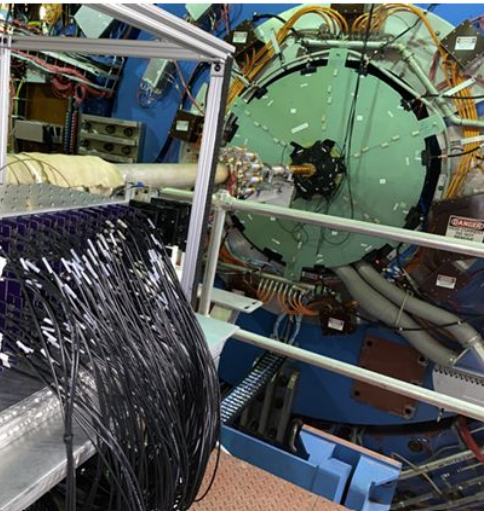
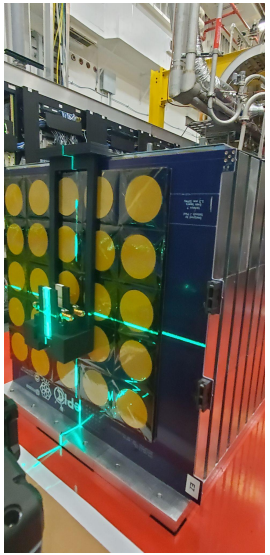
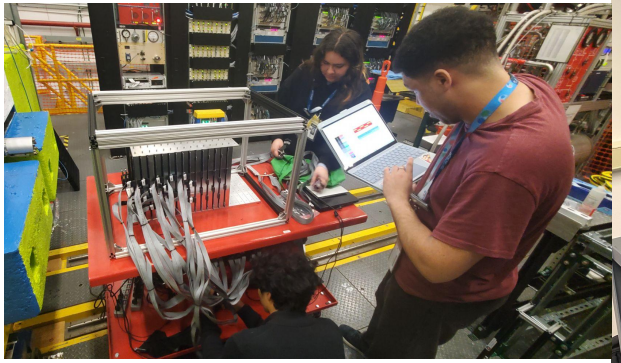
Recent beamtest activity Insert/ZDC

Miguel Arratia, UC Riverside
Calo Meeting, 05/07/2025



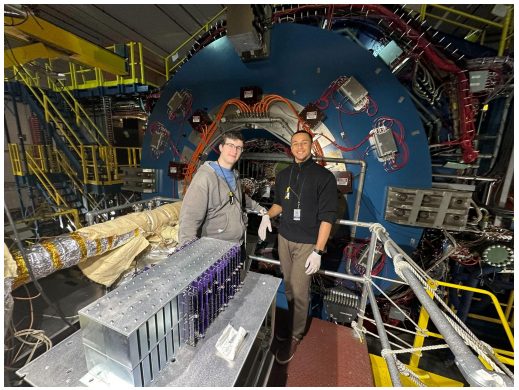


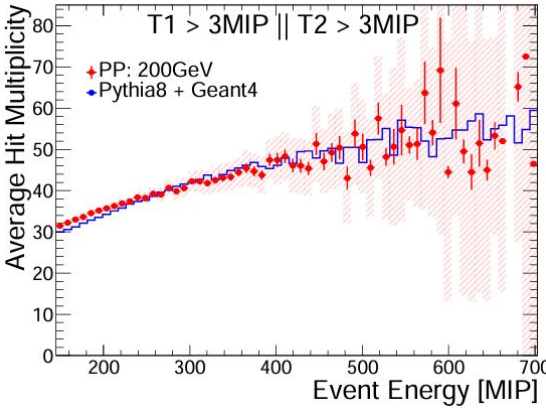


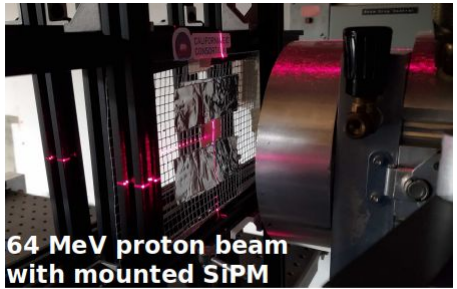
2024

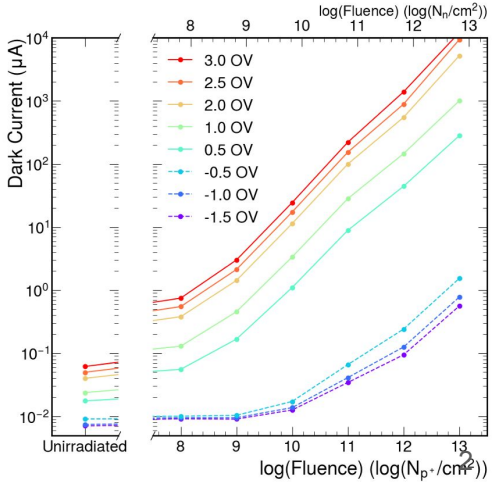
- Test in STAR Hall @ RHIC , 200 GeV pp collisions
  Status: **Analysis completed**.
  [2501.08586] First-Ever Deployment of a SiPM-on-Tile Calorimeter in a Collider: A Parasitic Test with 200 GeV pp Collisions at RHIC

- Test SiPM irradiation @ UC Davis Cyclotron.
  Status: **Analysis completed**
  [2503.14622] Measurement of SiPM Dark Currents and Annealing Recovery for Fluences Expected in ePIC Calorimeters at the Electron-Ion Collider





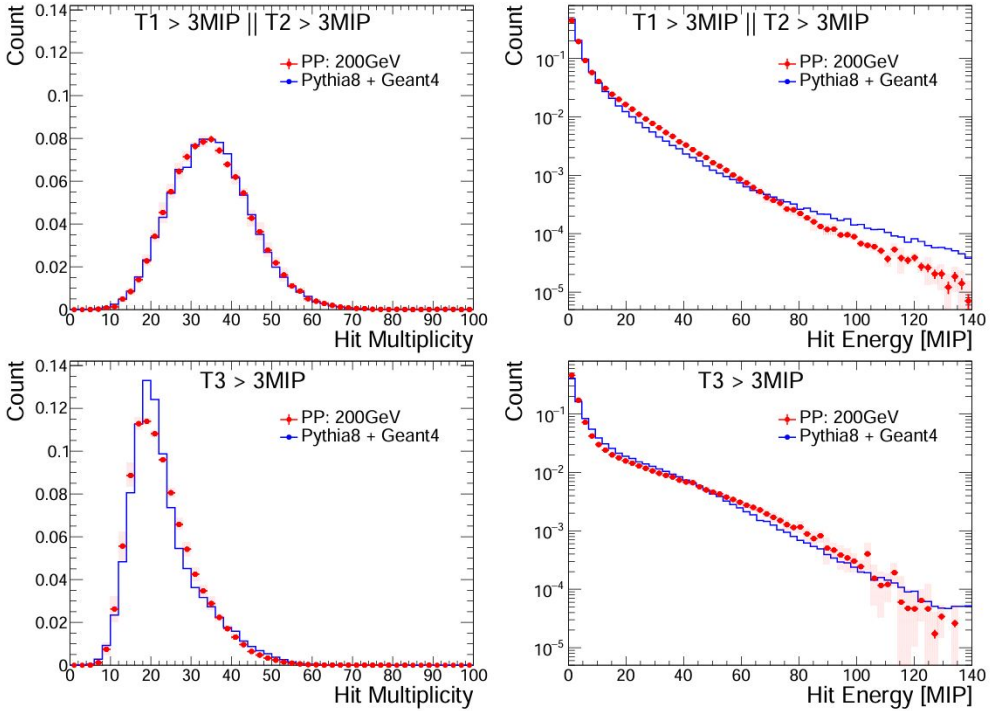




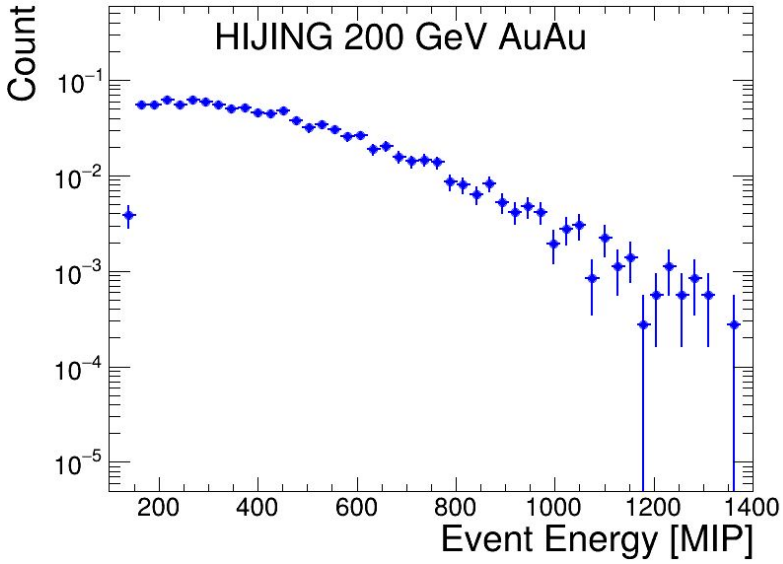
1) 2025 RHIC STAR

- RHIC test part II, 200 GeV AuAu run.
  Status: Ready to go, waiting for beam.

200 GeV pp collisions



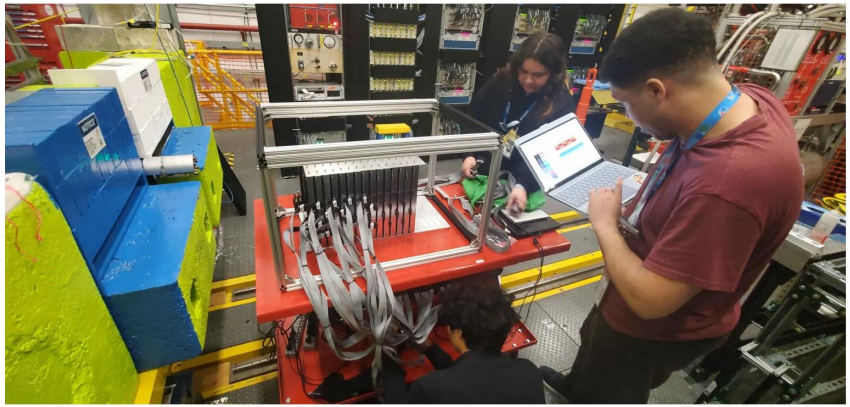
200 GeV AA collisions



2) 2025 JLab test

- Generation-3 prototype testing.

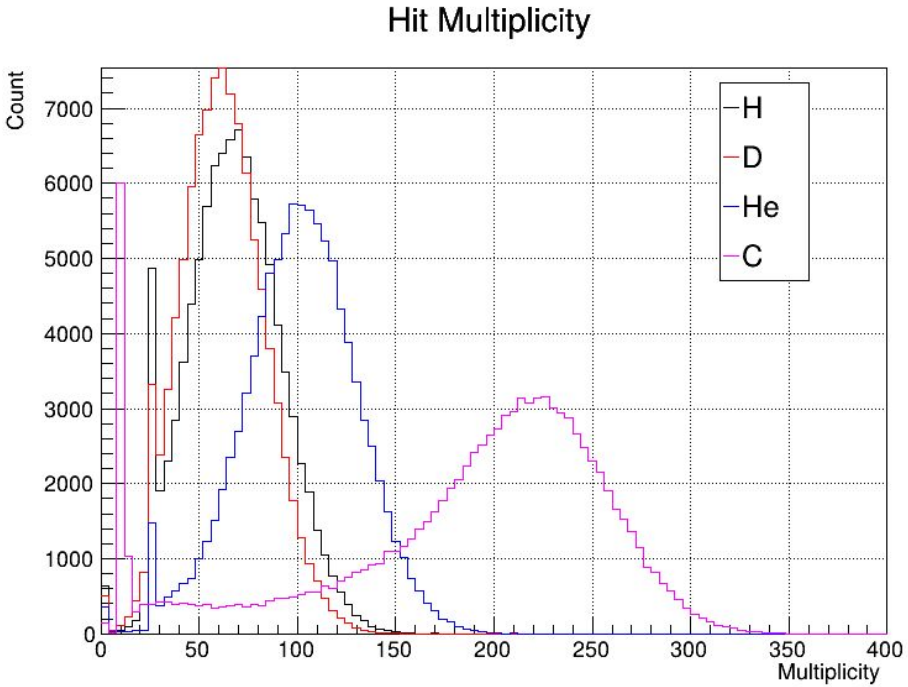
  - At JLab Hall-D positron 4 GeV
  Status: Beam test completed as per last week. Analysis ongoing.



3) 2025 parasitic test BNL/NASA

-

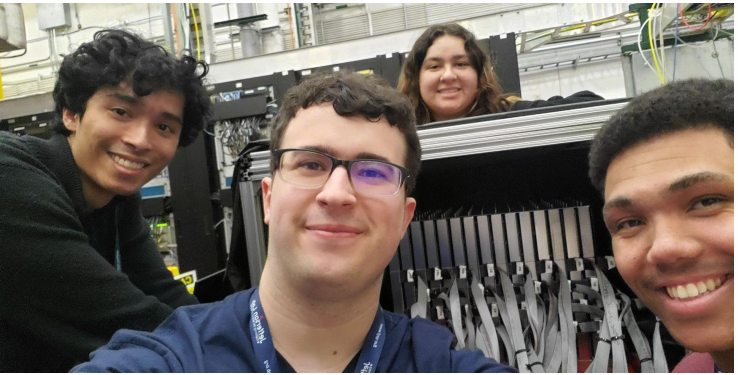
- At BNL NASA 1-6 GeV deposited energy with protons, and light-ion beams
Status: Installation ongoing.

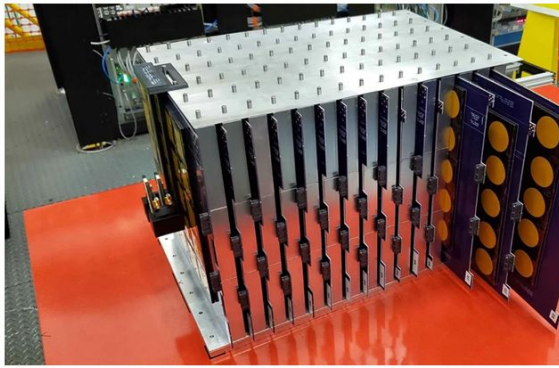


3rd generation prototype for test at JLab

-Design for ZDC SiPM boards complete.
-All assembly process (including laser cutting, SiPM soldering with reflow oven, tile affixing), final, with cost-effective solutions.
- 375 channels, 15 layers, ~16 X0 for 4 GeV positron test.

Test of generation-3 prototype at Jefferson Lab





First installation Feb 6
Data taking April 23-30

375 channels, >98% live & calibrated

Gen-3 prototype critical step to full scale

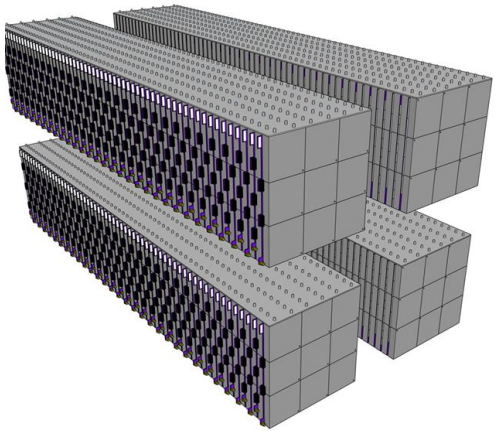
Design for ZDC is modular.
Prototype at JLab is ~6% of full ZDC size, ~10% at BNL/NASA.

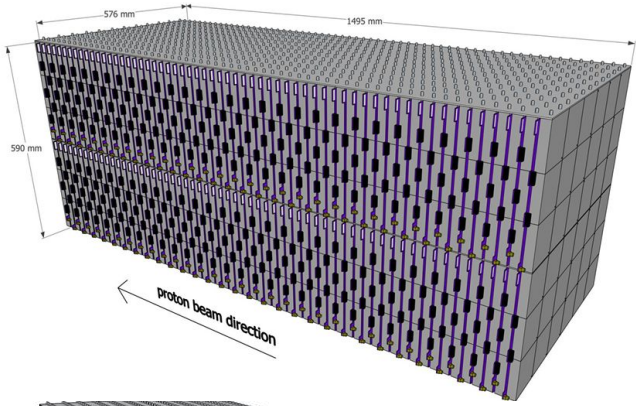
SiPMs boards designed by UCR are final.
Connectors, custom cables, etc.

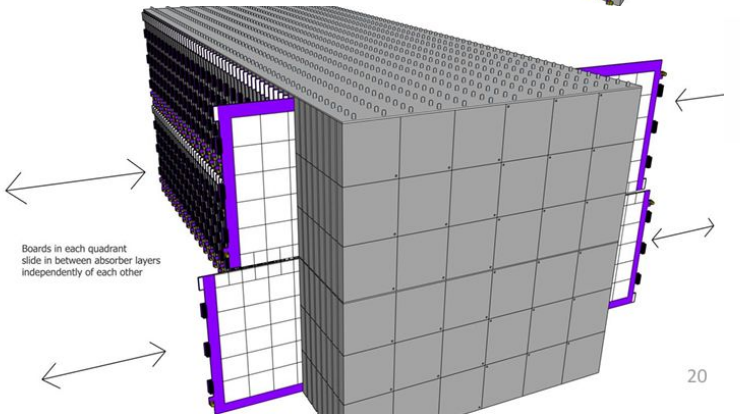
Established “final” protocols for SiPM-on-tile units assembly, including laser-cut ESR, wrapping, QA etc.

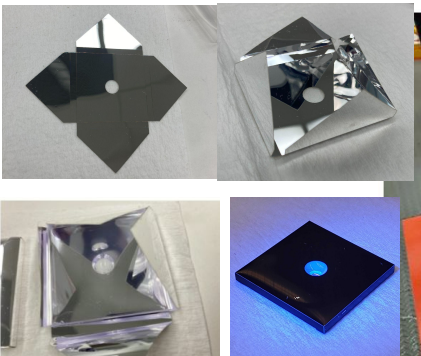
Established “final” protocols for SiPM board soldering, affixing tiles, testing, transport.

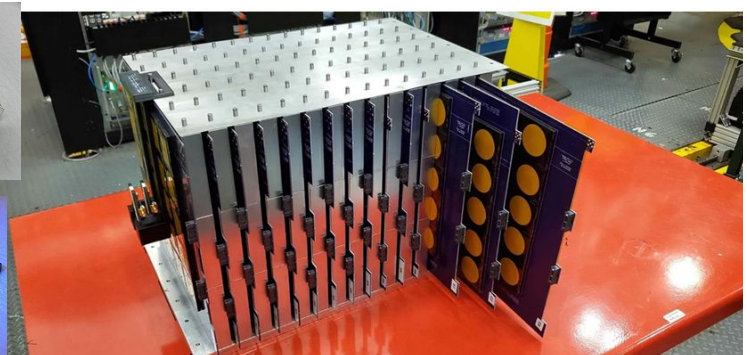
Scaling to the full ZDC



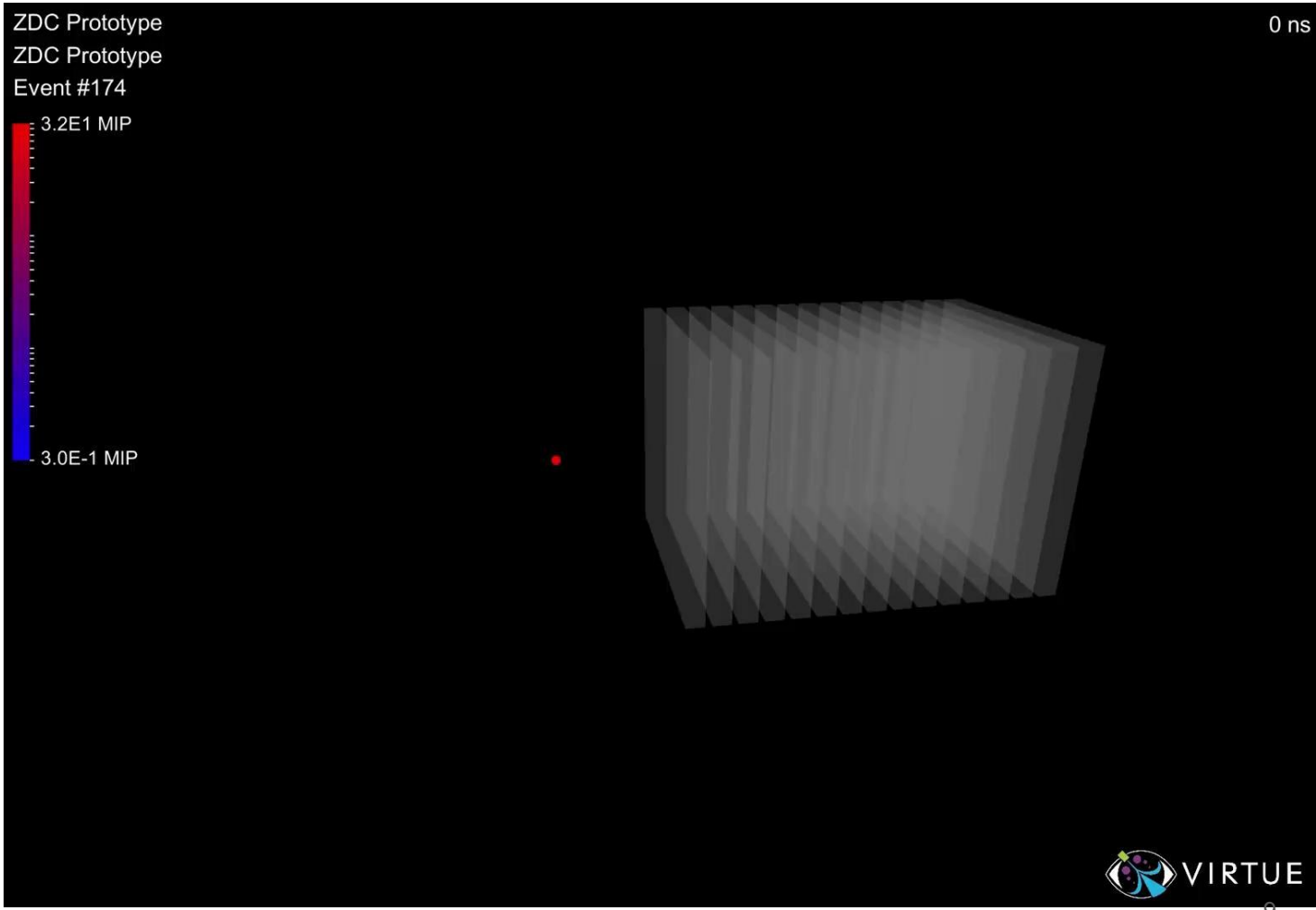






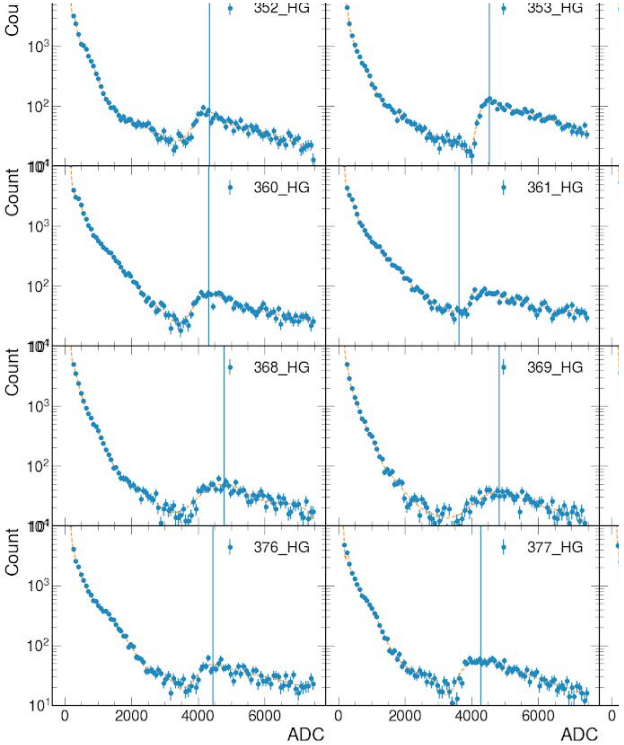


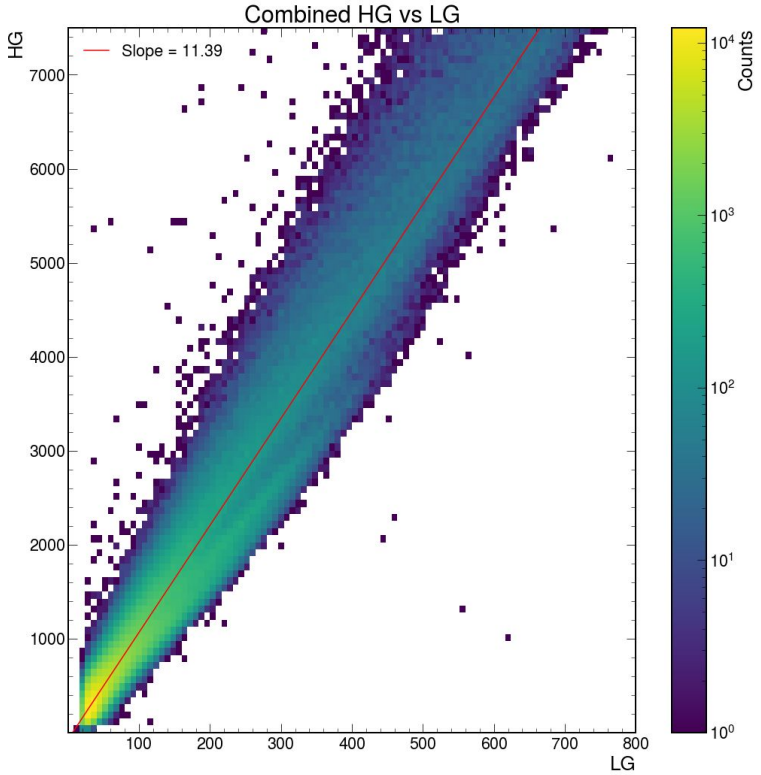
Real data!


ZDC Prototype
ZDC Prototype
Event #174
3.2E1 MIP
3.0E-1 MIP
0 ns
VIRTUE

Calibration

Channel-by-channel calibration with MIPs insitu, and
channel-by-channel high-gain/low-gain cross-calibration

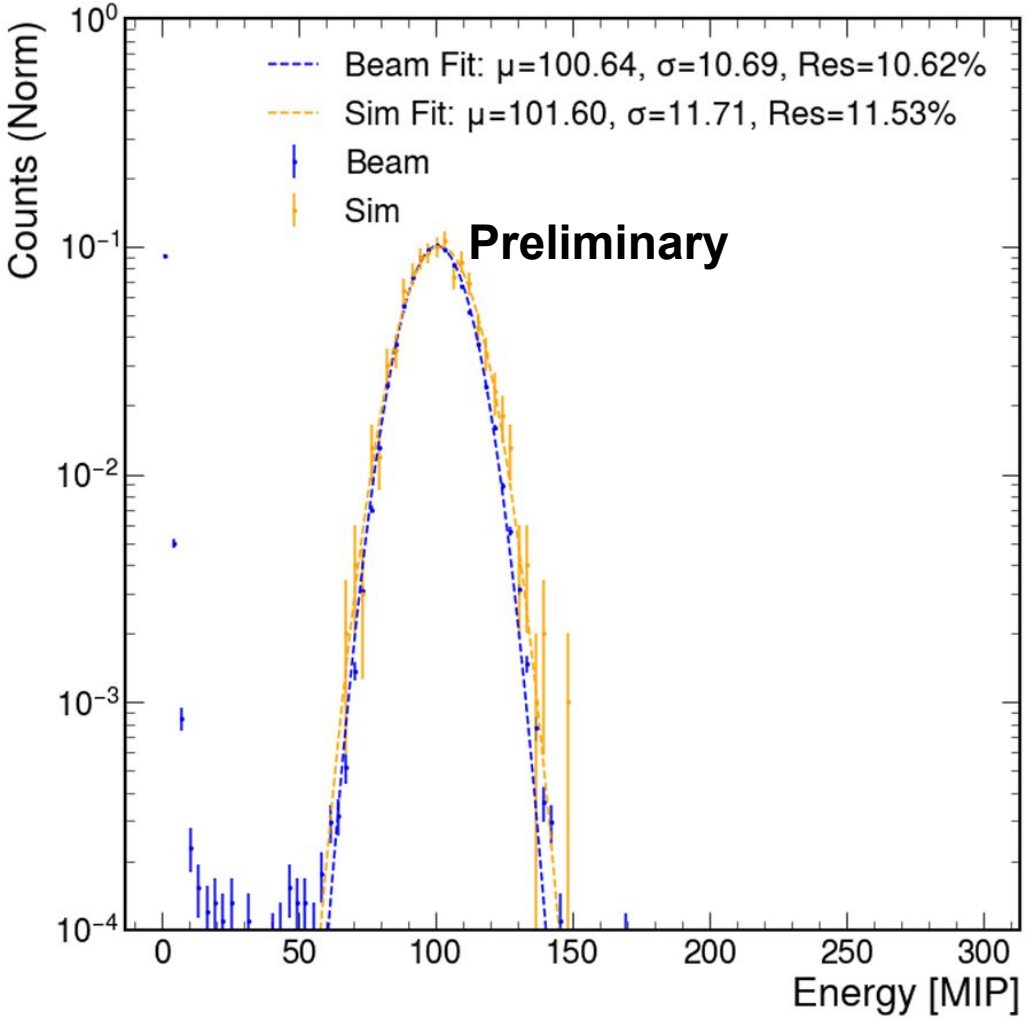




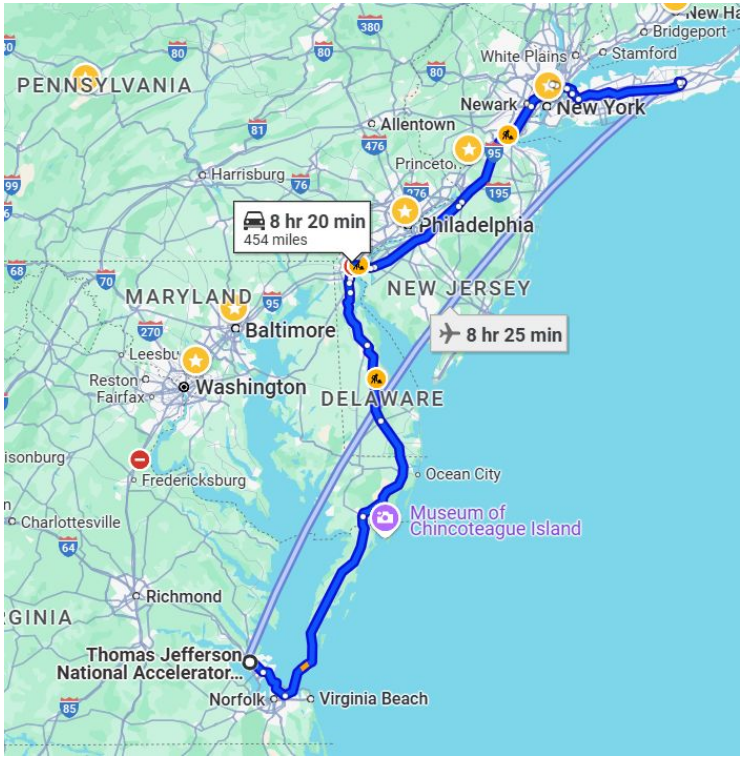
Analysis going well (this is our 3rd time performing test of prototypes)

Expect to quantify:

- EM energy response
- Test staggered-layer design to improve angle reconstruction.
- 4D shower shape

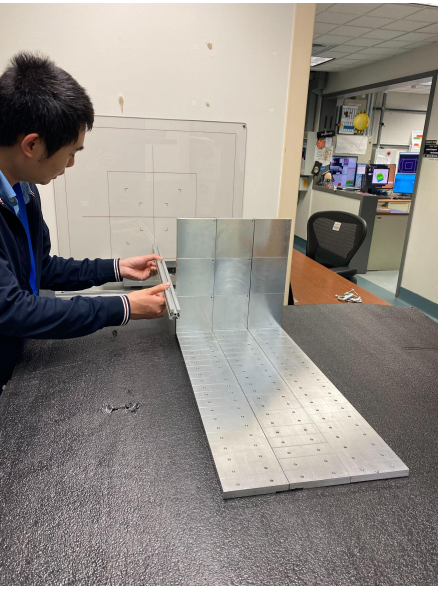
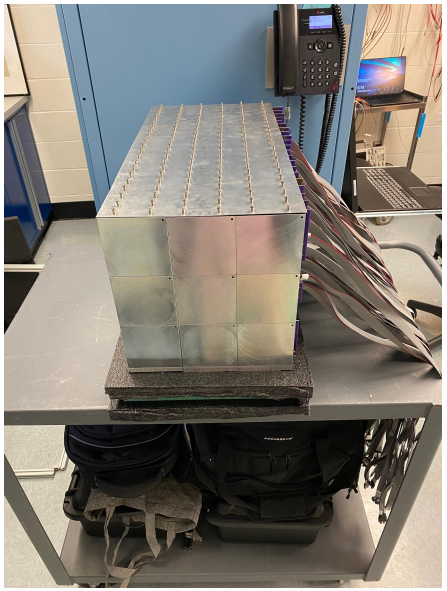
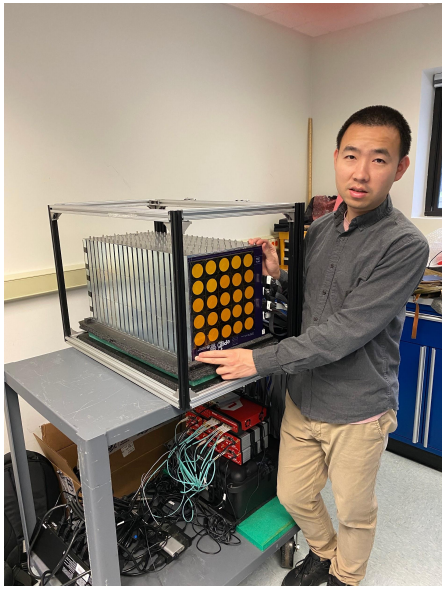


Transport from JLab to BNL



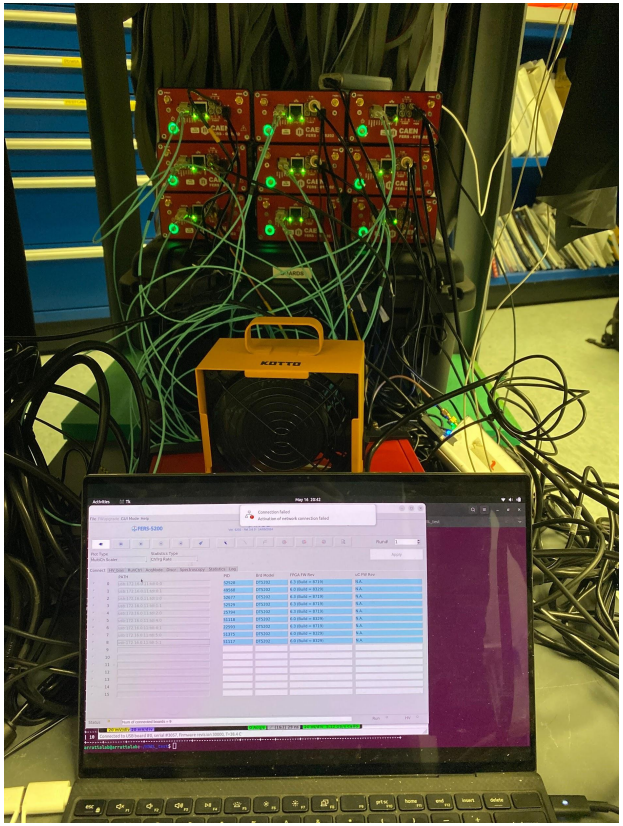
Successful transport experience
May 2-3 2025

Assembling prototype at BNL/NASA facility


- Detector size was increased to 575 channels (~10% ZDC and ~10% Insert)--> **Proof we are shovel ready.**
- Parasitic, beam dump experiment with 2.5 GeV proton beams scheduled for 5/21
- Further parasitic tests in heavy-ion beams, to sample up to 6 GeV deposited energy

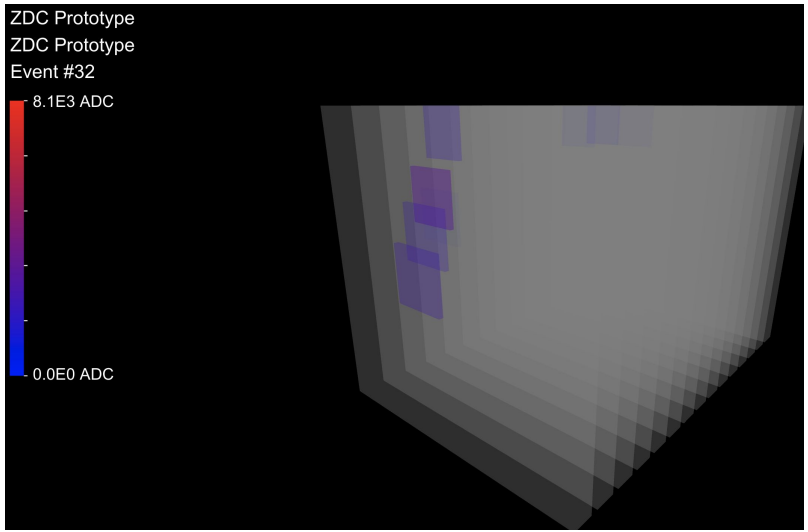
DAQ system used in BNL/NASA

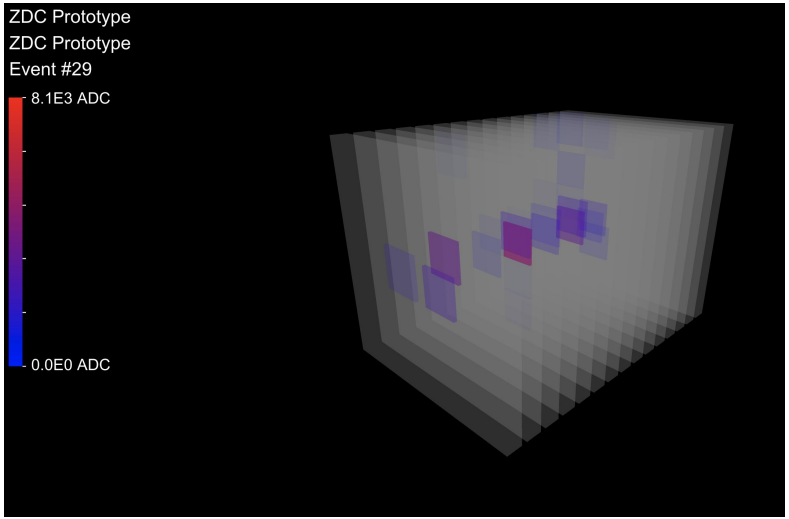


Cosmic rays

DAQ tested with external trigger scintillator.

Works as expected





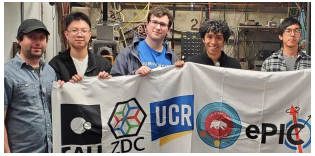
Summary

2023

Jefferson Lab

2024

CROCKER NUCLEAR LABORATORY
CYCLOTRON SERVICES

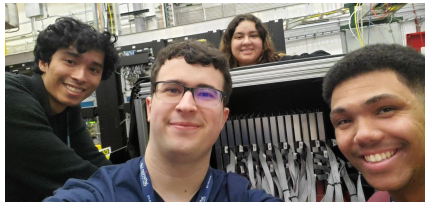


2024-2025

Brookhaven National Laboratory

2025

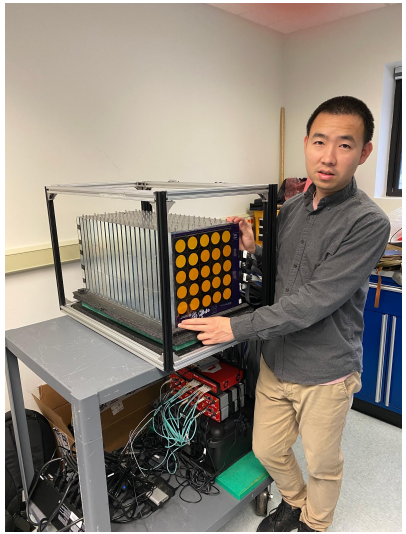
Jefferson Lab



2025

Brookhaven National Laboratory

NASA



Conclusions

2025 is going to be busy with 3 beam tests (parasitic RHIC in STAR Hall, parasitic Hall-D JLab & parasitic BNL/NASA proton and light-ion)

Main point of tests is to validate “final” modular design with significant % of full-scale ZDC/Insert to show (e.g. NSF) that we are “shovel ready”. In addition, an important goal is development and consolidation of assembly and QA protocols and transport.

We welcome anyone interested in collaborate, as we’ve just done with JLab test (L. Preet U Regina).