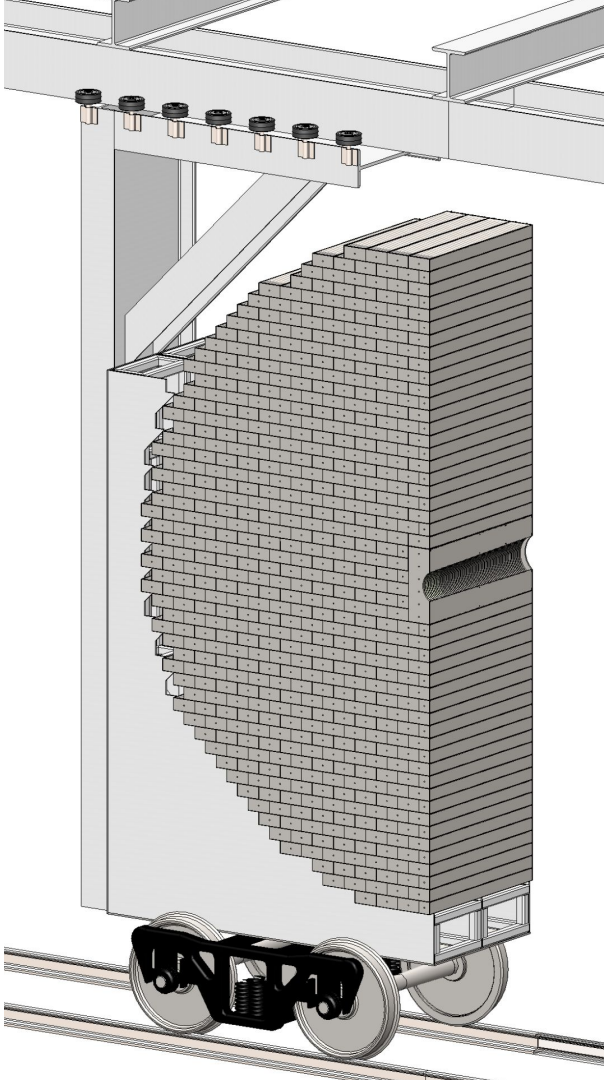
DSC-forward HCal and Insert

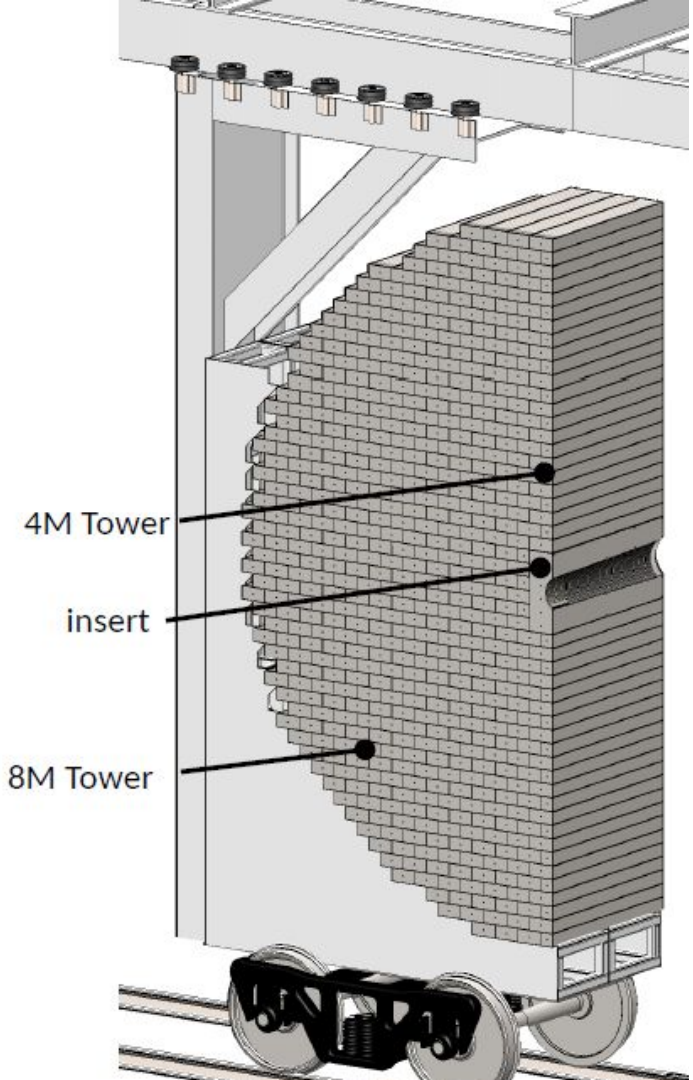
Miguel Arratia

UC RIVERSIDE

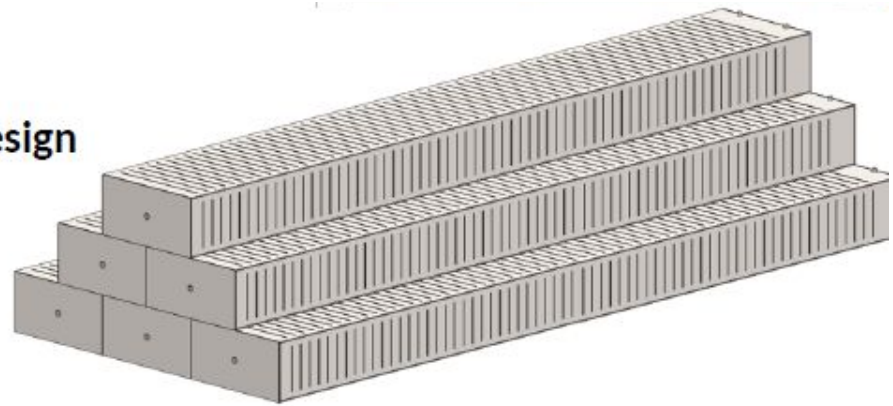


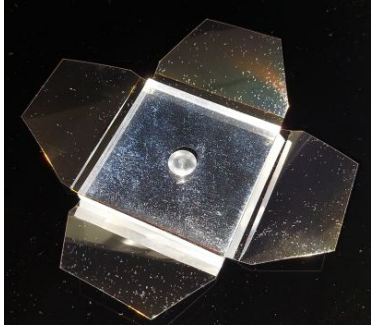
Outline

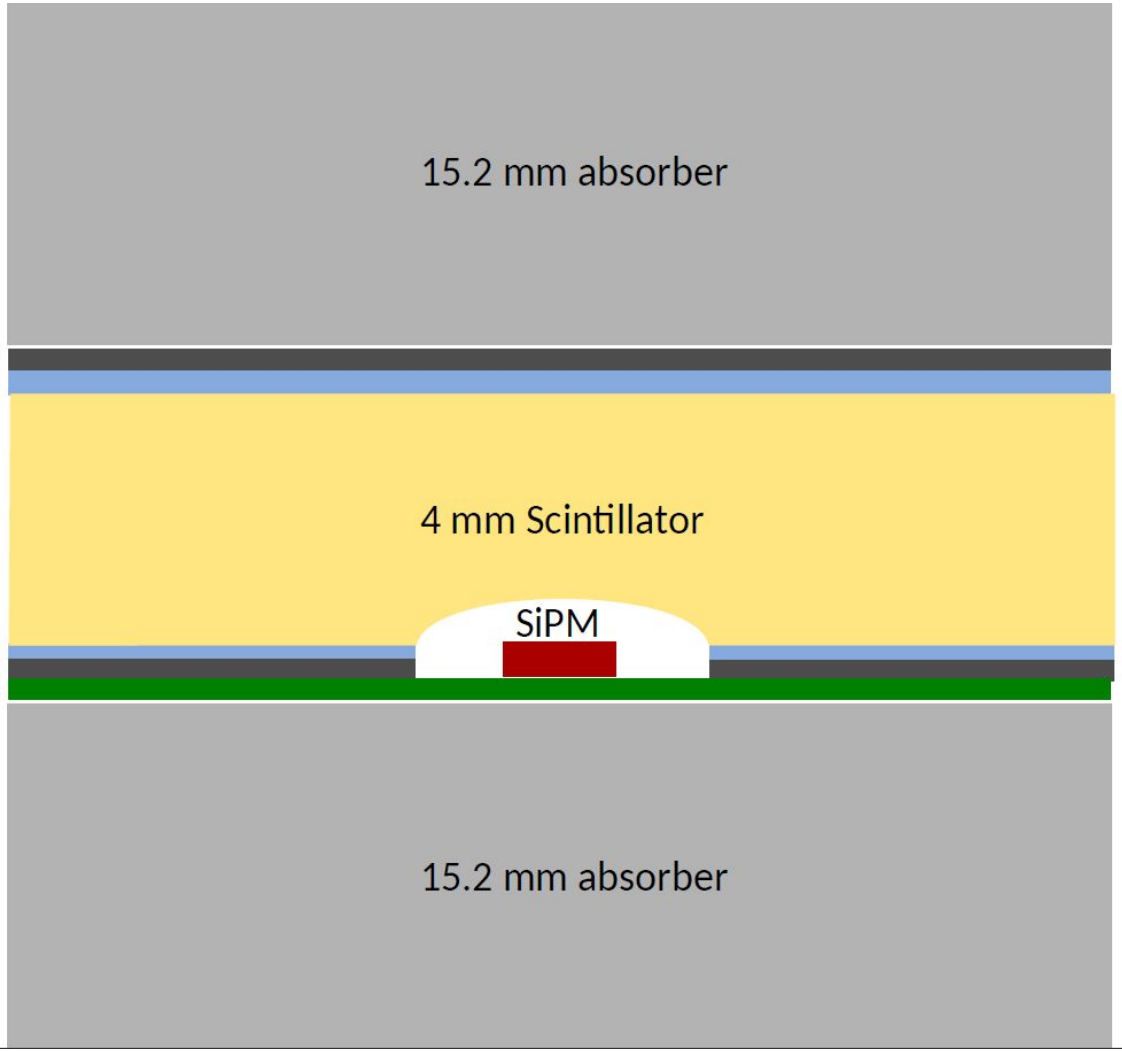
- Description of current LFHCAL design
- Ongoing R&D
- Simulations

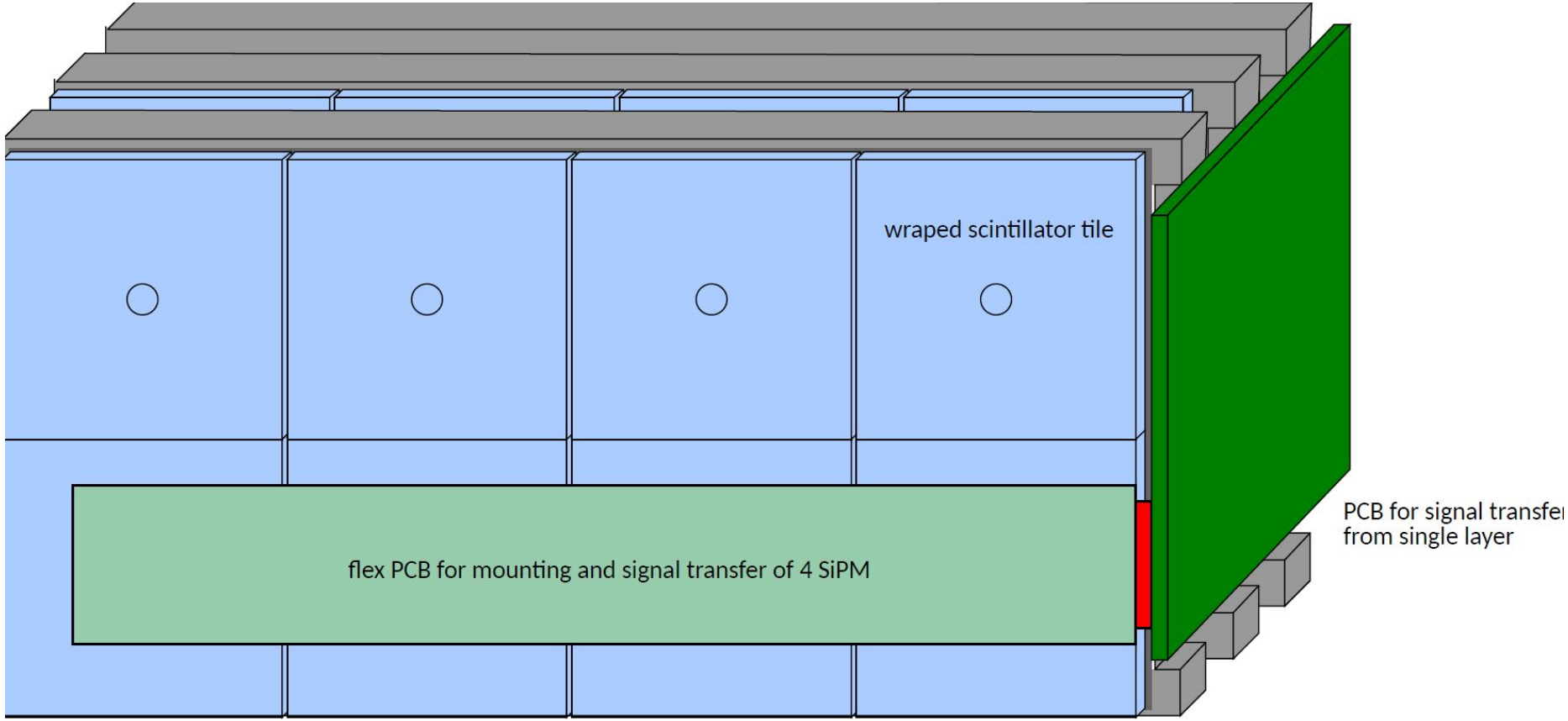


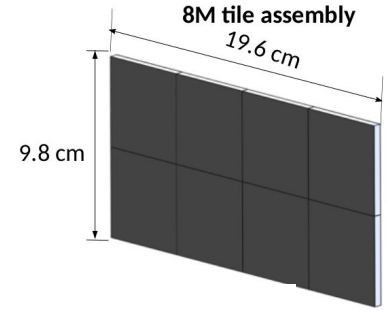
Stacking design

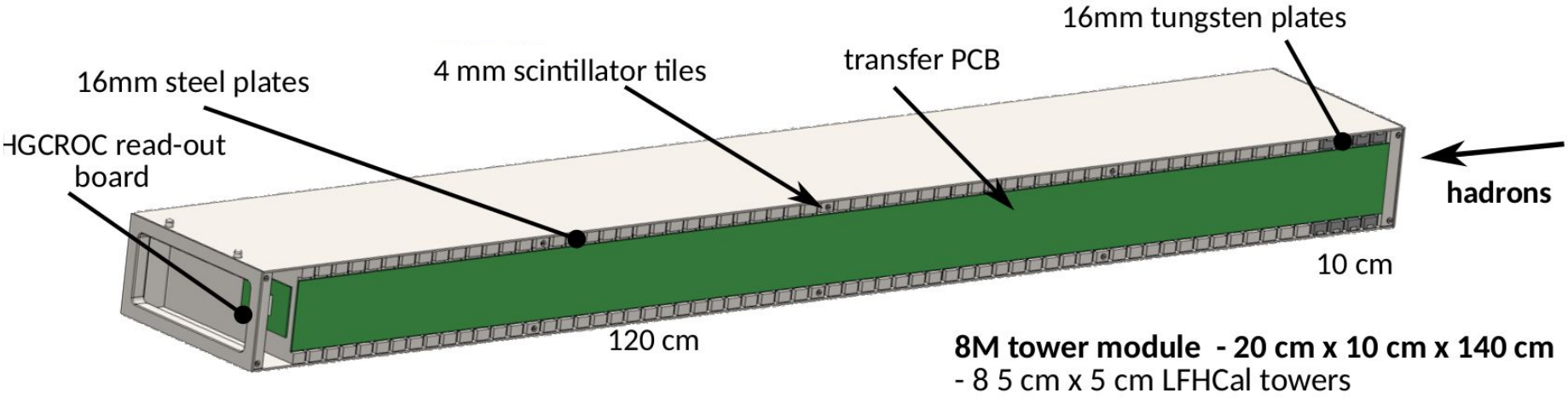





15.2 mm absorber
0.1 mm kapton + 0.05 mm glue
0.2 mm reflective foil
0.25mm air ga
4 mm Scintillator
SiPM
0.1 mm reflective foil
0.1 mm kapton + 0.05 mm glue
flex pcb 0.2mm
0.25mm air gap
15.2 mm absorber

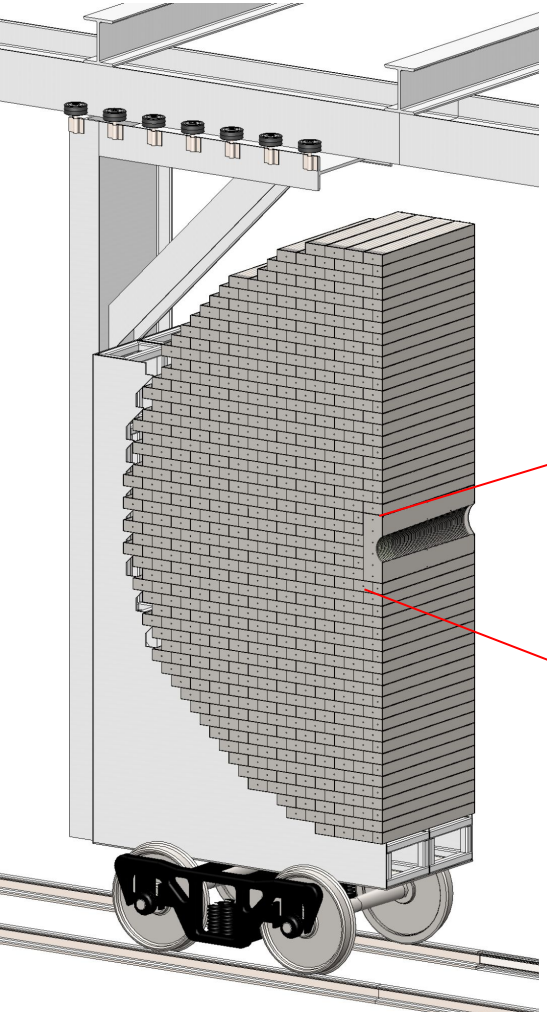

wraped scintillator tile
flex PCB for mounting and signal transfer of 4 SiPM
PCB for signal transfe
from single layer

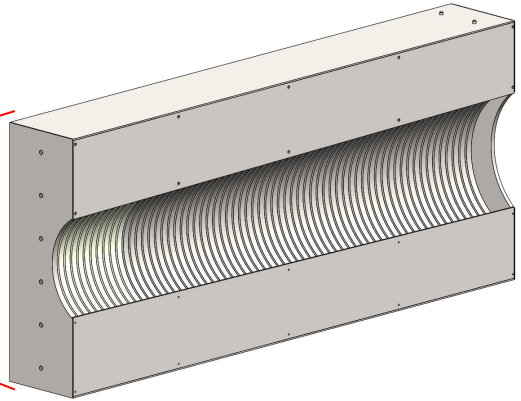


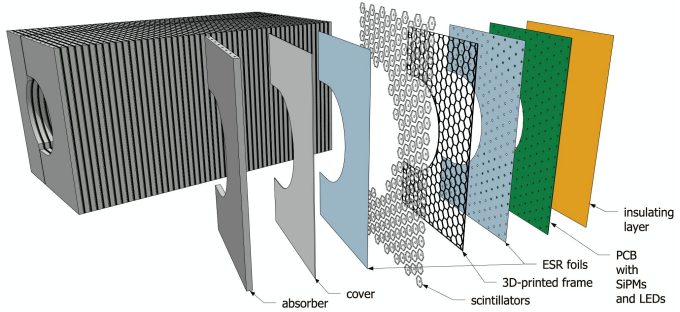


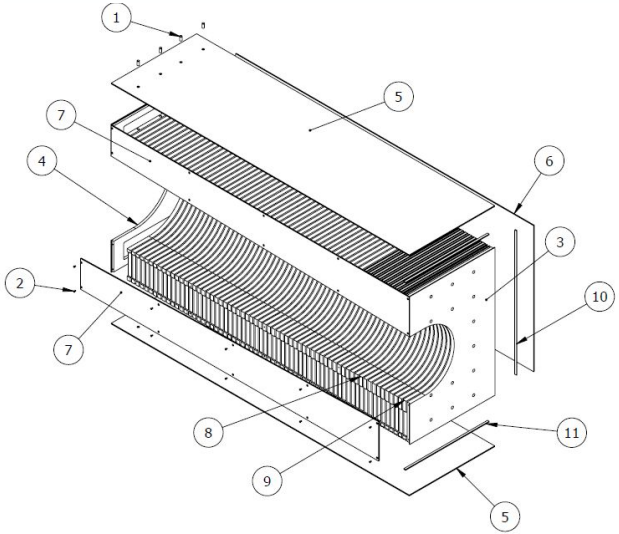
8M tower module - 20 cm x 10 cm x 140 cm
- 8 5 cm x 5 cm LFHCal towers

Insert accommodates beampipe shape, covering 3.2<η<4
Allows the SiPM boards to remain accessible for annealing

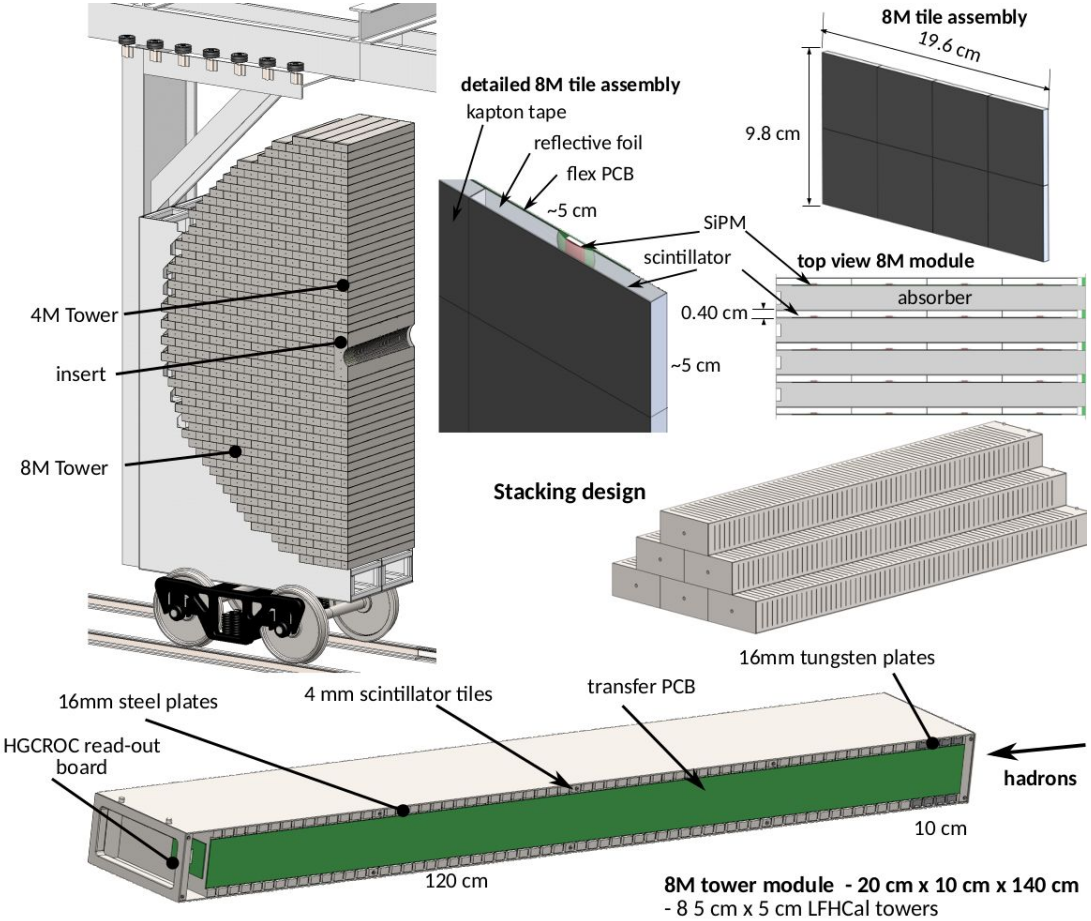








Summary


4M Tower
insert
8M Tower
detailed 8M tile assembly
kapton tape
reflective foil
flex PCB
~5 cm
SiPM
scintillator
~5 cm
8M tile assembly
19.6 cm
9.8 cm
top view 8M module
absorber
0.40 cm
Stacking design
16mm tungsten plates
transfer PCB
4 mm scintillator tiles
16mm steel plates
HGCROC read-out board
hadrons
10 cm
120 cm
8M tower module - 20 cm x 10 cm x 140 cm
- 8 5 cm x 5 cm LFHCal towers

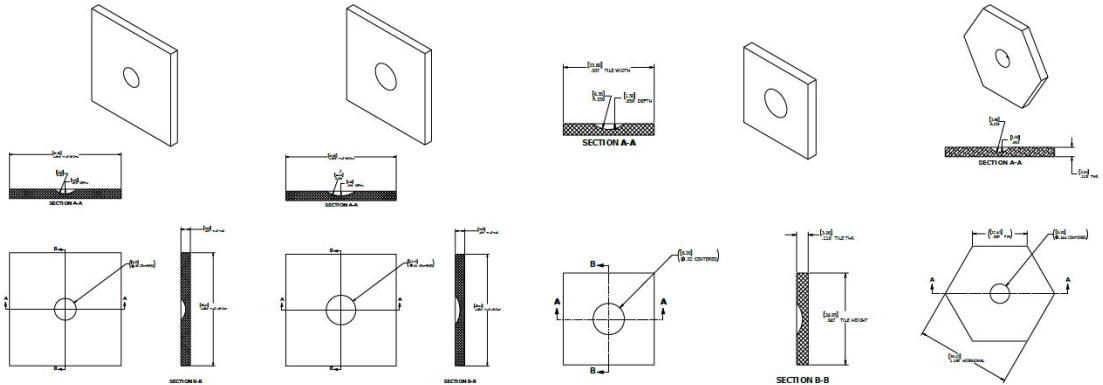
Plans and Milestones for FY24 eRD107

- Tile production optimization using machining & injection molding (April 2024)
- Reconstruction optimization (September 2024)
- Sensor board development (March 2024)
- Test module assembly (April 2024)

Injection Molded cells

Fermilab

Submission for cells submitted (eRD107)



(a) 5 cm × 5 cm, 0.5 inch ball mill

(b) 5 cm × 5 cm, 0.875 inch ball mill

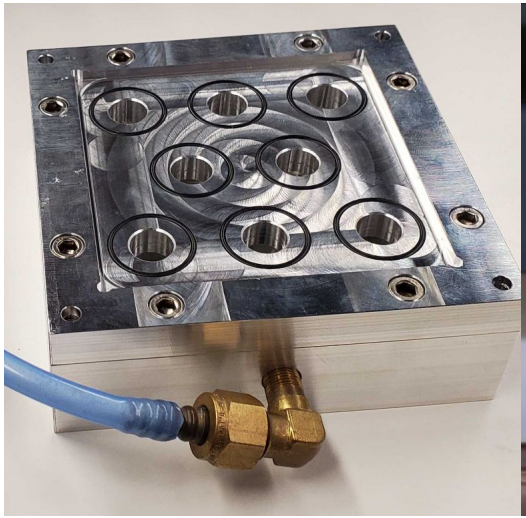
(c) 2.5 cm × 2.5 cm, 0.5 inch ball mill

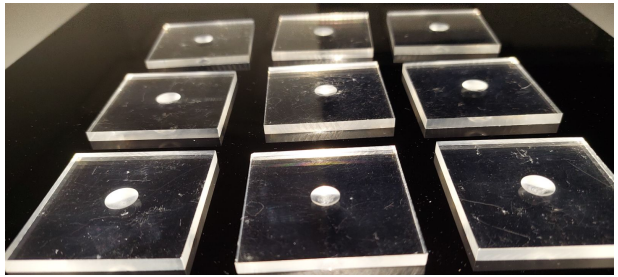
(d) hexagonal, 0.5 inch ball mill

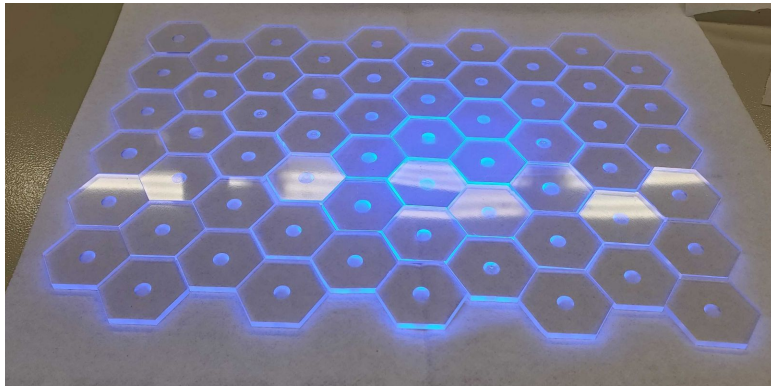
Machining scintillator cells

(higher yield, probably preferable option for high-radiation region)

@ONL

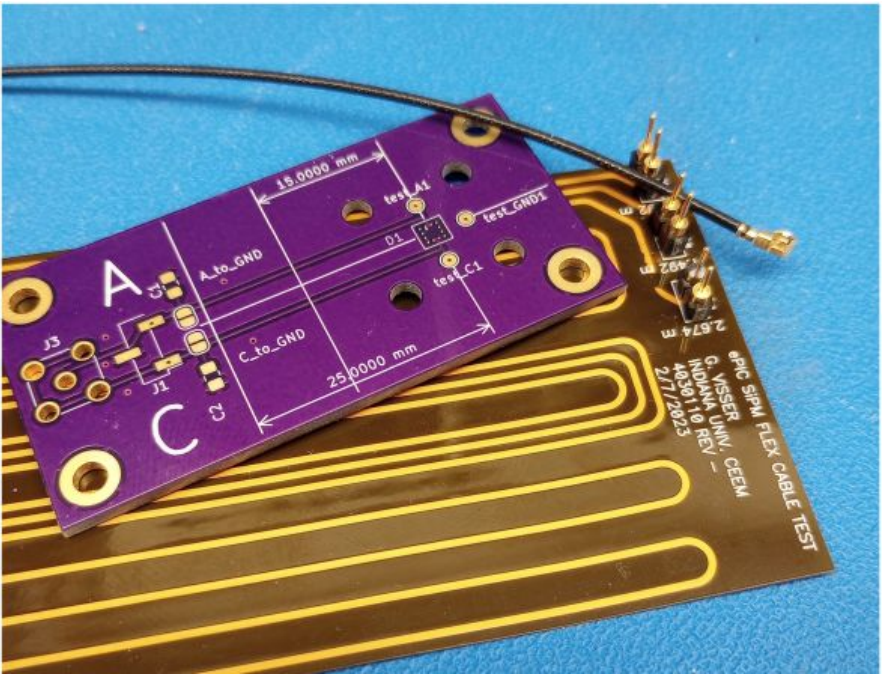




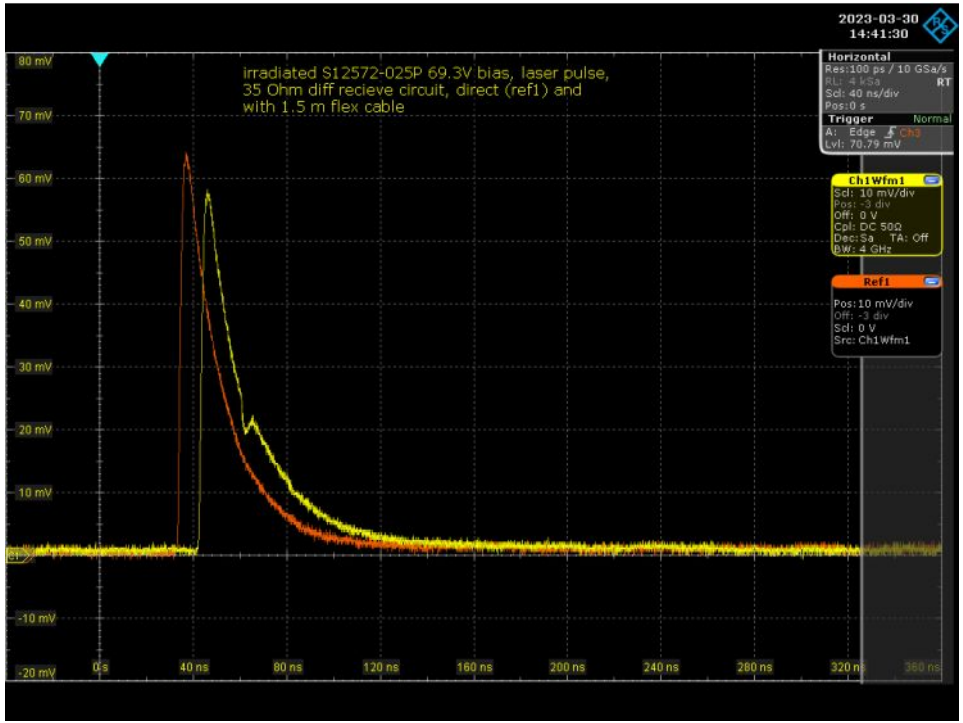


@UCR

Flex cable testing



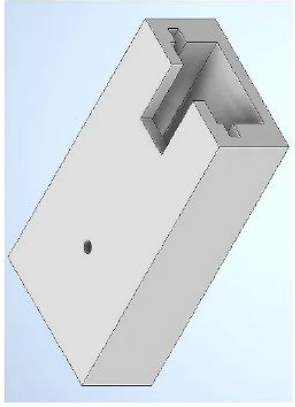
@OakRidge & Indiana



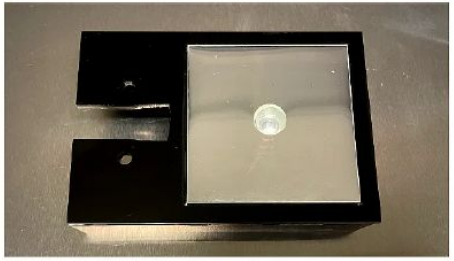
SiPM-on-tile characterization

(a) Light-tight Faraday box with connector panel

(b) SiPM on a PCB board

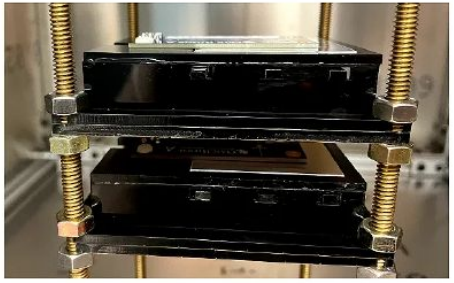


(c) SiPM Holder with hole to shine 400 nm LED photons



(d) Tile-SiPM holder with scintillator tile

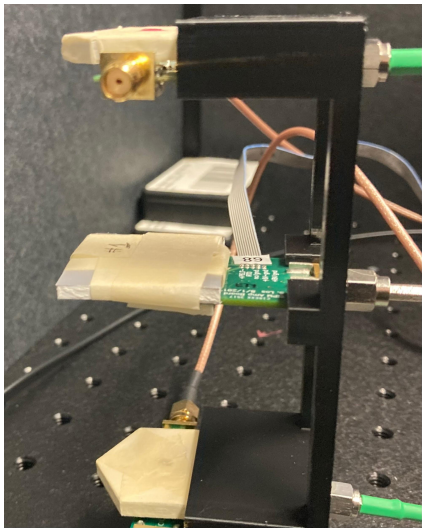
(e) Tile-SiPM holder with SiPM board



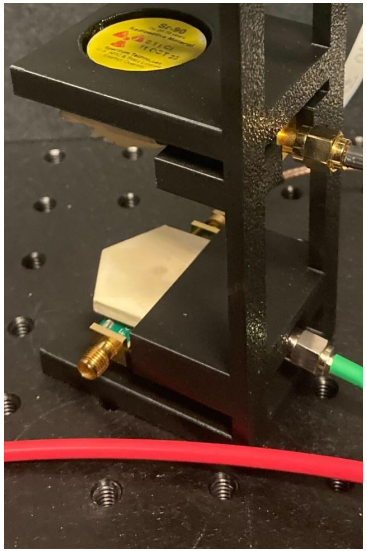
(f) Two Tile-SiPM holders on shelf

SiPM-on-tile light-yield measurements

Cosmics



Sr-90



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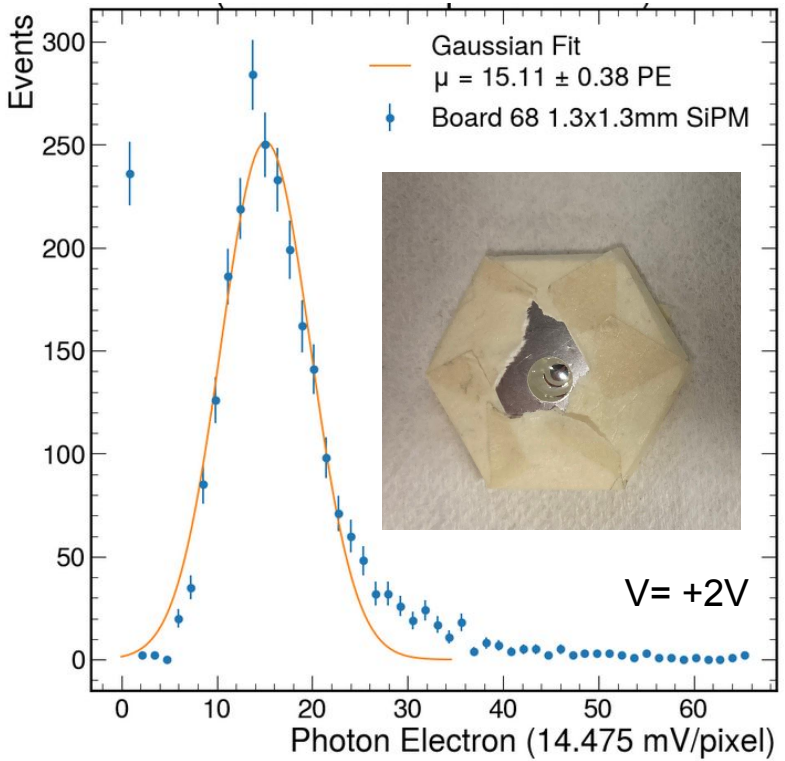
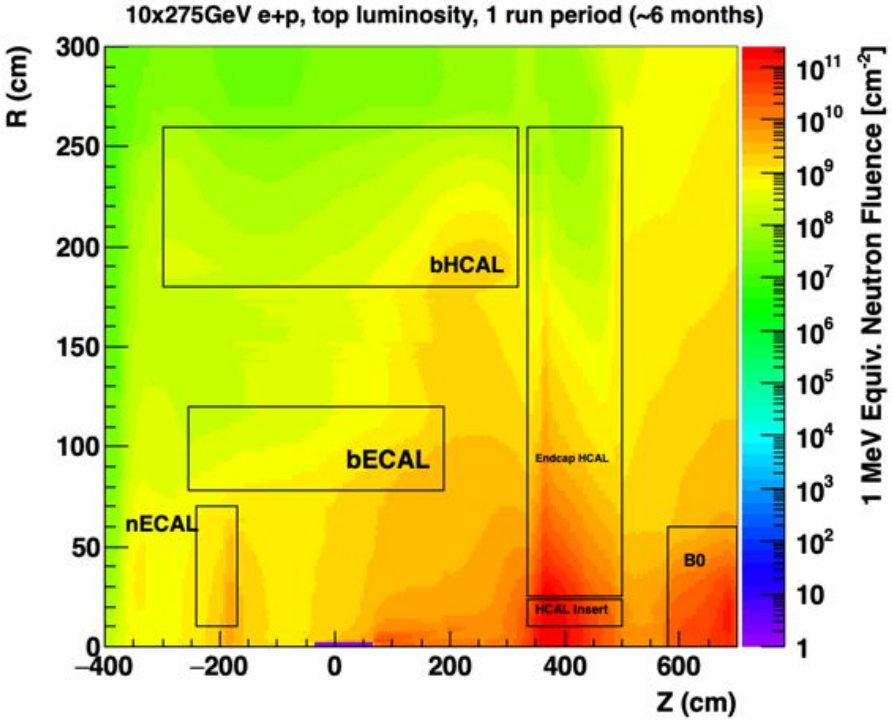


Challenge: Neutron Flux



Up to 5e13 1 MeV neutrons / cm2 over lifetime of experiment (TDR)	**Up to 1e12 1 MeV neutrons / cm2 Per year at top luminosity.**
Operating temperature: -30C (TDR)	**Operating temperature: room temperature** (Dark current at RT at 2V is ~30 higher than at -30C)

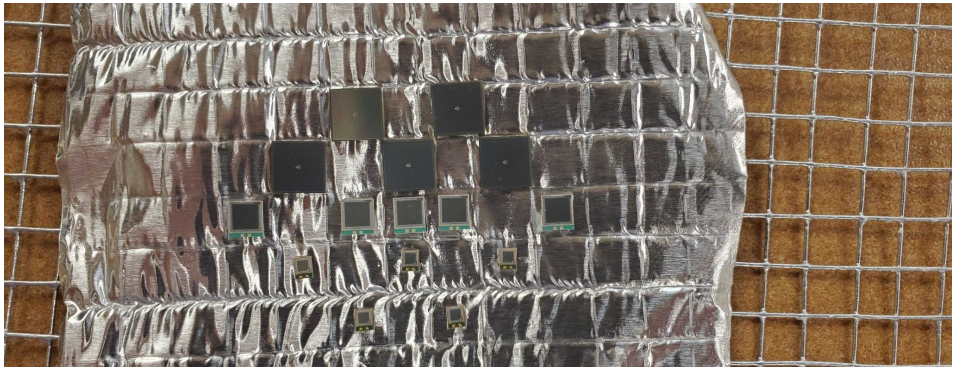
max neutron fluence in 1 year of EIC is similar to the maximum tolerable in CMS HGCAL design <u>over lifetime</u>

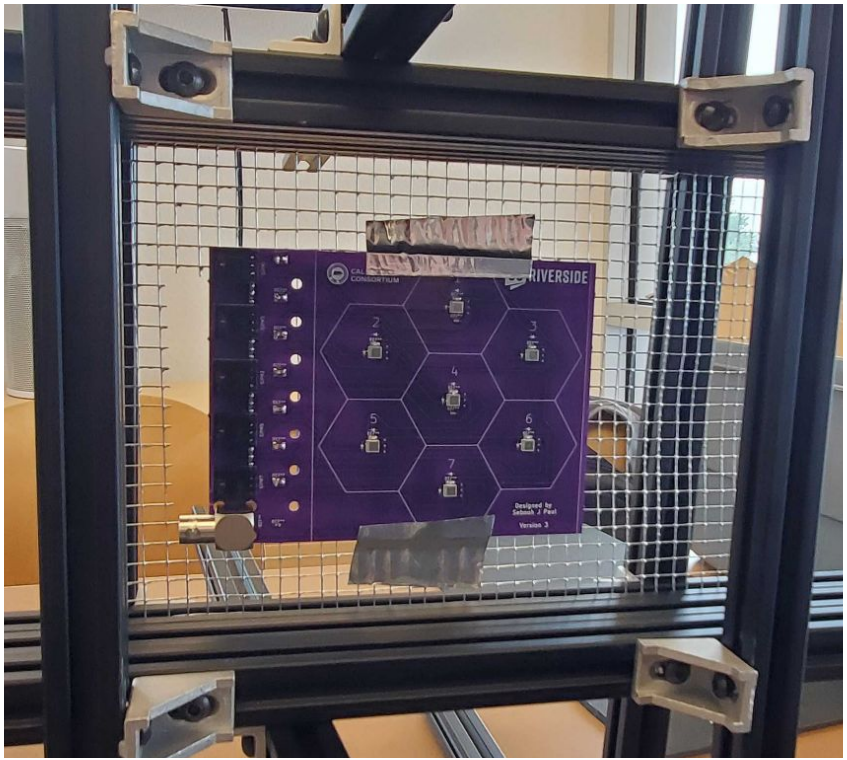
SiPM irradiation test

BERKELEY ACCELERATOR SPACE EFFECTS

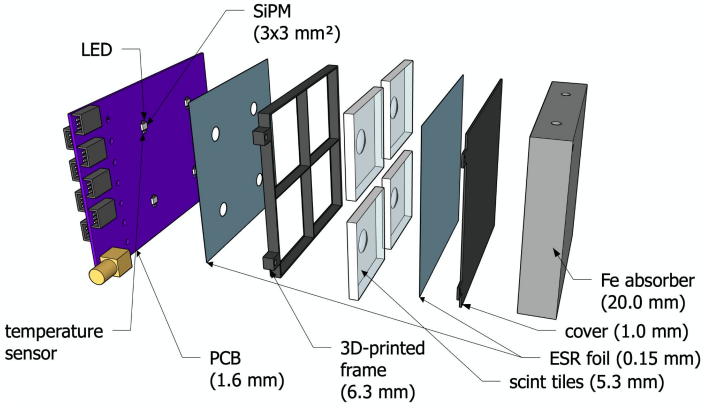
CALIFORNIA EIC CONSORTIUM

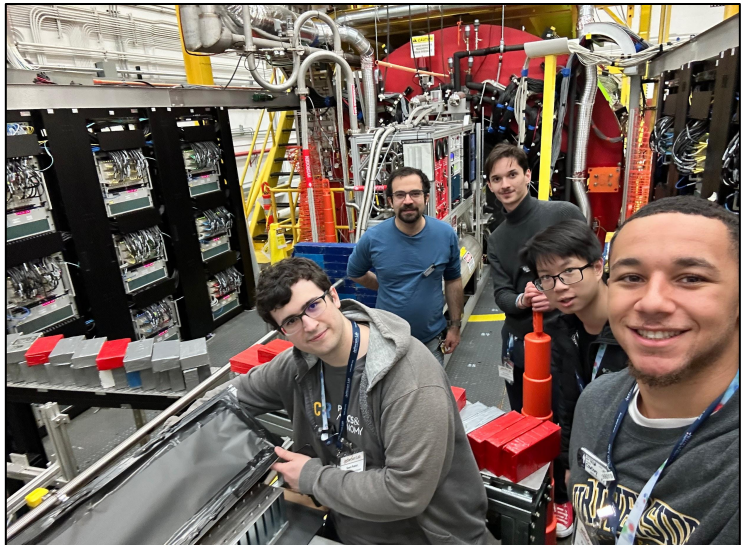
*now planned for ~Sep. 2023

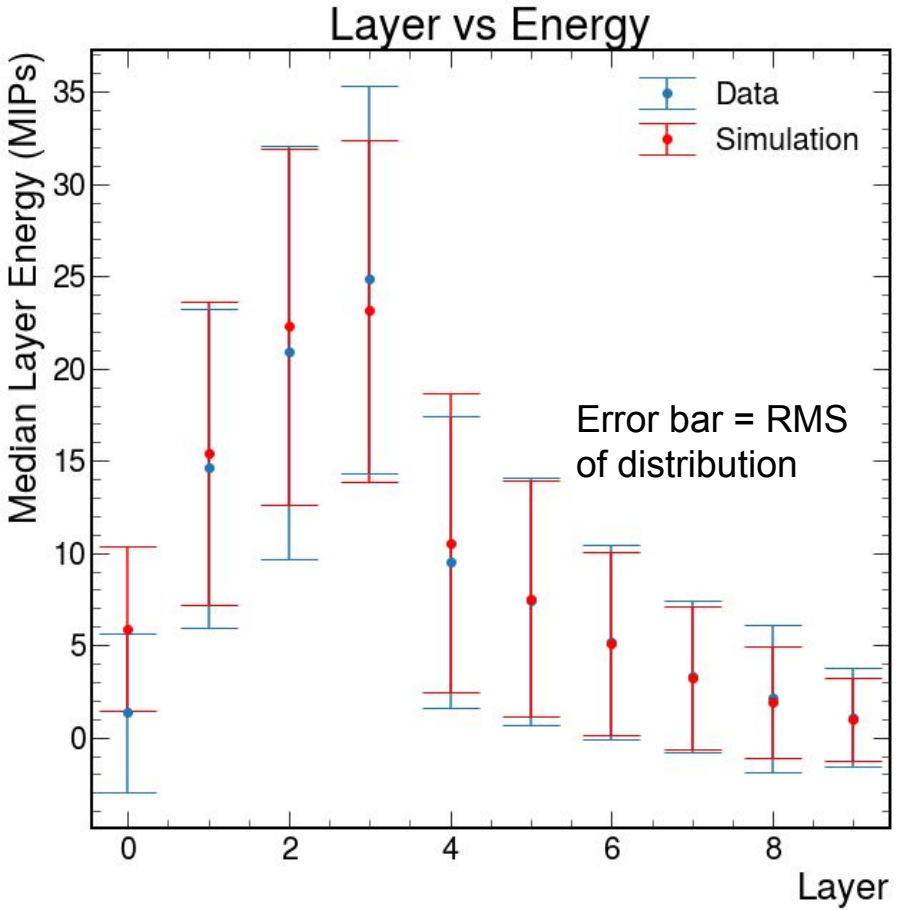




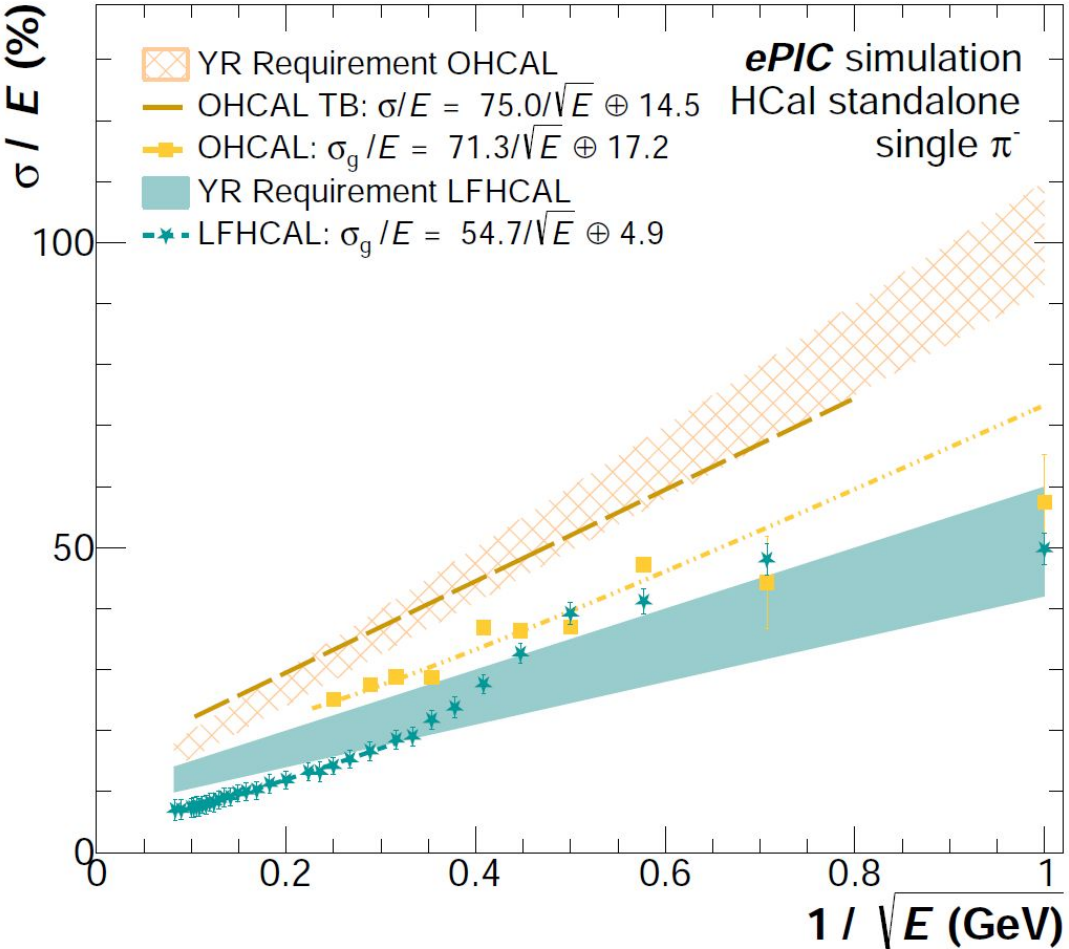
First calorimeter insert prototype test beam, Jan 2023 @JLab



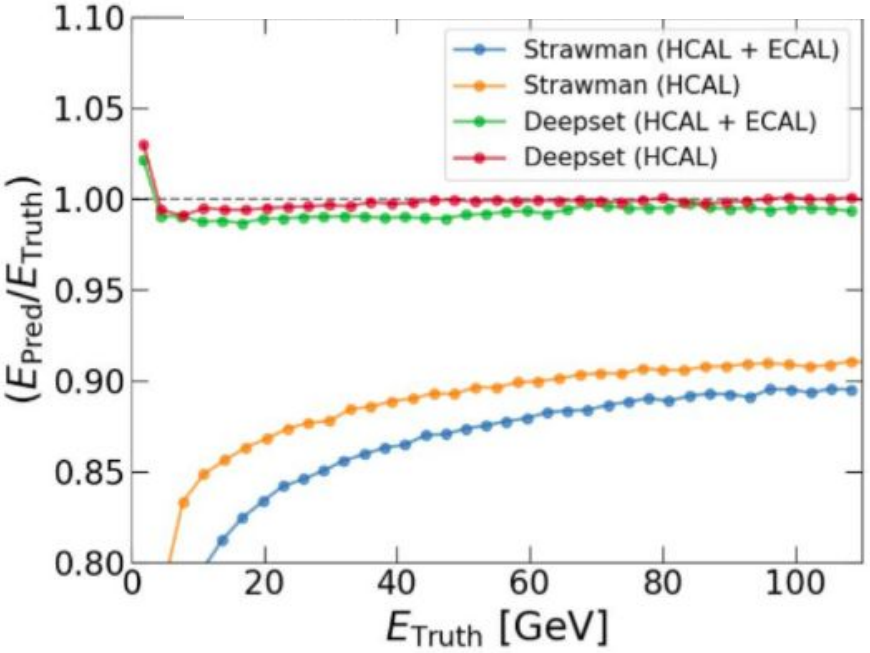


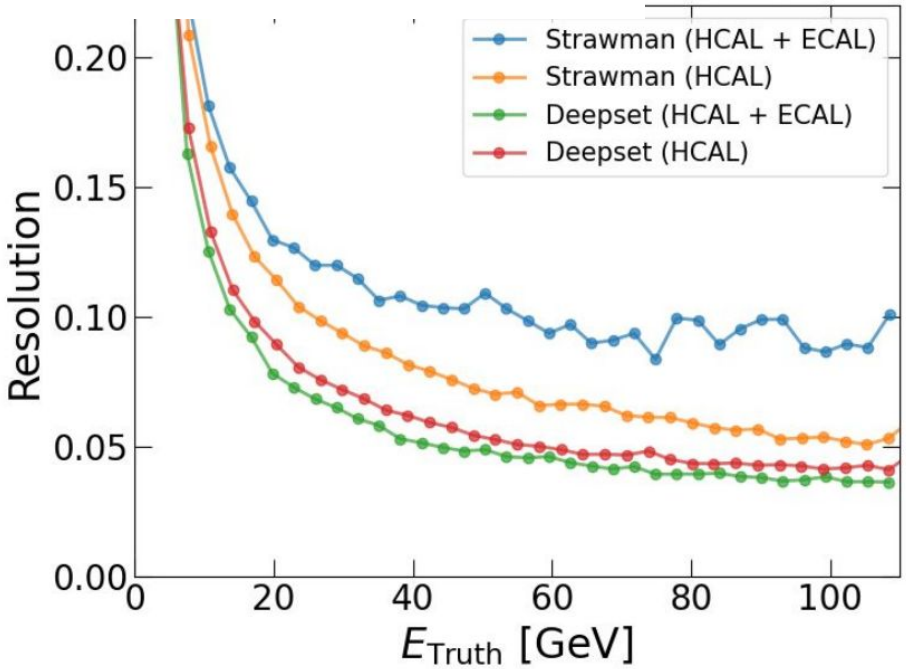


Simulated performance



Software compensation with point-cloud networks (insert)





Summary

- Forward HCAL design has been refined with SiPM-on-tile approach, facilitating future construction.

- Ongoing R&D on sensor unit testing now, and moving to mechanical prototypes and test beams

- Simulations have been refined with increased realism; active development of AI-based approaches