Plans for ECAL Simulations, Calibration and Reconstruction

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Outline

Calorimeter Stack

- Simple geometry for fast iterations
- Two ECAL sections with differing active materials: silicon and scintillator
- Include HCAL as tail catcher to avoid leakage (analog scintillator)
- Need to define active layer thickness: as thin as possible, still feasible
- Parameters to vary:
  - Absorber thickness for both sections (longitudinal segmentation)
  - Transition point between sections
  - Number of layers
  - Readout cell sizes (lateral segmentation)
- Constraints:
  - Keep total thickness in X_0 (approximately) constant
  - Do not exceed current ECal size

Simulation Framework

Mokka

- Write new driver starting from existing examples
- More details possible
- Once defined, simple variation using Mokka steering parameters
- Full access to GEANT4 treatment of hits, e.g. includes Birks' law (attenuation of light yield)

SLIC

- Re-use existing TestBeamCalorimeter prototype
- Geometry of flat parallel layers composed of multiple slices: active + absorber + electronics
- Simple geometry description using XML

Digitisation

- As simple as possible – as complex as necessary
- Noise cut at 0.5 MIP, depends on active material and thickness
- Time cut to reject very late hits, e.g. 100 ns
- No saturation
- No noise
- No cross-talk
- No encoding into bits (dynamic range)
- Is this good enough?
  - We are just comparing relative performance
  - Any possible bias when comparing silicon and scintillator signals?

Calibration

- Determine sampling fraction from mean energy deposit of test samples
- γ at various energies within 1–50 GeV
- Solve for sampling fractions c_i:

$$E_{\text{true}} = c_1 \cdot E_{1,\text{vis}} + c_2 \cdot E_{2,\text{vis}} + \ldots$$

- Linearity has to be cross checked since there might be an energy dependence of the sampling fractions

Analysis (Single Particles)

- Determine linearity and energy resolution for all setups using single e, γ for E =1–50 GeV
- This (hopefully) provides a performance dependence of the different parameters
- Conclude which parameter allows best cost saving for lowest performance loss

Analysis (Two Photons)

- Determine impact of lateral segmentation on two γ reconstruction depending on distance between them (generate with two parallel particle guns)
- Determine distribution of two photon separation from π^0 decays in full detector simulation: depends on calorimeter radius and typical π^0 energy
- Conclude on maximum cell size for efficient two photon reconstruction using PandoraPFA for clustering, e.g. SlicPandora or CALICE Pandora

Full Detector

- Assess performance in full detector model (ILD)
- Detailed implementation of ECAL geometry (see talk by Angela)
- Verify results for single particle performance: repeat study for a small selection of the studied ECAL geometries
- Quantify performance for a default jet sample: $\mathrm{Z}' \rightarrow \mathrm{q}\overline{\mathrm{q}}$ at various $m_{\mathrm{Z}'}$ or rather some physics sample?
- Real PFA study including magnetic field

Summary

- Decide on simulation package for stack simulation
- Implement stack geometry in a flexible way: XML or Mokka driver with suitable parameters
- Is the simple hit digitisation scheme sufficient?
- Implement calibration code, i.e. determinate sampling fractions (Java version exists but needs modification for stack geometry)
- PandoraPFA for lateral segmentation study in stack geometry
- Implement flexible ECAL geometry for full detector geometry
- Simulate a lot of samples ...