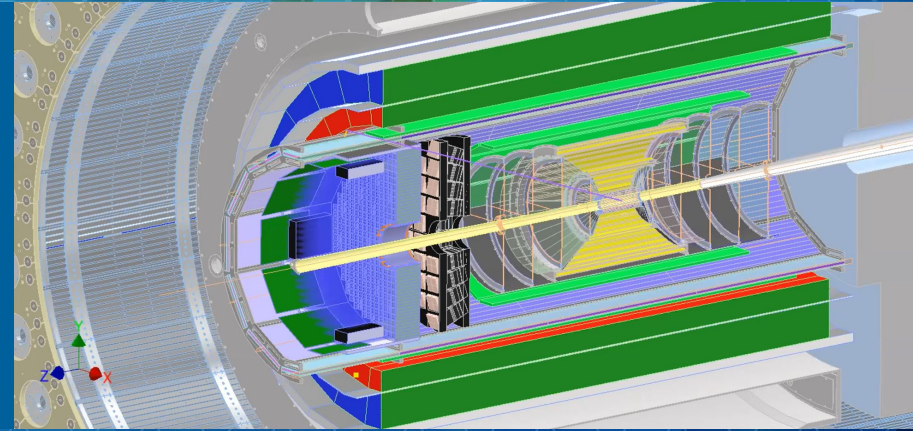


ePIC Calorimetry Meeting

Barrel Imaging Calorimeter ePIC TDR Planning



05/15/2024



TDR Structure

- ✓ ready to write
- ⚠ partially ready to write
- ✗ lots of to do

Design

- Overview ✓
- Detector Requirements ✓

Performance

- Performance with *most up to date geometry/envelopes* ⚠
 - Energy resolution, Position resolution,
 - e/pi separation, gamma/pi0 separation
- Beam test benchmarking (e resolution) ⚠
- Literature benchmarking (pion response) ⚠
- Backgrounds ✗

Sector Design, Mechanics and Integration

- Sector design and construction ⚠
- Tracker mechanics ✗
- End-of-sector box mechanics ⚠
- Deflection studies ✗
- Barrel assembly and integration tooling ⚠

AstroPix Wafers & Modules

- AstroPix characteristics and readiness ✓/⚠
- Automated wafer testing ⚠
- Module & stave design ⚠
- Stave bus design ✗
- Module assembly and scalability ✗

End-of-sector Box and Readout

- SiPMs characteristics ✓/⚠
- SiPM boards and FEB ⚠/✗
- LED system ✓/⚠
- Tracker End-of-tray card (RDO) ✗
- Slow controls (temperature, humidity) ⚠

Cooling

- Cooling system design ⚠
- Global heat load simulations ✗

System Testing

- System Calibration ✗
- System QC ✗
- System Demonstration ⚠/✗

High-level timeline

Performance

Performance

1. Performance with *most up to date geometry/envelopes* 🚧
 - a. Energy resolution, Position resolution,
 - b. e/pi separation, gamma/pi0 separation
2. Beam test benchmarking (e resolution) 🚧
3. Literature benchmarking (pion response) 🚧
4. Backgrounds ✖

Tasks	Time	Missing Workforce/Resources
1a and 1b	June 2024 (repeated depending on implementation of design)	FTEs on reconstruction algorithms implementation and validation.
2	August 2024	
3	October 2024 (depending on beam test success)	
4	November 2024	Requires input from background task-force and work on reconstruction algorithms.

System Testing

1. System Calibration ✘
2. System QC ✘
3. System Demonstration ⚠/✘










Tasks	Time	Missing Workforce/Resources
1, 2	July 2024 Internal preliminary design review Sep 2024 Preliminary design review May 2025 Internal final design review	
3	May 2024 FTBF Beamtest (Commissioning, e/pion response) September 2024 First Integrated Mechanical Test Article Nov/Dec 2024 FTBF Beamtest (Integrations, e/pion response) July 2025 Large Integrated Test Article	

Sector Design, Mechanics and Integration

1. Sector design and construction 🚧
2. Tracker mechanics ✖
3. End-of-sector box mechanics 🚧
4. Deflection studies ✖
5. Barrel assembly and integration tooling 🚧

Tasks	Time	Missing Workforce/Resources
1,2,3	July 2024 Internal preliminary design Sep 2024 Preliminary design review Jan 2025 Internal final design review	
4	July 2024 Sector-scale FEA Dec 2024 Full system FEA	
5	May 2024 Assembly Strategy Decision (w/ Project) Dec 2024 Assembly and tooling design	

End-of-sector Box and Readout

1. SiPMs characteristics  
2. SiPM boards and FEB   
3. LED system  
4. Tracker End-of-tray card (RDO) 
5. Slow controls (temperature, humidity) 







Tasks	Time	Missing Workforce/Resources
1	July 2024 Irradiation Studies (FBTF tests) Sep 2024 Start Bidding/Procurement	
2, 3, 4, 5	July 2024 Internal preliminary design Sep 2024 Preliminary design review Mar 2025 Internal final design review	Formal FEB expert (Norbert has been helping us)

Cooling

1. Cooling system design 🚧
2. Global heat load simulations ✖

Tasks	Time	Missing Workforce/Resources
1, 2	July 2024 Internal preliminary design Sep 2024 Preliminary design review Jan 2025 Internal final design review	TBD: FEA expert to conduct simulations (can recruit from BIC DSC or maybe get help from Project)

AstroPix Wafers & Modules

1. AstroPix characteristics and readiness  
2. Automated wafer testing 
3. Module & stave design 
4. Stave bus design 
5. Module assembly and scalability 

Tasks	Time	Missing Workforce/Resources
1	Nov 2024 AstroPix v5 characterization June 2025 AstroPix v6 characterization (production chip)	
2	Jul 2024 chip-level QC testing for AstroPix v3 Nov 2024 chip-level QC testing for AstroPix v5 Jan 2025 transition from chip to wafer-level QC testing	
3,4,5	July 2024 Internal preliminary design Sep 2024 Preliminary design review Apr 2025 Internal final design review	

Progress Report

In-person BIC Workshop - May 14-17, 2024

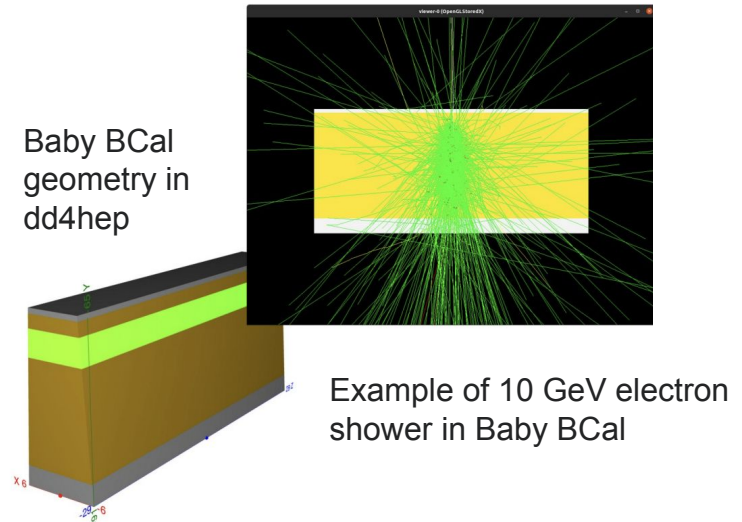
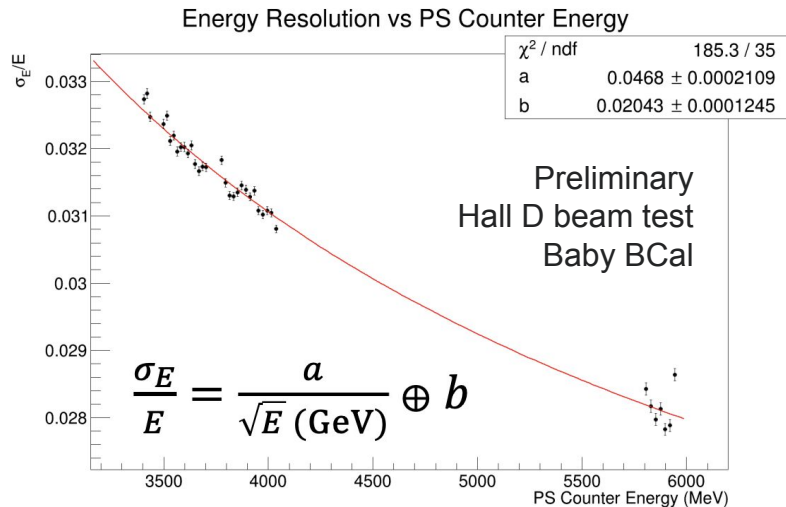
<https://indico.bnl.gov/event/22517/timetable/>

- Day 1: Updates on ongoing R&D and simulation work
- Day 2: Summary of the status of global, end-of-sector box, and AstroPix module interfaces and work on rev. 1 interfaces documents
- Day 3: Interfaces documentation and detailed PED work planning
- Day 4: Prototypes and test articles - planning



Performance and System Testing

1. Most up to date detector envelopes included in the simulation <https://github.com/eic/epic/pull/729>
2. Update during the BIC in Person Workshop (May 14-17) on electron energy resolution from Hall-D beam test in 2023 and simulations
J. Zharling: <https://indico.bnl.gov/event/22517/contributions/91532/>
J. Richards: <https://indico.bnl.gov/event/22517/contributions/91533/>



Performance and System Testing

3. Update on ongoing ~~beam~~ cosmics test in **Fermilab Beam Test Facility (May 8-14)**

H. Klest, M. Zurek, B. Kim: <https://indico.bnl.gov/event/22517/contributions/91530/>,

<https://indico.bnl.gov/event/22517/contributions/91531/>, <https://indico.bnl.gov/event/22517/contributions/91624/>

- AstroPix and Baby BCal (SciFi/Pb) installed and tested with **cosmics** in the FBTF
- Based on performed tests further ongoing efforts to fully readout the Baby BCal (+other FTBF detectors and cosmic paddles) in the same data stream
- **No beam delivered to FBTF so far as of today. Possibility of one week of June 12.**
- Goal:
 - Fully commission the setup with the beam including the first test of the integration between AstroPix and SciFi/Pb.
 - Benchmark response to pions.




Current ANL AstroPix
Telescope Setup

~~Planned BIC Setup!~~

Sector Design, Mechanics and Integration

1. Extensive work on finalizing **revision 1 of the interfaces document for BIC** over the last few months, with a series of topical meetings and writing sessions during the in-person BIC Workshop.
2. **Freezing interfaces** as PED funds become available to some of our collaborators will allow teams to **focus on sub-component designs** with clearly defined envelopes and conditions

		Interface Documentation ePIC Barrel ECAL Project	
Project Document No.: epic-bic-xx-XXXX	Institute Document No.: xxx	Created: 11 April 2024 Modified: May 17, 2024	Page: 1 of 62 Rev. No.: 0.1

<h2>Interface Documentation</h2> <p>ePIC Barrel ECAL Project</p> <p><i>Abstract</i></p> <p>This document will cover technical details on the Astropix Modules, AstroPix wafer quality control, End-of-Sector Board (EOSB), and Global Design interfaces.</p>
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Single Sector, 82.5cm radius
Detector Length = 440cm
Total Length including EOS boxes = 470cm

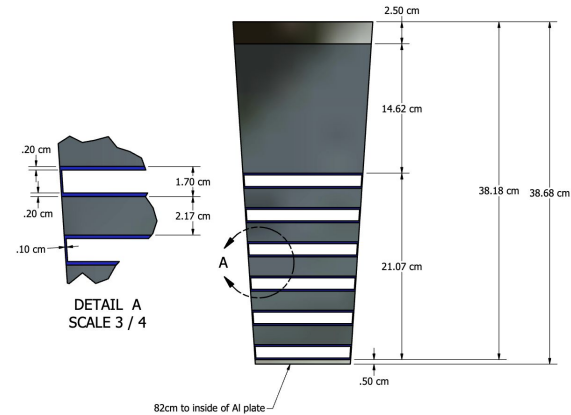


Figure 2: Single Sector, End View. Sectors build of the layers of scintillating fibers embedded in lead shown in gray and 6 slots for AstroPix layers shown in white.

End of Sector Box

1. Finalizing mechanical interfaces for the designs of SiPM and HGCROC PCB, end-of-tray card (AstroPix FPGA), cooling, lightguides, connectors, etc.

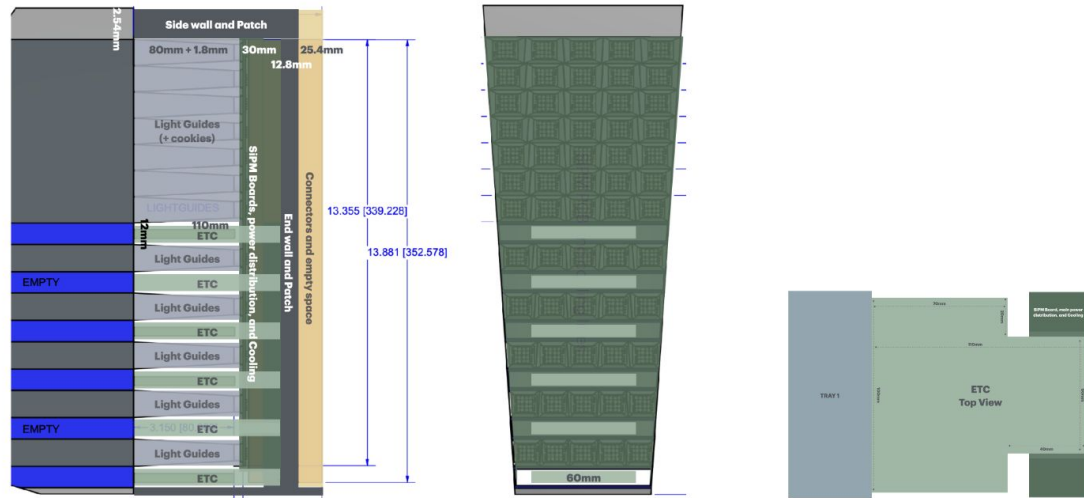
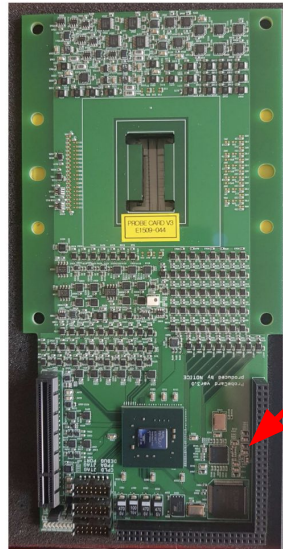


Figure 11: Napkin sketch of the mechanical envelopes for the ESB. Left: Side view in the middle of a sector. Center: Rear view cutout at the SiPM PCB Right: Top view of the AstroPix readout FPGA. **TODO: replace with engineering drawings**

AstroPix Wafers & Modules

1. See the presentation by Manoj Jadhav (TIC Meeting, May 20) on AstroPix Update
2. AstroPix v5 status (to be submitted for an engineering run in June) at the BIC in-person meeting:
Nicolas Striebig <https://indico.bnl.gov/event/22517/contributions/91071/>
3. Developments towards wafer testing in Korea:
Sanghoon Lim: <https://indico.bnl.gov/event/22517/contributions/91072/>
 - a. Initial version of AstroPix v3 probe card for the carrier card only expected in a few weeks



Probe card for ALPIDE

