

# Calorimeter Insert Prototype Testing During 200 GeV PP Run at RHIC

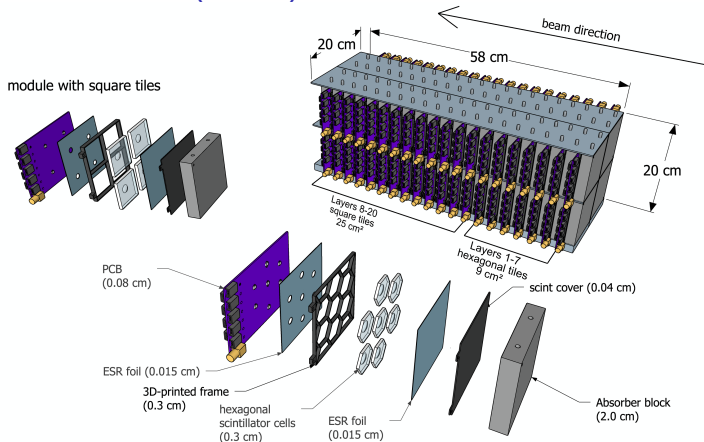
Weibin Zhang

2024-07-27



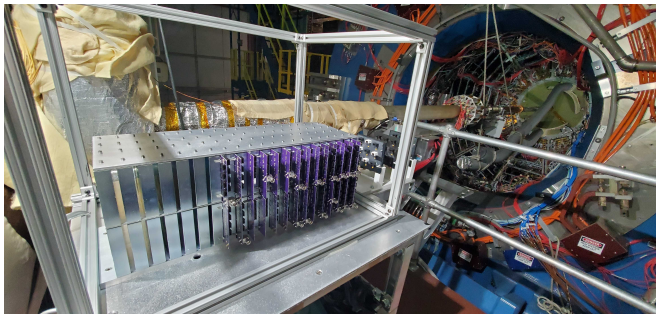
CALIFORNIA EIC  
CONSORTIUM

# Calorimeter Insert (CALI): Gen-II



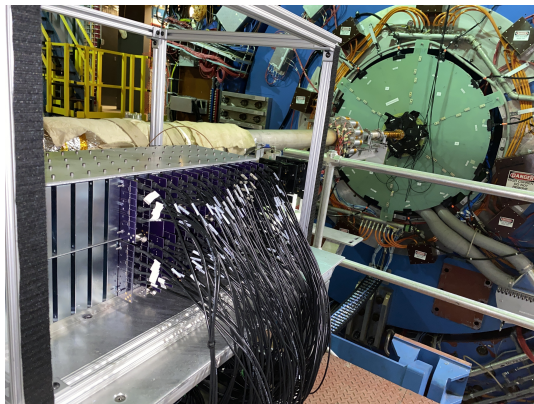
- First beam test at JLab in 2023 ([Instruments](#))
- 20 sampling layers: 4 hexagonal layers + 16 square layers
- Iron absorber + scintillator tile + SiPM (on tile) + PCB
- 20 cm × 20 cm transverse active area

## Beam Test at BNL



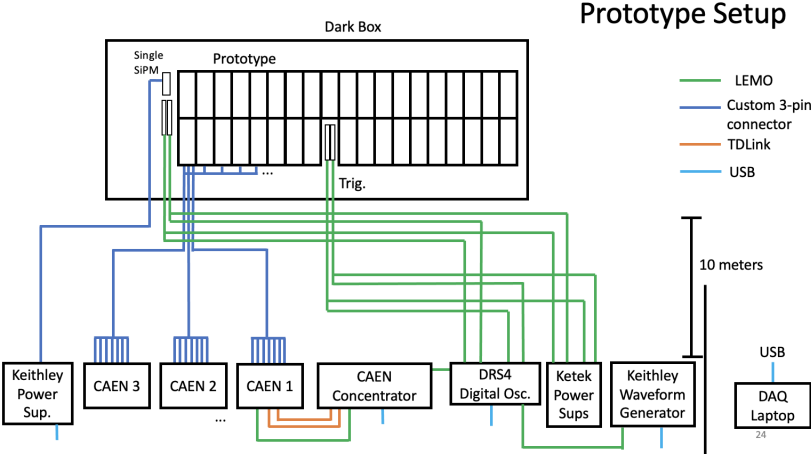
- Operating and calibrating the prototype in realistic conditions, as well as quantifying system degradation due to radiation damage
- Measurement of MIP response using isolated tagged charged hadron
- Measurement of core of hadronic shower using isolated tagged charged hadron
- Measuring  $\pi^0$  invariant mass and spectra to verify calibration and showcase the separation of two showers with a fine 3D shower shape

# Installation in the STAR Hall

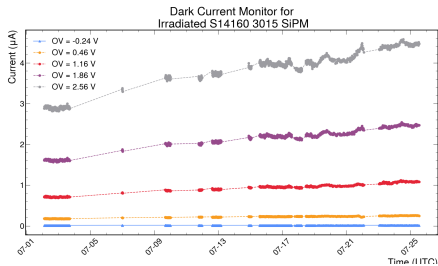
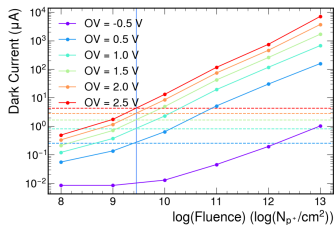


- East platform of the STAR detector, parallel to the beampipe
- $3.2 < \eta < 3.6$
- 192 (268)/368 channels readout (connected)
- Hodoscope installed, but not in use yet

# Trigger and Readout



# Radiation Monitoring



- Irradiation test at UC Davis last month as reference to calculate fluence for the BNL test
- Since RHIC Run24, the radiation received by the prototype is about  $10^9 - 10^{10}$  p/cm<sup>2</sup>

# Operation

← → ↻ 🔒 Not secure cali:8080/BNL\_test/#

CALI HOME QA CHANNEL PTRG COSMIC MISC

Select Run

Select Day

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						

Run	Type	Flag	StartTime	StopTime	Len (m)	#Ch	Trigger	Events	PedRun	LG	HG	Vbias (V)
1357	data	good	2024-07-25 00:58	2024-07-25 02:28	90	192	T1 && T2 && T3	80107	1354	27	55	43
1358	data	good	2024-07-25 02:28	2024-07-25 03:58	90	192	T1 && T2 && T3	71317	1354	27	55	43
1359	data	good	2024-07-25 03:59	2024-07-25 05:29	90	192	T1 && T2 && T3	66117	1354	27	55	43
1360	data	good	2024-07-25 05:29	2024-07-25 06:59	90	192	T1 && T2 && T3	62780	1354	27	55	43
1361	data	good	2024-07-25 06:59	2024-07-25 08:29	90	192	T1 && T2 && T3	14144	1354	27	55	43
1362	data	good	2024-07-25 08:30	2024-07-25 09:32	17	192	T1 && T2 && T3	3811	1354	27	55	43
1363	ptrg	good	2024-07-25 09:36	2024-07-25 09:36	0	192	0	13669	-1	27	55	43
1364	data	good	2024-07-25 09:37	2024-07-25 11:07	90	192	T1 && T2 && T3	8509	1363	27	55	43
1365	data	good	2024-07-25 11:08	2024-07-25 12:38	90	192	T1 && T2 && T3	36396	1363	27	55	43
1366	data	good	2024-07-25 12:38	2024-07-25 14:08	90	192	T1 && T2 && T3	77681	1363	27	55	43
1367	data	good	2024-07-25 14:09	2024-07-25 15:39	90	192	T1 && T2 && T3	70512	1363	27	55	43
1368	data	good	2024-07-25 15:39	2024-07-25 17:09	90	192	T1 && T2 && T3	65788	1363	27	55	43
1369	data	good	2024-07-25 17:09	2024-07-25 18:39	72	192	T1 && T2 && T3	50220	1363	27	55	43
1370	data	good	2024-07-25 18:40	2024-07-25 20:10	90	192	T1 && T2 && T3	15713	1363	27	55	43
1371	data	good	2024-07-25 20:10	2024-07-25 21:40	90	192	T1 && T2 && T3	68757	1363	27	55	43
1372	data	good	2024-07-25 21:41	2024-07-25 23:11	90	192	T1 && T2 && T3	70374	1363	27	55	43
1373	data	good	2024-07-25 23:11	2024-07-26 00:41	90	192	T1 && T2 && T3	65555	1363	27	55	43

- Data taking and analysis are automated
- Website presentation: [http://138.23.151.181:8080/BNL\\_test/](http://138.23.151.181:8080/BNL_test/)
- Run information is stored in a database
- Analysis framework ([github](#))

# High Gain MIPs

CALI HOME QA CHANNEL PTRG COSMIC MISC

Run: 1333 1334

2024-07-23

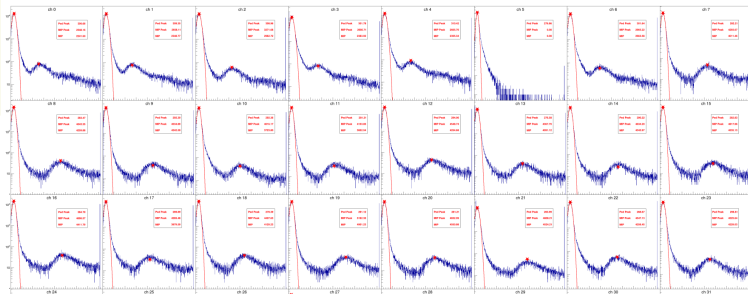
2024-07-19

2024-07-17

2024-07-03

2024-07-02

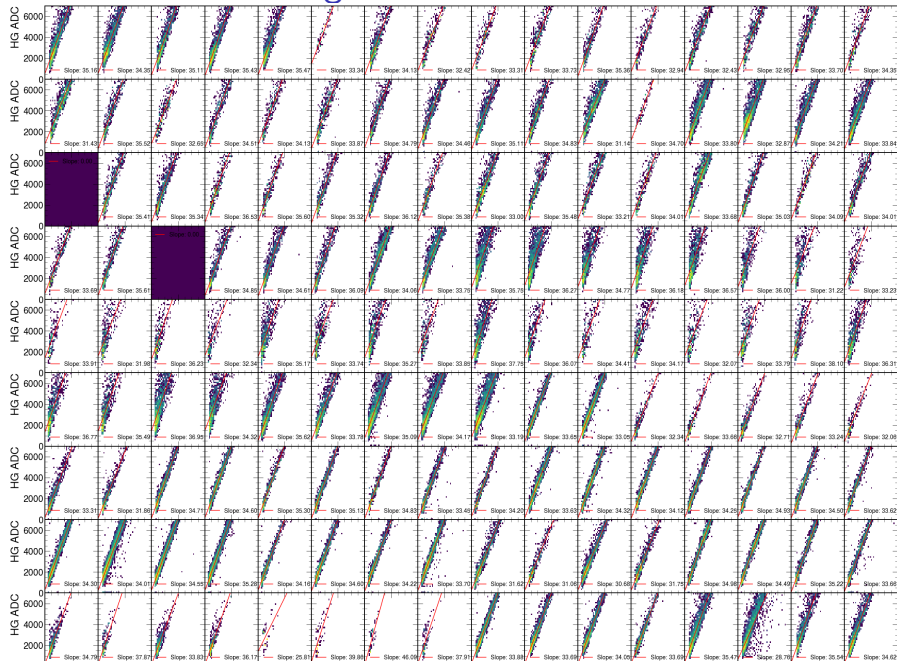
2024-06-13



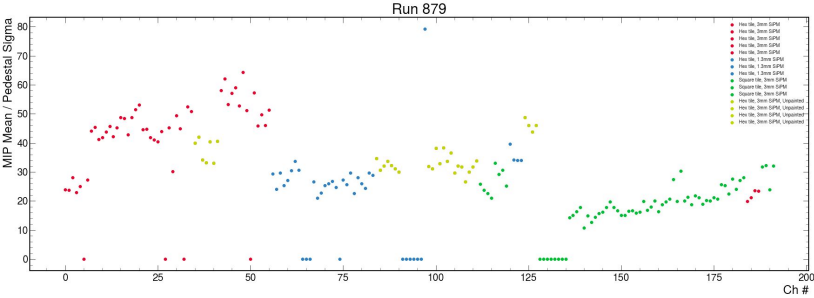
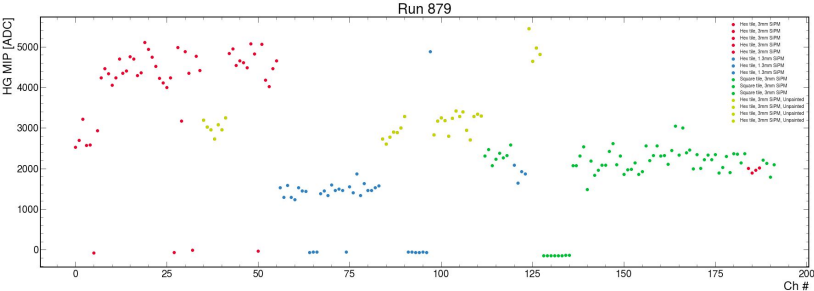
- In-situ MIP calibration with collision data



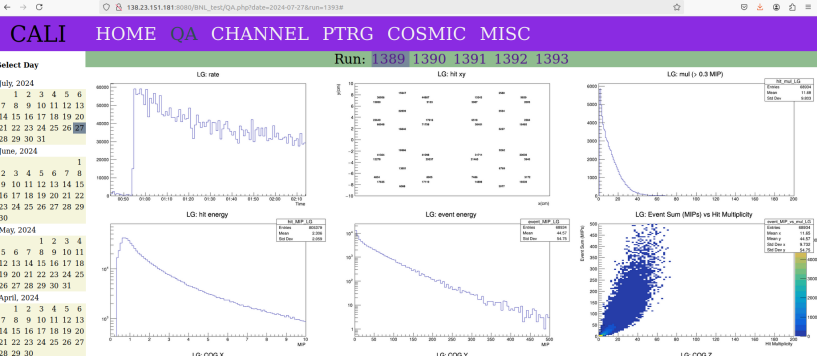
# Cross Calibration: High Gain vs Low Gain



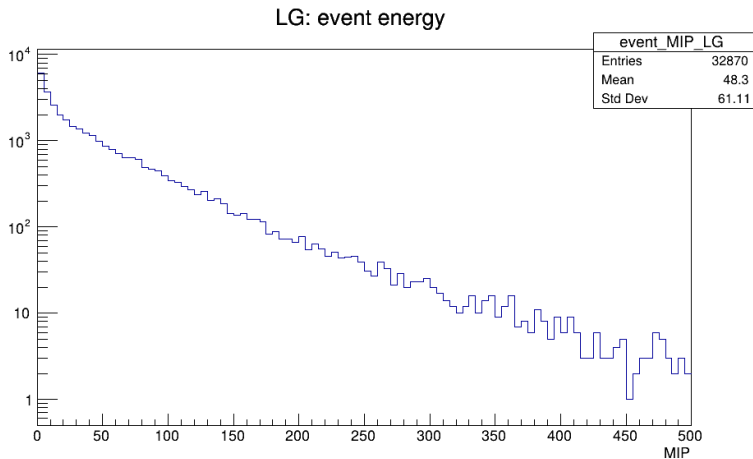
# MIP Calibration and Signal-to-Noise Ratio



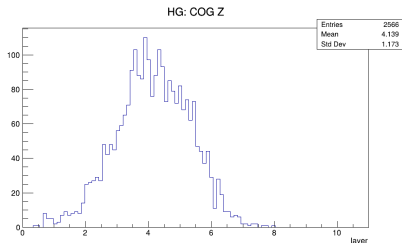
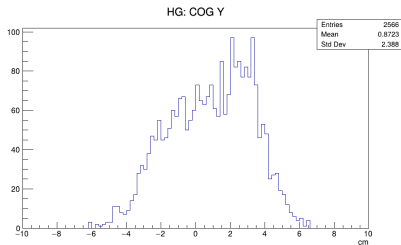
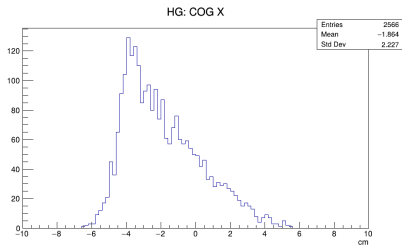
# Data: QA Plots



# Event Energy



# Data: Center-of-Gravity (COG)

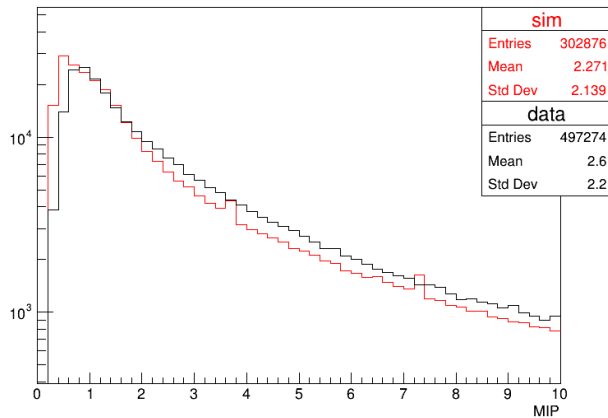


$$\text{COG} = \frac{\sum_i E_i \cdot \vec{X}}{\sum_i E_i}$$

- Shower shape analysis is under development
- Aims at separating the two photons from  $\pi^0$

# Simulation

## Hit Energy



- Pythia8 vs data
- Fine tune needed

## Summary

- The first operation of a SiPM-on-tile calorimeter in a collider ever
- The goal: maintain stable performance along time under harsh radiation environment – radiation effect, MIP response, shower shape analysis and particle reconstruction
- Everything is on track, the experiment is about to complete commissioning, we have learnt a lot
- Will run it until next year (the end of RHIC), including both pp and AA collisions
- More SiPM boards and CAEN units (HGROC) will be added
- Shower shape analysis is under development

## Acknowledgements

We are grateful to the kind help from BNL, particularly Akio Ogawa, Oleg Tsai, Timothy Camarda, Wayne Betts, Prashanth Shanmuganathan, Rahul Sharma and Jameela Middleton.

Special thanks to William Struble for his great help with the installation.

