Simulated performance of ALLEGRO calorimeter

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Noble Liquid Calorimetry and ALLEGRO

Sampling calorimetry relying on ionization of liquefied noble gas:

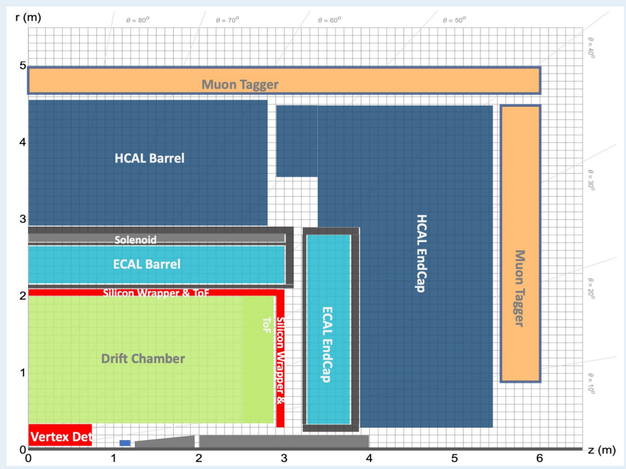
Based on alternating layers of absorbers, noble liquid and read-out electrodes

Successful in many HEP experiments:

- MarkII, DØ, H1, NA48/62, ATLAS

ALLEGRO = A Lepton coLlider Experiment with Granular calorimetry Read-Out

- A Noble-Liquid ECAL Based, general-purpose detector concept for FCCee



- Vertex Detector
- Drift Chamber (±2.5 m active)
- Silicon Wrapper + ToF
- Solenoid B=2T, sharing cryostat with ECAL
- High Granularity ECAL:
  - - Noble liquid + Pb or W
- High Granularity HCAL / Iron Yoke:
  - - Scintillator + Iron
- Muon Tagger

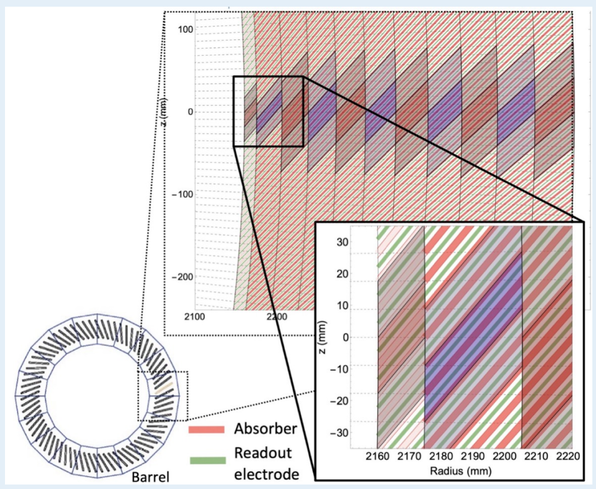
ALLEGRO ECAL design

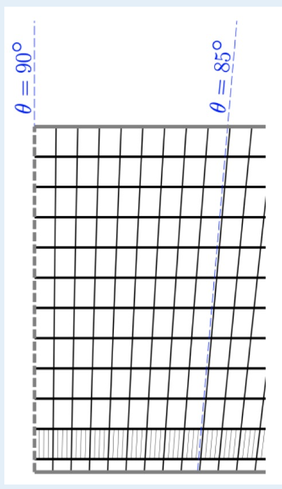
Barrel design driven by the solution for electrodes:

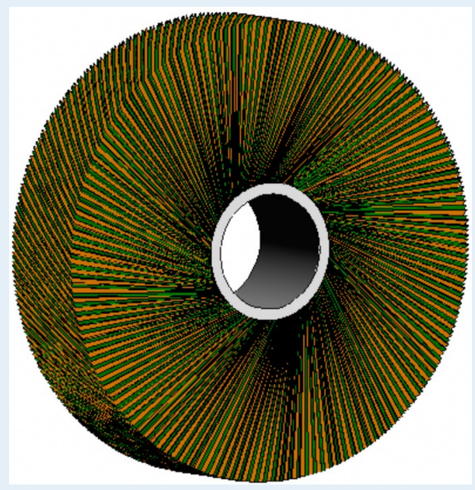
- 1536 straight inclined (50°) 1.8 mm absorber plates
- Multi-layer PCBs as readout electrodes
- 1.2-2.4 mm LAr gaps (LKr considered)
- 40 cm deep (22 X_0)
- $\Delta\theta$=10 (2.5) mrad for regular (strip) cells, $\Delta\phi$ = 8 mrad

Endcap:

- “Turbine design” with many thin absorber plates

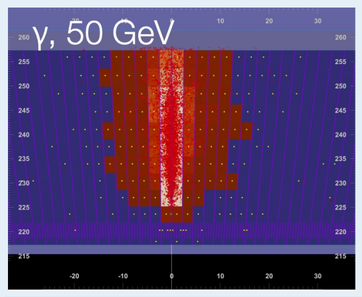


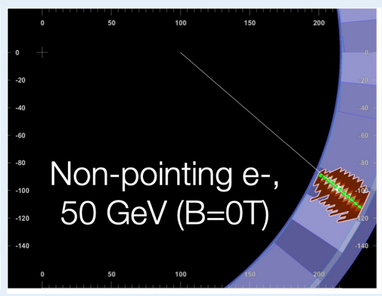


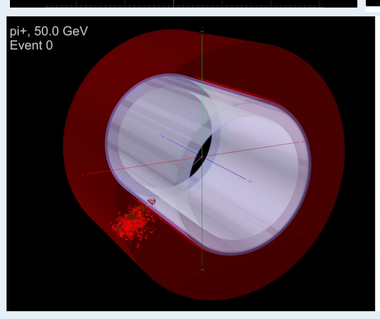


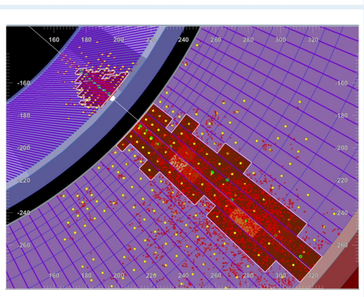
Clustering performance

- Topo and sliding-window clustering algorithms re-designed based on the new calorimeter segmentation
- Nice event display tool was developed
- Enabled clustering with ECal + HCal combination



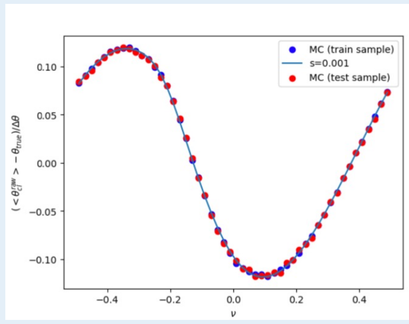


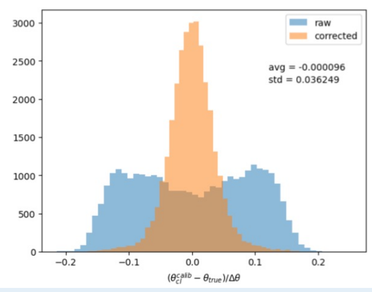


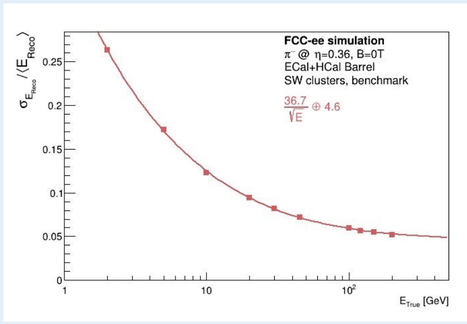


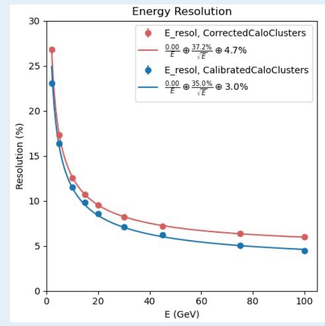
Resolution correction and calibration

- S-curve is observed in θ resolution due to the finite cell size that will lead to a bias of measurement to the center of cell
  - A “common” detector effect:
    - We have observed that curve before in the ATLAS detector
  - Corrected by re-defining the barycenter calculation
    - Use log E_cell weights:
- Energy resolution to single pion with combined reconstruction in ECal and HCal barrels, calibration with benchmark method in red, with MVA in blue



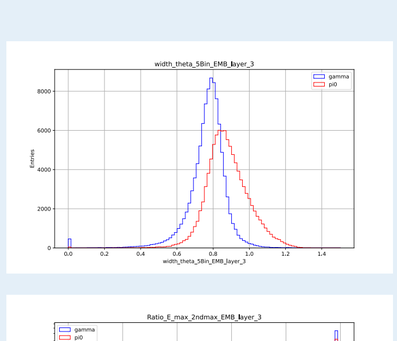


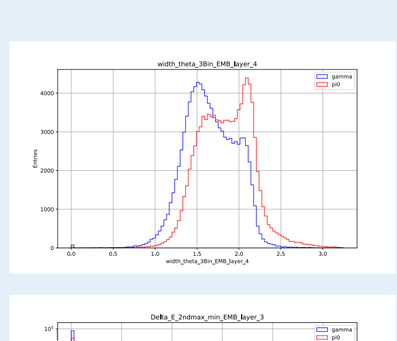


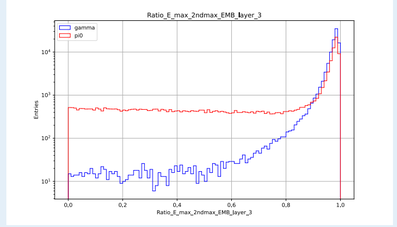


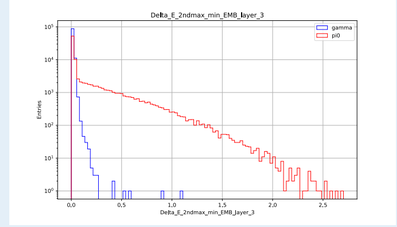
Photon identification

- Photon and pi0 behave similarly in calorimeter
- Series of discriminant parameters calculated based on shower shapes
  - Energy of cluster, num. of cells, energy fraction of layers…
  - BDTs trained using these shape parameters
- Test custom detector versions
  - Move strip layer to L2, L3, L4, and L5 (default is L1)

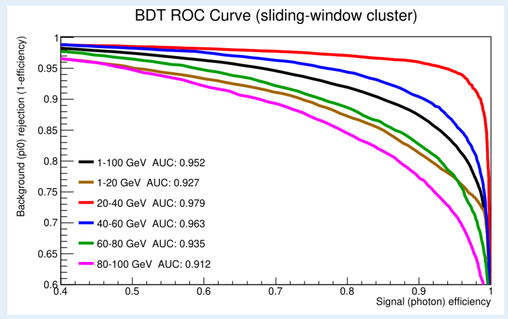


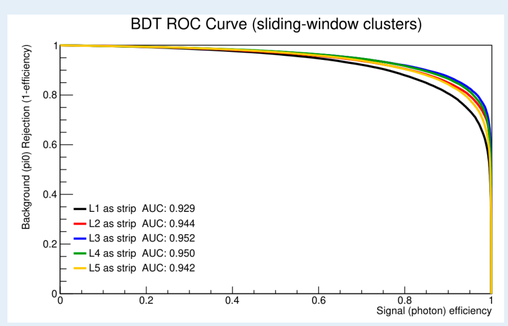






Shape parameter distributions





Outlook

- First complete geometry implementation of the ALLEGRO benchmark is available
- Lots of exciting work ahead in optimisation & converting the concept to actual detector

allegro.web.cern.ch