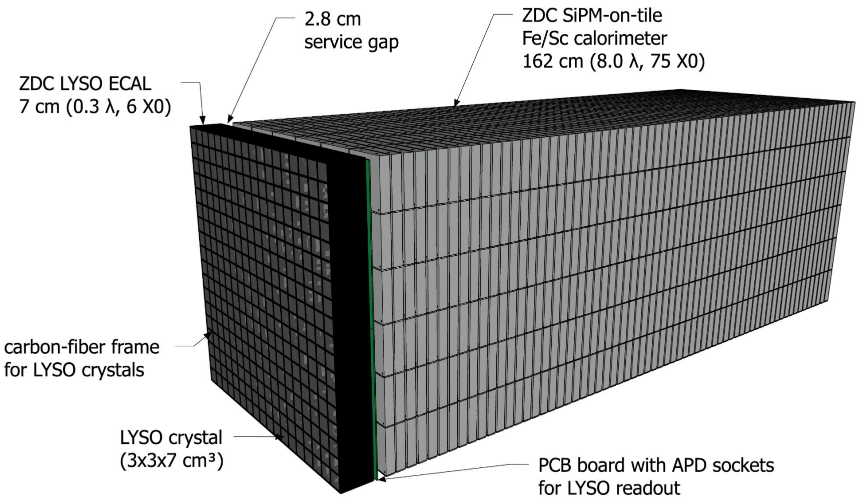
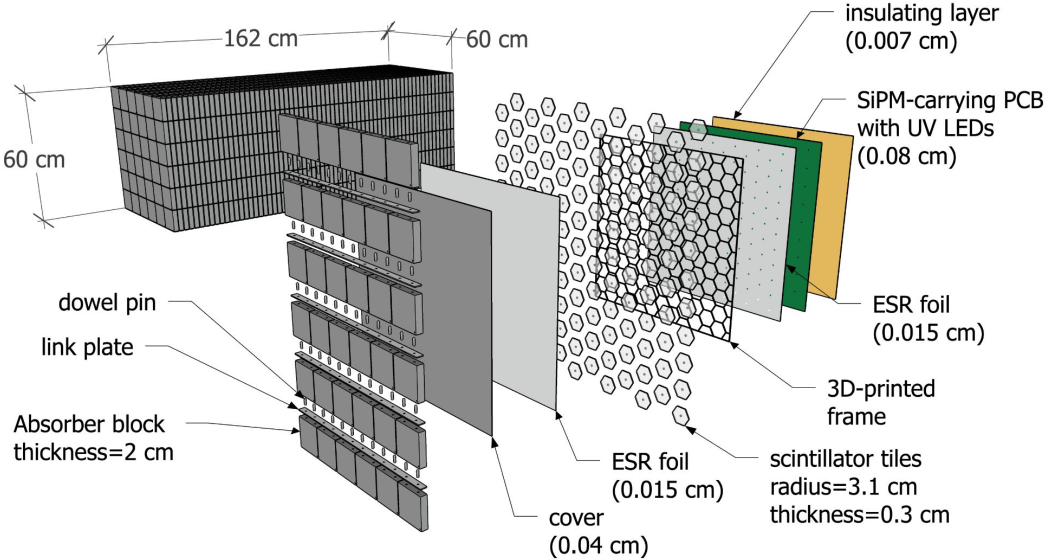


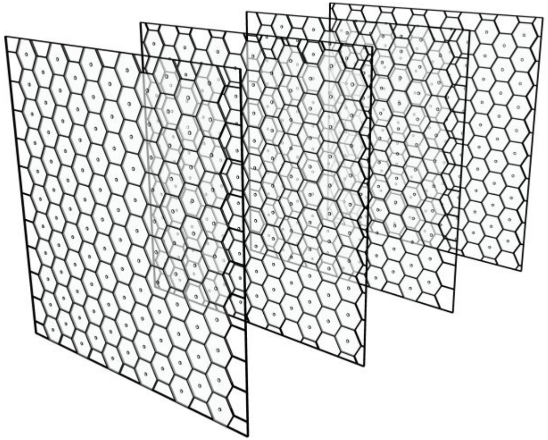
Update on SiPM-on-tile ZDC Towards TDR

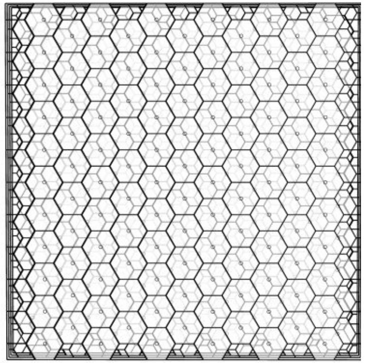
Miguel Arratia, UC Riverside
TIC meeting 29th April 2024

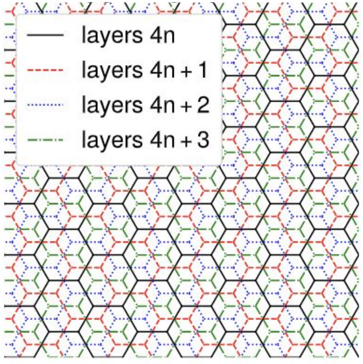
ZDC

SiPM-on-tile ZDC



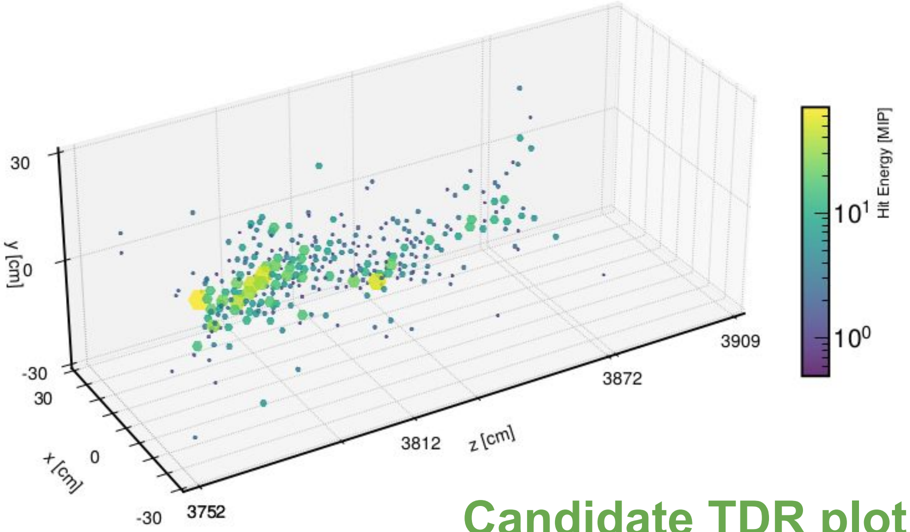




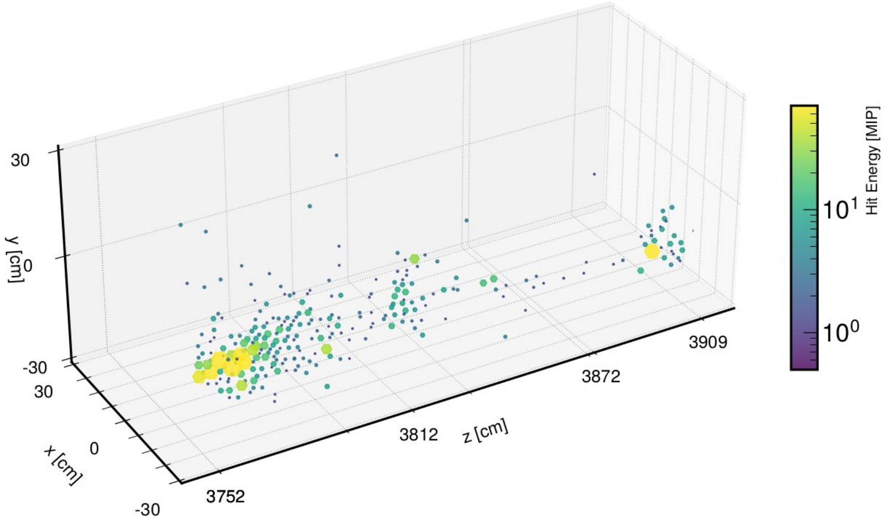


Staggered design described in
"Leveraging staggered tessellation for enhanced spatial resolution in high-granularity calorimeters" NIMA 1060 (2024) 169044

Shower Examples
100 GeV neutrons

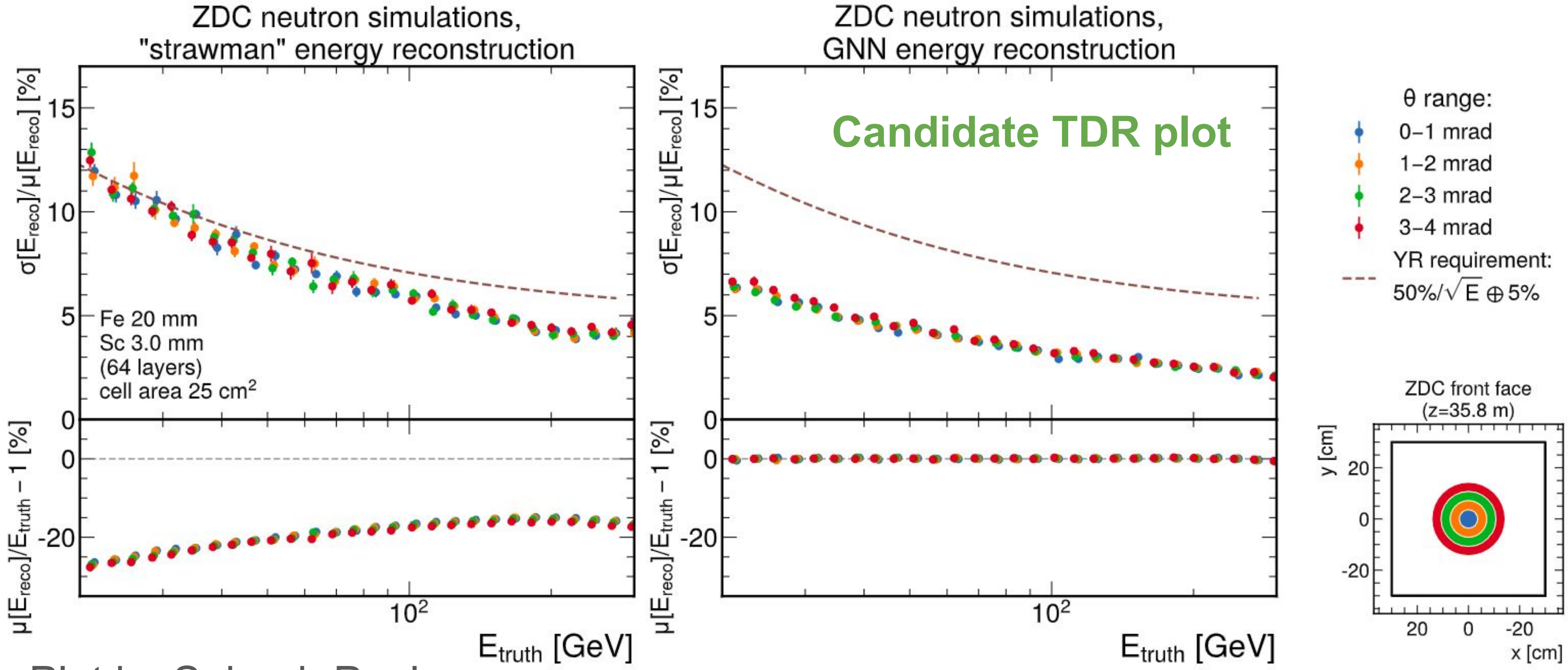


Candidate TDR plot



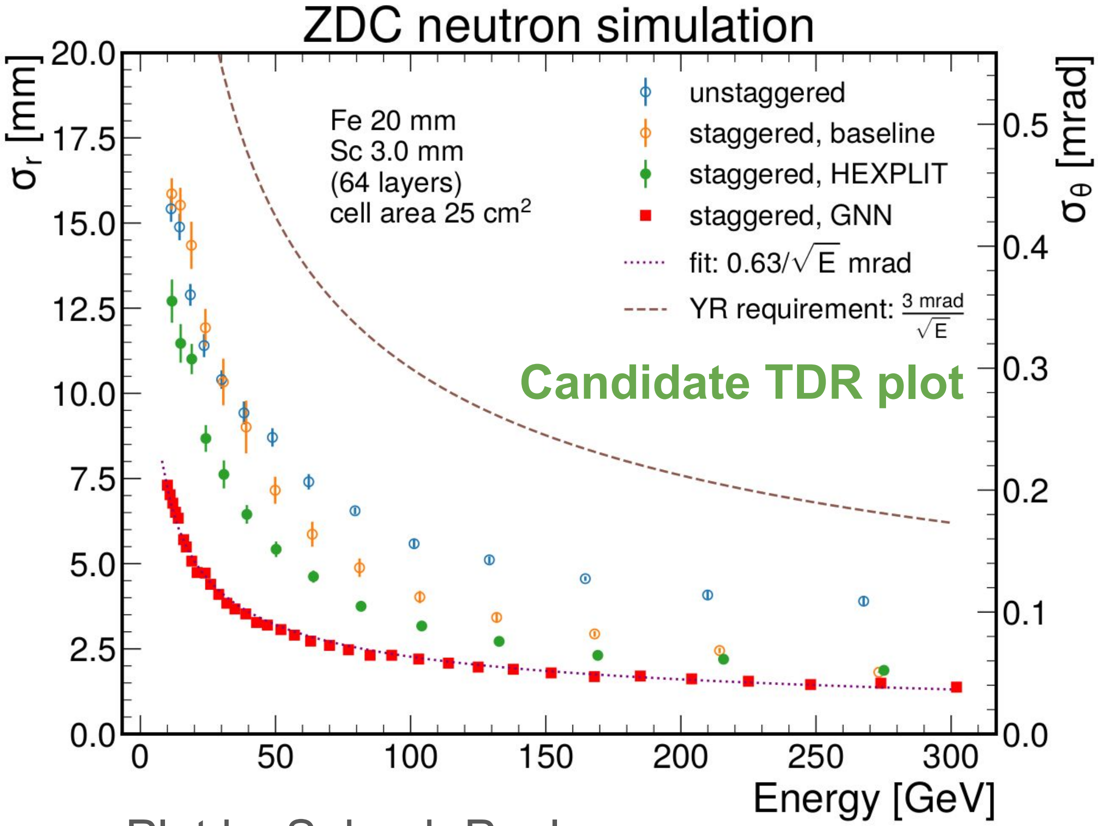
Energy Resolution

- Software compensation needed for the Fe/Sc design established by GNNs, which is the state-of-the-art. Detailed in https://arxiv.org/abs/2310.04442 (to appear in JINST). Note that CALICE catched up: https://arxiv.org/abs/2403.04632



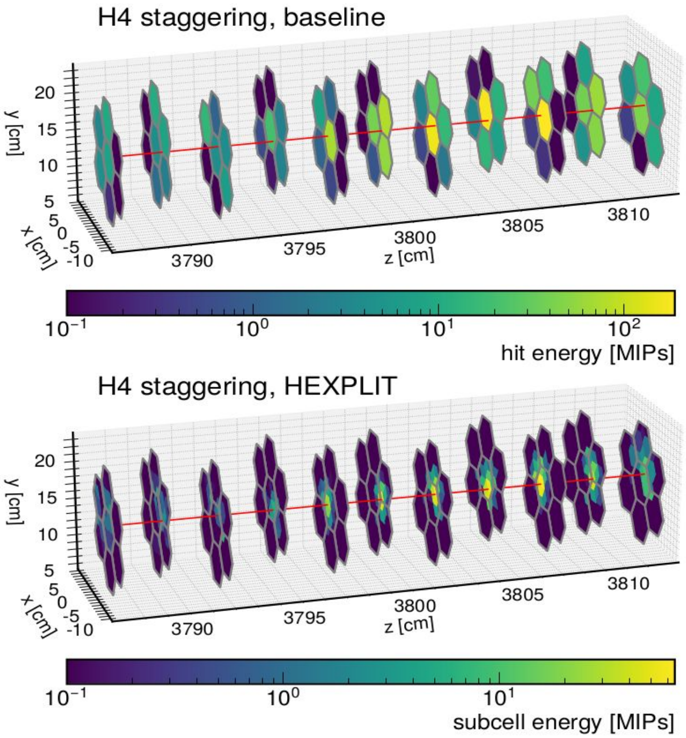
Plot by Sebouh Paul

Position Resolution

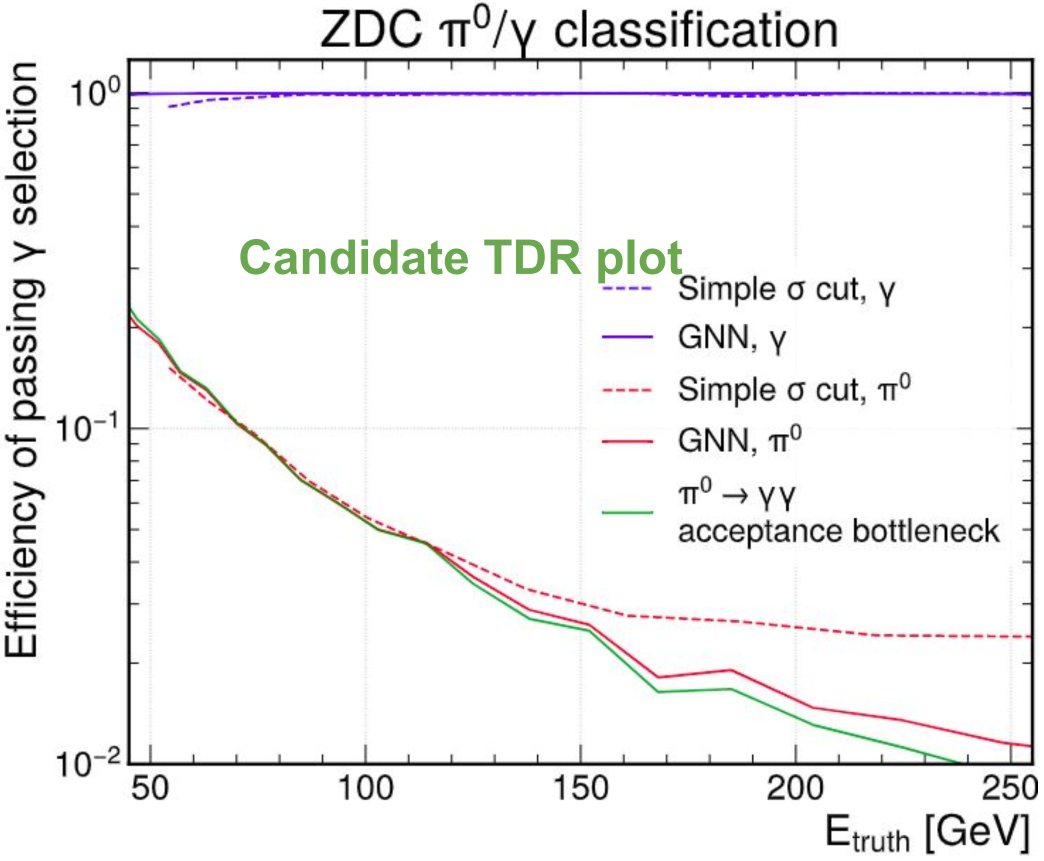


Plot by Sebouh Paul

HEXPLIT design and algorithm described in *"Leveraging staggered tessellation for enhanced spatial resolution in high-granularity calorimeters"* NIMA 1060 (2024) 169044



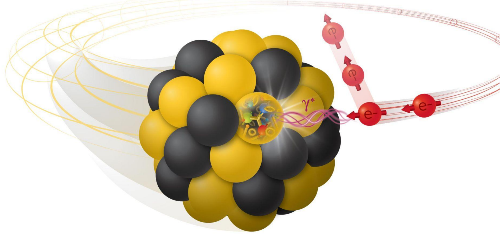
Gamma-pi0 separation

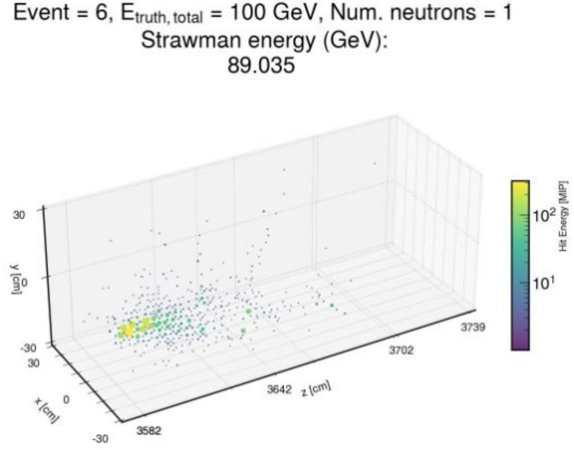


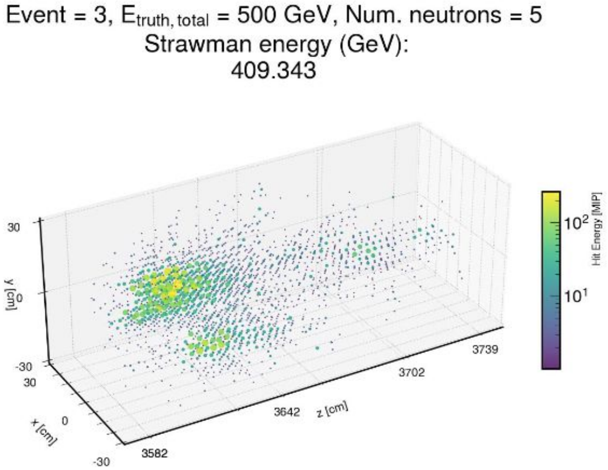
Plot by Ryan Milton

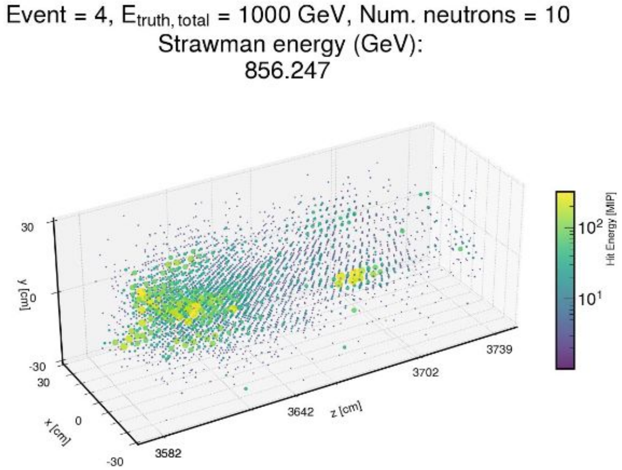
Multi Neutron Response

In eA collisions, spectator neutrons are monoenergetic with beam energy, i.e. 100 GeV each









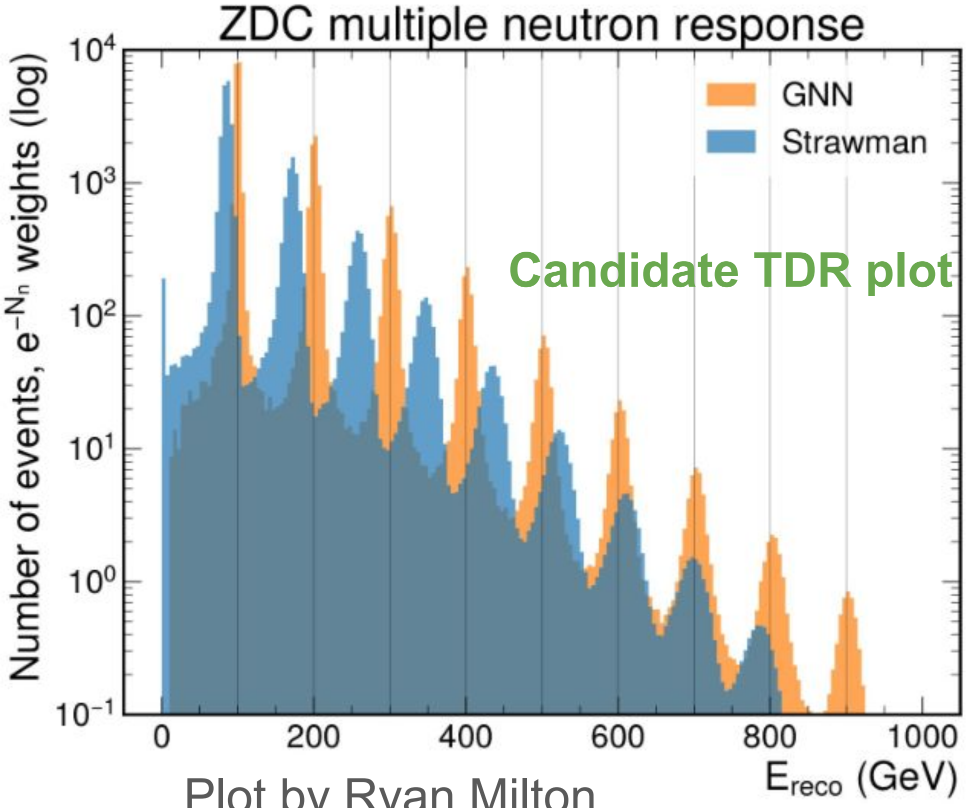
Example even showers with multiple 100 GeV neutrons

eA response

GNN reconstruction able to apply software compensation when showers overlap

Fixes scale, improves resolution.

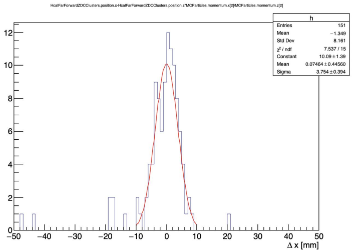
Plot emphasizes linearity, dynamic range



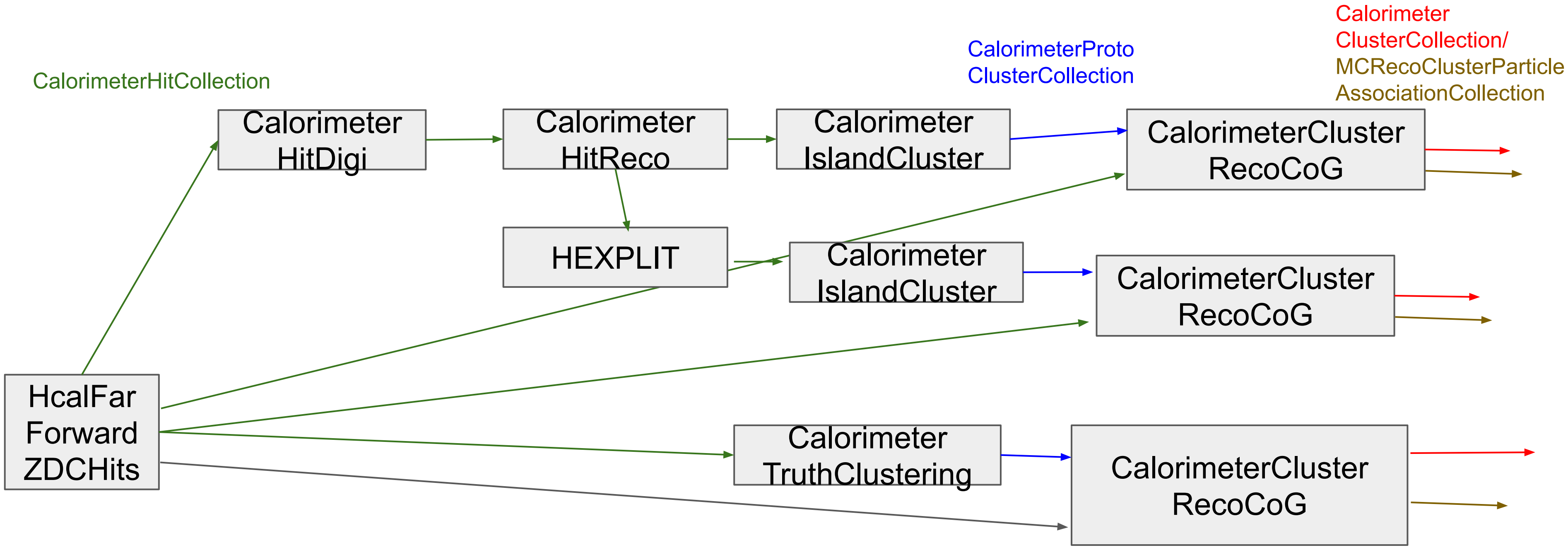
Candidate TDR plot

Plot by Ryan Milton

Algorithms/factories included in ZDC pipelines

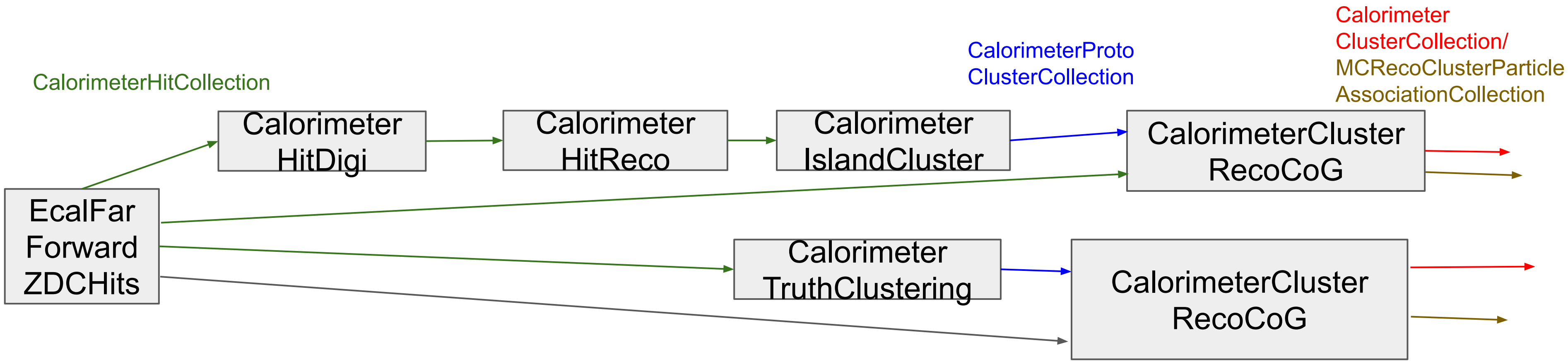


ZDC SiPM-on-tile:

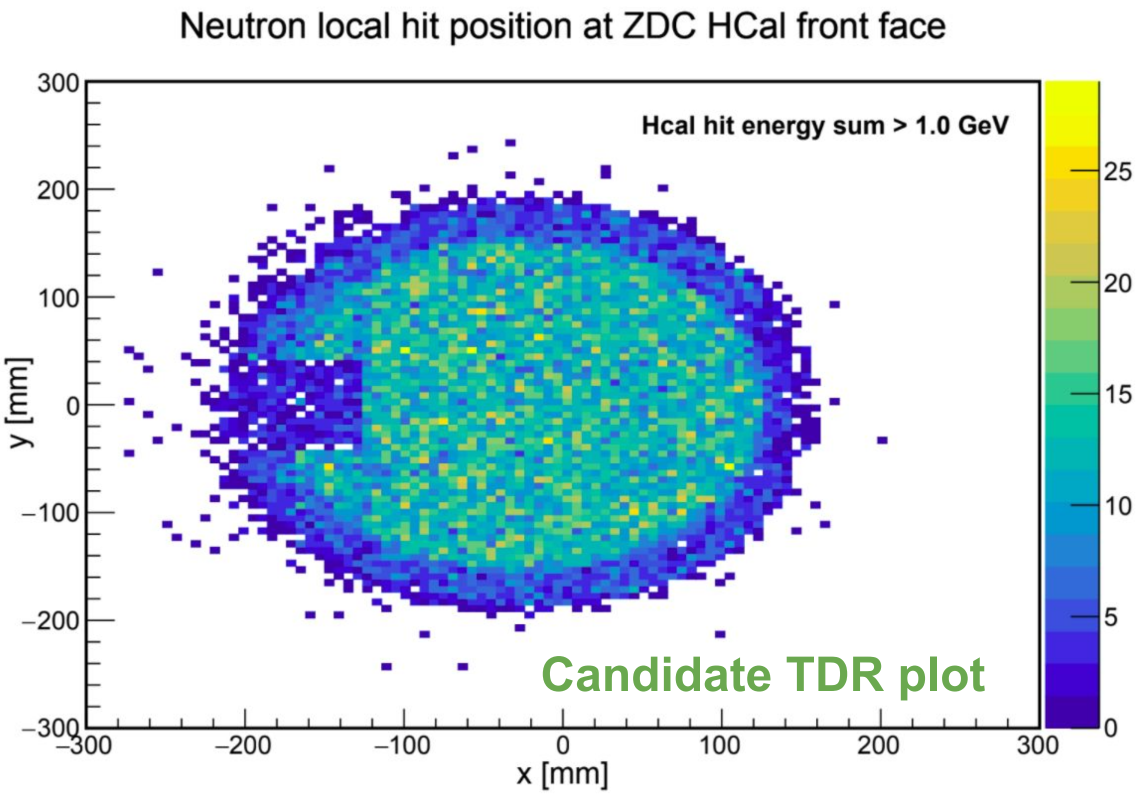


Algorithms/factories included in ZDC pipelines

ZDC LYSO:

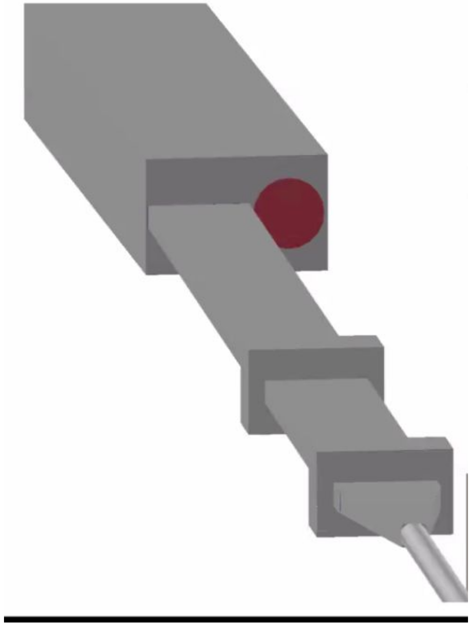


Acceptance studies



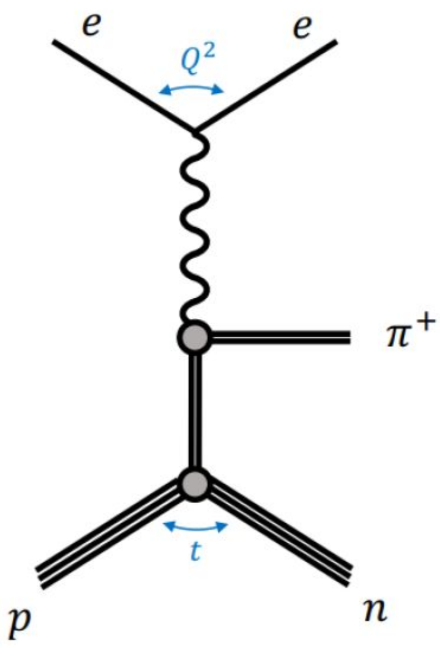
Plot Barak Schmookler

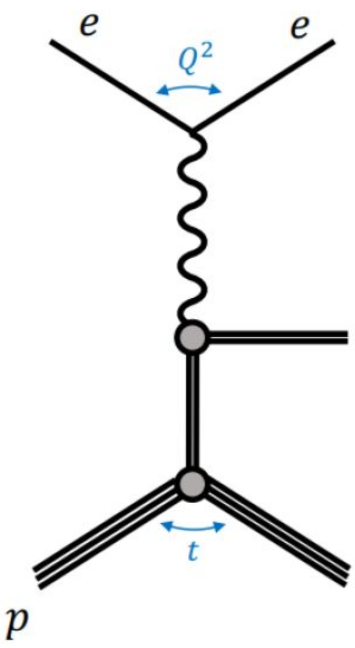
Including latest version of beam line from Alex.



ZDC Physics Benchmark

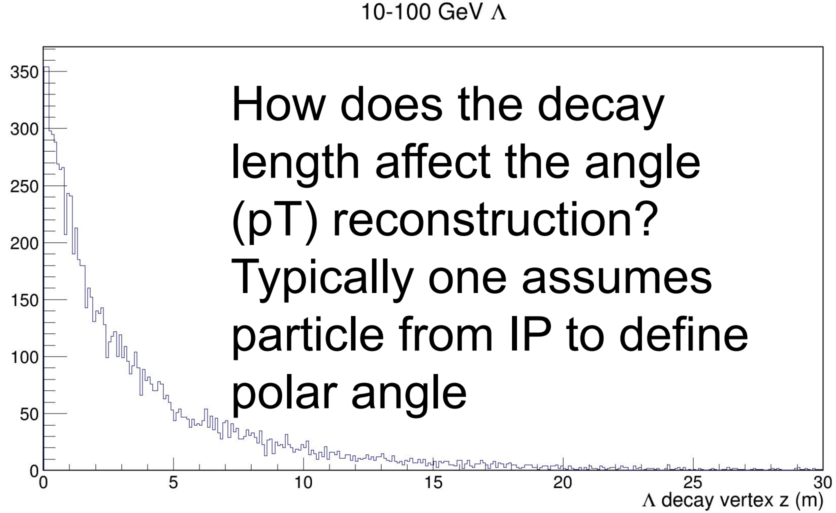
https://github.com/eic/physics_benchmarks/tree/demp_zdc/benchmarks/demp/





K+

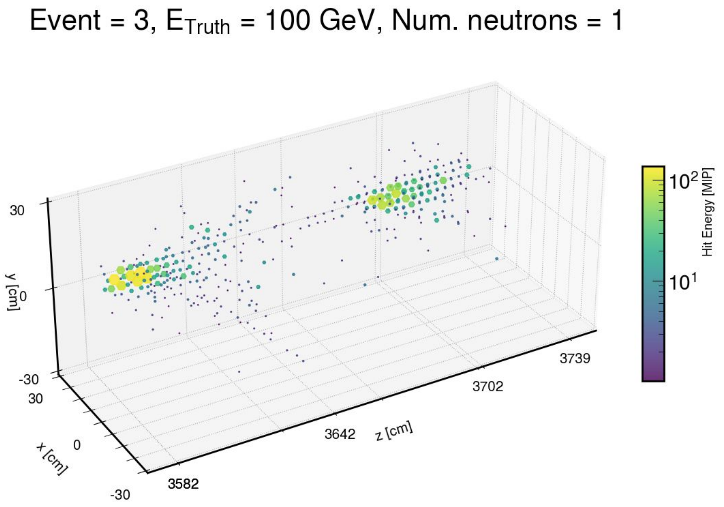
Lambda - > n pi0



How does the decay length affect the angle (pT) reconstruction? Typically one assumes particle from IP to define polar angle

Work in progress:
- Lambda reconstruction
- Tweaks to 3D topological clustering algorithm
- GNN model to be run within EICRECON using ONXX

Comment on Clustering



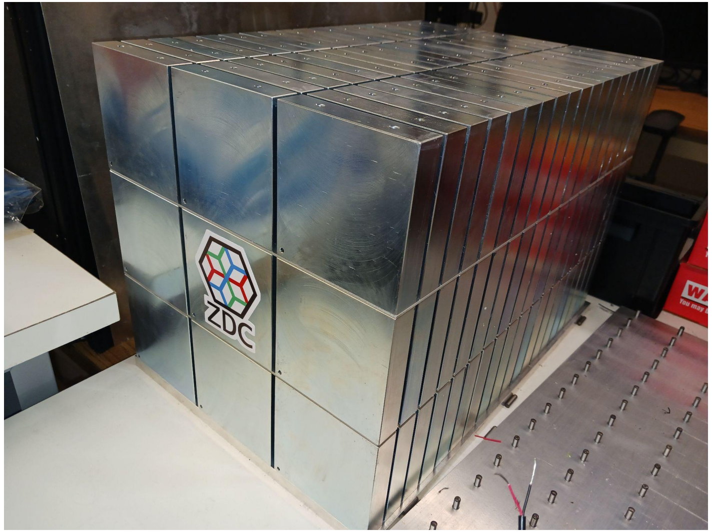
Given high granularity of ZDC, any decent clustering, like the 3D Topological Clustering, will yield more than one cluster per neutron in cases like these.
Same is true for granularity of LFHCAL, and H1 and ATLAS (similar longitudinal granularity)

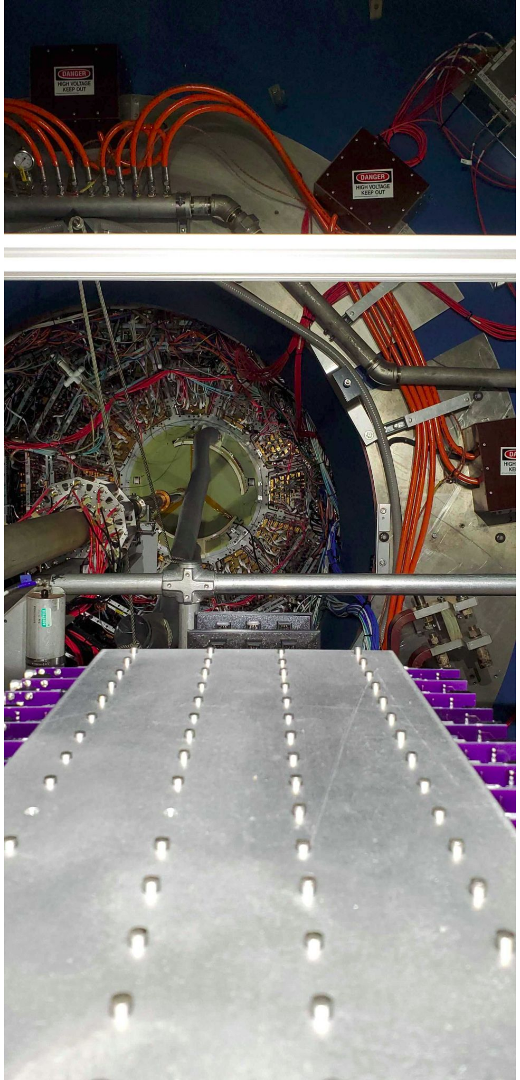
“Clusters” needed for calibration and noise suppression but cannot be our “final” object for neutron analysis.

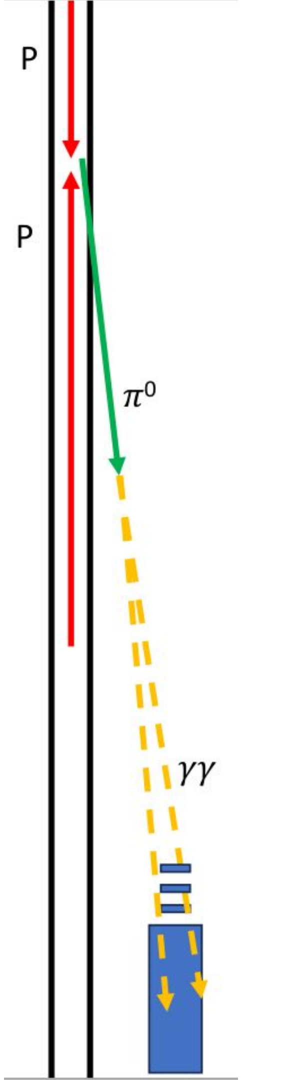
We are working on a “ReconstructedNeutron” object class for ZDC which will take TopoClusters and merge them to get reconstructed 4-vector for “physics analysis”

Testing

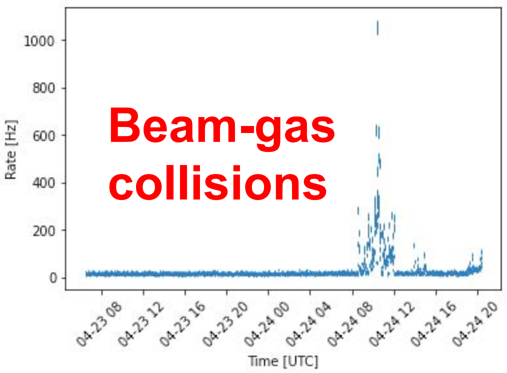
- **UC Davis Test May 14-15th**
  Radiation Damage SIPMs, S/N quantified
- **Ongoing Insert/ZDC prototype at RHIC**
  In-situ calibration, operation, rad damage
- **Generation-3 prototype test, Fall 24 @ JLab**
  Scale up, uniformity, test of HEXPLIT design

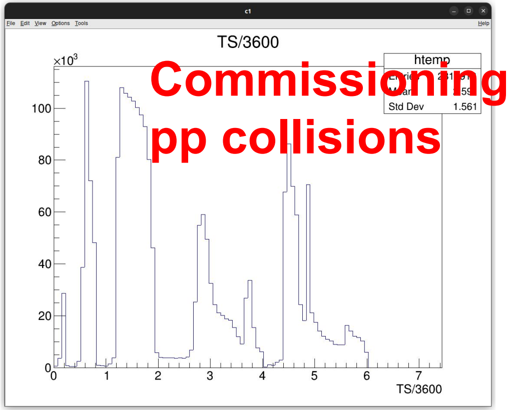


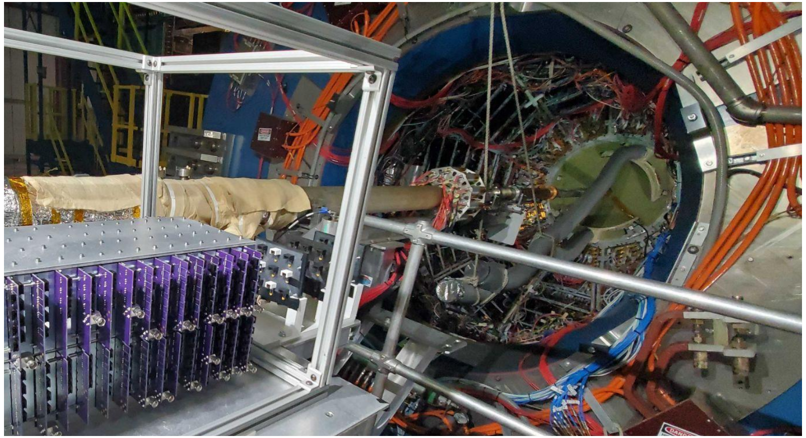


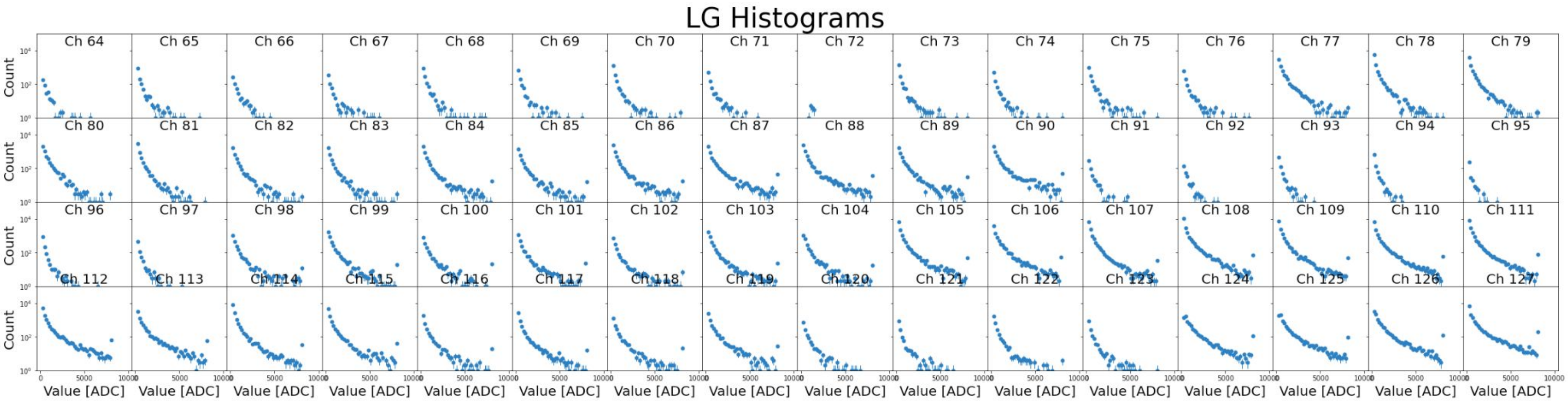


First SiPM-on-tile Calorimeter operating in a Collider ever!

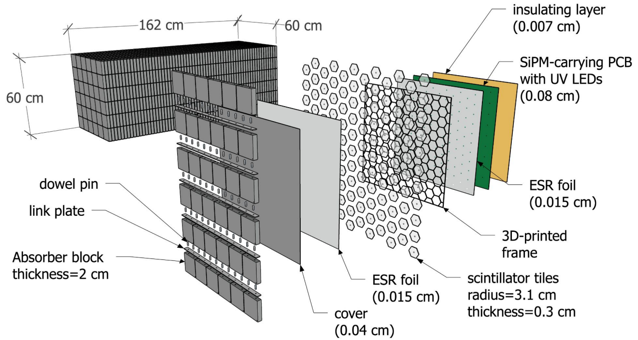


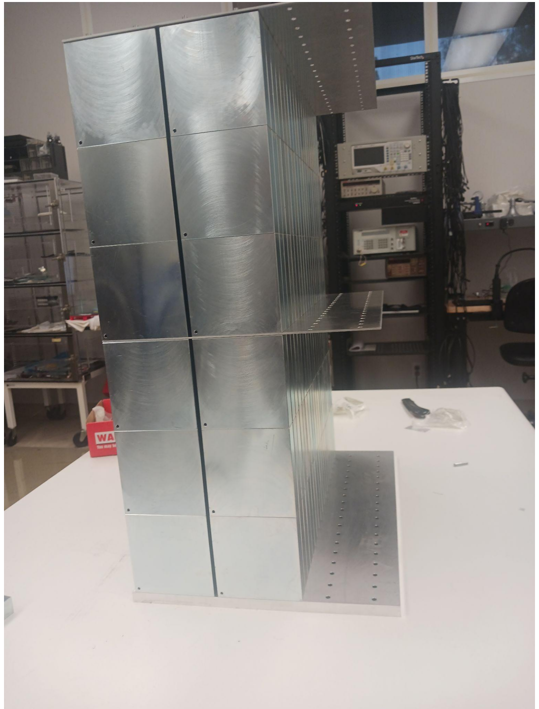


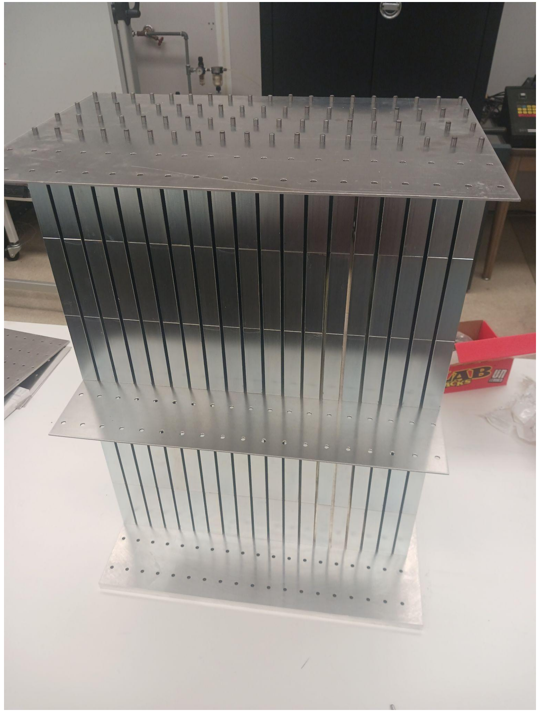


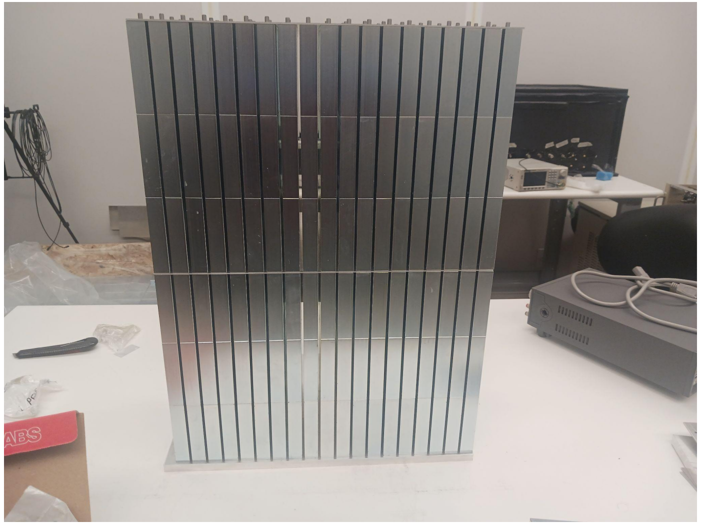


Mechanical Structure

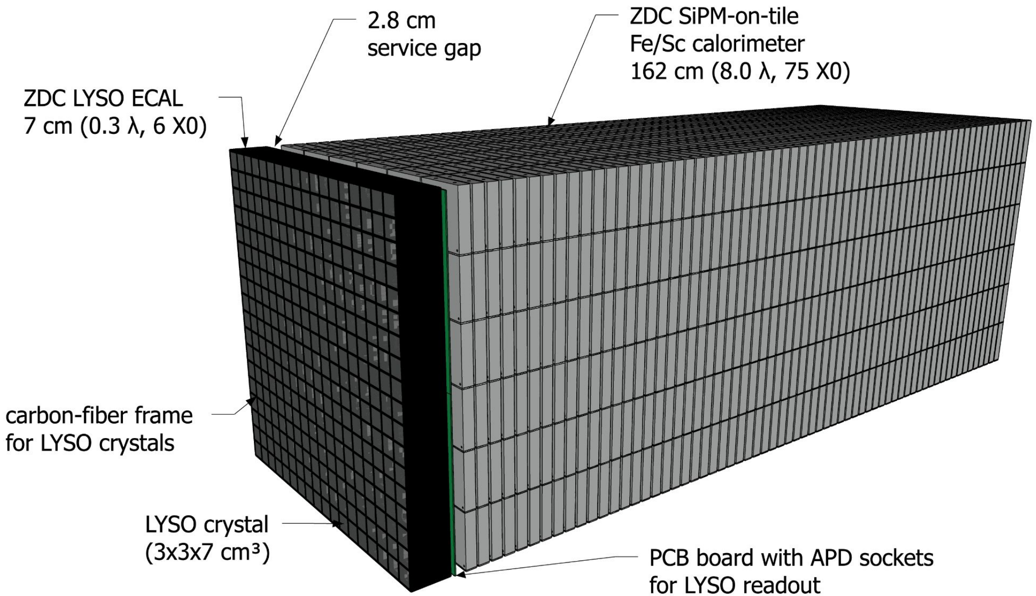








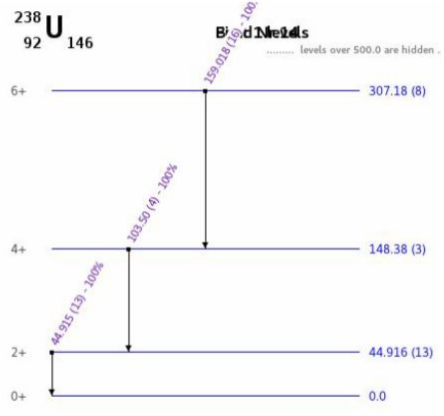
Linking plates every 3 rows seem OK, leaving space for 30x30 cm PCBs
We will included updated SketchUp blow out model

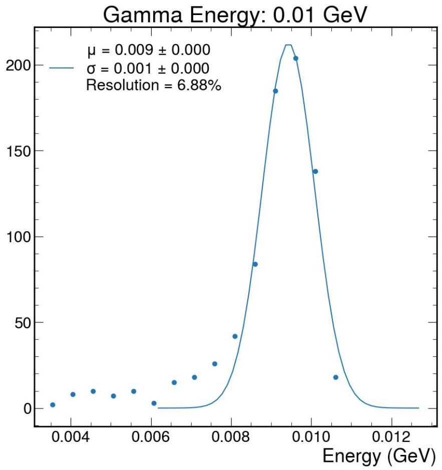


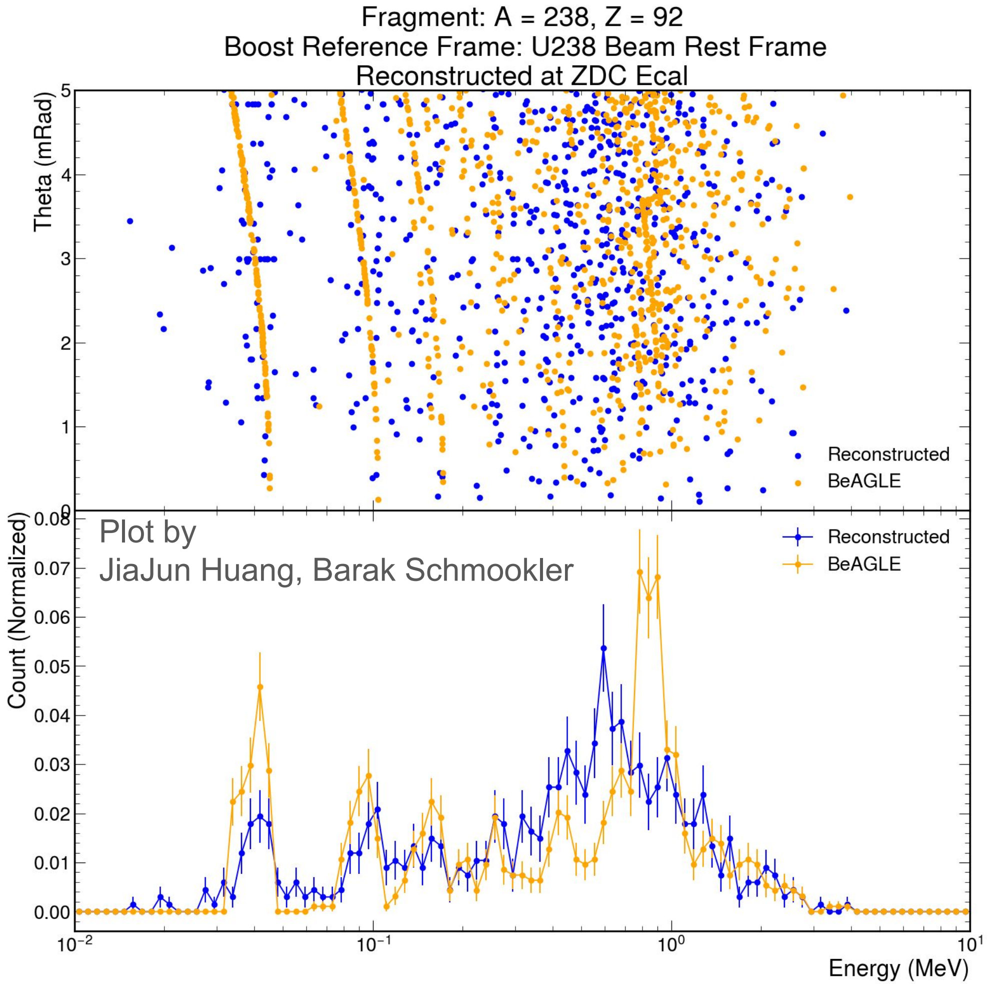
Low-energy ɣ→ LYSO
High-energy ɣ and π0→ Fe/Sc
High-energy neutrons → Fe/Sc

Money Plot for LYSO

LYSO is able to reconstruct the first line of U238 (45 keV), which shows up at ~10 MeV in the lab frame







Summary SiPM-on-tile ZDC status

TRD studies on track to be ready

Geometry (including staggering) and
reconstruction algorithms (including HEXPLIT)
already implemented in EICRECON.
GNN on the works.

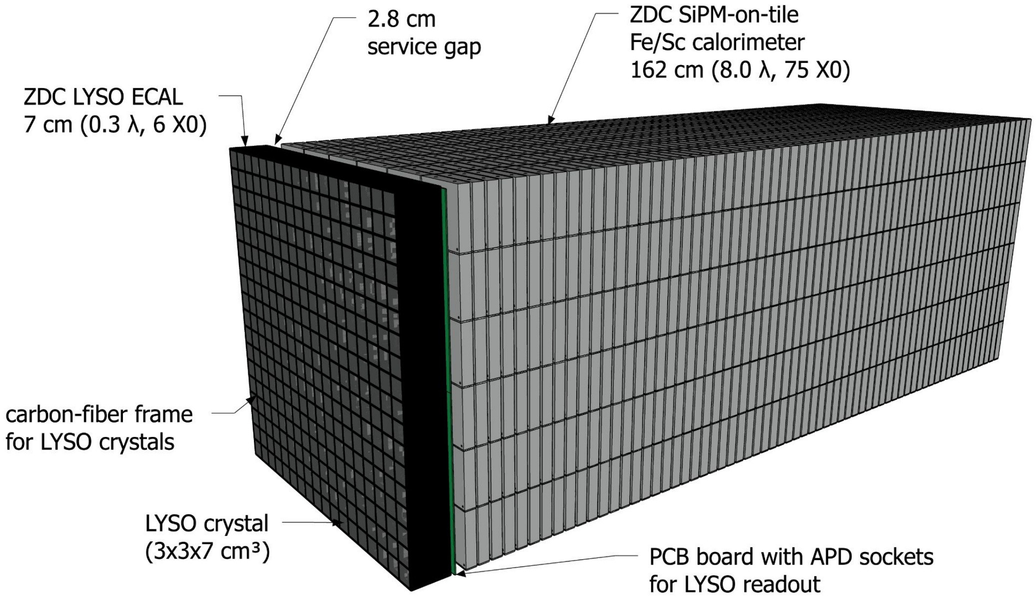
Physics benchmarks:
DEMP (charged pion + n), well underway
DEMP (charged Kaon + Lambda) starting

Prototype and irradiation tests ongoing,
should result in papers before pre-TDR

Sketchup for more realistic mechanical structure
and PCBs under way

Backup

Reminder: Combined system could be LYSO crystal ECAL (Oct 9th design) and SiPM-on-tile Fe/Sc

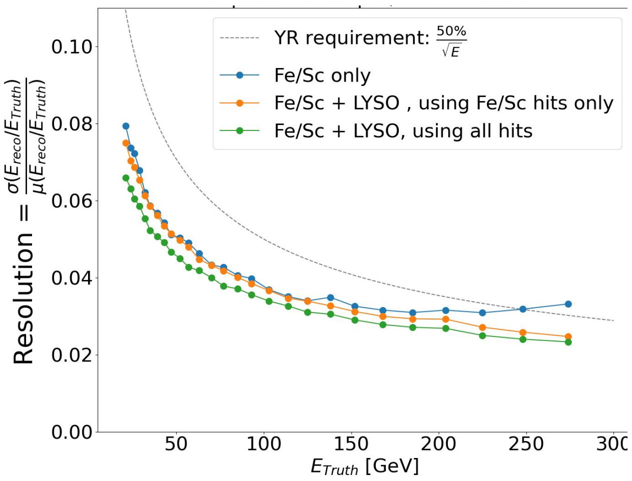


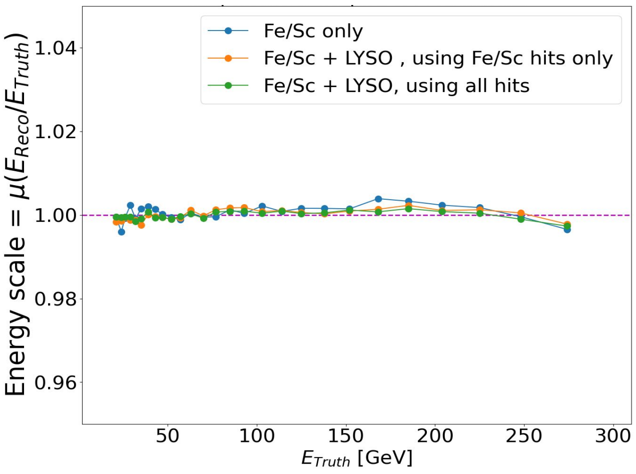
Meets all physics requirements while maximizing synergies with other ePIC subsystems, reducing cost and risks.

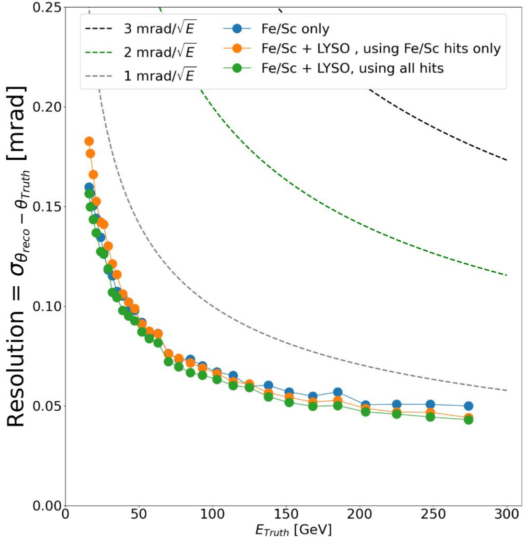
Low-energy ɣ→ LYSO
High-energy ɣ and π0→ Fe/Sc
High-energy neutrons → Fe/Sc

Combined LYSO + Fe/Sc neutron performance with GNNs

GNN yields optimal reconstruction, software compensated linear response







- Adding LYSO slightly improves energy resolution.
- No significant impact on the angular resolution

Credit: Bishnu Karki, Sebastian Moran, Ryan Milton