General Discussions

EIC Project R&D

- FY22 status
- FY23 plan

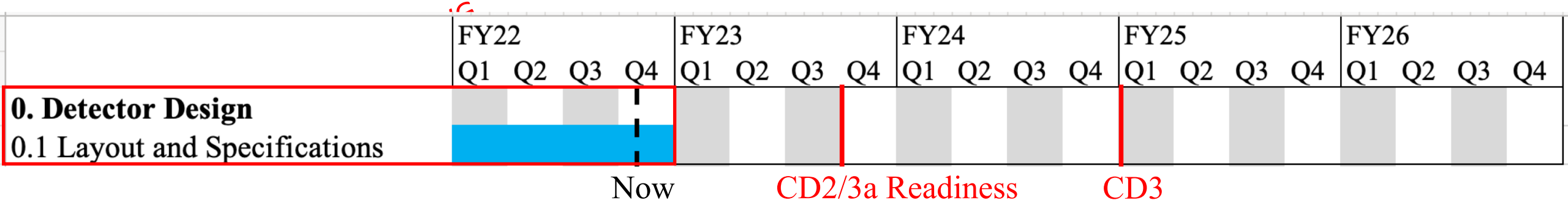
EIC Generic R&D

eRD112: Detector Design

Design Fabrication Testing

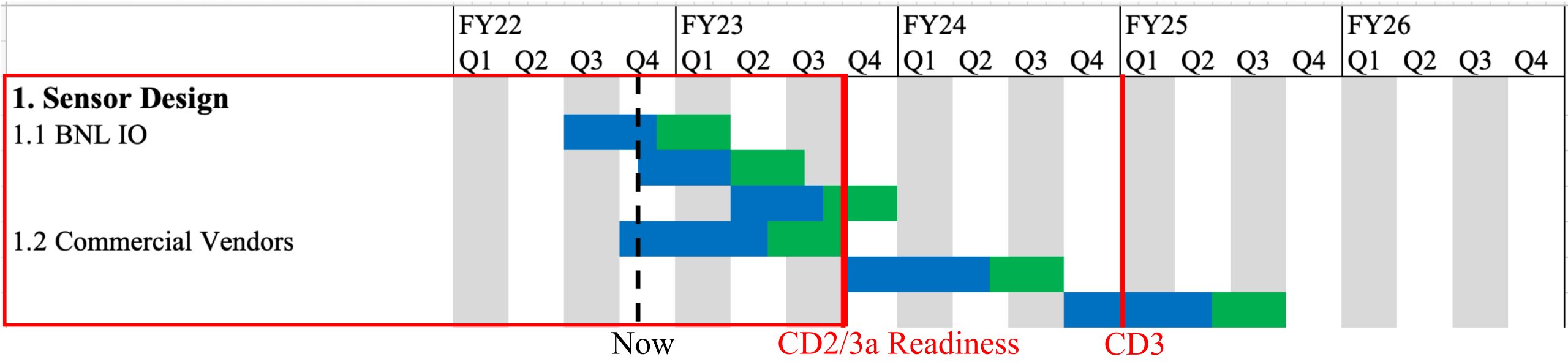
Detector overall design

- **Deliverable (June 2022 -> September 2022):** Definition of physics and performance specifications for different sub-systems, with a focus on detector layout, material budget requirement, timing, and space resolution targets.



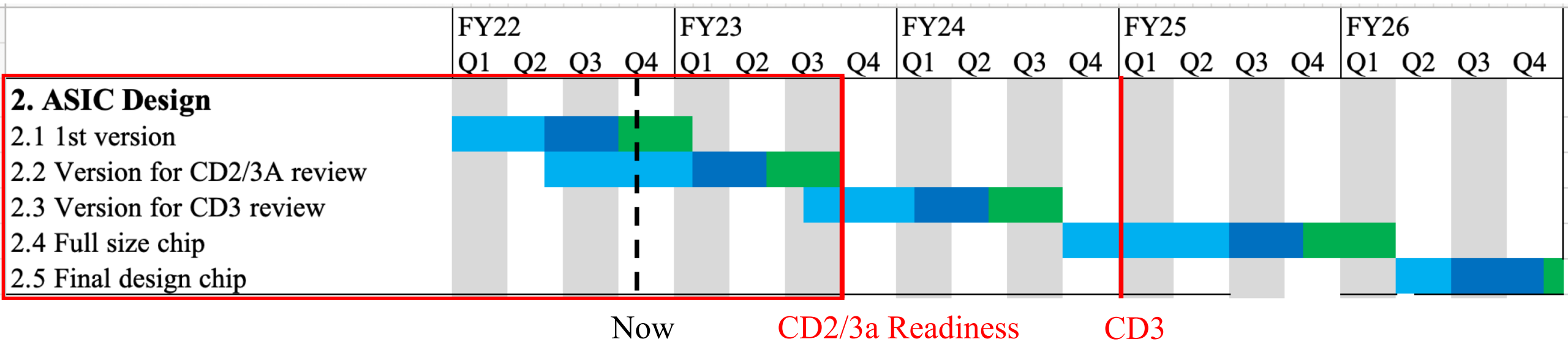
Work led by Nicolas Schmidt and Friederike Bock (ORNL). See recent reports at the EPIC TOF WG meetings https://indico.bnl.gov/category/414/

eRD112: Sensor R&D



- **FY22**:
  - Production of thin (20 and 30 um) sensors for ToF application with time resolution ~20 ps by BNL IO.
  - Production of medium/large-area sensors with different doping concentration, pitch, and gap sizes between electrodes to optimize performance by BNL IO and HPK.
  - **Deliverable (June 2022-> December 2022)** Sensor prototypes that meet space resolution specifications of the various subsystems and have a time resolution of 20-30 ps
- **FY23 Q1-> FY23 Q3**: Design and submission for fabrication of advanced sensor prototypes with <20 ps time resolution and space resolution that matches RPs, ToF, and Tracker requirements. This will be baseline for CD2/3A.
- **FY23 Q4-> FY24 Q2**: Sensor batch submission with optimized sensor layouts and performance, based on laboratory and test-beam results. This sensor design will be used as baseline for the CD3 review.
- **FY25**: Module-size sensor fabrication with target time and space performance.

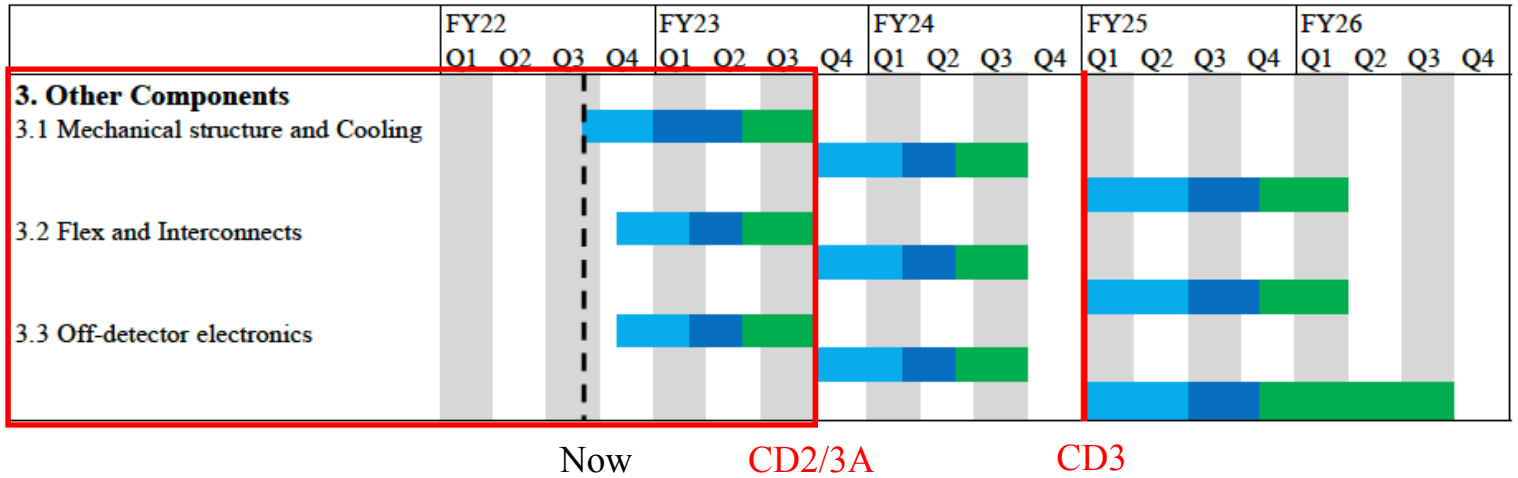
eRD112: Frontend ASIC



- **FY22 (funded externally):**
  - A first ASIC prototype that is compatible with EIC Roman Pot requirements and can read out an AC LGAD with ~500 um pitch and ~30 ps time resolution.
  - **Deliverable (Sept. 2022)**: A prototype ASIC design to readout AC LGADs using signal sharing across neighboring electrodes and has 30 ps time resolution with low power consumption.
- **FY23 Q1**: 2nd ASIC prototype design and submission with better performance and extended features. This design will be used as baseline in the CD2 review.
- **FY24 Q2**: Third ASIC submission, aiming to match ToF timing requirements. This ASIC design will be used as baseline for the CD3 review.
- **FY25**: Full-scale ASIC submission.

eRD112: Other Components

- **Light-weight mechanical structure and Cooling**
  - **May 2022**: Formation of a team of experts to start developing the cooling strategy and identifying mechanical requirement.
  - **FY23 Q1**: Development of a general cooling strategy and mechanical requirements to be used as baseline for CD2 review.
  - **FY24 Q2**: Cooling demonstrator and building of a mechanical module. This will be used as baseline for the CD3 review.
  - **FY25**: Development of final cooling system.
- **Flex, Interconnects and off-detector electronics**
  - **July 2022**: Formation of a team of experts to start developing strategy for flex, interconnects, and off-detector electronics.
  - **FY23 Q1**: Development of a general layout of exes and off-detector electronics to be used as baseline for the CD2 review.
  - **FY24 Q2**: Advanced design and prototyping of exes, interconnects, and off-detector electronics. This will be used as baseline for the CD3 review.
  - **FY25**: Production of exes, interconnects, and off-detector electronics with fin design.



EIC Project R&D: eRD112 FY22 Fund

We are writing to you in response to your proposal for EIC Project Detector R&D entitled "*EIC AC LGAD R&D Proposal*", submitted by you on February 24, 2022.

As you know, the start of project R&D was unexpectedly difficult due the US budget delays because of the long Continuing Resolution. While the situation has improved the funding is still far from ideal. We reviewed the situation and your proposal carefully and in accordance with the project's priorities and the overall planning status, **$200,000** are awarded to eRD112 for the remainder of FY22.

This funding is in support of achieving the milestones as listed in the proposal. Please note that this effort and its milestones will be entered, and progress tracked in the EIC project portfolio management system (P6). The timelines were adjusted to accommodate the delayed start of the R&D program.

The project R&D funding will be transmitted via one or more R&D subcontracts with BNL. We ask you kindly to get in touch with Anna Mendez (amendez@bnl.gov) and provide a one-page Statement-of-Work (SOW) that is needed to establish the contract.

We will contact you frequently to learn about the status of your R&D. Towards the end of FY22 we kindly ask for a written progress report.

EIC Project R&D: eRD112 FY22 Fund

- **Sensor fabrication:**
  - $50k for sensor fabrication by BNL Instrumentation Division – talks by Gabriele on June 1 and today
  - $50k for sensor fabrication by HPK – discussion in progress with KEK/Tsukuba (US-Japan ACLGAD)
- **Test board fabrication and assembly**
  - $3k for ten single-channel UCSC boards – Bruce: boards produced
  - $17k for x(>20) 16-channel Fermilab boards – ~ $280/board (20ps) with 4-6 weeks delivery time (?)
- **FTE**
  - BNL ($20k): wafer probe testing and dicing for the whole BNL production sensors
  - UIC ($24k): sensor mounting, wire-bonding and testing BNL production sensors
  - UCSC ($11k): sensor mounting, wire-bonding and testing BNL production sensors
  - Rice ($17k): sensor testing
  - LANL ($8k): sensor testing
- **Paperwork status:** all SOWs submitted on June 28. Non-competing procurement justifications provided. Waiting for Project office to contact us and issue the contracts.

EIC Project R&D: FY23 Proposal

- Proposals

  1. We ask all ongoing projects to prepare the next round of proposal for FY23. They are due October 1, 2022. Same guidelines as for FY22 apply. Please describe milestones, timeline, and budget in detail. Please remember to be inclusive and integrate the interested parties in the community.

  2. The projects that were put on hold previously, eRD109 (ASICs/Electronics) and eRD106 and eRD107 (forward calorimetry) should submit their proposals as well, also due October 1, 2022. The organization of eRD109 will need coordination between many subdetectors to account all the needs.

  3. The Si consortium also should submit a new proposal for sensor development (ITS3) due October 1, 2022. The project code will be eRD113.

  These new proposals should be relatively straightforward to write. To first order, we follow the documented plan for the project-supported R&D. The proposals should follow the guidance of the series of meetings we have had with the various eRD groups last Fall and concentrate on detector R&D tasks that mitigate project detector technical, cost or schedule risk. We do inform you early about this new round of proposals so that we can expedite the start of projects that were put on hold before. It eases also the planning for the ongoing projects that continue into FY23.

- DAC Review Meeting

  There will be a 2-3 day review meeting in October. The status of all ongoing projects should be presented as well as all FY23 proposal. More details on this meeting will be announced soon.

EIC Project R&D: Inputs for FY23 Plan

- **Sensor fabrication and testing:**
- **ASIC submission and testing**
- **Mechanical structure and cooling**
- **Flex, interconnects, off-detector electronics**
- **?**

EIC Generic R&D

- The focus of this EIC-related generic detector R&D program is to evaluate opportunities to achieve new, cost-effective detector capabilities that reduce risk. This program will support advanced R&D on innovative detector concepts that either the one detector in the project scope or a second detector could incorporate.
- TJNAF will share proposals with the Electron-Ion Collider project (EIC). Should EIC determine that a proposal would directly support the project, EIC may use project funds to cover the costs of the work.
- Funded proposals will be selected on the basis of peer review by an EIC-related Generic Detector R&D Advisory Committee consisting of internationally recognized experts in detector technology and collider physics.
- Webpage: https://www.jlab.org/research/eic_rd_prgm
- Relevant FY22 proposals for AC-LGAD

  05 Continued Development and Evaluation of a Low-Power High-Density High Timing Precision Readout ASIC for AC-LGADs (HPSoC)

  06 A new radiation tolerant low power Phase-Locked Loop IP block in a 65 nm technology for precision clocking in the EIC frontend electronics

  11 Development of a Generic, Low-power and Multi-channel Frontend Readout ASIC for Precision Timing Measurements at EIC

Proposals for alternative detector technologies

03 Precise Timing with a Micro Pattern Gaseous Detector

10 Implementation of a gain layer in Monolithic Active Pixel Sensor (MAPS) for high resolution timing application

16 Development of High Precision and Eco-friendly MRPC TOF Detector for EIC

24 Simplified LGAD structure with fine pixelation