

Benchmarks and muon reconstruction

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THE OHIO STATE UNIVERSITY

1 Updates

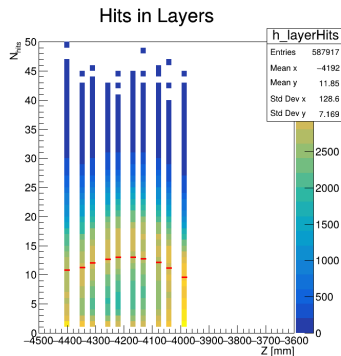
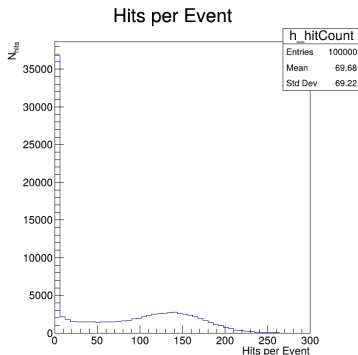
- The aim of the benchmarks is to provide automated tests for each update of geometry
 - Bachelor thesis at WUT by Michał Sieczczyński
- All benchmarks implemented here:
 - https://github.com/eic/detector_benchmarks/pull/168
- Include:
 - Acceptance check: `nhcal_acceptance`
 - https://github.com/eic/detector_benchmarks/tree/master/benchmarks/nhcal_acceptance
 - 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

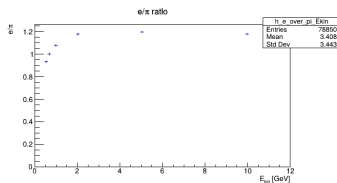
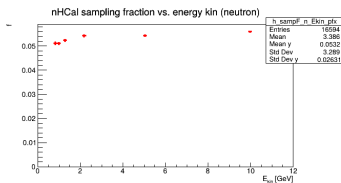
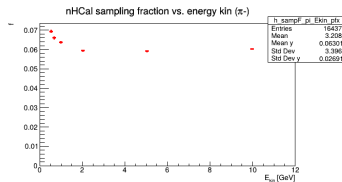
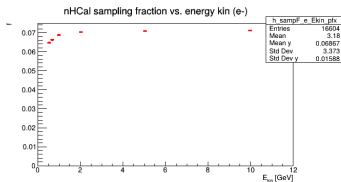
The screenshot displays the EIC web interface for viewing pipeline results. The browser address bar shows the URL: `eicweb.phy.anl.gov/EIC/benchmarks/detector_benchmarks/-/pipelines/145783/builds`. The left sidebar contains a navigation menu with options: Explore, Project, detector_benchmarks, Manage, Plan, Code, Build, Pipelines (selected), Jobs, Pipeline schedules, Artifacts, Deploy, Operate, Monitor, and Analyze. The main content area shows a list of pipeline builds for the project "EIC / benchmarks / detector_benchmarks / Pipelines / #145783". Each build entry includes a status (Passed), a timestamp (00:02:24, 00:02:46, 00:00:21, 00:01:14, 00:01:08), a duration (21 hours ago), a job name (e.g., #8078858: collect_results:nhcal_pion_rejection), a collector (collect), and a download icon. The job names are followed by a link to the job details (e.g., #8078858: collect_results:nhcal_pion_rejection).

Status	Timestamp	Duration	Job Name	Collector	Download
Passed	00:02:24	21 hours ago	#8078858: collect_results:nhcal_pion_rejection	collect	Download
Passed	00:02:46	21 hours ago	#8078856: collect_results:nhcal_dimuon_photoproduction	collect	Download
Passed	00:00:21	21 hours ago	#8078854: collect_results:nhcal_sampling_fraction	collect	Download
Passed	00:01:14	21 hours ago	#8078852: collect_results:nhcal_basic_distribution: [epic_full]	collect	Download
Passed	00:01:08	21 hours ago	#8078850: collect_results:nhcal_basic_distribution: [epic_backward_hcal...	collect	Download

- 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

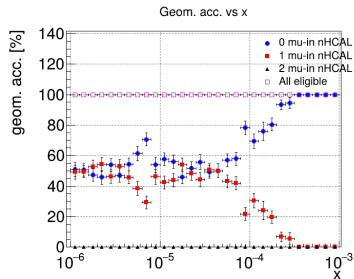
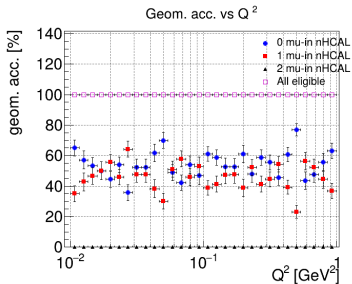


- Basic distributions for neutrons
- Hits per layer, energy, sum of energy etc.
- Helpful for verification of geometry or reconstruction
- Feel free to add new distributions!

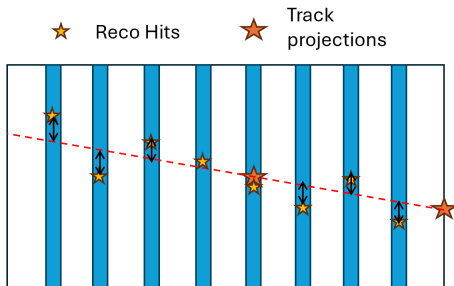


- Different results than mine may be due to:
 - larger thickness
 - binning
 - large solid angle range in simulation
- We use mostly the same code
 - I plan to check it on my simulation files to verify

Pythia8 simulated $\gamma\gamma \rightarrow \mu\mu$

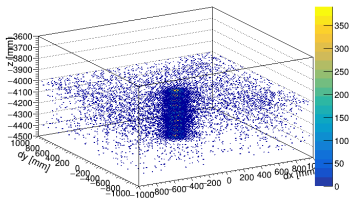


- Kinematic acceptance for dimuon photoproduction events
- Defined according to the acceptance requirements requested by ePIC
 - Pions energy: 1 GeV, 5 GeV, 10 GeV
 - Hit in any of the sensitive layers
 - nHCal only geometry

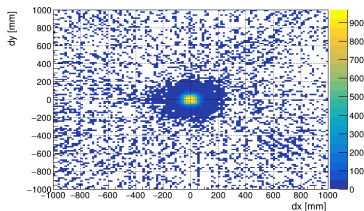


- Projected track across the layers assuming a straight line between the 2 projections (surface and $1\lambda_0$)
- Requiring both projections to 395 cm and 410 cm layers
- Connected the 2 projections with a straight (red dashed) line to calculate distance to reco hits
- Good enough approximation
- Accepting 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

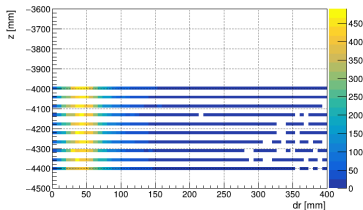
3D residuals (rec - proj): dx, dy vs z



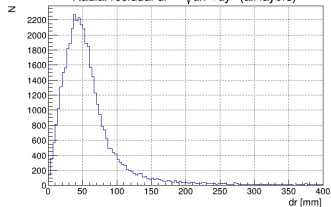
Residuals (rec - proj): dx vs dy (all layers)



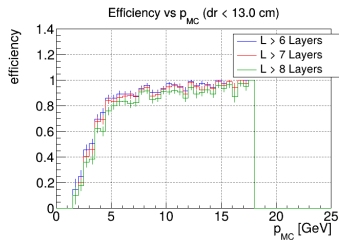
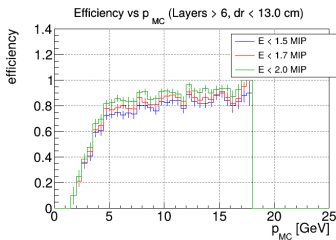
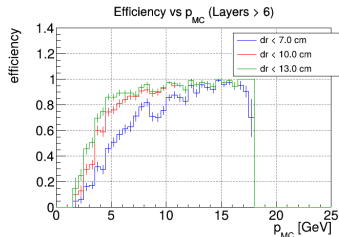
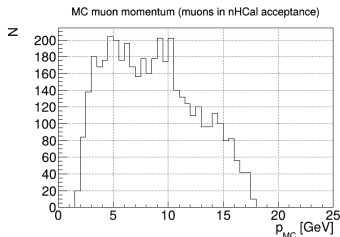
Radial residual (rec - proj) vs z



Radial residual $dr = \sqrt{dx^2 + dy^2}$ (all layers)

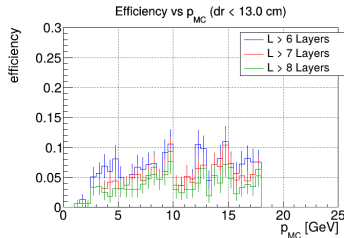
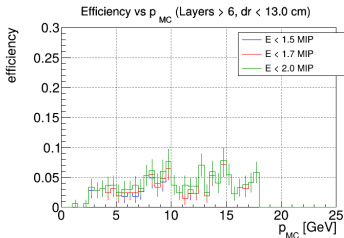
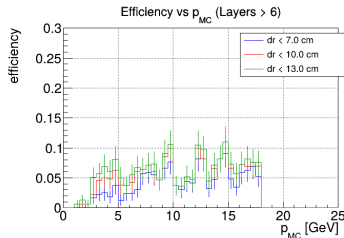
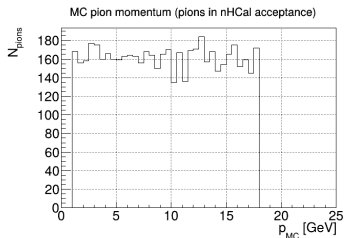


- 10 layers of 4 cm steel and 4 mm scintillator
- 10 cm × 10 cm tiles
- Muons leave a narrow ionization trail in the detector



- 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

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

BACKUP