ALLEGRO ECAL crosstalk emulation

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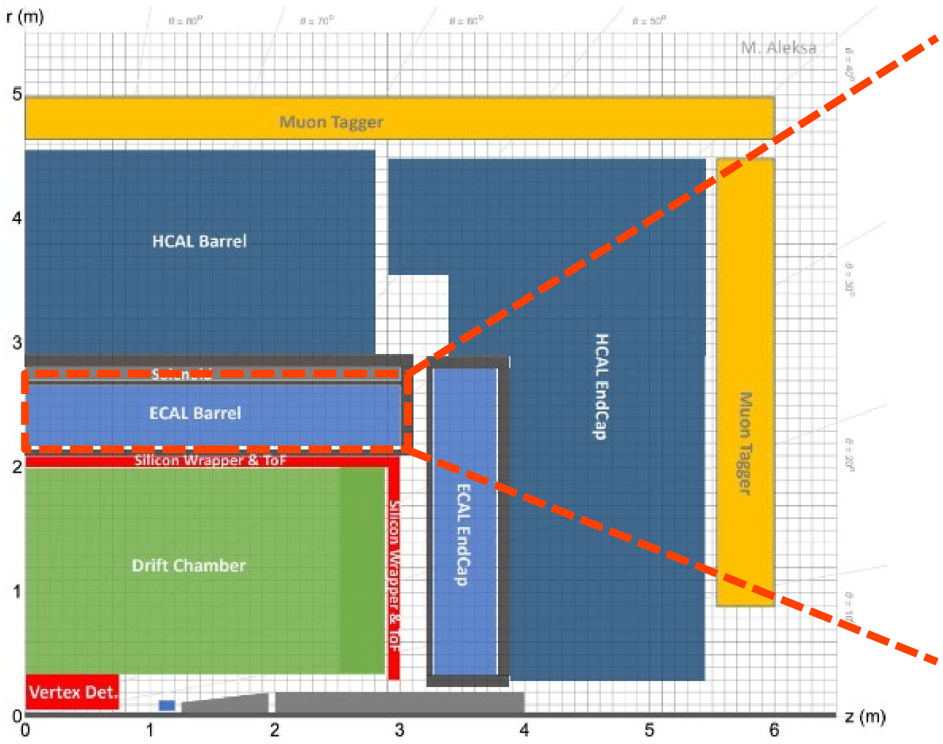
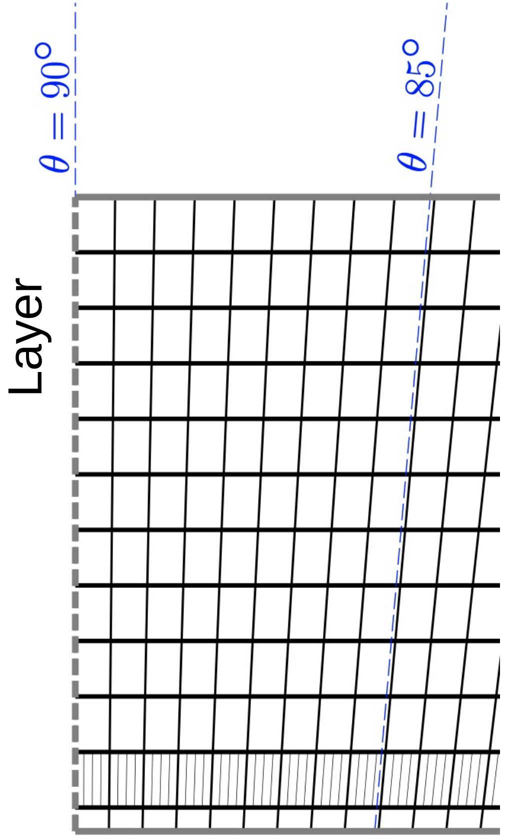
ALLEGRO detector geometry

- Layout of ALLEGRO v02





12 layers in total: The cells for the 2nd layer have 4 times better granularity (the strip layer).

1 Module of ALLEGRO ECAL

Crosstalk in the ECAL

High granularity readout electrode:

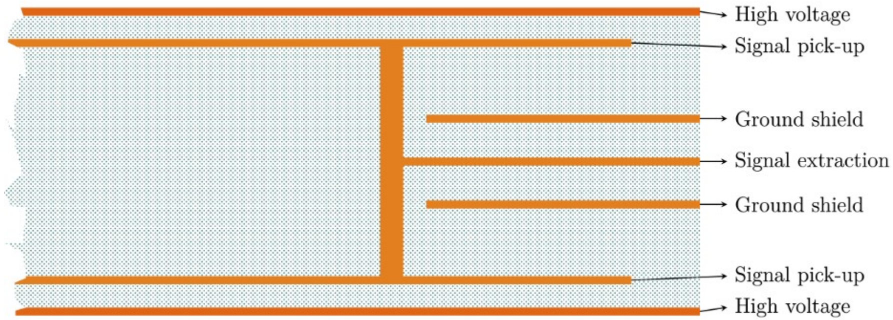
A delicate balance among granularity, noise level and crosstalk.

What do we want to know from the crosstalk emulation?

- The degradation of detector performance (spatial resolution, PID, ...) has to be understood, in order to guide the design of readout electrodes.

A study in two steps:

- a. Mapping of crosstalk neighbours for the ALLEGRO ECAL.
- b. Inclusion of crosstalk effects in the computation of cell energies.



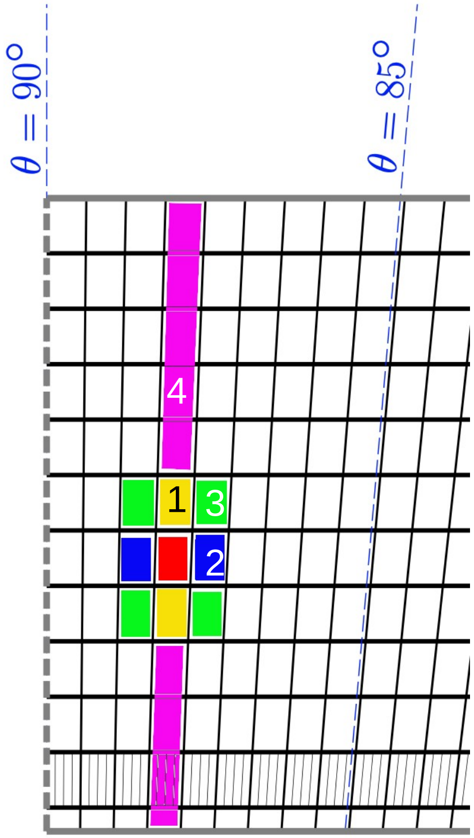
Side view of the 7-layered PCB for ALLEGRO ECAL

Types of crosstalk neighbours

- 4 types of neighbours are considered.

Type 1: Direct radial neighbours.
Type 2: Direct theta neighbours.
Type 3: Diagonal neighbours.
Type 4: Other cells in the theta tower.

Different crosstalk coefficients will be assigned to each type in the computation of cell energies.



Crosstalk coefficients

Three sets of crosstalk coefficients are tested.

Type	1: Radial	2: Theta	3: Diagonal	4: Tower
No crosstalk	0	0	0	0
Realistic	0.7%	0.2%	0.04%	0.1%*
Conservative	3%	2%	1%	1.5%*

- No outer/inner asymmetry is assumed for crosstalk coefficients between radial neighbours.

Values in the "realistic" case are taken from the latest measurement, apart from the type 4 (*a guessed value at the same magnitude).

- The "conservative" case allows to understand the tolerance of the performance to the crosstalk effect.

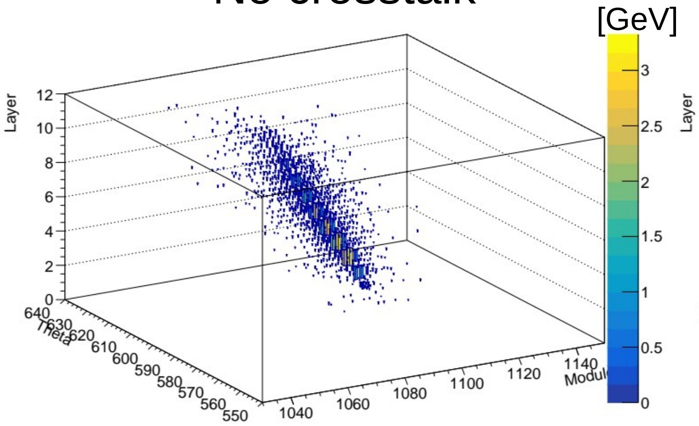
Software implementation

- Generate a map of crosstalk for all calorimeter cells with a given detector geometry.
- Read the map of crosstalk during the detector full simulation.
- Recalculate the energy deposit of each calorimeter cell in a EM shower according to the crosstalk effect.
- Propagate new values of energy deposit per cell to downstream algorithms (i.e. cluster reconstruction).

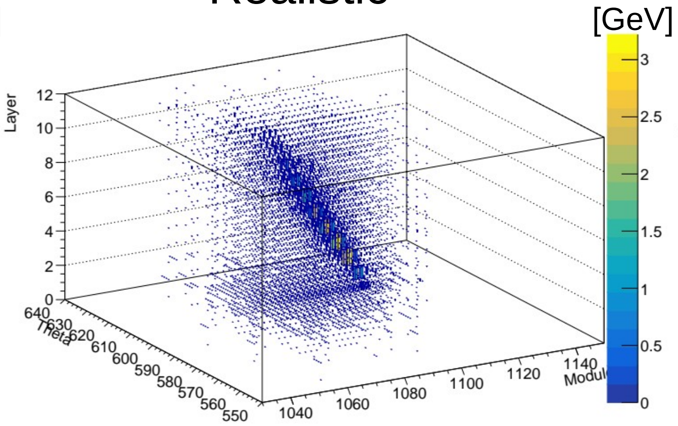
Involved software packages:
k4geo, k4RecCalorimeter and k4FWCore

Signal per cell for the same event

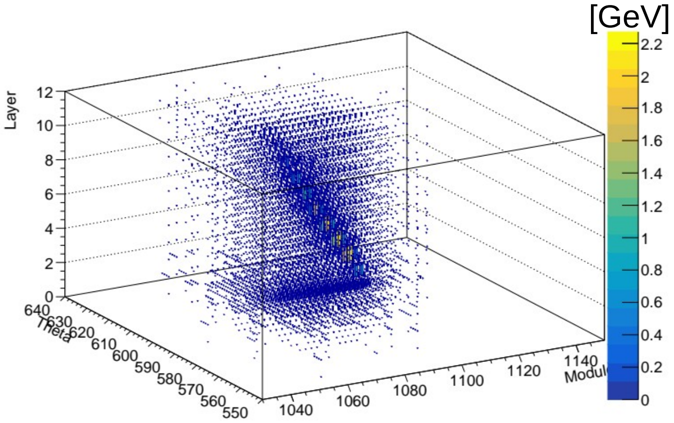
No crosstalk



Realistic



Conservative

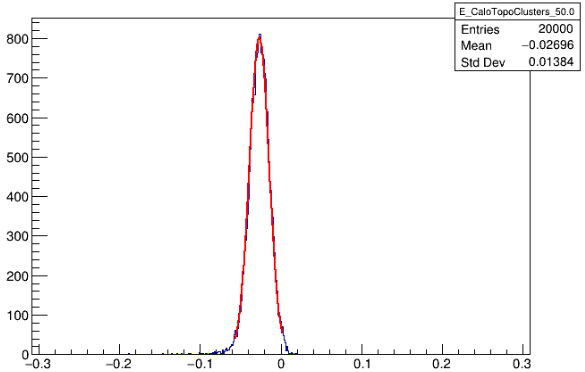


- Cell signal = (Total hit energy + Crosstalk) / Sampling fraction.
- The crosstalk causes a spread of the signal in all three dimensions (layer, module and theta).
- A displacement of module indices of about 45 is observed for the **50 GeV incoming electron**, which agrees with the 50-degree inclination angle of readout panels for ALLEGRO v02.

Energy response

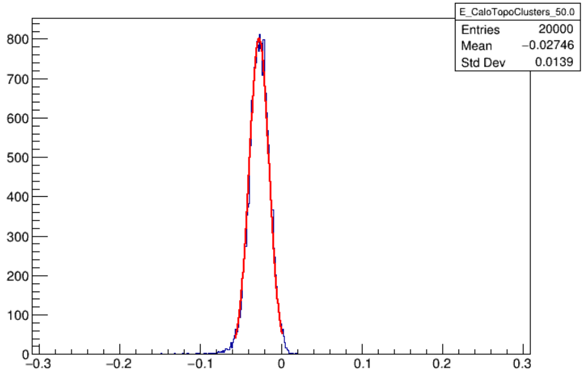
- 20,000 events with a 50 GeV electron were generated for each setting.

No crosstalk



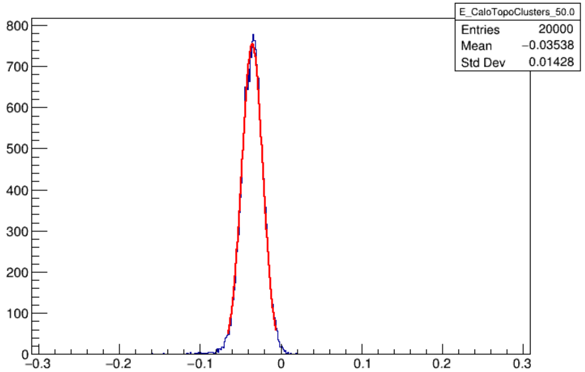
- 2.696 +/- 1.384 %

Realistic



- 2.746 +/- 1.390 %

Conservative



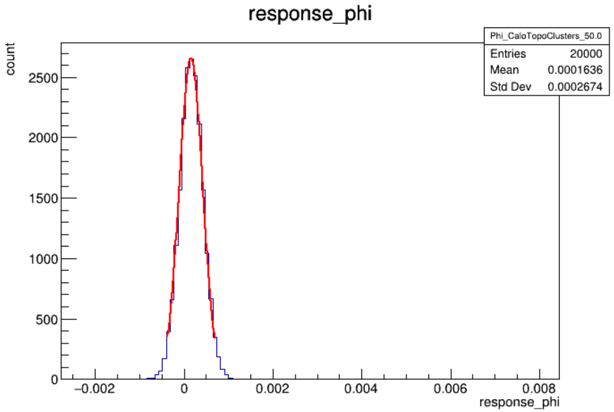
- 3.538 +/- 1.428 %

- Response = (E_reco – E_true) / E_true.
- Response calculated from ATLAS-like calorimeter “TopoCluster”.
- 4 per-mil degradation in the “optimistic” case and 3% degradation in the “conservation” case.

Phi response

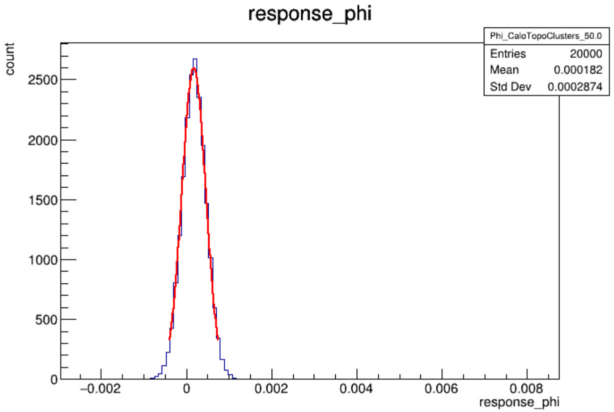
- 20,000 events with a 50 GeV electron were generated for each setting.

No crosstalk



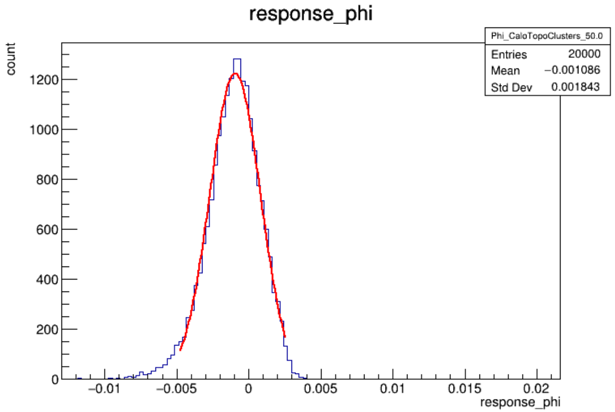
0.003 +/- 0.004 %

Realistic



0.003 +/- 0.005 %

Conservative



- 0.017 +/- 0.029 %

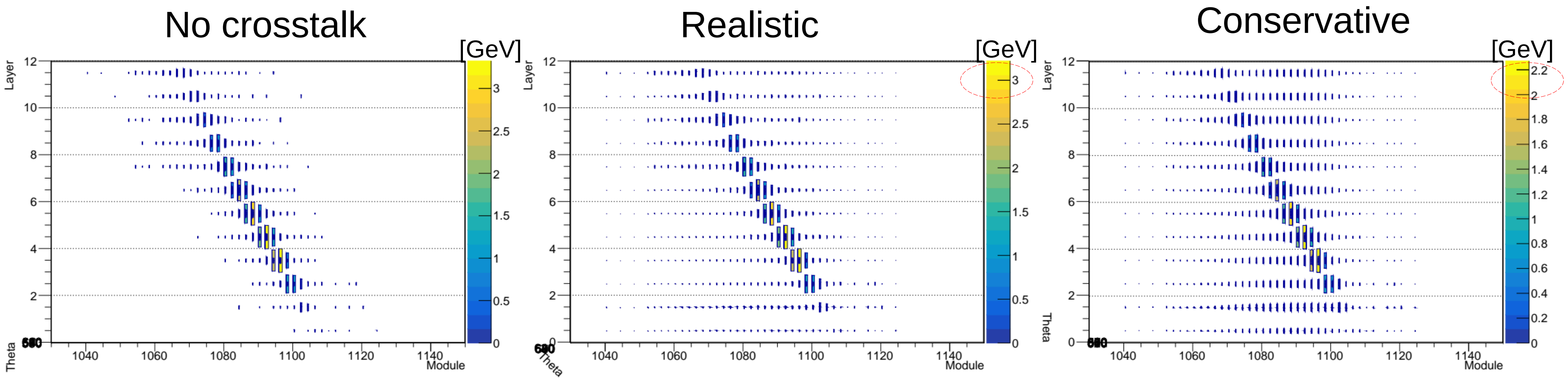
- Response = Phi_reco – Phi_true.
- Response calculated from ATLAS-like calorimeter “TopoCluster”.
- Large bias and smearing effect are found only in the “conservative” case.

Summary

- The crosstalk effect has been implemented in the simulation of the ALLEGRO ECAL barrel.
- The crosstalk does not seem to have a big impact on the energy resolution. However, the degradation of the spatial resolution is noticeable when the crosstalk reaches percent level.
- Shower shape variables will soon be available for studying the impact of crosstalks on the photon/pion identification.

Backup

Signal per cell for the same event

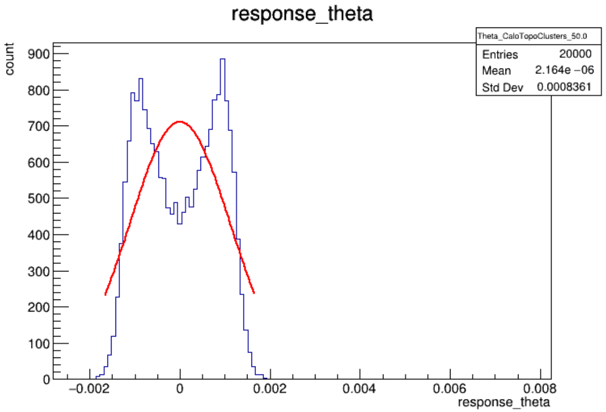


- Cell signal = (Total hit energy + Crosstalk) / Sampling fraction.
- The crosstalk causes a spread of the signal in all three dimensions (layer, module and theta).
- A displacement of module indices of about 45 is observed for the **50 GeV incoming electron**, which agrees with the 50-degree inclination angle of readout panels for ALLEGRO v2.

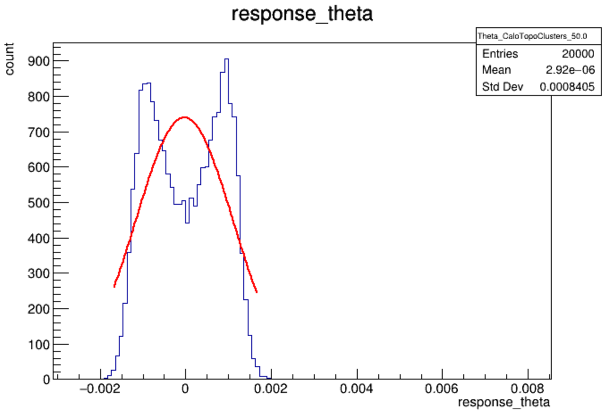
Theta response

- 20,000 events with a 50 GeV electron were generated for each setting.

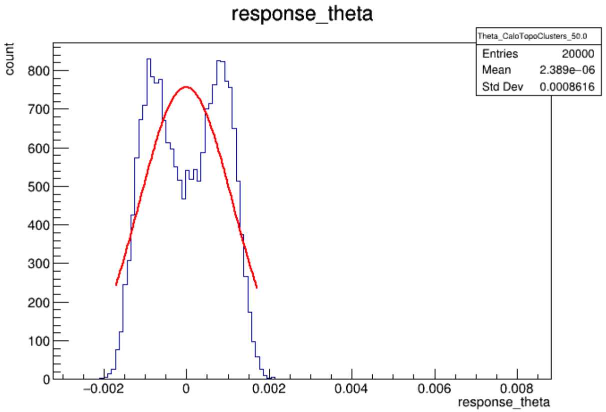
No crosstalk



Realistic



Conservative



- Response = Theta_reco – Theta_true.
- Response calculated from ATLAS-like calorimeter "TopoCluster".
- Impact on the theta distribution without the "[log(E) reweighting]" is hard to quantify. Results need to be updated.

Detector geometry

- Layout of ALLEGRO (taken from Giovanni)