Benchmarks and muon reconstruction

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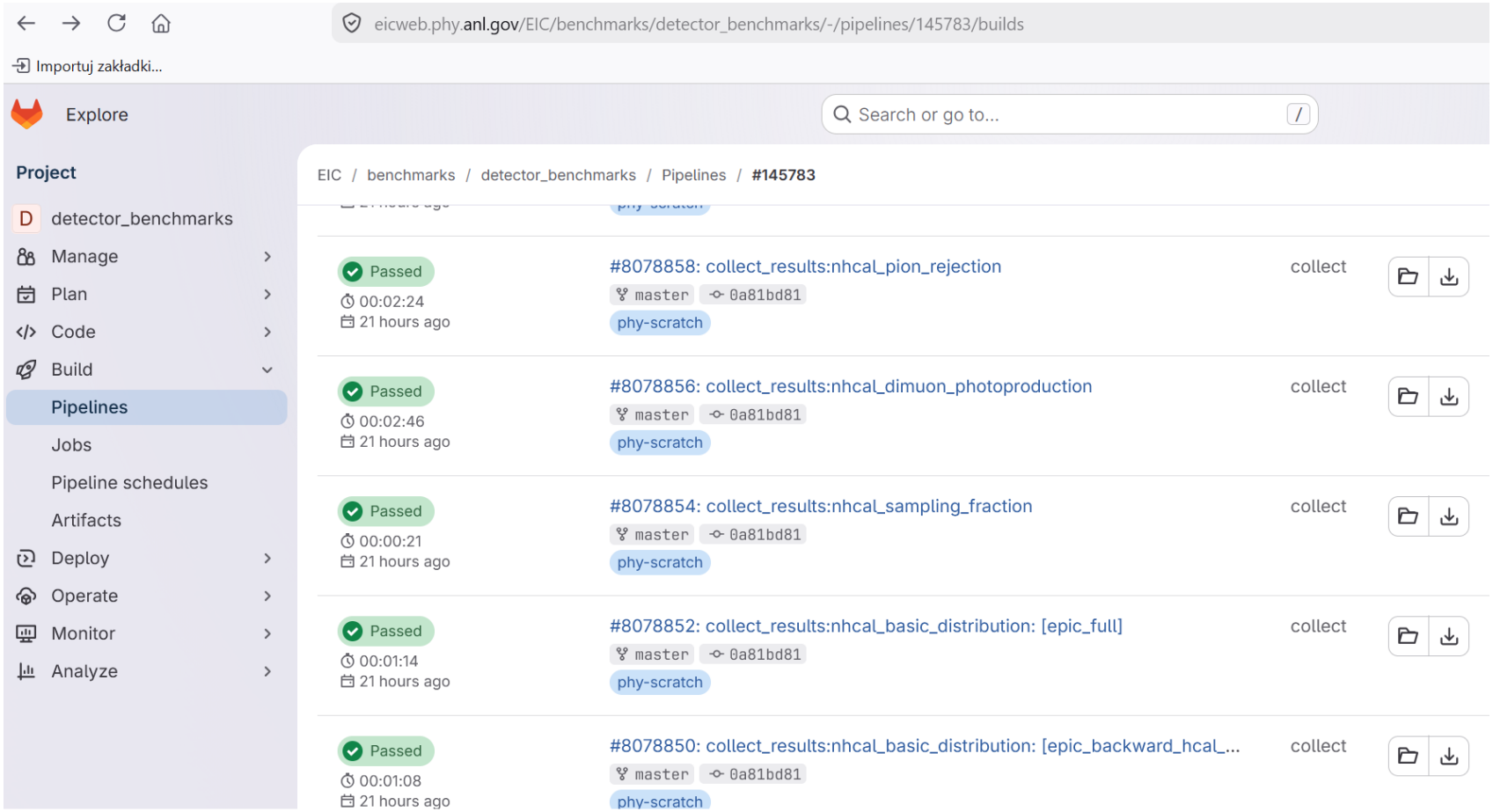
THE OHIO STATE UNIVERSITY

Outline

nHCal detector benchmarks

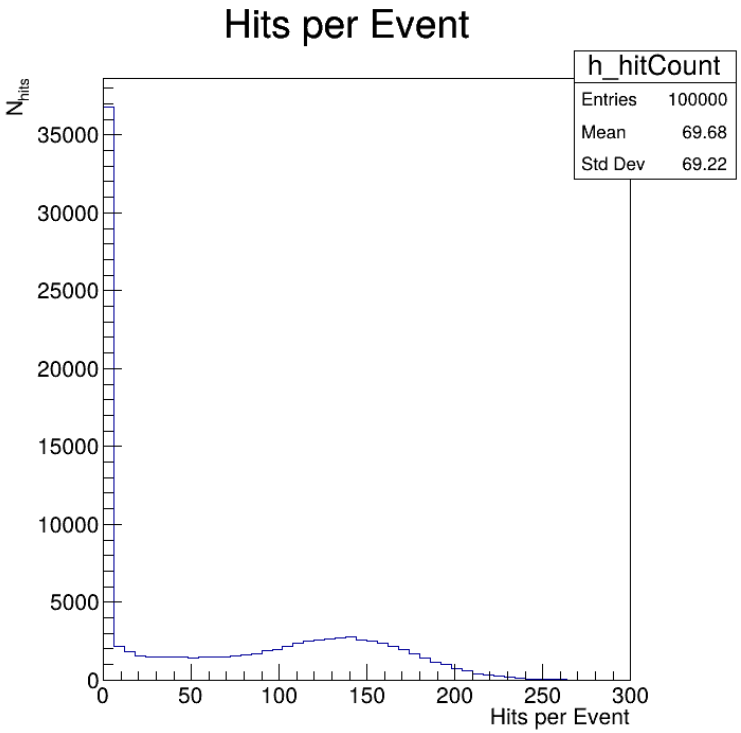
- The aim of the benchmars is to provide automated tests for each update of geometry
  - Bachelor thesis at WUT by Michał Sieczczyński
- All benchmarks implemented here:
  - `https://github.com/eic/detector_benchmarks/pull/168`
- Include:
  - Acceptance check: `nhcal_acceptance`
    - `https://github.com/eic/detector_benchmarks/tree/master/benchmarks/nhcal_acceptance`
  - Basic distributions: `nhcal_basic_distribution`
    - `https://github.com/eic/detector_benchmarks/tree/master/benchmarks/nhcal_basic_distribution`
  - Sampling fraction: `nhcal_sampling_fraction`
    - `https://github.com/eic/detector_benchmarks/tree/master/benchmarks/nhcal_sampling_fraction`
  - Dimuon photoproduction: `nhcal_dimuon_photoproduction`
    - `https://github.com/eic/detector_benchmarks/tree/master/benchmarks/nhcal_dimuon_photoproduction`
  - Pion rejection: `nhcal_pion_rejection`
    - `https://github.com/eic/detector_benchmarks/tree/master/benchmarks/nhcal_pion_rejection`

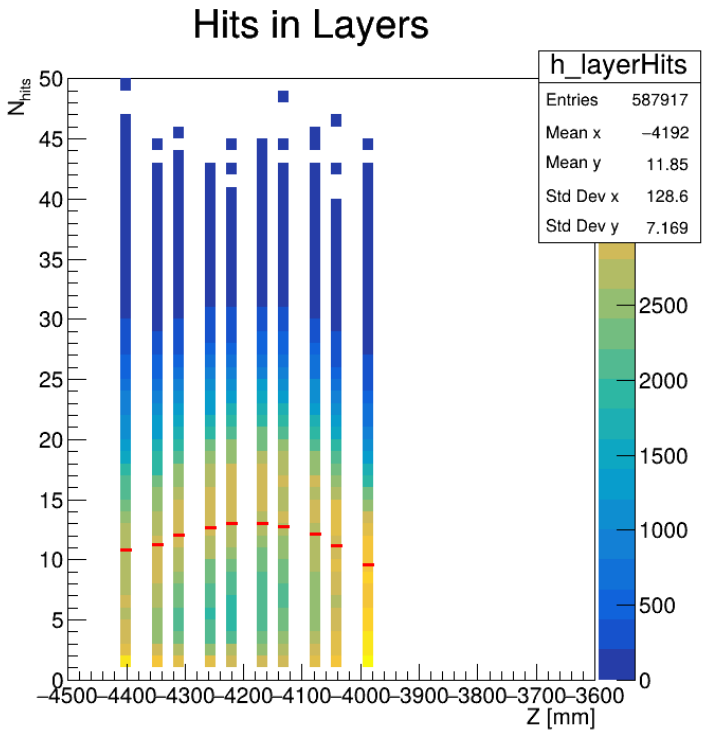
Pipelines and job results



- Results produced automatically
- Check the produced results by clicking icons on the right hand side
- `https://eicweb.phy.anl.gov/EIC/benchmarks/detector_benchmarks/-/pipelines`

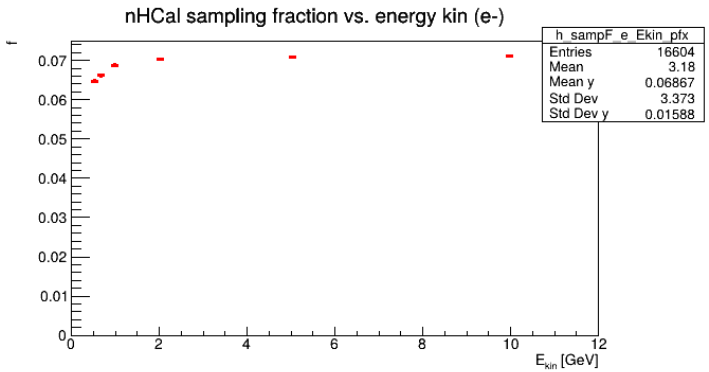
Basic distributions

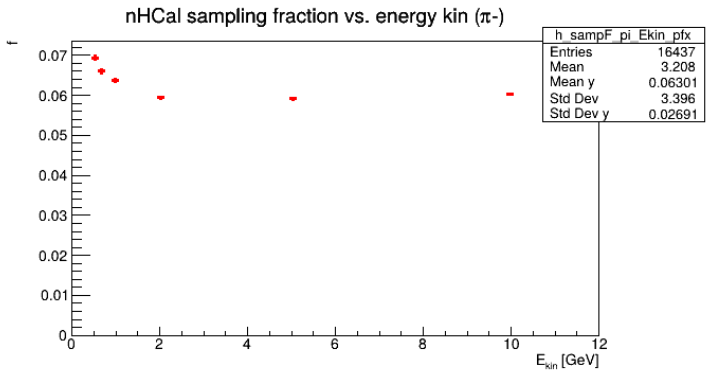


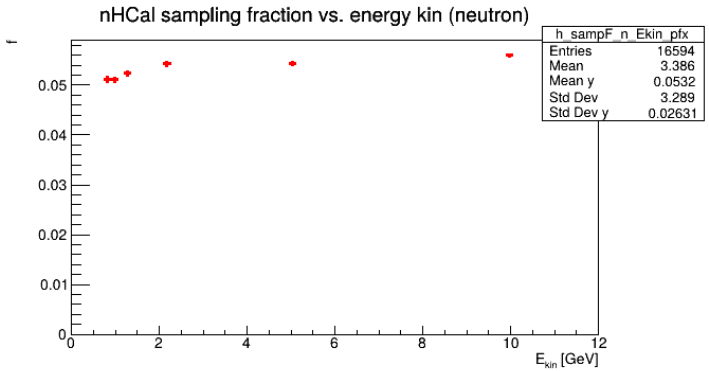


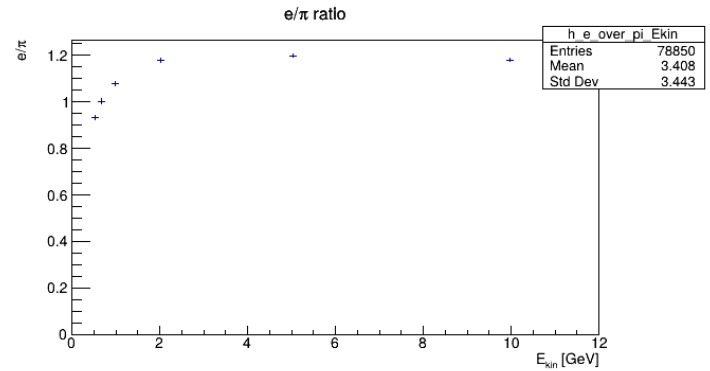
- Basic distributions for neutrons
- Hits per layer, energy, sum of energy etc.
- Helpful for verification of geometry or reconstruction
- Feel free to add new distributions!

Sampling fraction





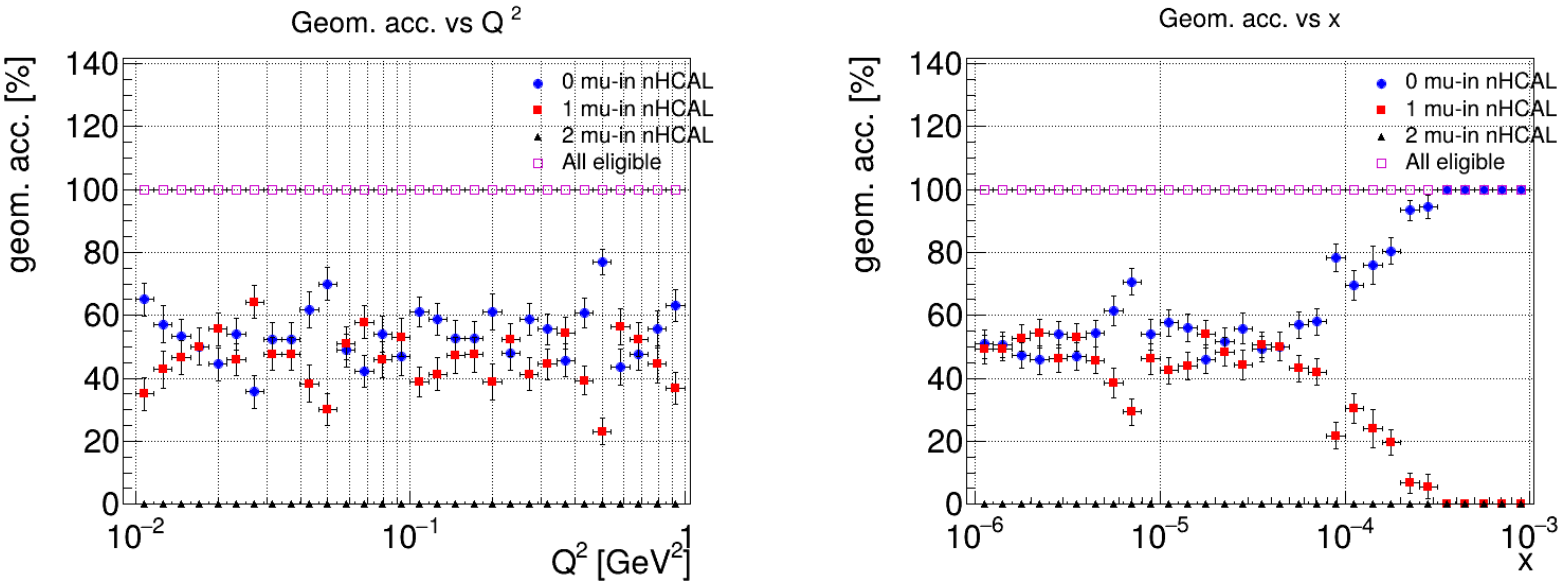




- Different results than mine may be due to:
  - larger thickness
  - binning
  - large solid angle range in simulation
- We use mostly the same code
  - I plan to check it on my simulation files to verify

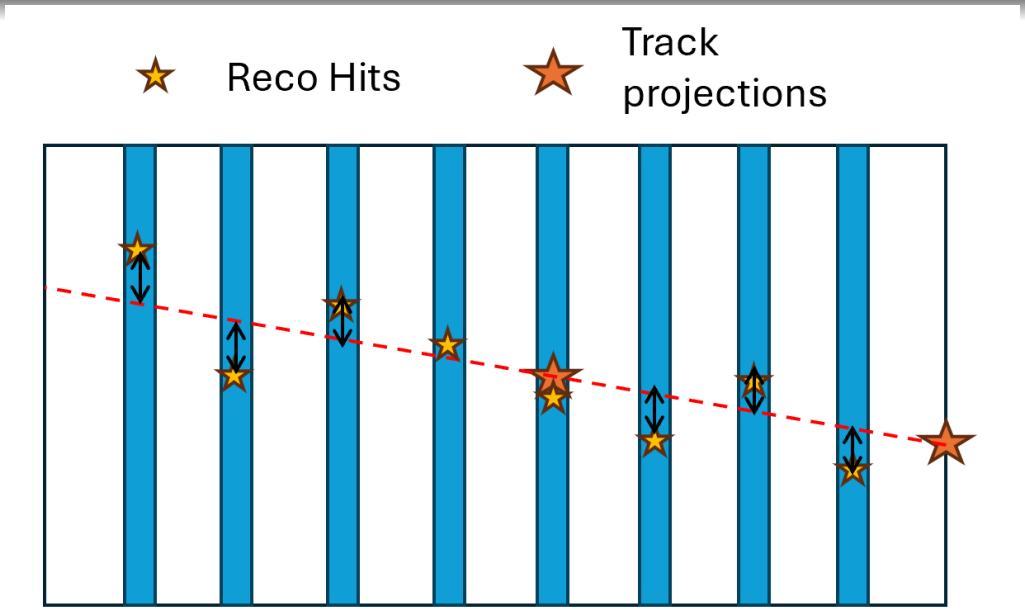
Dimuon photoproduction - acceptance

Pythia8 simulated $\gamma\gamma \to \mu\mu$



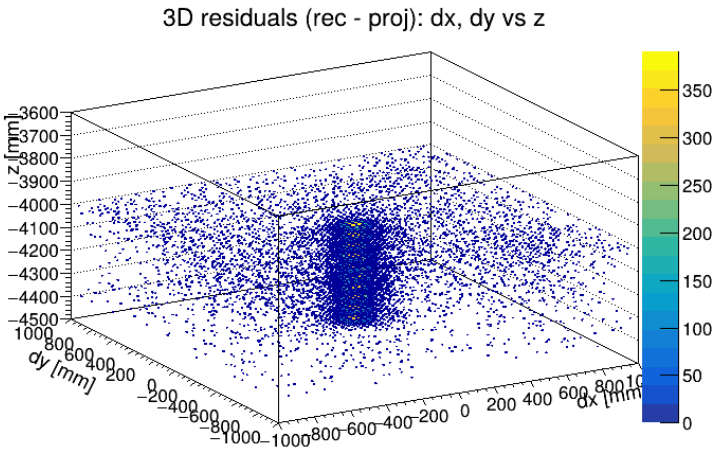
- Kinematic acceptance for dimuon photoproduction events
- Defined according to the acceptance requirements requested by ePIC
  - Pions energy: 1 GeV, 5 GeV, 10 GeV
  - Hit in any of the sensitive layers
  - nHCal only geometry

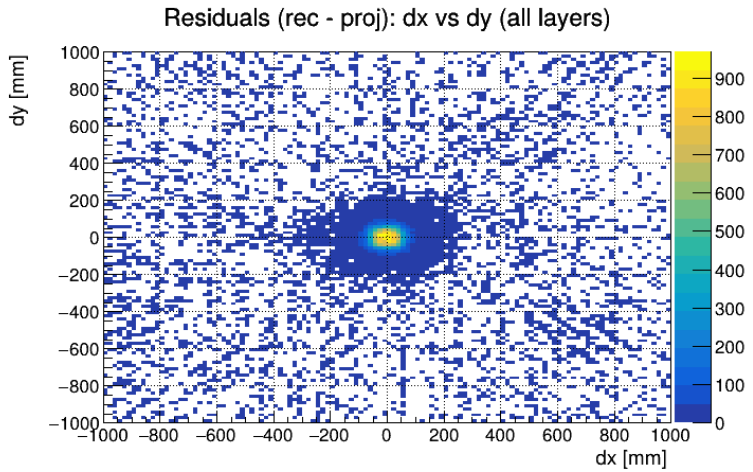
Muon reconstruction

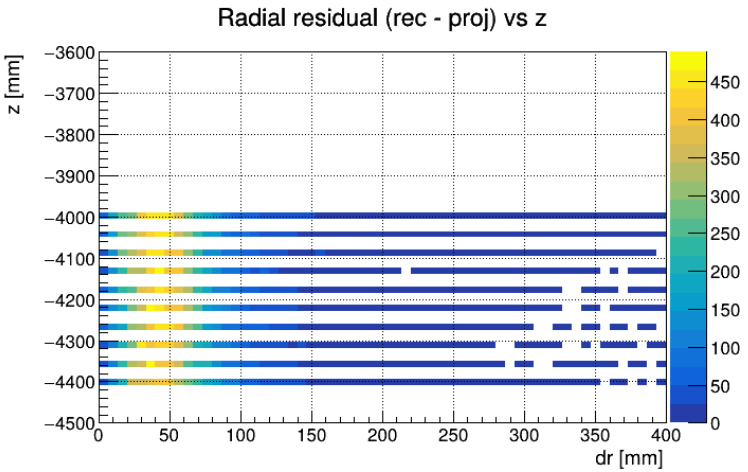


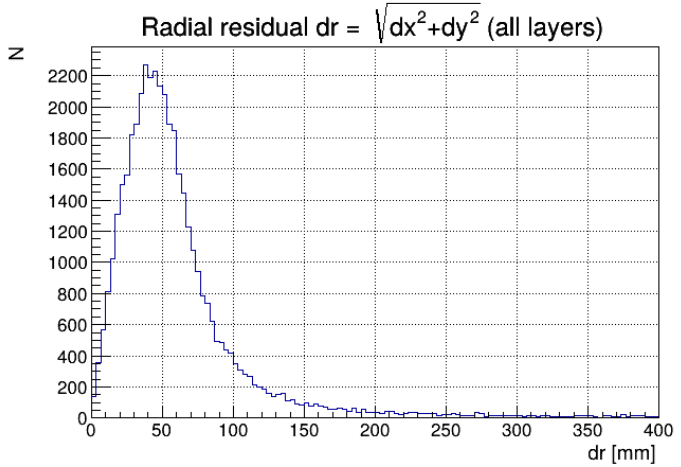
- Projected track across the layers assuming a straight line between the 2 projections (surface and $1\lambda_0$)
- Requiring both projections to 395 cm and 410 cm layers
- Connected the 2 projections with a straight (red dashed) line to calculate distance to reco hits
- Good enough approximation
- Accepting tracks with N hits within given distance from the projection (Δr) within the layer
- Hit energy has to be below $< n$
- Isolation cut: Ratio of hit energy/to the hit energy+surrounding tiles has to be > 0.8

Muon identification



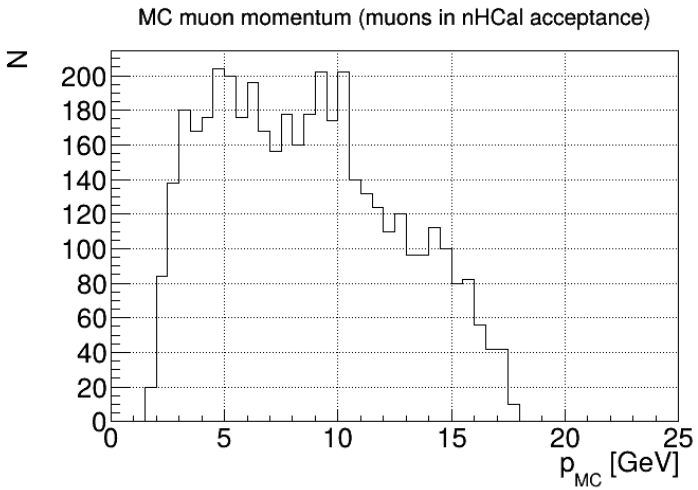


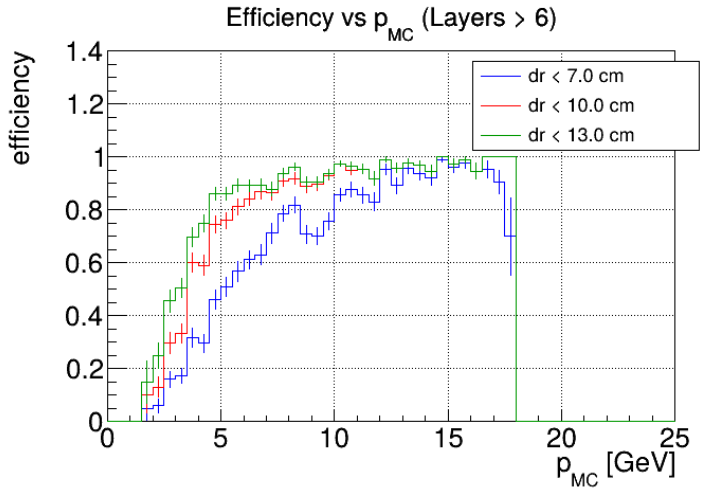


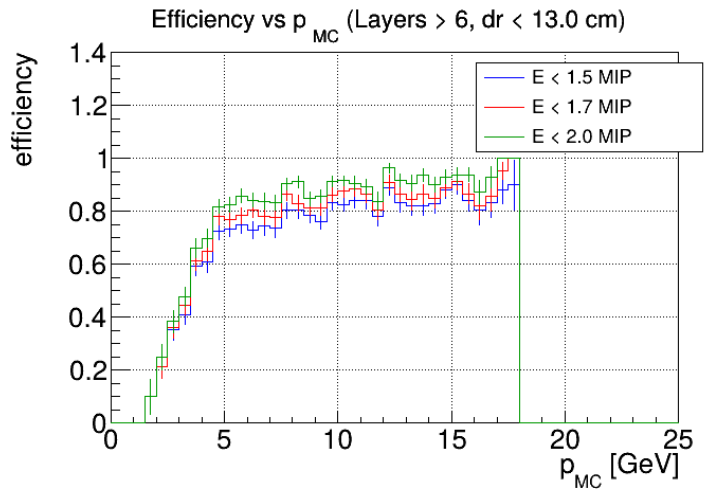


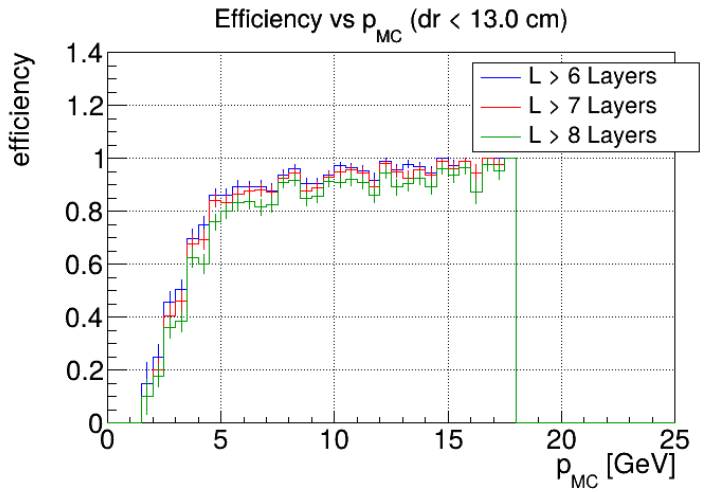
- 10 layers of 4 cm steel and 4 mm scintillator
- 10 cm $\times$ 10 cm tiles
- Muons leave a narrow ionization trail in the detector

Muon identification



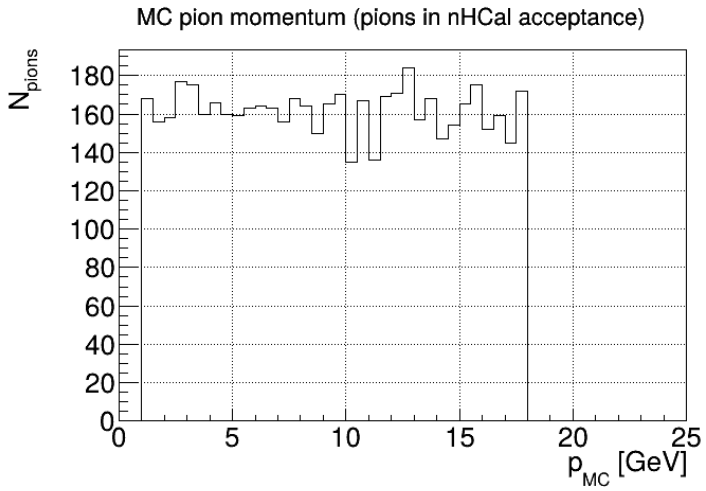


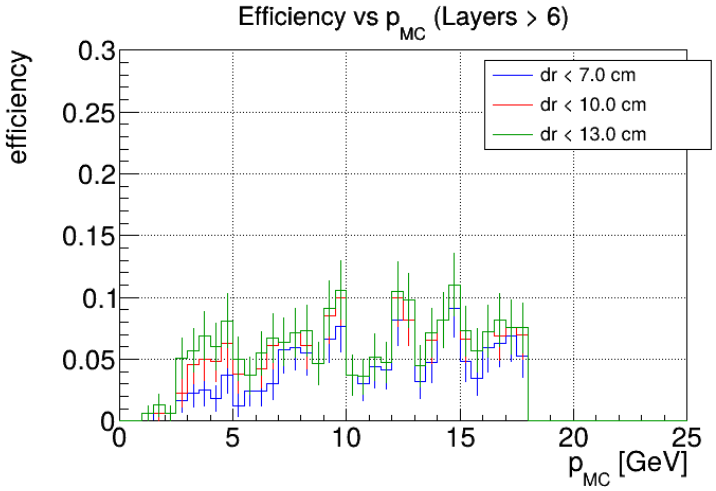


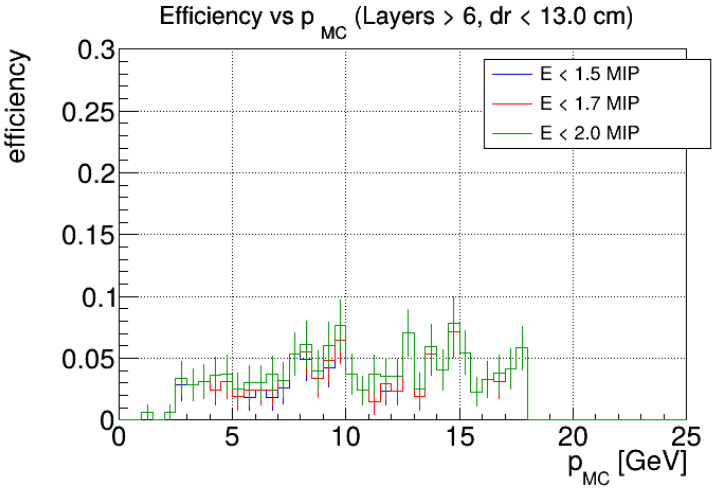


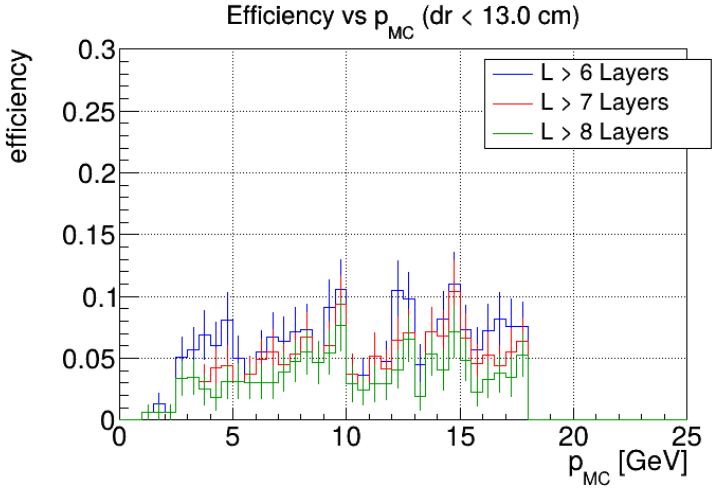
- Muon ID efficiency 90% – 95% depending on the cuts

Pion rejection









- 5% of pions pass the simple muon ID criteria
- May be indistinguishable from muons for a given thickness
- Expected fraction of pions not interacting hadronically:
- $e^{-2.5} = 0.082085$ nHCal
- $e^{-3.5} = 0.0301974$ nHCal+EEEMCal
- This means we may need a thicker detector to improve muon/pion ID

Summary

- All benchmarks implemented
- Provide automatic tests for each update of geometry
- Feel free to make additions

BACKUP