Backward Endcap HCAL

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CALO Workfest @ ePIC Collaboration Meeting

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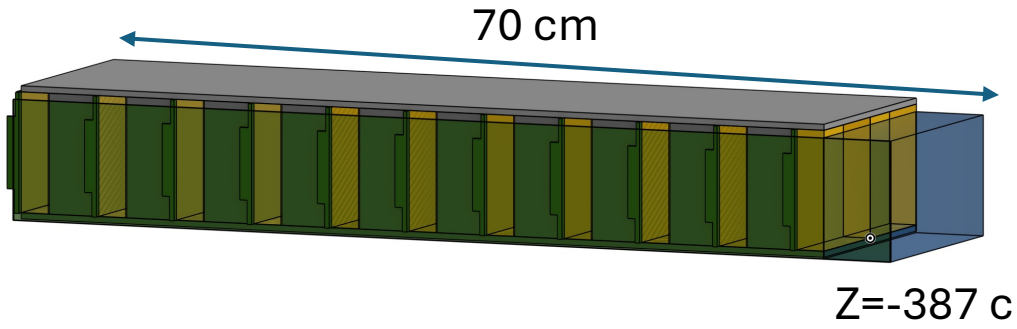
General Updates and Short-term Goals

- nHCAL gross detector design fixed before PDR (Oct 2025)



10 layers of each: 4 cm steel + 2.4 **cm scintillator**
+ Initial scintillator layer (2.4 cm)
Electronics in front (towards IP)

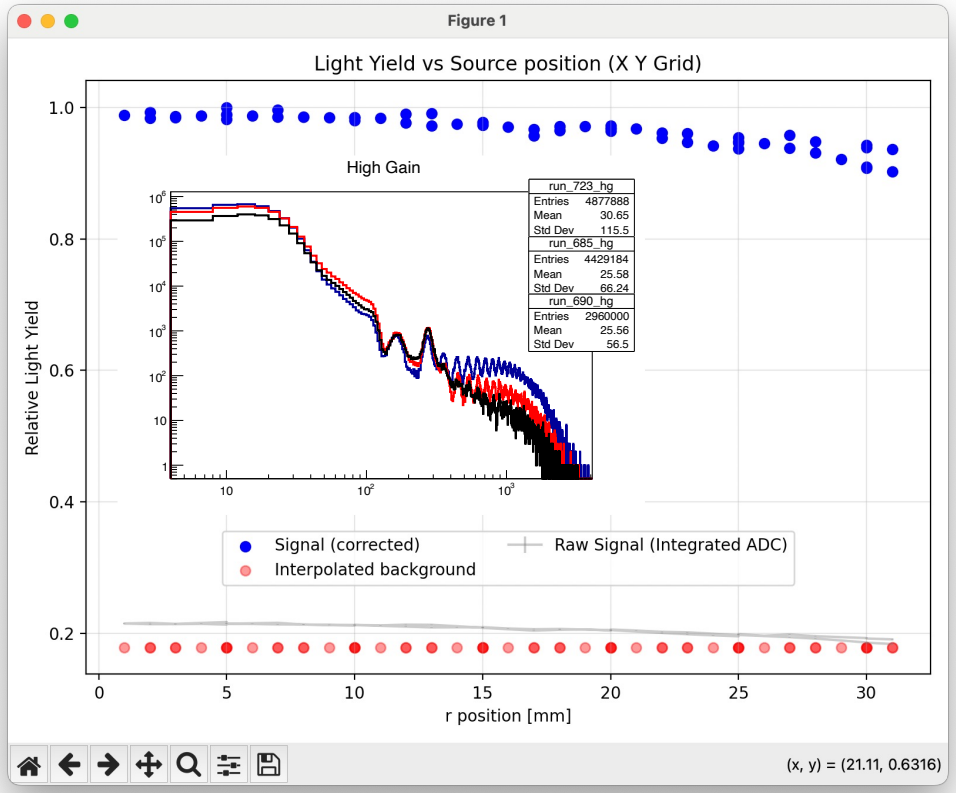
- Full Modules (2M = 10x10cm x 2), Half Modules (1M = 10x10cm x1)
- 21,880 channels (36 / CALOROC) = 1130 without sharing
- Merged into ePIC main: PR#979 (Nov 12)

- nHCAL tightly coupled to LFHCAL technology + benefit
  - Main goals are to verify the deviations from LFHCAL / traditional sampling calo design
  - Transverse tile size (10x10cm nHCAL) vs (4.7x4.7cm, LFHCAL) === Light Uniformity
  - This is also the main point needed to address PDR comments

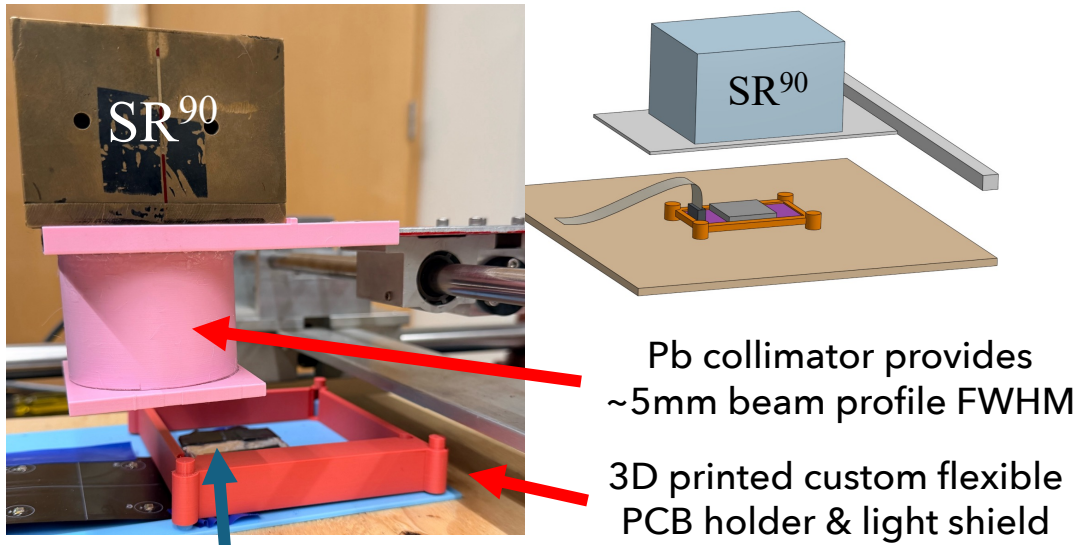
Light uniformity for 10x10 cm tiles

- Ongoing tests:
  - Verify light yield in lab tests on 10x10 tiles.
  - For now based on 5x5 tile extrapolation:

Expect ~20-30 light loss by edge of 10cm tile assuming SiPM on tile *center*



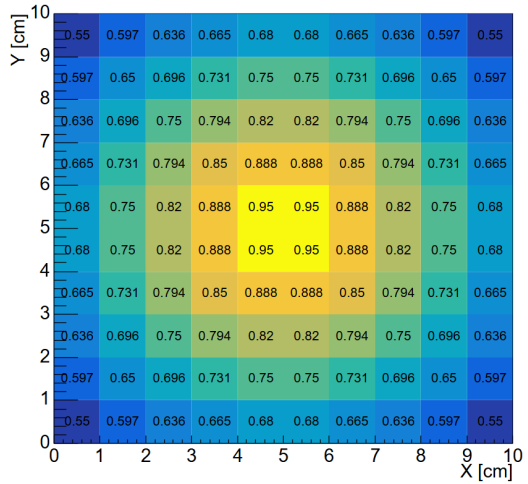
Fully automated (CNC driven) tile-testing apparatus



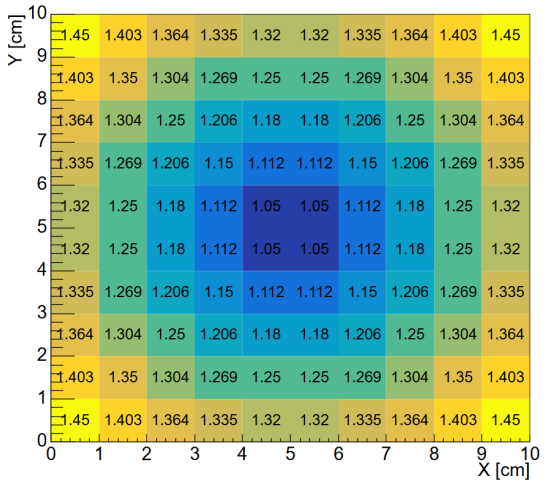
DAQ: CAEN CITROC-1A (thank you Oak Ridge :)

Impact of light non-uniformity

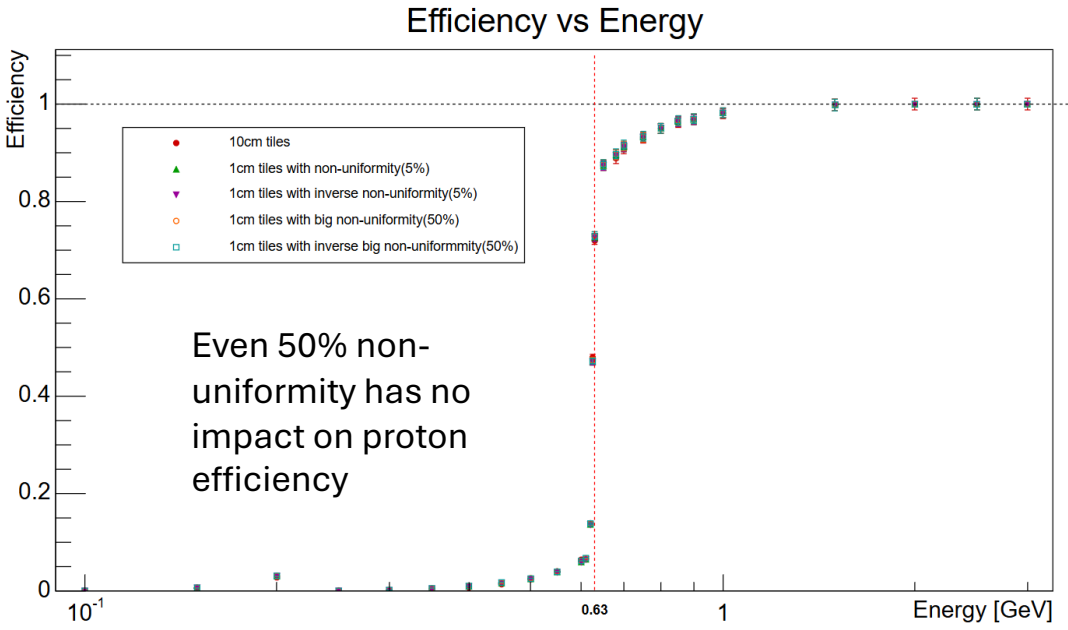
- Investigate light non-uniformity on efficiency of the HCal.
- Method in simulation:
  - Reduce the tile size from default 10cmx10cm to 1cmx1cm,
  - Apply different weight to each 1cm × 1cm sub-tile to model non-uniform light collection on larger 10x10cm tile



1cm tiles with big non-uniformity(50%)



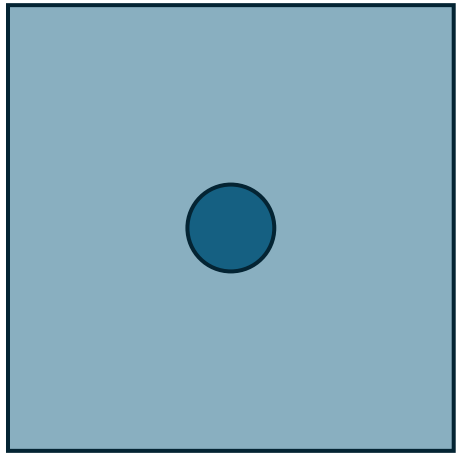
1cm tiles with inverse big non-uniformmity(50%)



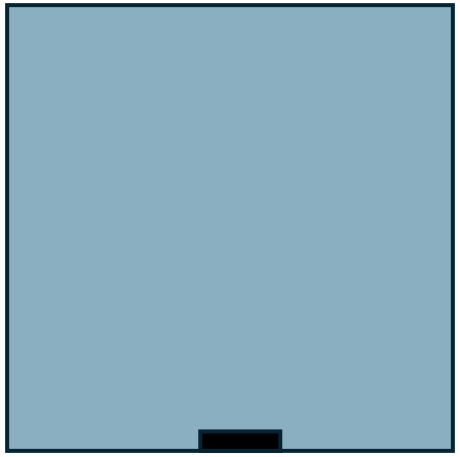
Next + most important: impact on MIPs

Mitigation and Optimization

- Large Scintillators (thick 2.4 cm) allow alternative SiPM placement:



SiPM on tile with dimple (default)



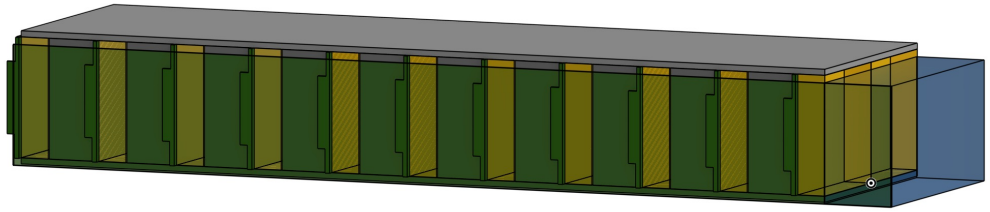
SiPM on edge (default)
Tests ongoing in OSU lab

Potential advantages:

- No need for PCB behind tiles (SiPMs directly on single long PCB (reduce complexity)
- Better light line-of-sight
- No need for dimple – reduce machining cost
- Needs to be verified in lab tests
- Potential disadvantage: longer light path on far side

Other variations:

- Edge + dimple
- Corner
- Double SiPM (on LFHCAL PCB)



Milestones for 1st quarter 2026

- Physics Motivated:
  - Muon Identification (shared with all HCALs)
  - Extended VM studies (J/psi + phi)
  - Electron ID - nHCAL impact on low-X events with punch-through
- Simulation:
  - Use of timing information for background rejection -> finalize timing requirements
  - Energy resolution for jets in full events (not only single / double jet guns)
  - Impact of light collection non-uniformity on MIPs (efficiency and identification)
- Design:
  - Complete 10x10cm light uniformity studies for all layouts (SiPM on tile dimple center / edge)
  - Reflective tape vs. titanium dioxide painted
  - Integrate CALOROC sample boards into DAQ system
  - Begin prototype construction (one 2M module)