)
  - Low-cost hybridization (15k)
  - Service hybrid (220k) (redistrib?)

## 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

**Sensor**   **Electronics**   **Sensor-ASIC integration**   **Mechanics**

# The Request

Dear DSLs,

Following what has already been communicated at the ePIC collaboration meeting (Jan 9-13, 2024), the DSLs are requested to prepare a TDR plan for their subsystem for calendar year 2024, including:

- The lab/testbeam/prototyping needed;
- The further progress needed for the reconstruction software;
- The verification of the implementation of the detector and detector response in simulation and validation using information from lab/testbeam exercises or from literature;
- The studies required to demonstrate the detector performance;
- The required engineering design;
- The needed resources to achieve 60% (CD-2) and 90% (CD-3) design completion;
- The plan should include the time required to draft the text for the pre-TDR (CD-2) and TDR (CD-3).

The plan should present the activities required month by month in order to allow progress to be monitored. The ultimate goal of this exercise should be 90% design completion consistent with the requirements of the TDR and CD-3, indicatively by the end of 2024. We recognize that the available time is limited. Therefore, please make an educated selection of the most essential studies doable within the available time.

We understand that a planning exercise like this will identify shortcoming in workforce and resources. Those shortcomings should be clearly identified so everyone is aware and we can work together to address them.

The plans will be presented at dedicated CC WG meetings, to be organized by the CC WG conveners over the next few weeks. The CC WG conveners will be asked to report on the status of the planning at the TIC meeting on Monday Feb. 19.

Thank you,

Silvia, John, Oskar, Matt, Prakha

| component                          | Current status   | R&D  | PED      | Beam Test              | 60%                                 | 90%                                    |
|------------------------------------|--|--|----------|------------------------|-------------------------------------|--|
| Sensors                            | prototyping: 1 <sup>st</sup> HPK prototype tested; 2nd HPK production in prep.; 1 <sup>st</sup> FBK prototype in prep. | eRD112 FY22<br>eRD112 FY23<br>eRD112 FY24-26 |          | 2022,<br>2023,<br>2024 | FY25 Q2 (2 <sup>nd</sup> HPK)       | FY26 (3 <sup>rd</sup> HPK)             |
| ASIC                               | Prototyping: FCFDv0 and FCFDv1 for BTOF, EICROC0 for FTOF  | eRD109 FY23<br>eRD109 FY24-26                |          | 2024                   | FY25 Q2 (FCFDv1,EICROC1)            | FY26 (FCFDv3, EICROC2)                 |
| Module Flex PCB                    | Prototyping: long PCB  | eRD109 FY23<br>eRD109 FY24                   | 2026     | 2025-                  | FY24 Q4 (M2M, M2SH)                 | FY26 (full-length integration)         |
| Module CF structure                | Prototyping: BTOF stave produced, thermal simulation underway  | eRD112 FY23                                  |          |                        | FY25 Q2 (full-length stave)         | FY26                                   |
| Module Assembly                    | Prototyping: Sensor/ASIC integration, Interposer   | eRD109 FY24<br>eRD112 FY24                   | In prep. | 2025-                  | Thermo-mechanic prototype FY24      | Fully functional module FY26           |
| Global support structure, Cooling  | Conceptual design  |  | Active   |                        | FY25 Q2 (1/12 with staves)          | FY26 Q1 (1/12 FTOF wedge)              |
| Service Hybrid                     | Prototyping: board layout  | eRD109 FY24                                  |          | 2025-                  | FY25 Q1 (with ETROC2)               | FY26 (final layout & ASIC)             |
| Backendelectronics, Power supplies | Possible PS models identified  | N/A  | N/A      |                        | Design in FY24 (with project)       | Purchase/test one in FY25              |
| Software and simulations           | Geometry and material in DD4HEP, have TOF PID, tracking $\delta p$   | N/A  | N/A      | N/A                    | PID LUT in global framework in FY24 | Refined material and responses in FY26 |

# Critical Paths and additional Resource requirements

- FCFD ASIC development and testing for BTOF (FNAL+LBL PED)
- BTOF module assembly (UCSC+Purdue PED)  
proposal in progress
- FTOF module assembly (ORNL PED?)
- BTOF+ FTOF Service Hybrid Engineering+parts (Rice/LBL PED)
- Long Flexible Print Circuit Board for BTOF staves (ORNL+Nara+RIKEN)  
eRD109 (beyond FY24?); discuss with Oskar
- Software+simulation:  
detector response + realistic material (additional institutions?)

# Strategy for the TDR (ASIC)

- BTOF digital block demonstration is in need (a concern)
  - It is important to show that "we can't show it now, but we will definitely be able to do it shortly"
  - It is necessary to fully understand and demonstrate the individual characteristics in pre-TDR
    - Characteristics of sensor, FCFD's analog block, and the combined performance
  - The FTOF study will help to corroborate the story
    - Successful signal readout of FTOF means "complete understanding of the AC-LAGD → analog → digital chain"
    - This knowledge shows that we have the technology to extend analog blocks to digital blocks while keeping a good timing resolution
  - Investigating the availability of other ASICs (e.g. HGCROC) is also important
- **The beam test at DESY is scheduled for June**
  - It is a good opportunity to show performance of the sensors and ASICs with realistic environment
  - Real MIP beam is mandatory to evaluate realistic performance
  - Before the beam test, the lab tests, e.g. radiation source and IR laser, is necessary
    - Gain uniformity, temperature dependence of gain, timing resolution, spatial resolution, and power consumption

# New items discussed (any updates?)

- Irradiation test
  - Limited strips, pixels more
  - Dose should be as low as possible  $<10^{14}$
  - European groups in the project
  
- BTOF, FTOF ASIC designs
  - Digitizer requirements for BTOF iteration with FNAL designer
  - Tonko will produce a similar requirement for FTOF



# New TOF DSC ORG

- **Leadership Structure**
- **Work packages combining BTOF and FTOF**
  1. Sensors (2 coordinators)  
Simone Mazza, Japanese colleague
  2. Frontend Electronics (all electronics that are on the detector) (2 coordinators)  
Wei Li, TBD
  3. Module local integration and assembly (2 coordinators)  
Mathieu/Matthew, Asian colleague
  4. System tests and validation (2 coordinators)  
[Prithwish Tribedy \(FF Liaison\)](#)+Takashi Hachiya
  5. Mechanical structure, cooling and global integration (2 coordinator)  
Andy Jung, Yi Yang
  6. DAQ & Clock distribution (1 coordinator)  
Tonko Ljubicic
  7. Power system, Detector slow control, monitor and safety system (1 coordinator)  
[Frank Geurts](#)
  8. Simulations, software & calibration, Database(1 coordinator)  
[TBC?](#)

| Position                                   | Candidate(s)                      |
|--|-----------------------------------|
| 1 Detector Subsystem Leader                | Zhangbu Xu                        |
| 1 Deputy DSL                               | Satoshi Yano                      |
| 2 Detector Subsystem Tech.<br>Coordinators | Mathieu Benoit,<br>Matthew Gignac |

# R&D efforts and contributions from 10/2023

| Institution   | Contact            | R&D Interest  |
|---|--------------------|---|
| Brookhaven National Laboratory                            | Alessandro/Zhangbu | Sensor prototyping, ASIC testing, Electronics development         |
| Fermi National Accelerator Laboratory                     | Artur Apresyan     | Sensor testing, ASIC prototyping                                  |
| Los Alamos National Laboratory                            | Xuan Li            | Sensor testing, simulation  |
| Rice University   | Wei Li             | Sensor testing, Electronics development                           |
| Oak Ridge National Laboratory                             | Oskar Hartbrich    | Sensor testing, ASIC testing, Electronics development, Simulation |
| <a href="#">Ohio State University</a>                     | Daniel Brandenburg | Electronics testing, Simulation                                   |
| Purdue University   | Andreas Jung       | Mechanical structure and cooling system prototyping               |
| University of California, Santa Cruz                      | Matthew Gignac     | Sensor testing, ASIC testing                                      |
| University of Illinois at Chicago                         | Zhenyu Ye          | Sensor testing, sensor-ASIC integration, ASIC testing, Simulation |
| Hiroshima University                                      | Kenta Shigaki      | Sensor prototyping and testing, Simulation                        |
| RIKEN   | Yuji Goto          |   |
| Shinshu University  | Kentaro Kawaide    |   |
| University of Tokyo                                       | Taku Gunji         | Online data reconstruction  |
| <a href="#">South China Normal University</a>             | Shuai Yang         | Simulation  |
| <a href="#">Univ of Science and Technology of China</a>   | Yanwen Liu         | Sensor prototyping, Electronics development, Simulation           |
| Indian Institute of Technology, Mandi                     | Prabhakar Palni    | Sensor testing, Simulation  |
| <a href="#">National Inst. of Sci. Education Research</a> | Ganesh Tambave     | Sensor prototyping and testing                                    |
| National Cheng-Kung University                            | Yi Yang            | Mechanical structure prototyping                                  |
| National Taiwan University                                | Rong-Shyang Lu     | Sensor prototyping, ASIC testing, Electronics testing             |

# Possible institution efforts and contributions from 10/2023

| Institution                                      | Working Group and Tasks  |
|--|--|
| Brookhaven National Laboratory                   | <b>BTOF:</b> sensor, sensor-ASIC integration, module assembly; <b>CS:</b> backend electronics; <b>DP:</b> simulation and reco. |
| Fermi National Accelerator                       |  |
| Los Alamos National Laboratory                   | <b>FTOF:</b> sensor, module assembly; <b>CS:</b> cooling system and support structure; <b>DP:</b> simulation and reco.         |
| Rice University                                  | <b>BTOF/FTOF:</b> Front-end electronics; <b>CS:</b> backend electronics; <b>DP:</b> simulation and reconstruction              |
| Oak Ridge National Laboratory                    | <b>BTOF/FTOF:</b> sensor, sensor-ASIC integration, frontend electronics, module assembly                                       |
| <a href="#">Ohio State University</a>            | <b>BTOF/FTOF:</b> module assembly; <b>CS:</b> backend electronics, alignment; <b>DP:</b> simulation and reco.                  |
| Purdue University                                | <b>BTOF/FTOF:</b> module structure; <b>CS:</b> cooling system and support structure  |
| Univ. of California, Santa Cruz                  | <b>BTOF:</b> sensor, sensor-ASIC integration, module assembly  |
| University of Illinois at Chicago                | <b>BTOF/FTOF:</b> sensor, sensor-ASIC integration, module assembly; <b>DP:</b> simulation and reconstruction                   |
| Hiroshima University                             | <b>BTOF/FTOF:</b> sensor, module assembly; <b>DP:</b> simulation and reconstruction  |
| RIKEN  | <b>BTOF/FTOF:</b> module assembly  |
| Shinshu University                               | <b>BTOF/FTOF:</b> sensor   |
| University of Tokyo                              | <b>CS:</b> streaming readout; <b>DP:</b> online reconstruction   |
| <a href="#">South China Normal University</a>    |  |
| <a href="#">Univ of Sci. and Tech. of China</a>  |  |
| Indian Institute of Tech., Mandi                 | <b>DP:</b> simulation and reconstruction   |
| <a href="#">National Inst. of Sci. Edu. Res.</a> |  |
| National Central University                      | <b>DP:</b> simulation  |
| National Cheng-Kung University                   | <b>BTOF/FTOF:</b> module structure; <b>CS:</b> cooling system and support structure  |
| National Taiwan University                       | <b>BTOF:</b> sensor-ASIC integration, frontend electronics, module assembly  |
| Univ. Técnica Federico Santa María               | <b>FTOF:</b> module assembly; <b>DP:</b> simulation and reconstruction   |

# Estimate of in-kind contributions (both domestic and international)

- Based on the previous table and new efforts,
- Estimate of in-kind contributions
- DSL will contact each group representative on this
- Please help us on this iteration with CAM

# Simulation Work Package and task list