Update & Plans

Miguel Arratia,

California EIC consortium meeting,
08/18/24 @ UC Davis

UCR EIC team 2024

Undergraduate /post bac students;

Miguel Rodriguez, **Mia Macias [RENEW]**, Ryan Tsiao, **Chase Owens [RENEW]**.

Graduate students:

Ryan Milton, Jiajun Huang, Sebastian Vasquez, Sean Preins [HEPCAT]

Postdocs: Weibin Zhang & STAR in Barish's group

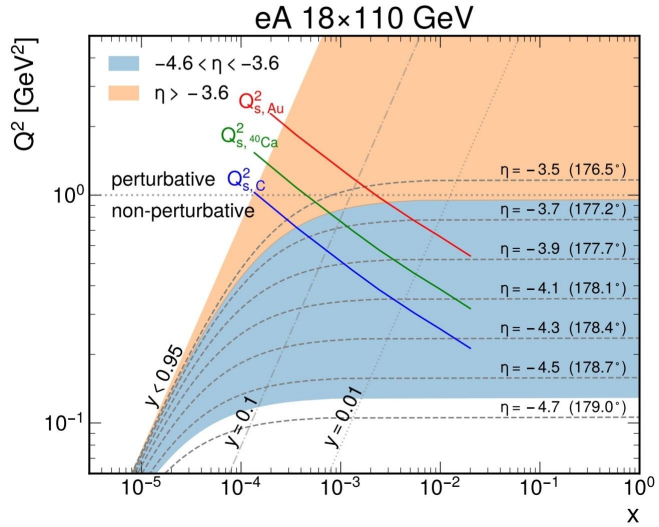
Sebouh Paul & CLAS12 in Arratia's group

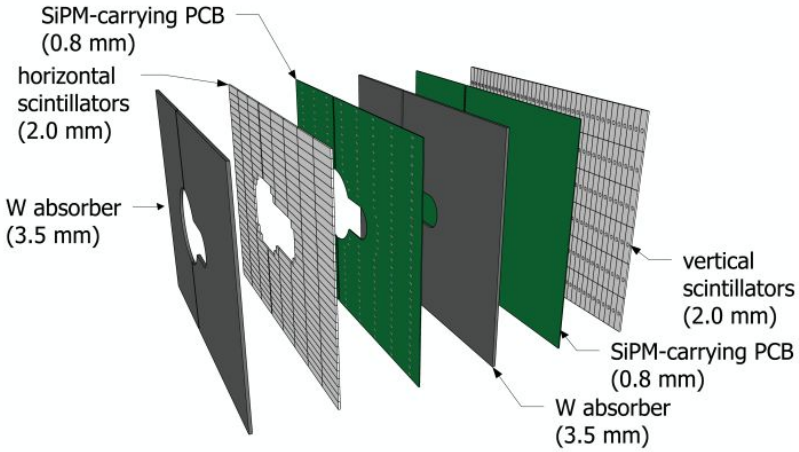
Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment

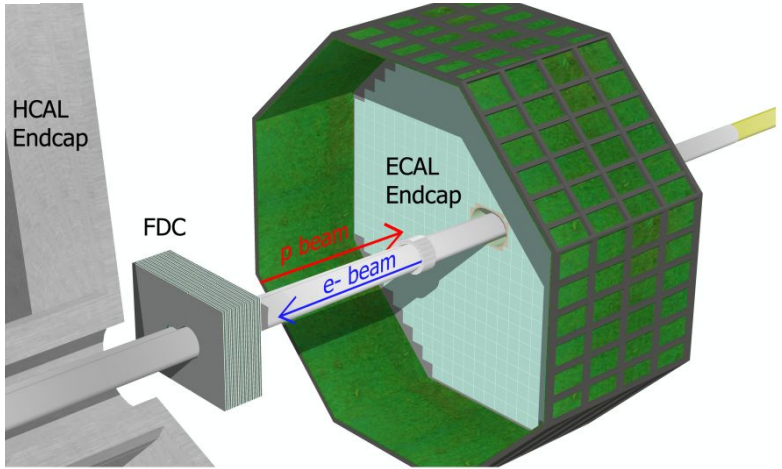
Volume 1063, June 2024, 169280

A few-degree calorimeter for the future electron-ion collider

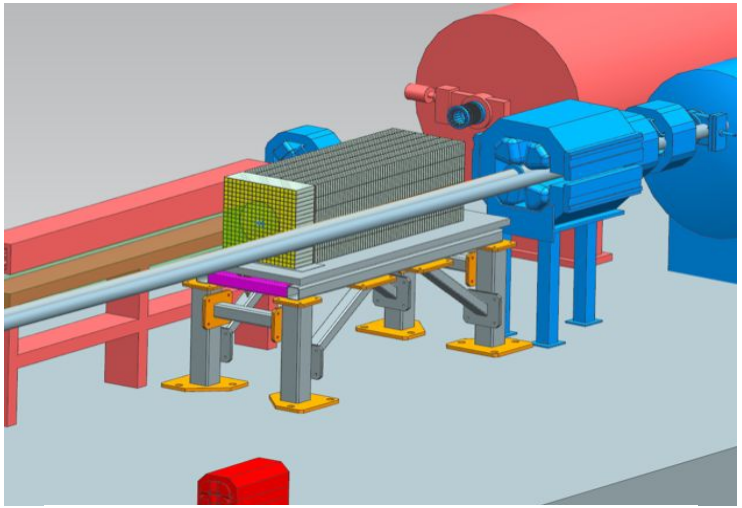
Miguel Arratia [a b], Ryan Milton [a], Sebouh J. Paul [a b], Barak Schmookler [a], Weibin Zhang [a]

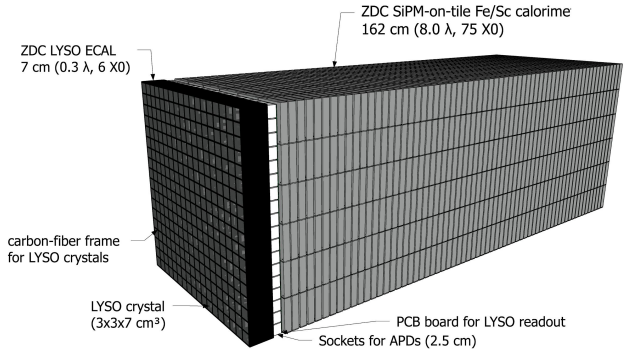


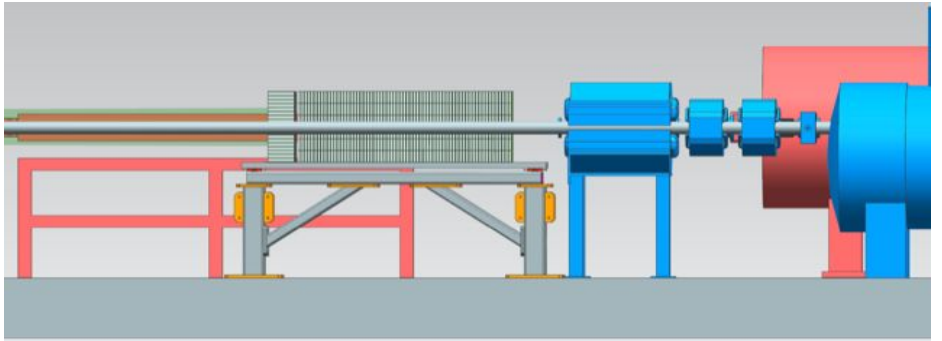


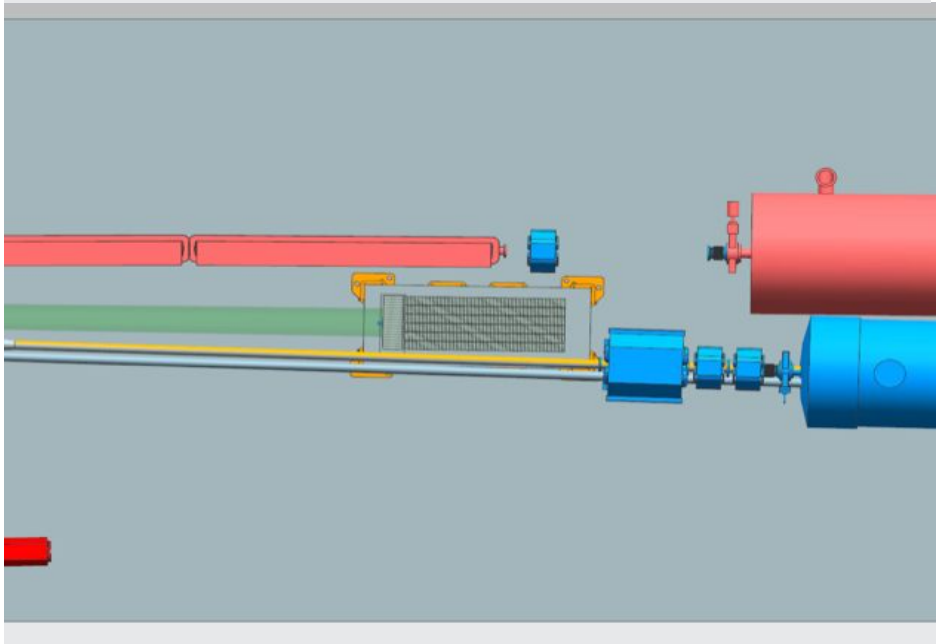


ZDC




ZDC SiPM-on-tile Fe/Sc calorime
162 cm (8.0 λ, 75 X0)
ZDC LYSO ECAL
7 cm (0.3 λ, 6 X0)
carbon-fiber frame
for LYSO crystals
LYSO crystal
(3x3x7 cm³)
PCB board for LYSO readout
Sockets for APDs (2.5 cm)





Physics > Instrumentation and Detectors

[Submitted on 11 May 2024]

Design of a SiPM-on-Tile ZDC for the future EIC and its Performance with Graph Neural Networks

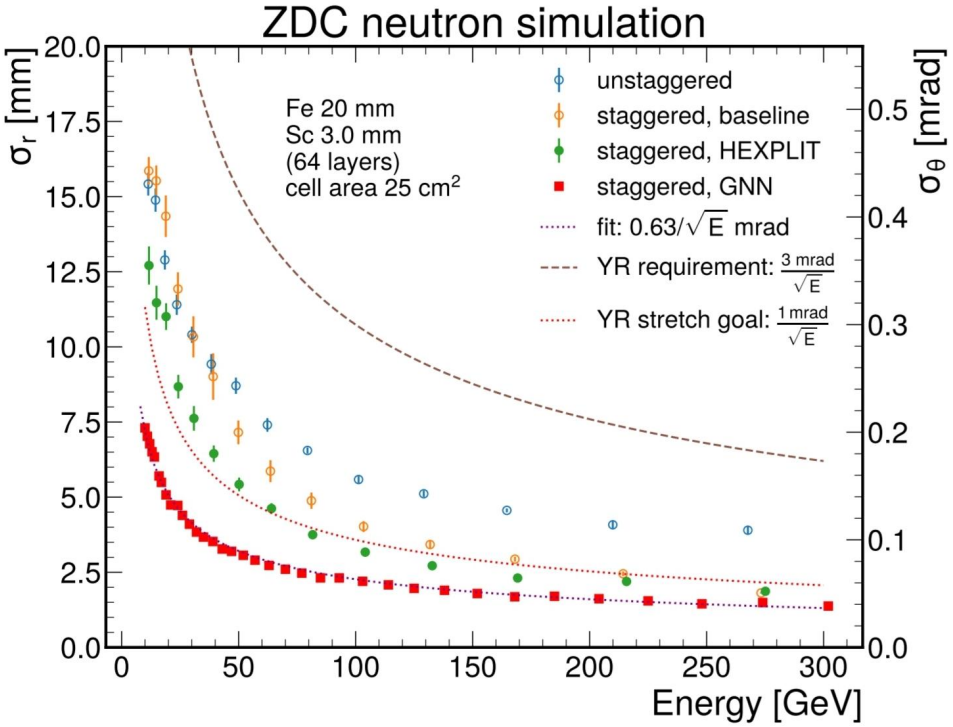
Ryan Milton, Sebouh J. Paul, Barak Schmookler, Miguel Arratia, Piyush Karande, Aaron Angerami, Fernando Torales Acosta, Benjamin Nachman

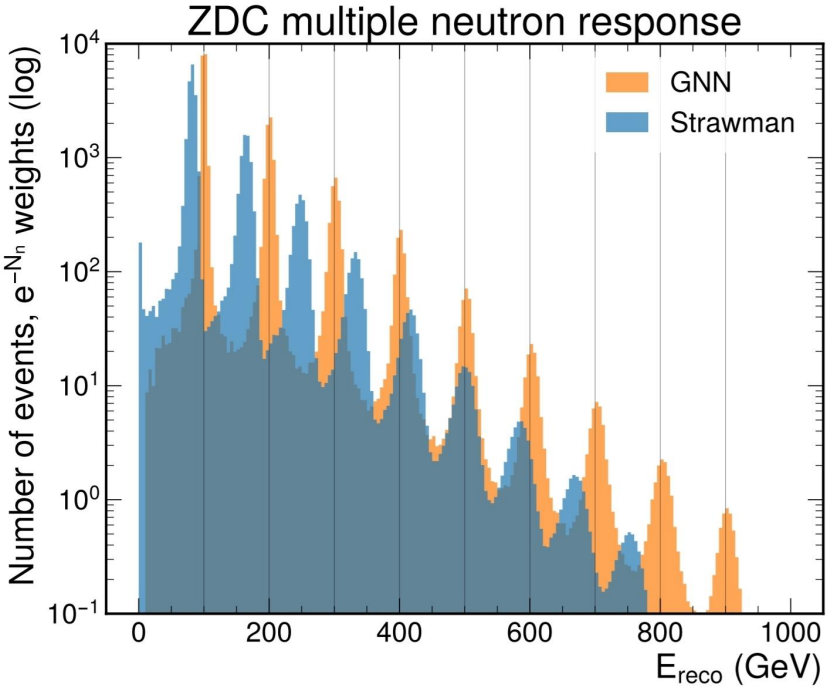
We present a design for a high-granularity zero-degree calorimeter (ZDC) for the upcoming Electron-Ion Collider (EIC). The design uses SiPM-on-tile technology and features a novel staggered-layer arrangement that improves spatial resolution. To fully leverage the design's high granularity and non-trivial geometry, we employ graph neural networks (GNNs) for energy and angle regression as well as signal classification. The GNN-boosted performance metrics meet, and in some cases, significantly surpass the requirements set in the EIC Yellow Report, laying the groundwork for enhanced measurements that will facilitate a wide physics program. Our studies show that GNNs can significantly enhance the performance of high-granularity CALICE-style calorimeters by automating and optimizing the software compensation algorithms required for these systems. This improvement holds true even in the case of complicated geometries that pose challenges for image-based AI/ML methods.

Comments: 9 pages, 9 figures. Code and datasets included

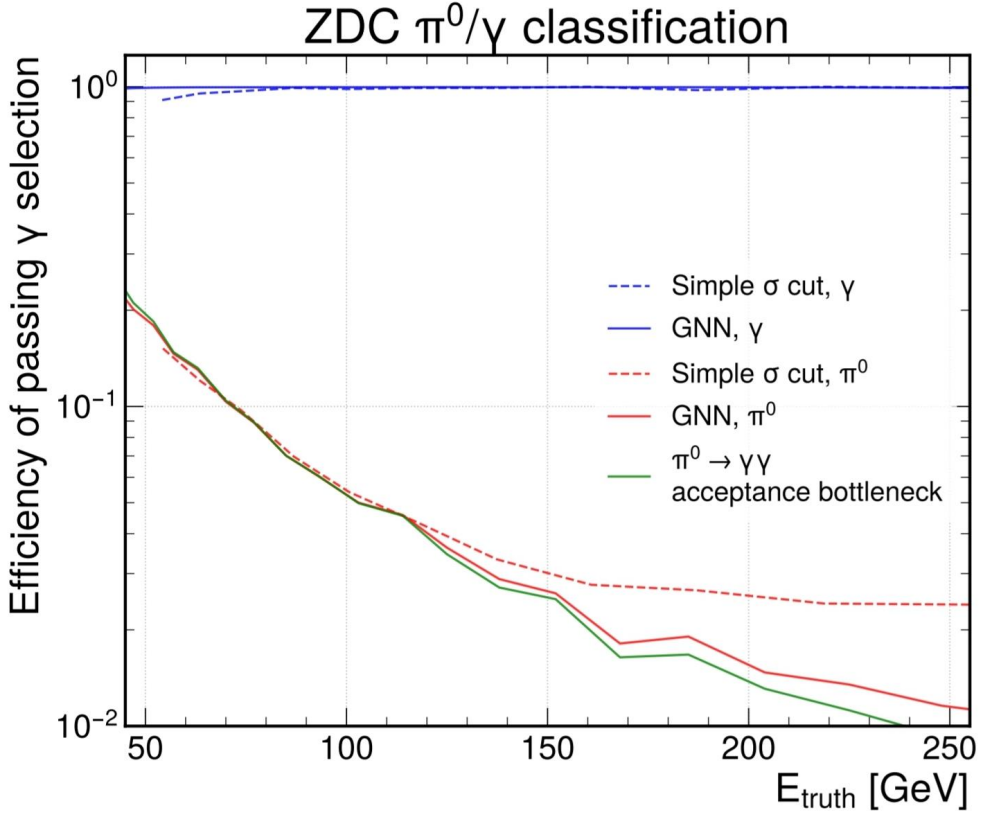
Subjects: **Instrumentation and Detectors (physics.ins-det)**; High Energy Physics - Experiment (hep-ex); Nuclear Experiment (nucl-ex)

Paper highlights

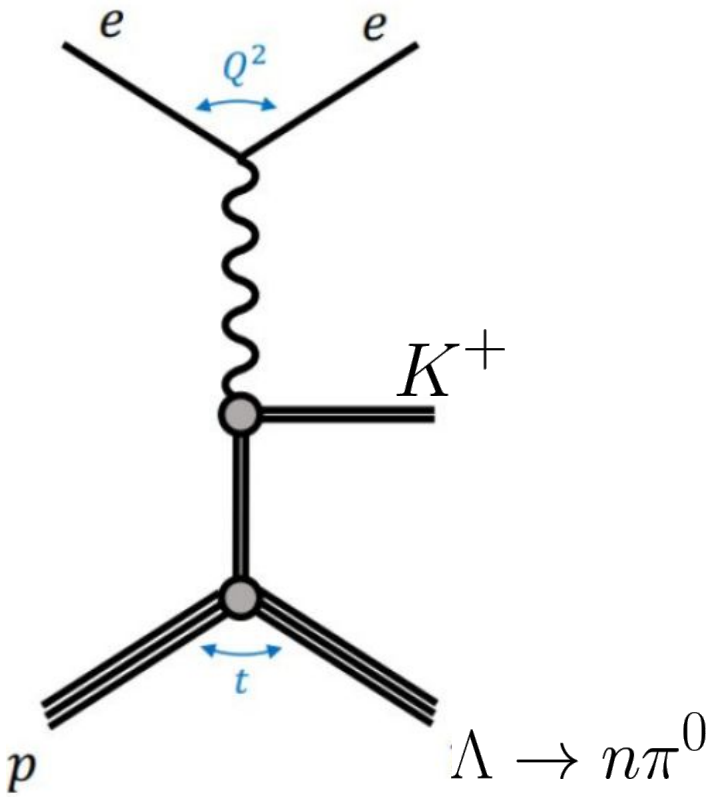




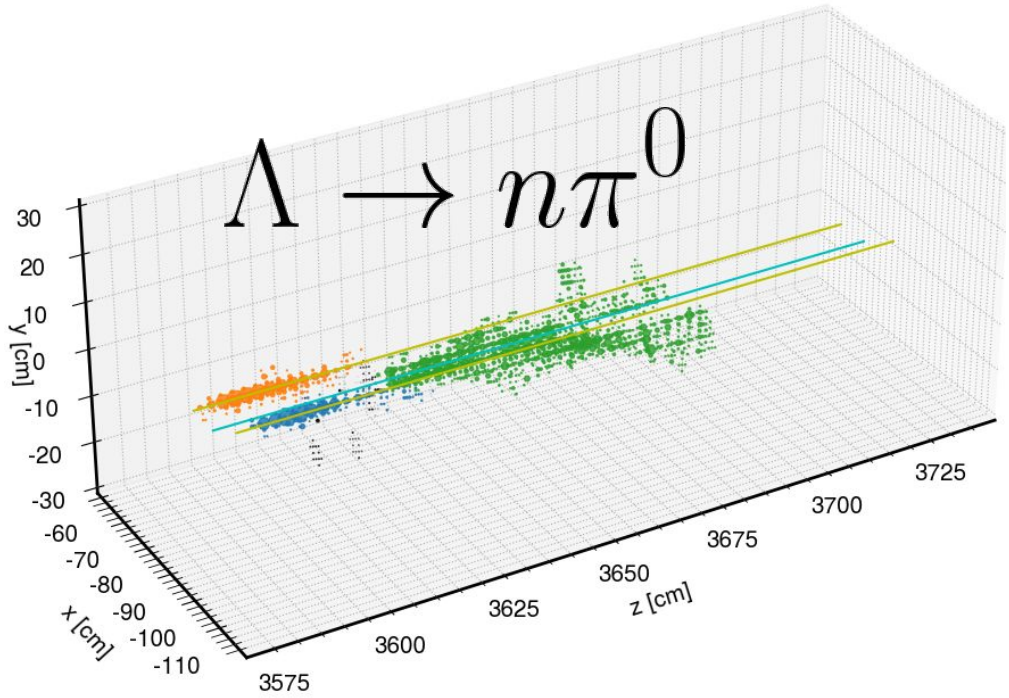
ZDC paper highlights



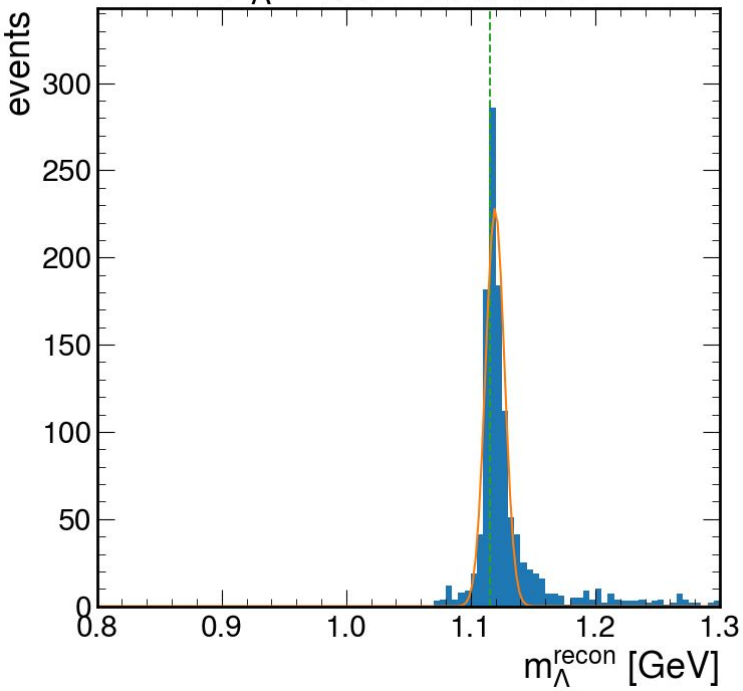
The missing piece



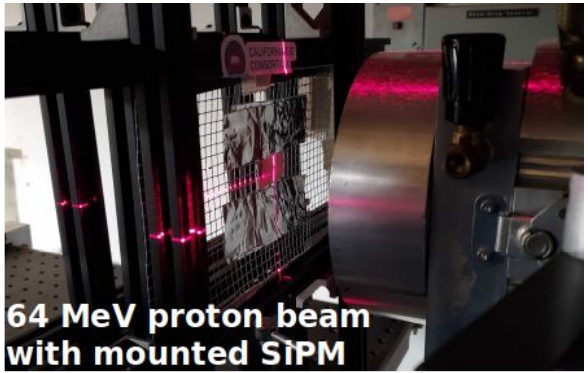
E_Λ = 100 GeV, θ_Λ=1.1 mrad, z_{vtx}=19.2 m



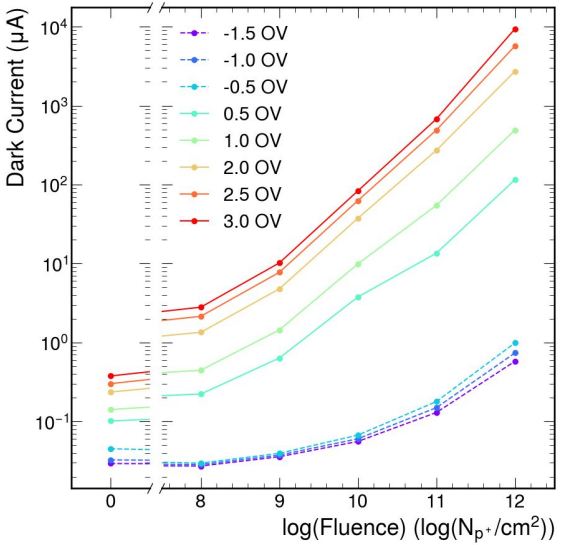
E_Λ = 100 – 275 GeV



SiPM proton irradiation test at UC Davis Cylotron – May 2024



- All SiPM models to be used in all ePIC Calorimeters tested for all fluence range relevant for EIC
- Dark current vs. proton fluence for set overvoltage values, and other measurements done
- High-temperature annealing studies relevant for ZDC are ongoing

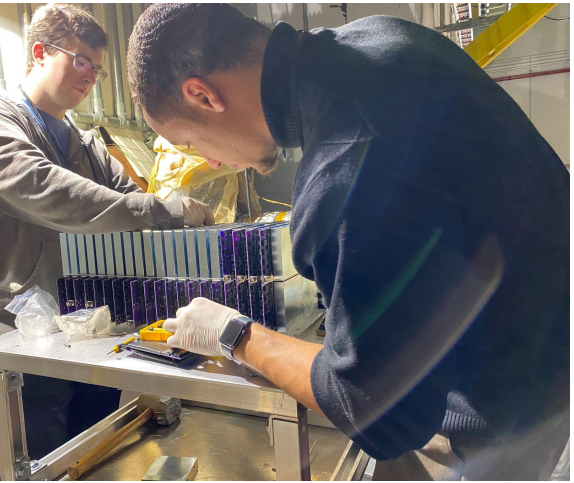


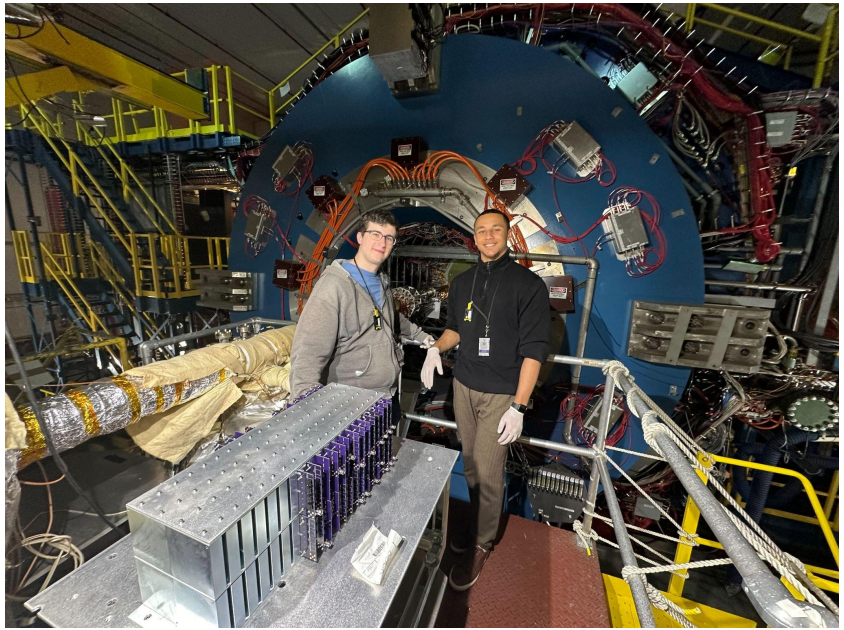
Parasitic Experiment at STAR Hall

Brookhaven National Laboratory

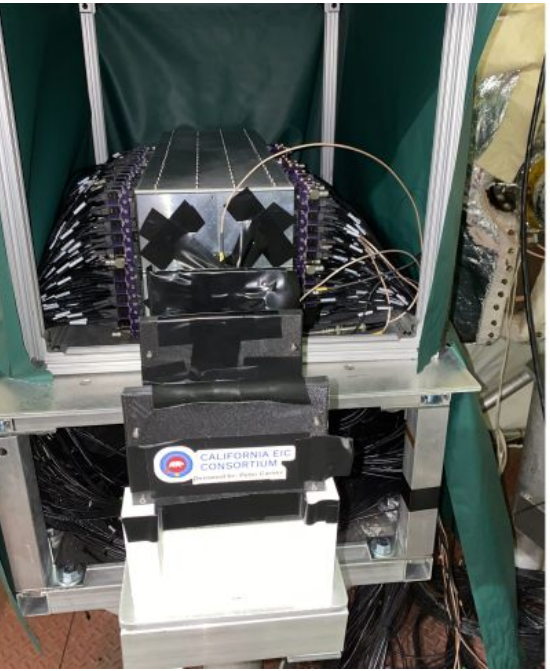
Goal: test in situ calibration (MIP and π0) and operation stability in EIC-like fluence.
Will run until the end of RHIC in 2025.

First SiPM-on-tile Calorimeter operating in a Collider ever!





Current Status



CALI

HOME QA CHANNEL PTRG COSMIC MISC

Run: 1664

Select Day

August, 2024

			1	2	3	
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

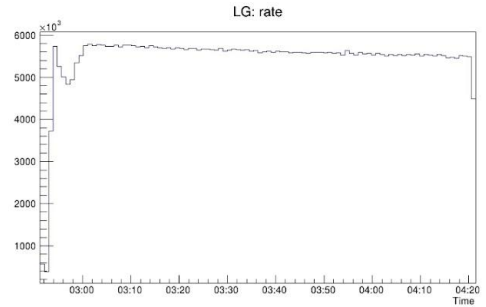
July, 2024

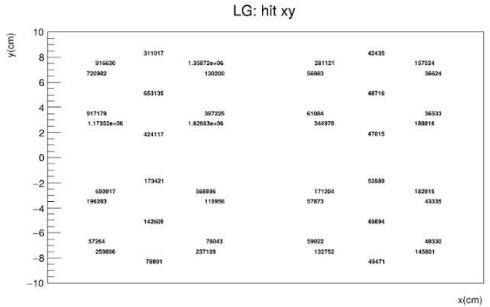
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

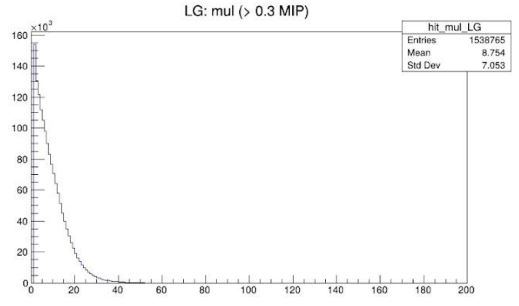
June, 2024

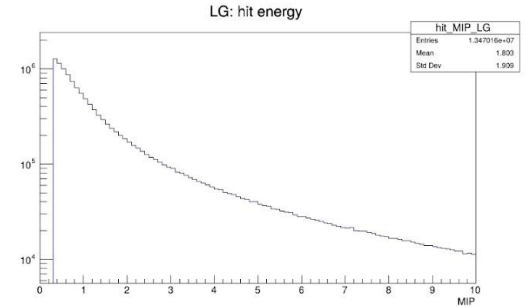
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

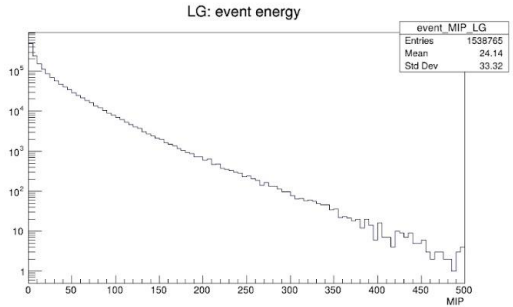
May, 2024

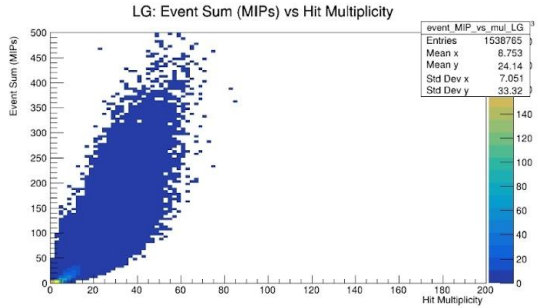


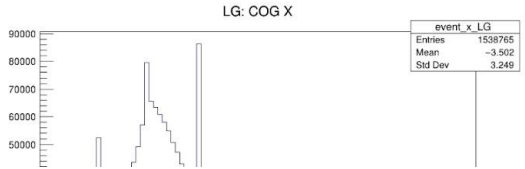


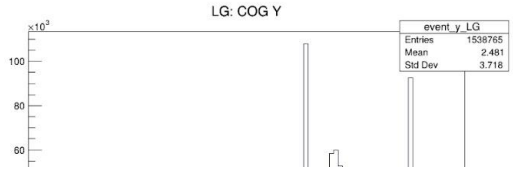


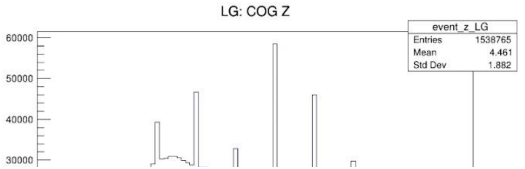












CALI HOME QA CHANNEL PTRG COSMIC MISC

2024-08-08

Run: 1579 1580

2024-07-31

2024-07-30

2024-07-23

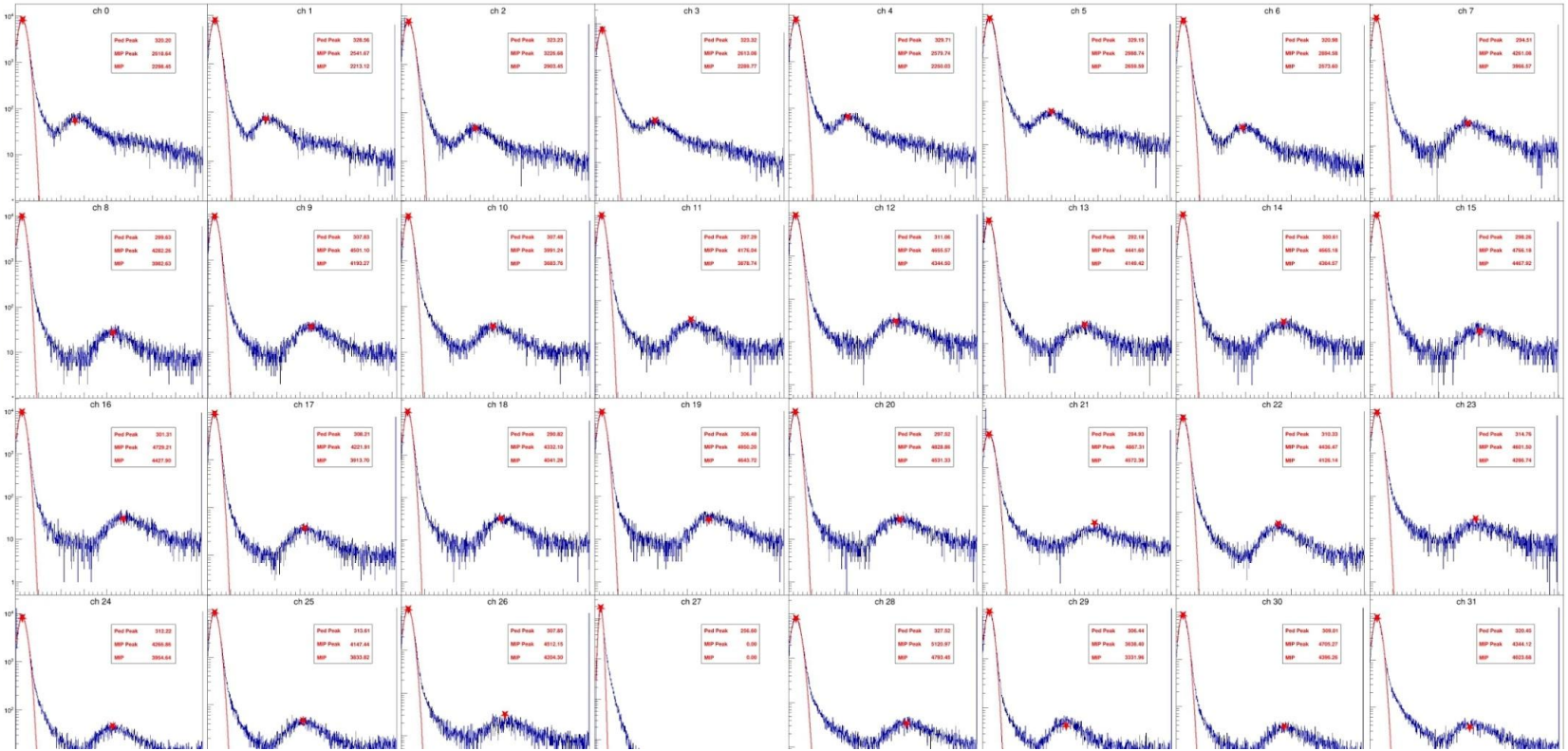
2024-07-19

2024-07-17

2024-07-03

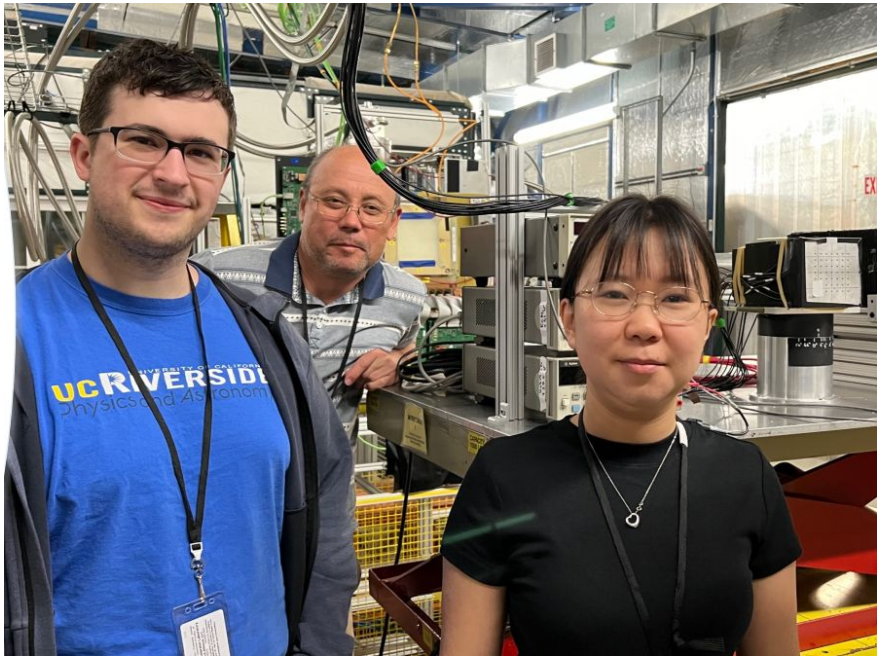
2024-07-02

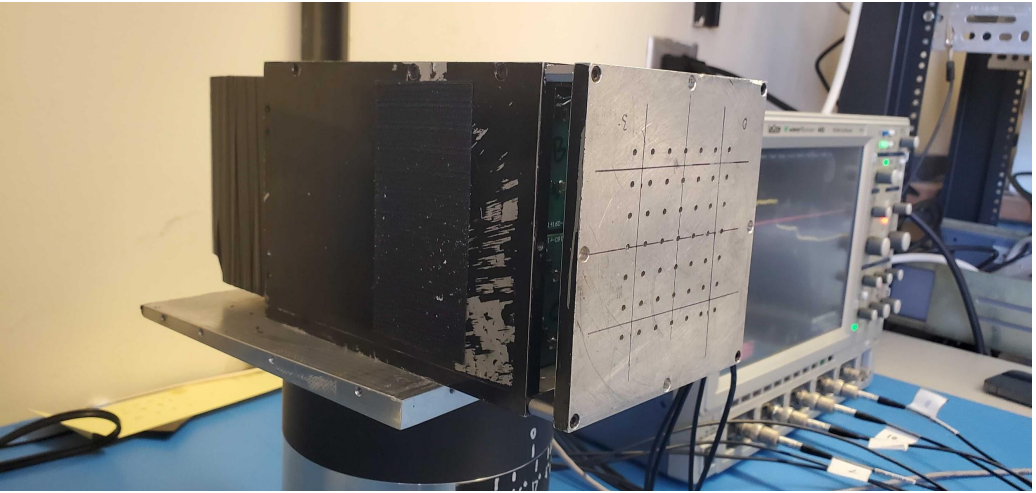
2024-06-13

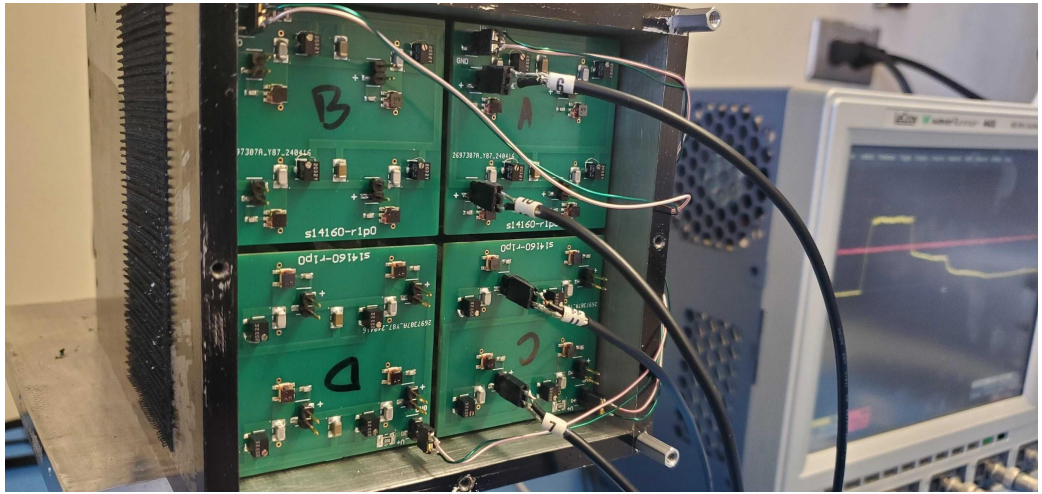


Fermilab

June 2024

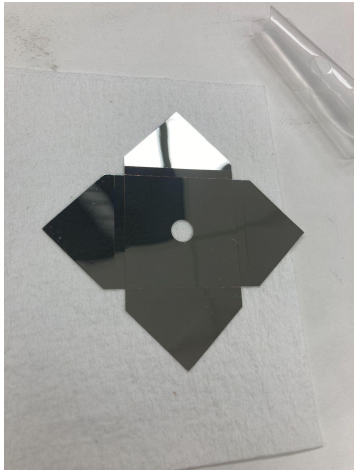





B
A
s14160-rlp0
s14160-rlp0
s14160-rlp0
D
C

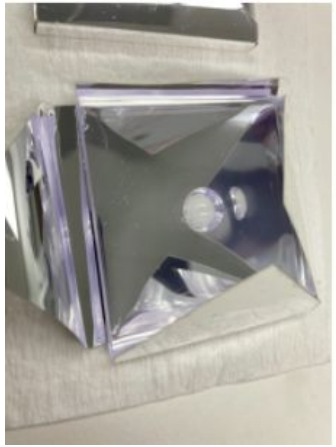
Gen-III Prototype construction (EIC project funded)

- 30x30 cm2 (¼ transverse area of full detector)
- 15 layers (full detector uses 60)
- Constructed similar to the full detector
- Staggered square cell pattern

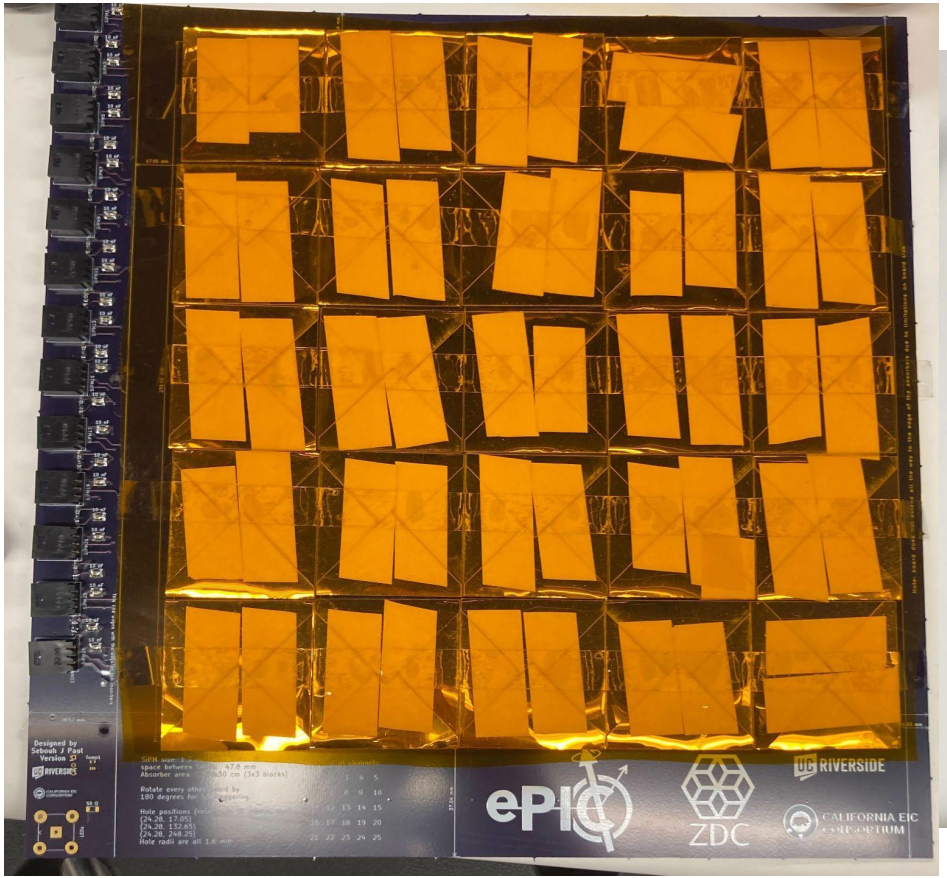


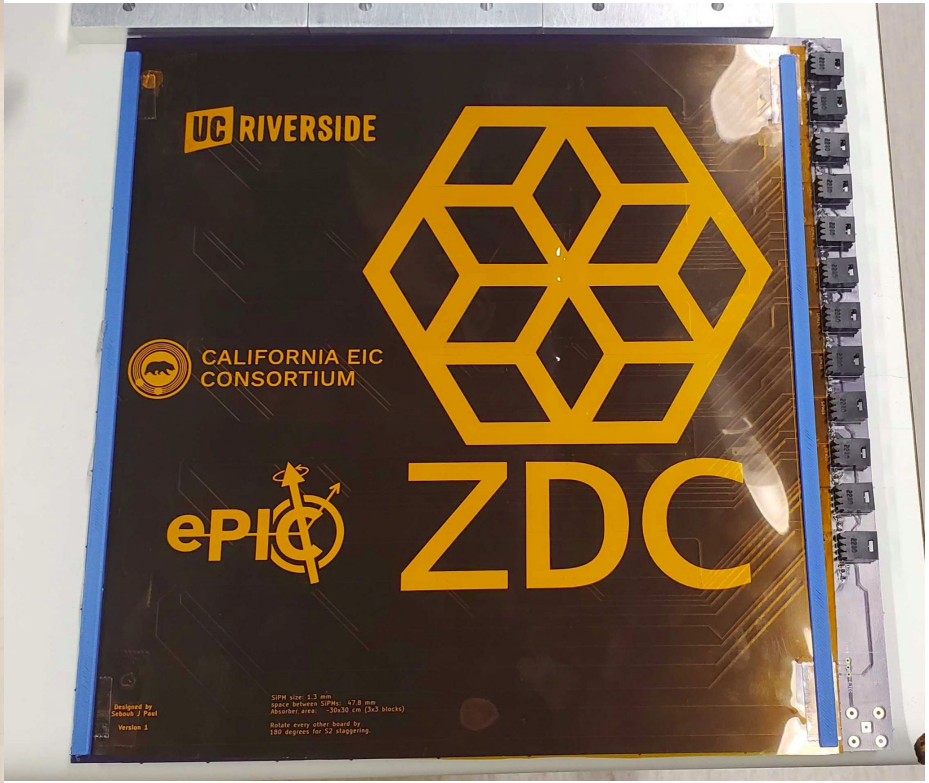
Laser cut sides with etched folds.

Folds are made.



Scintillator is placed


ePIC
ZDC
UC RIVERSIDE
CALIFORNIA EIC CONSORTIUM


UC RIVERSIDE
CALIFORNIA EIC CONSORTIUM
ePIC
ZDC

Slide from last consortium mtg at UCLA

Next steps for insert prototype testing

2023

Jefferson Lab

Second round of testing in Hall-D, with 128 channel ECAL-size prototype

Exploring possibility in Hall B (tagged hadrons)

2023

BERKELEY LAB

SiPM irradiation testing @88" cyclotron

2023

Fermilab

Together with UCLA's W/SciFi ECAL

2024

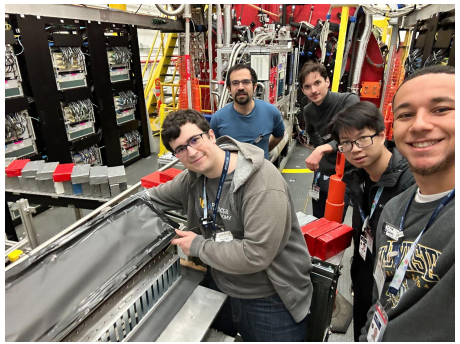
Brookhaven National Laboratory

East-side of STAR near beam pipe.
Operate parasitically during 200 GeV pp run

Slide presented in last consortium meeting at UCR

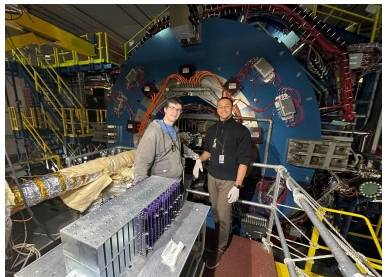
2023

Jefferson Lab



2024

Brookhaven National Laboratory



2024

CROCKER NUCLEAR LABORATORY
CYCLOTRON SERVICES

Funding From EIC Project (Sasha) secured!

2024

Jefferson Lab

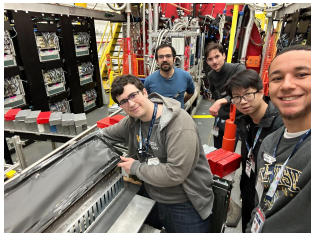
2025?

Fermilab

Today

2023

Jefferson Lab



Published

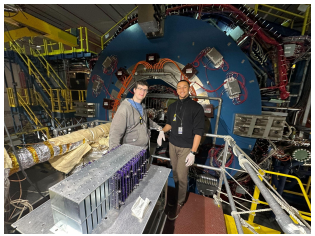
2024

CROCKER NUCLEAR LABORATORY
CYCLOTRON SERVICES

Analysing

2024-2025

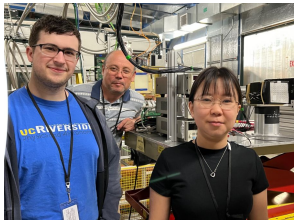
Brookhaven National Laboratory



Ongoing
+
Analysing

2024

Fermilab



Analysing

2024?

Jefferson Lab

Building

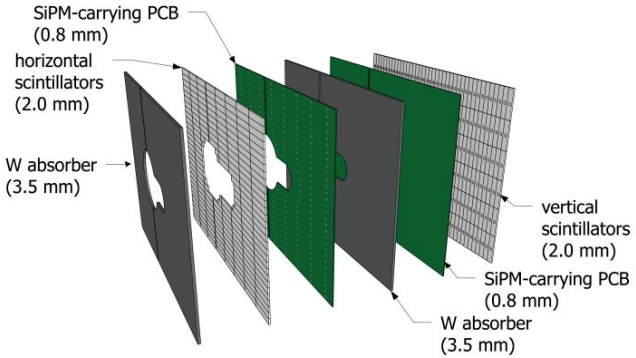
2025?

Fermilab

+

Planning

CALI ZDC



“We will design these and attract construction funds to California”