ZDC SiPM-on-tile update

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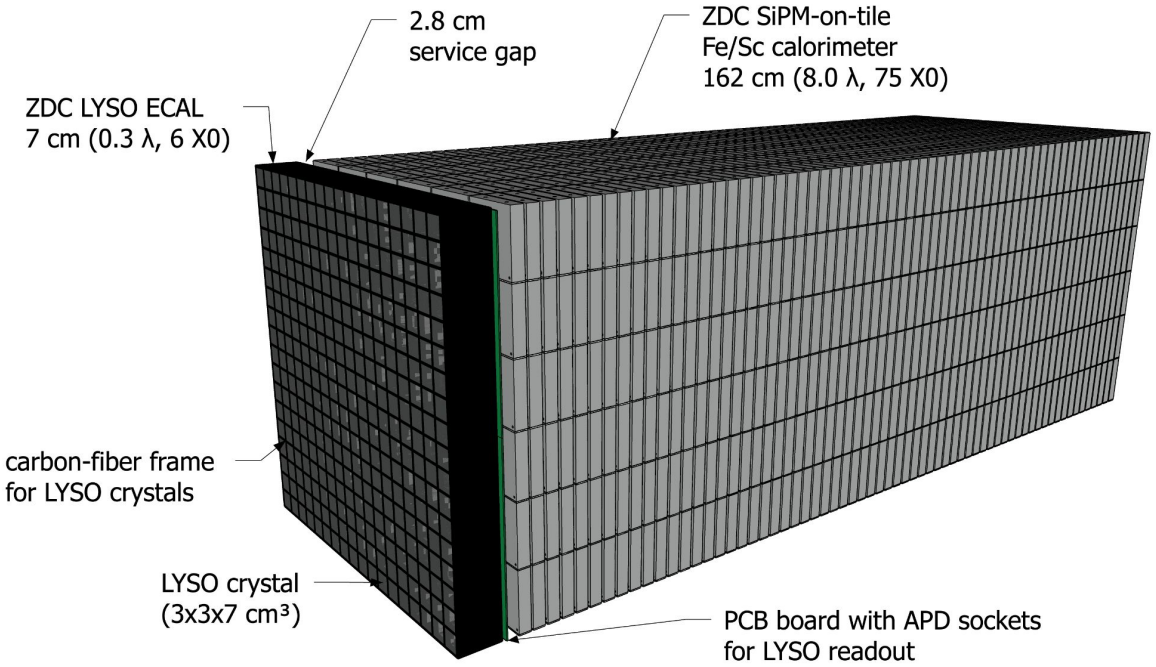
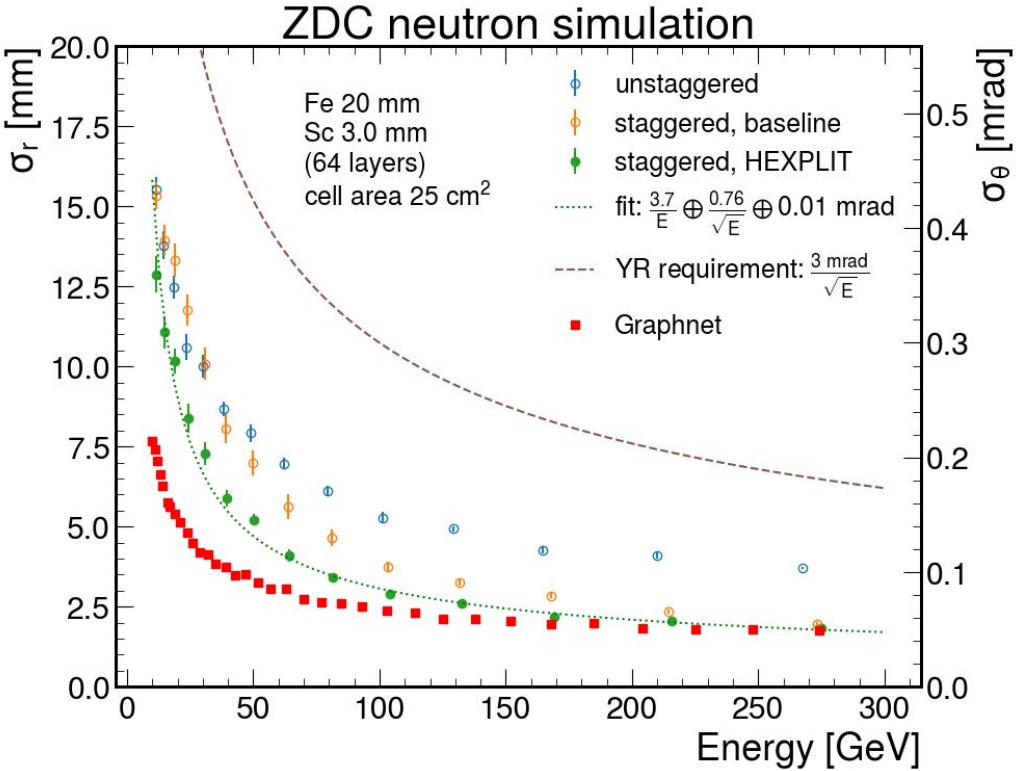


ePIC TIC meeting Nov 20th 2023

Update on neutron position resolution (Fe/Sc only)

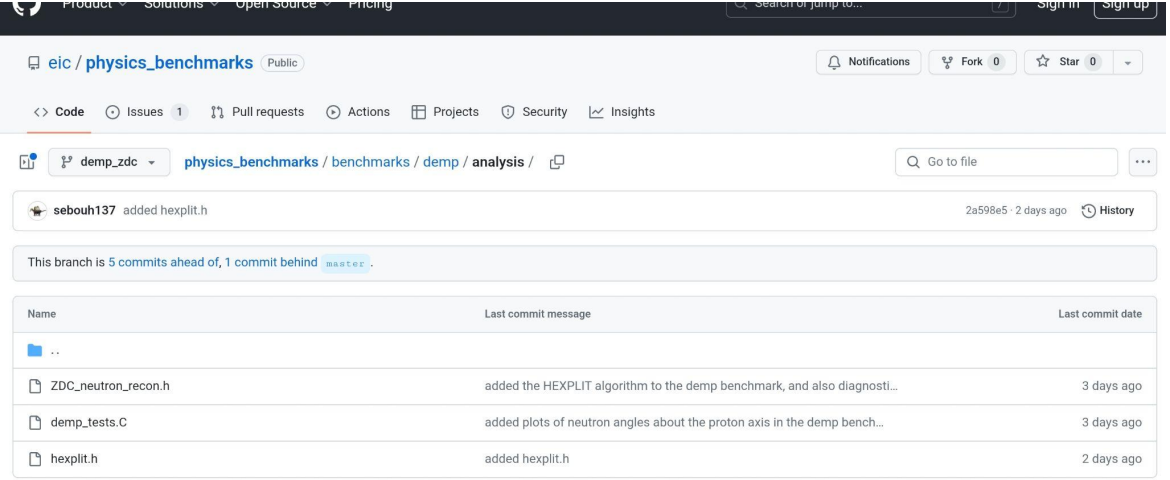


Credit: Bishnu Karki & Ryan Milton & Sebouh Paul

Last time we presented GraphNet results for energy. Now extended to angles.

GraphNet significantly improves angular resolution at low energy, but is similar to HEXPLIT algorithm at highest energies.

ZDC Physics Benchmark in ePIC software



Credit: Barak Schmookler & Sebouh Paul

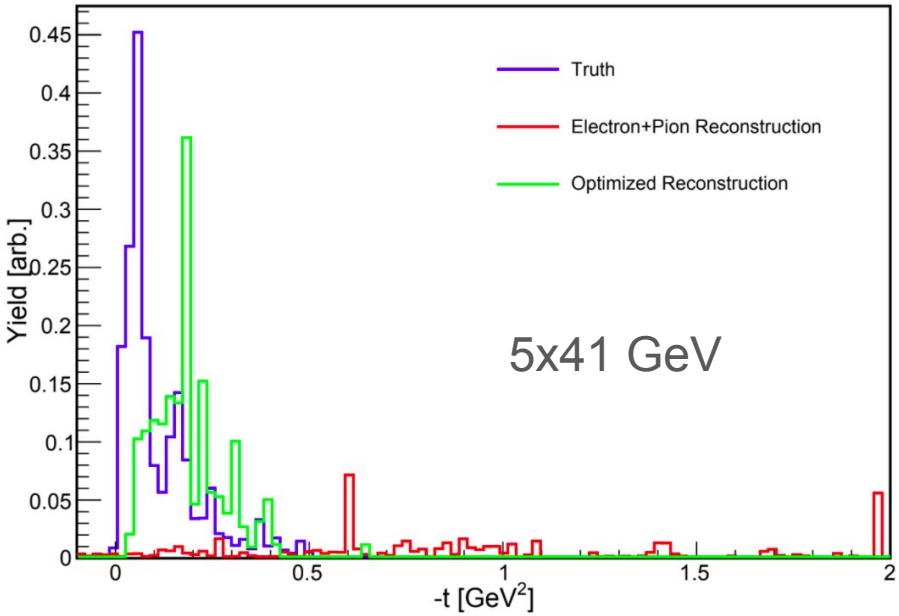
News:

- New benchmark with Deeply Exclusive Meson Production (DEMP) events from ePIC official production in S3

- Neutron reconstruction is fully implemented, including with C++ implementation of the HEXPLIT algorithm.

Benchmarking *t* distribution measurement for DEMP

https://github.com/eic/physics_benchmarks/tree/demp_zdc



Credit: Barak Schmookler & Sebouh Paul

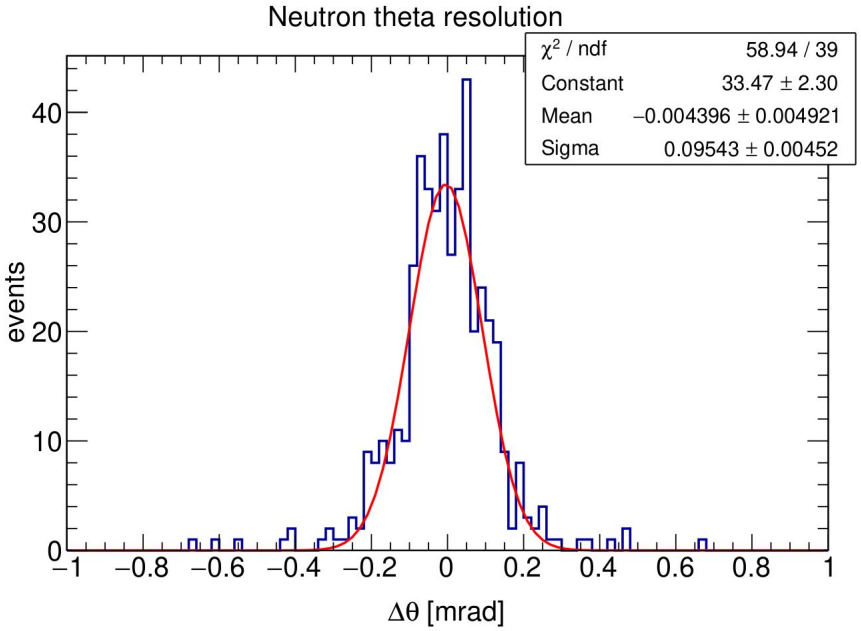
Full event reconstruction of e- pi+ n final state measured with ePIC detector and proposed SiPM-on-tile ZDC

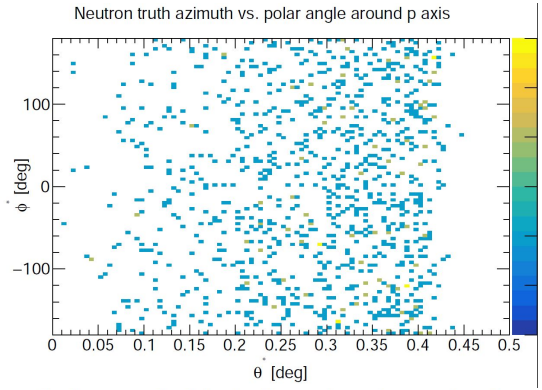
First pass at reconstruction of ***t*** distribution using “optimal” technique that combines neutron angle with tracks from e- and pi+ to extract ***t***, as suggested in ECCE studies.

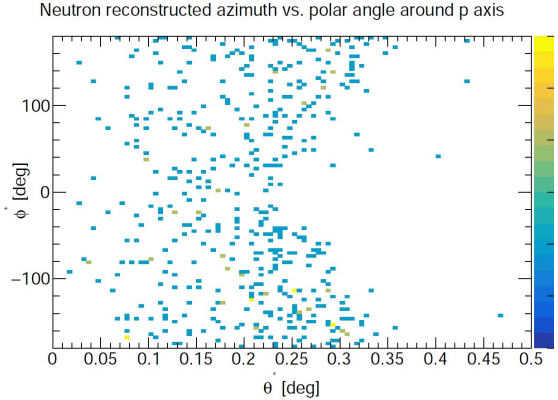
More plots from DEMP benchmark

https://github.com/eic/physics_benchmarks/tree/demp_zdc

Neutron Acceptance 5x41 GeV

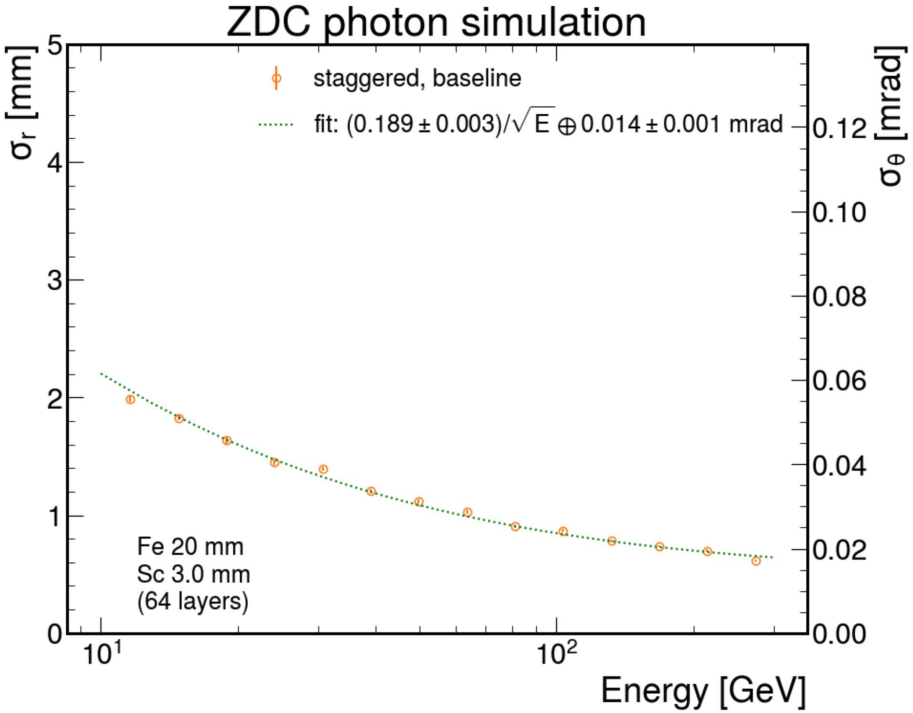


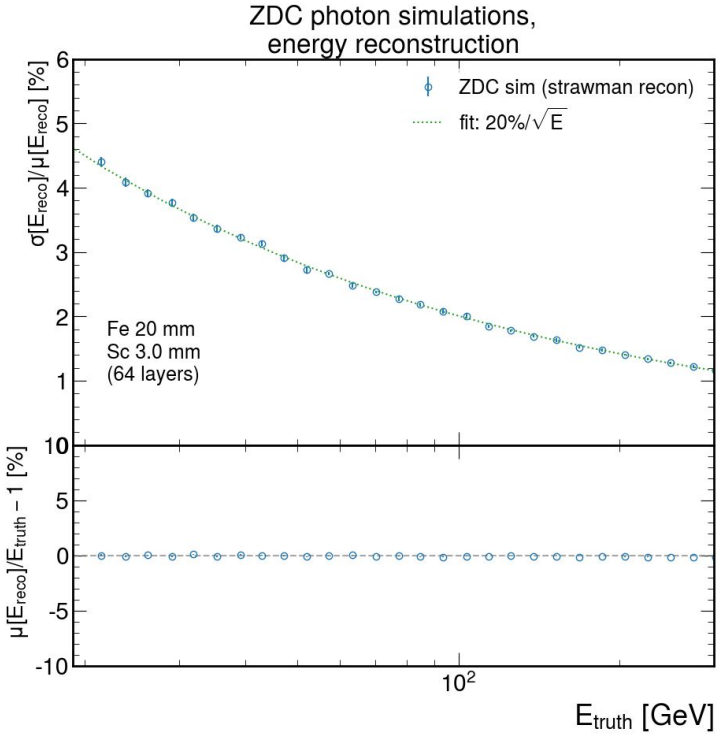




Credit: Barak Schmookler & Sebouh Paul

Fe/Sc SiPM-on-tile photon performance



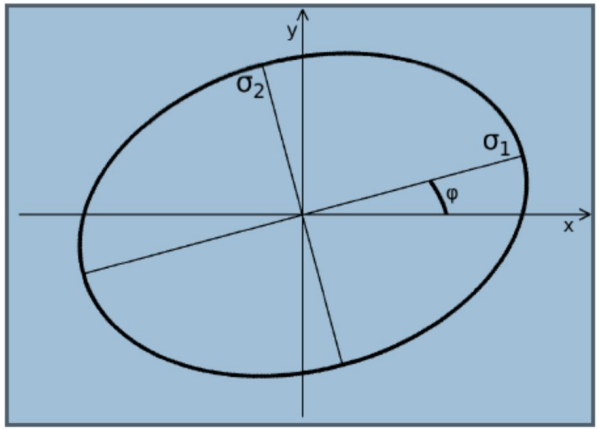


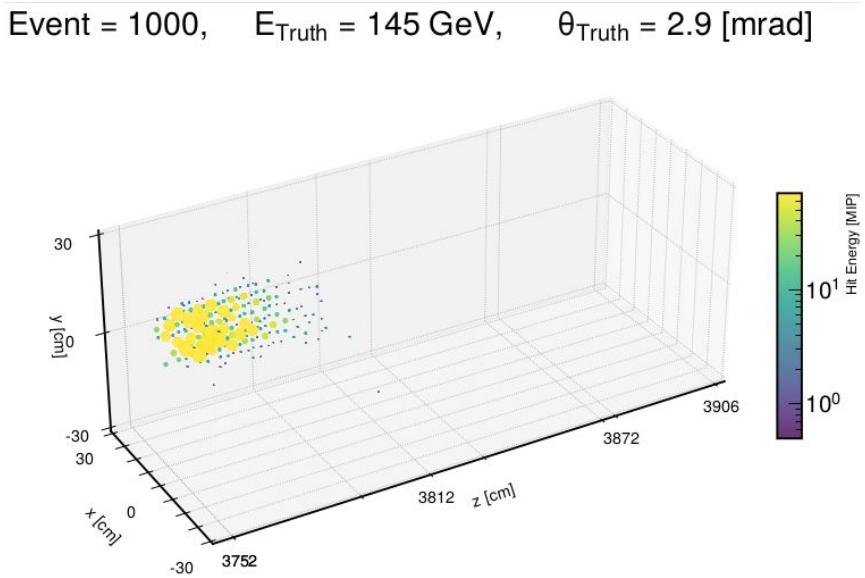
Credit: Sebouh Paul

Fe/Sc SiPM is adequate for high-energy photons

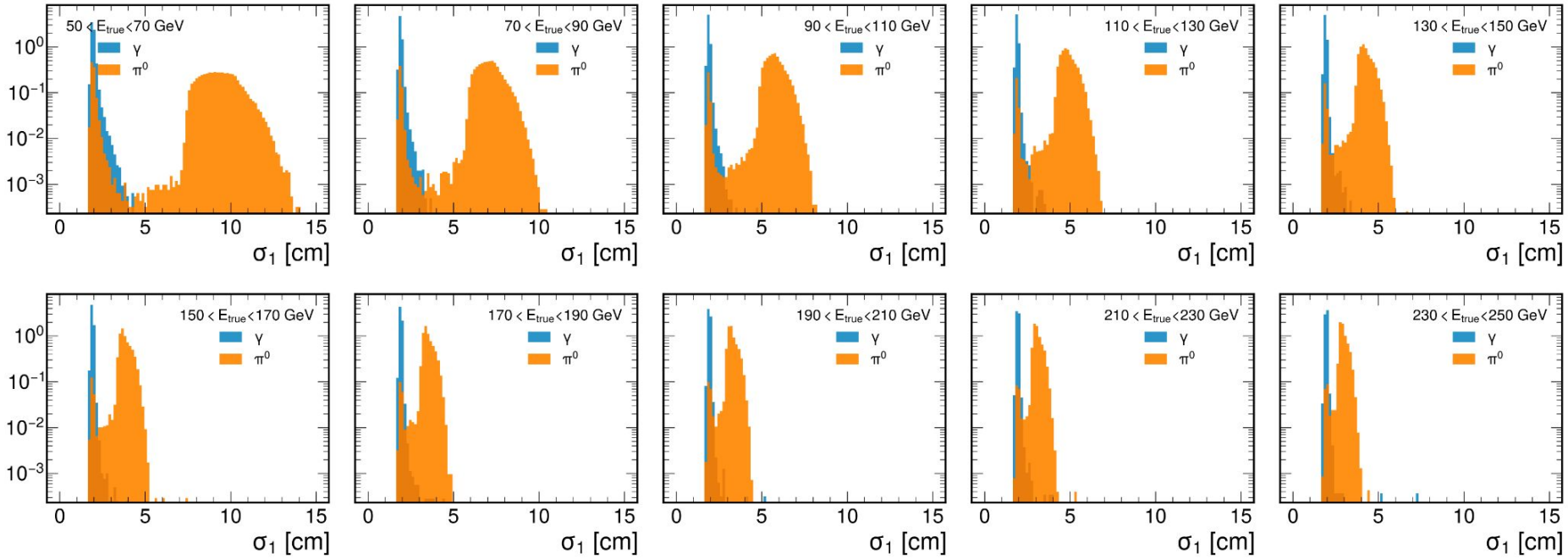
Fe/Sc π0 rejection

- π0 in u-backward channel lead to two backgrounds:
  reducible: 2 ɣ hit ZDC. “irreducible”: 1 ɣ hit ZDC. See Zach’s paper for details
- We started estimating rejection power based on simple shower shape analysis, and are carrying out GNN-based classification studies.





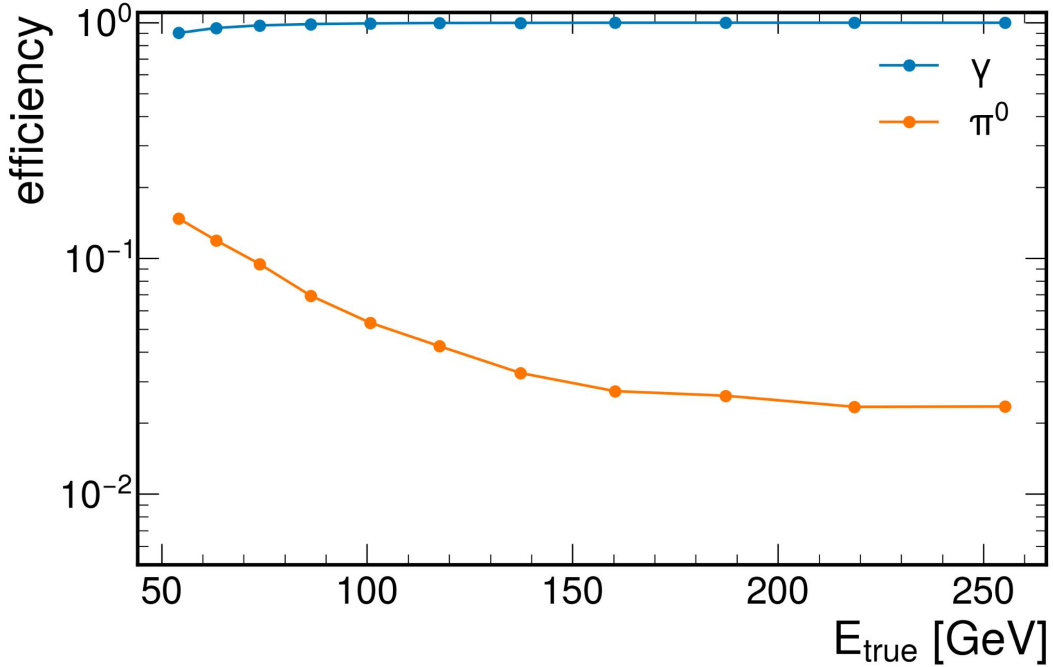
Preliminary performance plots for γ/π0 identification



Single photon peak well separated from diphoton distribution.

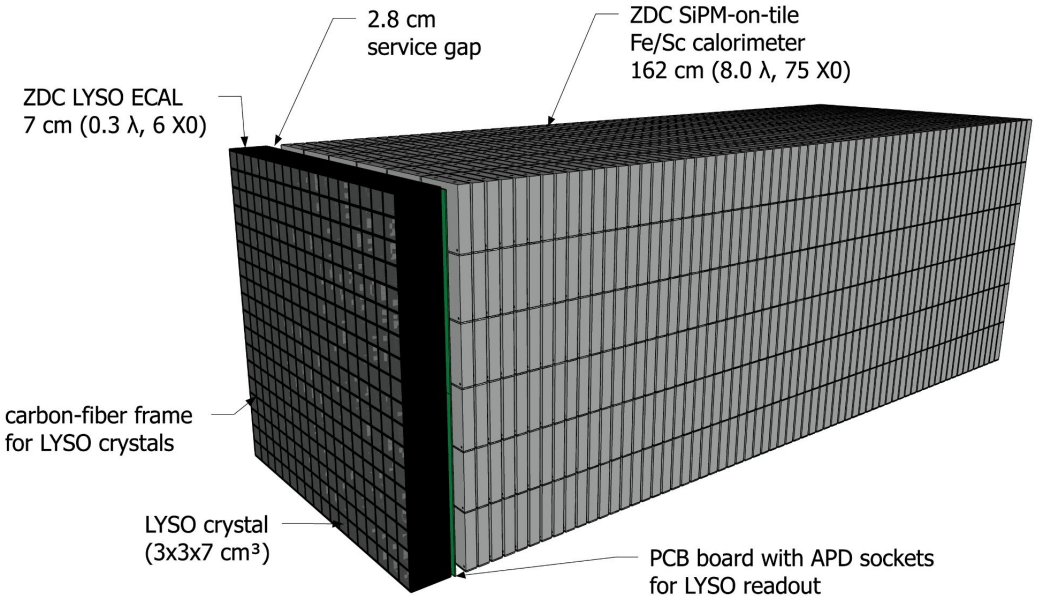
The single photon peak in pi0 (other photon missing ZDC acceptance) is “irreducible” with shower shape only

Preliminary performance plots for γ/π0 identification



Only a few percent of the π0s are misidentified as photons at high energy. Some of these could be events where one of the two photons from the π0 decay misses the ZDC

We propose to combine LYSO crystal ECAL (from last ZDC TIC) and SiPM-on-tile Fe/Sc model

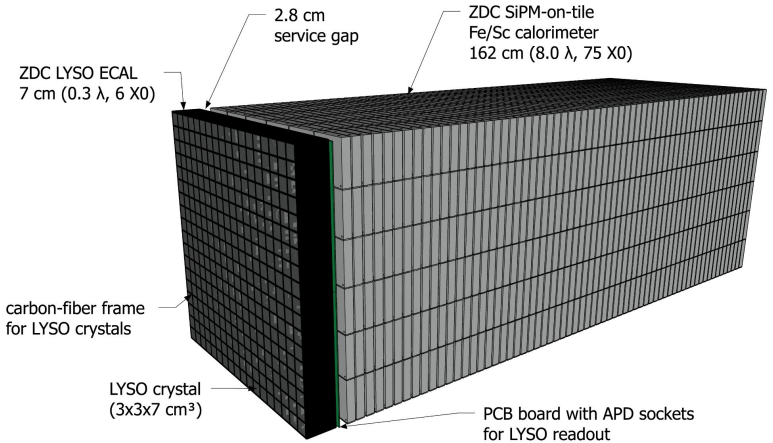


We think this can meet all physics requirements while maximizing synergies with other ePIC subsystems, reducing cost and risks.

Low-energy $\gamma \rightarrow$ LYSO
High-energy γ and $\pi 0 \rightarrow$ Fe/Sc
High-energy neutrons $\rightarrow$ Fe/Sc

LYSO + SiPM-on-tile ZDC option already in ePIC git

Thanks Michael Murray and Michael Pitt for sharing LYSO model



Credit: Barak Schmookler & Sebouh Paul

eic / epic Public

Code | Issues 64 | Pull requests 23 | Actions | Projects | Security | Insights

Files

ZDC_LYSO

Go to file

- .devcontainer
- .github
- _layouts
- bin
- calibrations
- compact
  - ecal
  - far_backward

epic / compact / far_forward.xml

bschmookler Updated configuration to use SiPM-on-tile ZDC

Code | Blame | 19 lines (16 loc) · 731 Bytes

```
1  <!-- SPDX-License-Identifier: LGPL-3.0-or-later -->
2  <!-- Copyright (C) 2022 Wouter Deconinck, Sakib Rahman -->
3
4  <lccdd>
5
6    <include ref="far_forward/ion_beamline.xml" />
7    <!--  <include ref="far_forward/beampipe_hadron_B0.xml" /> -->
8    <include ref="far_forward/electron_beamline.xml" />
9    <include ref="far_forward/B0_tracker.xml"/>
10   <include ref="far_forward/B0_ECal.xml"/>
11   <include ref="far_forward/offM_tracker.xml"/>
12   <!--  <include ref="far_forward/ZDC.xml"/> -->
13   <include ref="far_forward/ZDC_SiPMonTile.xml"/>
14   <include ref="far_forward/ZDC_Crystal_LYSO.xml"/>
15   <include ref="far_forward/roman_pots_eRD24_design.xml"/>
16   <include ref="far_forward/vacuum.xml"/>
17   <include ref="far_forward/magnets.xml"/>
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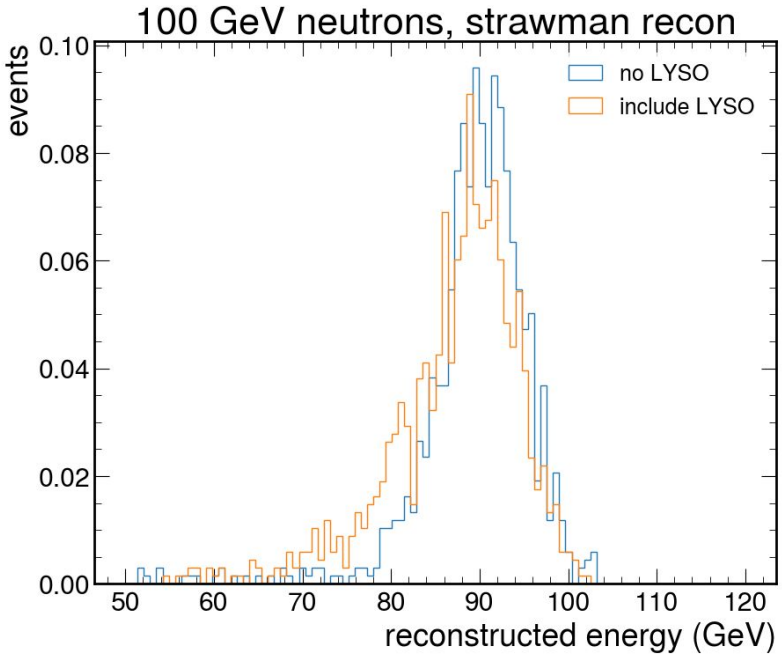
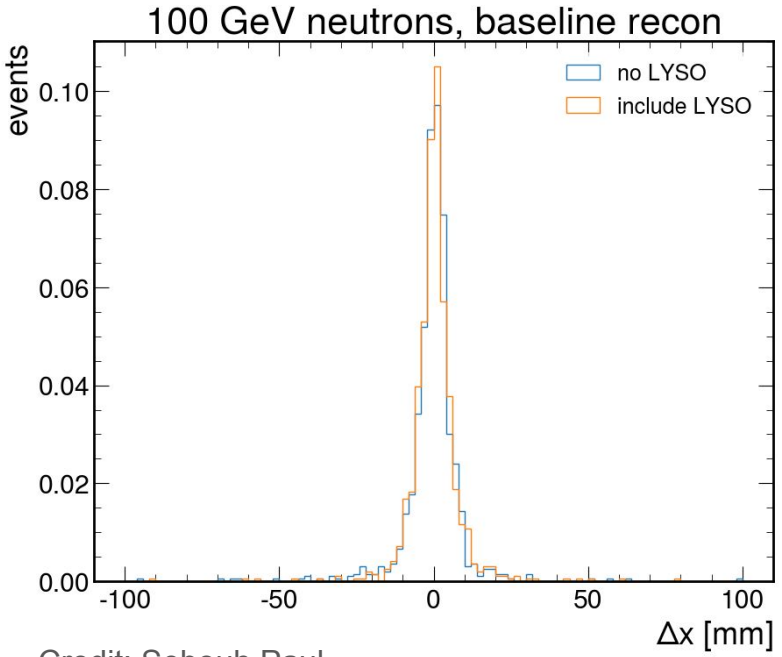
Neutron angular resolution with LYSO + SIPM-on-tile Fe/Sc





Credit: Sebouh Paul

While some good fraction of neutrons interact in LYSO (0.3 lambda),
it is very close to Fe/Sc so position resolution not affected. Energy resolution affected but can be improved combining LYSO and Fe/Sc

Conclusions

We've advanced on a ePIC benchmarks for ZDC, including neutron reconstruction algorithms.

We have quantified EM performance for Fe/Sc SiPM-on-tile. This is adequate for high-energy photons expected at ZDC.
We have started to quantify pi0 rejection with simple shower shape, achieving already a few percent contamination at high energy.

We proposed LYSO + Fe/Sc calorimeter as a combined system that meets all requirements.
We quantified impact of LYSO material on neutron performance, finding only minor degradation.
Combined EM performance ongoing.