Backward Hadronic Calorimeter

Geometry optimization work plan

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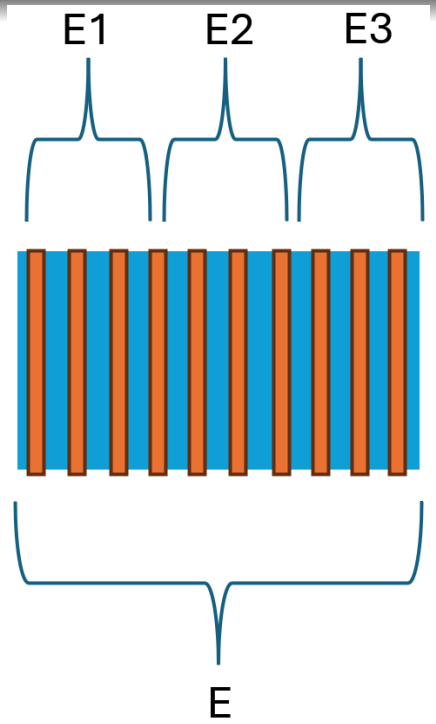
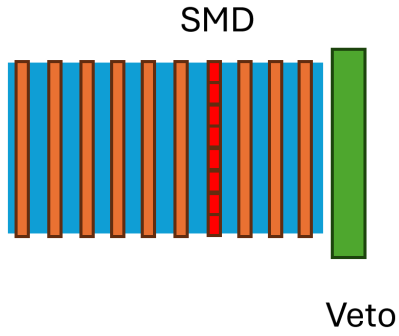
THE OHIO STATE UNIVERSITY

Outline

Readout segmentation and Veto layer





- Independent vs. integrated readout from layers
  - Affects 3D clustering etc. (loss of information)
  - If removed, most likely no effect on energy resolution
  - Can reduce channels by up to factor of 10
  - Using 3 segments gives each segment $\approx \lambda_0$ (similar to LFHCAL)
  - May be harder to detect low energy neutrons with integrated readout due to higher threshold

In order to check the segmentation we need to do reconstruction by adjusting the hit merging with eicrecon command line eg.:

Listing: Example digitized hit merging to create segments

```
eicrecon -PEHCAL:HcalEndcapNMergedHits:fieldTransformations="layer:layer-fmod(
    layer,3)"
```

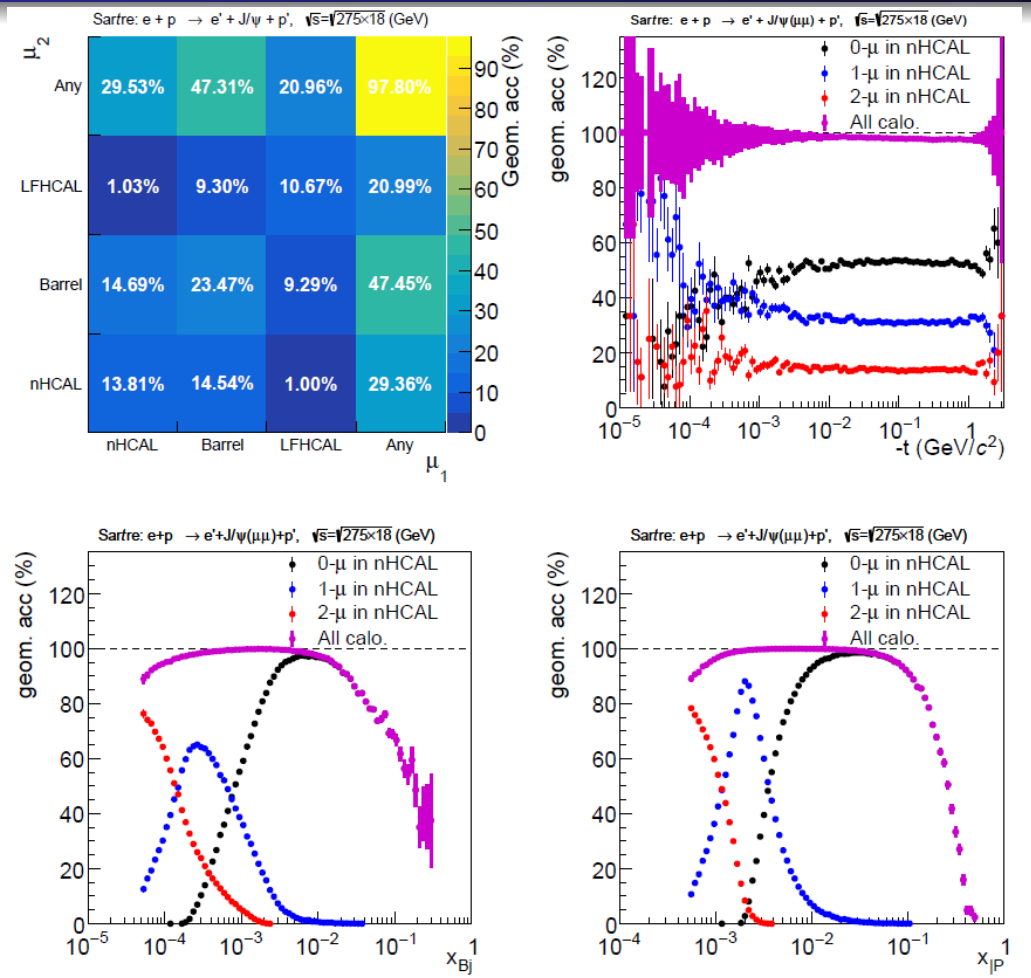
Geometry versions to investigate

1. Tile and absorber thickness
   1. 4 cm steel, 4 mm scintillator, 10 layers 45 cm total
   2. 4 cm steel, 3 mm scintillator, 10 layers 44 cm total
   3. 3 cm steel, 4 mm scintillator, 13 layers 45.2 cm total + air gaps
   4. can check more in principle
2. Detector length
   1. 4 cm steel, 4 mm scintillator, 10 layers 45 cm total
   2. 4 cm steel, 4 mm scintillator, 12 layers 54 cm total + air gaps
   3. 4 cm steel, 4 mm scintillator, 15 layers 67.5 cm total + air gaps
3. Use parameters below to optimize geometry:
   - e/h response
   - energy resolution
   - **neutron detection efficiency**
   - **muon ID efficiency**

The above can be done, by:

1. Adding a dedicated compact geometry `.xml` file with the above modifications and `{.yml` file that points to it
   - See chat: `https://chat.epic-eic.org/main/pl/5pgnsmyp7fn19r8mrznw8iwgxy`
2. Compiling epic repository
3. Running npsim pointing to that specific geometry (detector) version `.xml`
4. Run the combined analysis code (please update!)
   `https://github.com/lkosarz/HCalGeomStudy`

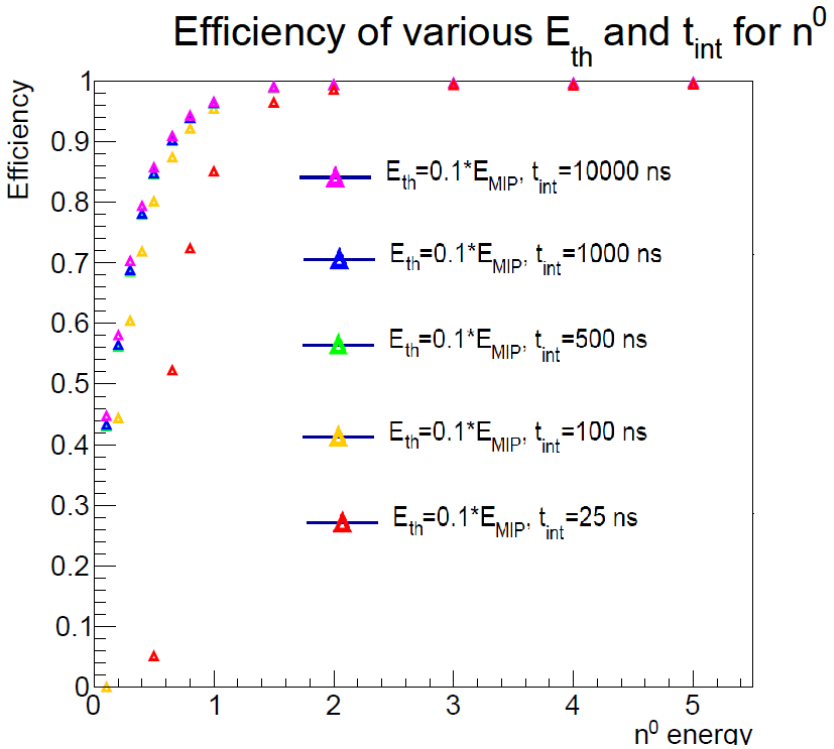
Muon identification study for VM reconstruction



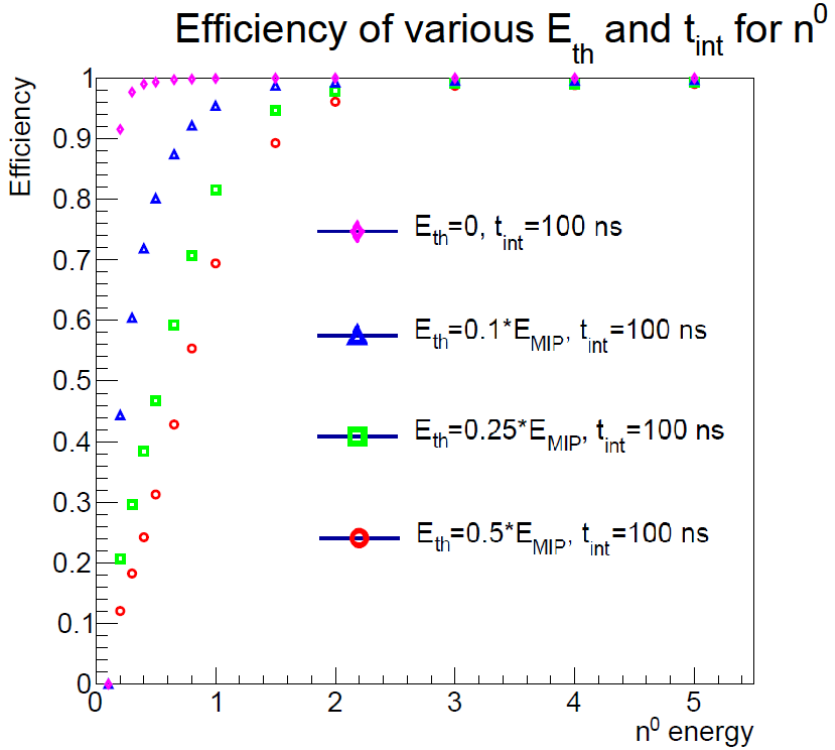
- Study of VM meson reconstruction complete: https://doi.org/10.5281/zenodo.14200156
- Need to optimize tiles for the muon detection
- Study muon identification efficiency and purity (in principle)
  - Focus on the efficiency of single muons with (full ePIC or nHCal only)
  - Need to try few different ID criteria
  - Example: `https://indico.bnl.gov/event/19559/#3-muons-with-lfhcal`

Neutron detection efficiency check

Integration time dependence



Threshold dependence



Sam Corey, OSU

- Revisit for different configurations during sampling fraction study to optimize geometry
- Efficiency of requiring a hit with a sum of hit contributions energy integrated up to t_{int} and passing a threshold E_{th}, $t_0 = 0$
- Checked with simulation only - no digitization
- Realistic digitization model with triggering development in progress
- E_{MIP} is 0.75 MeV per layer
- E_{th} has the biggest impact
- 100 ns from event start is good enough, but lower energy neutrons may need longer times

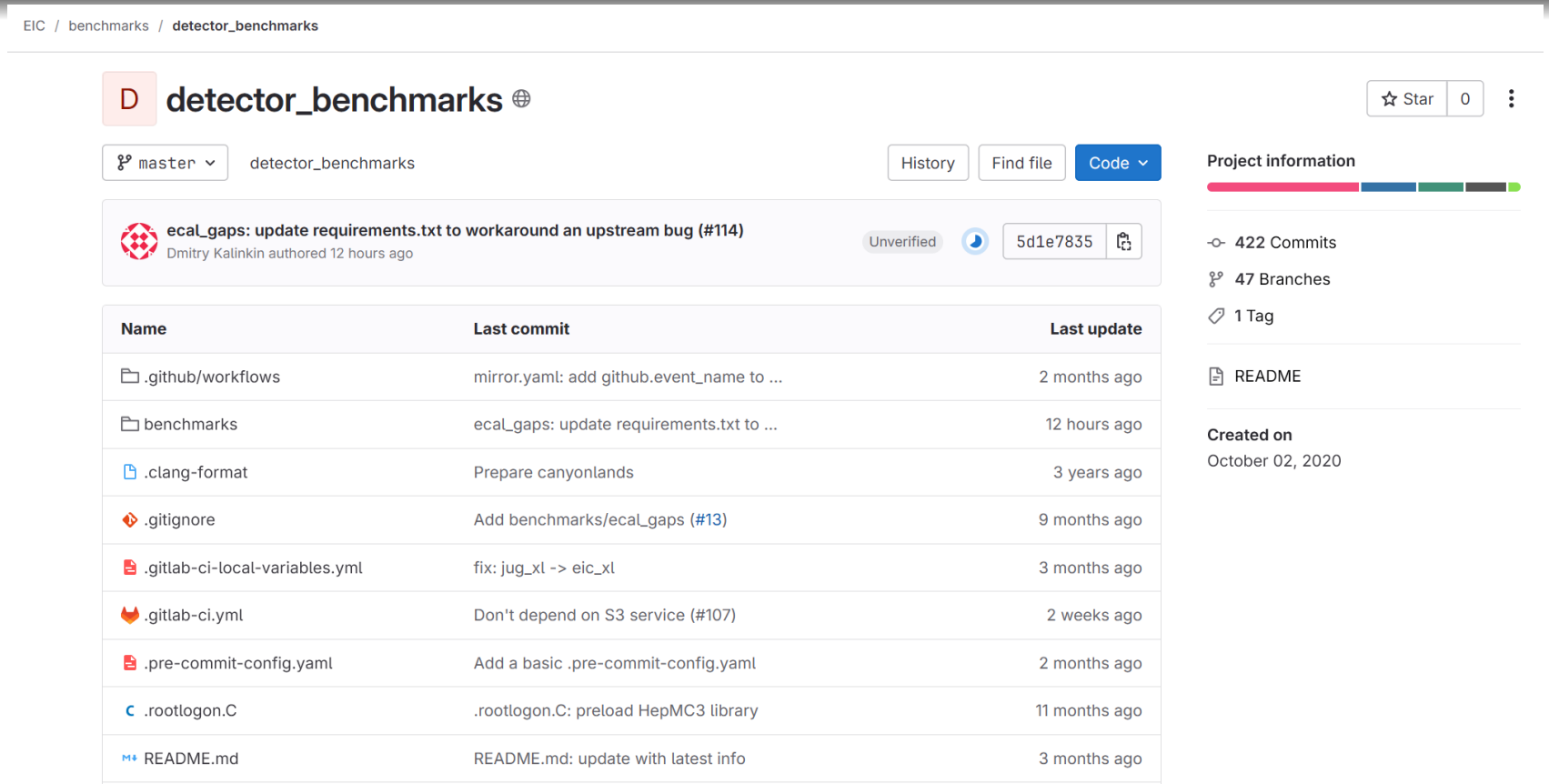
Summary

Overall we need a few simulations:

1. nHCal only for the purpose of:
   - Neutron detection efficiency study (readout from scintillators only)
   - Sampling fraction (readout from all layers (absorber+scintillators))
2. Full ePIC for muon identification efficiency
3. Can be implemented as benchmarks too (with a quick progress an undergrad at WUT can help)

BACKUP

Benchmarks for CD/CI



- Develop benchamrks for CD/CI
- `https://eicweb.phy.anl.gov/EIC/benchmarks/detector_benchmarks`
- `https://indico.jlab.org/event/420/contributions/8307/attachments/6911/9434/20210504-Automated_workflows.pdf`
- Useful for automated checks: hit distributions, acceptance etc.
- Ideal task for bachelor and undergraduate students
- Submitted a thesis proposal at Warsaw University of Technology
  - May be piked up by a student around February-March 2025