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Presentation

Electron Reconstruction in the Beam Cal

Rosca, A (DESY)

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Electron Reconstruction in the Beam Calorimeter

Aura Rosca, DESY

LCSW2011

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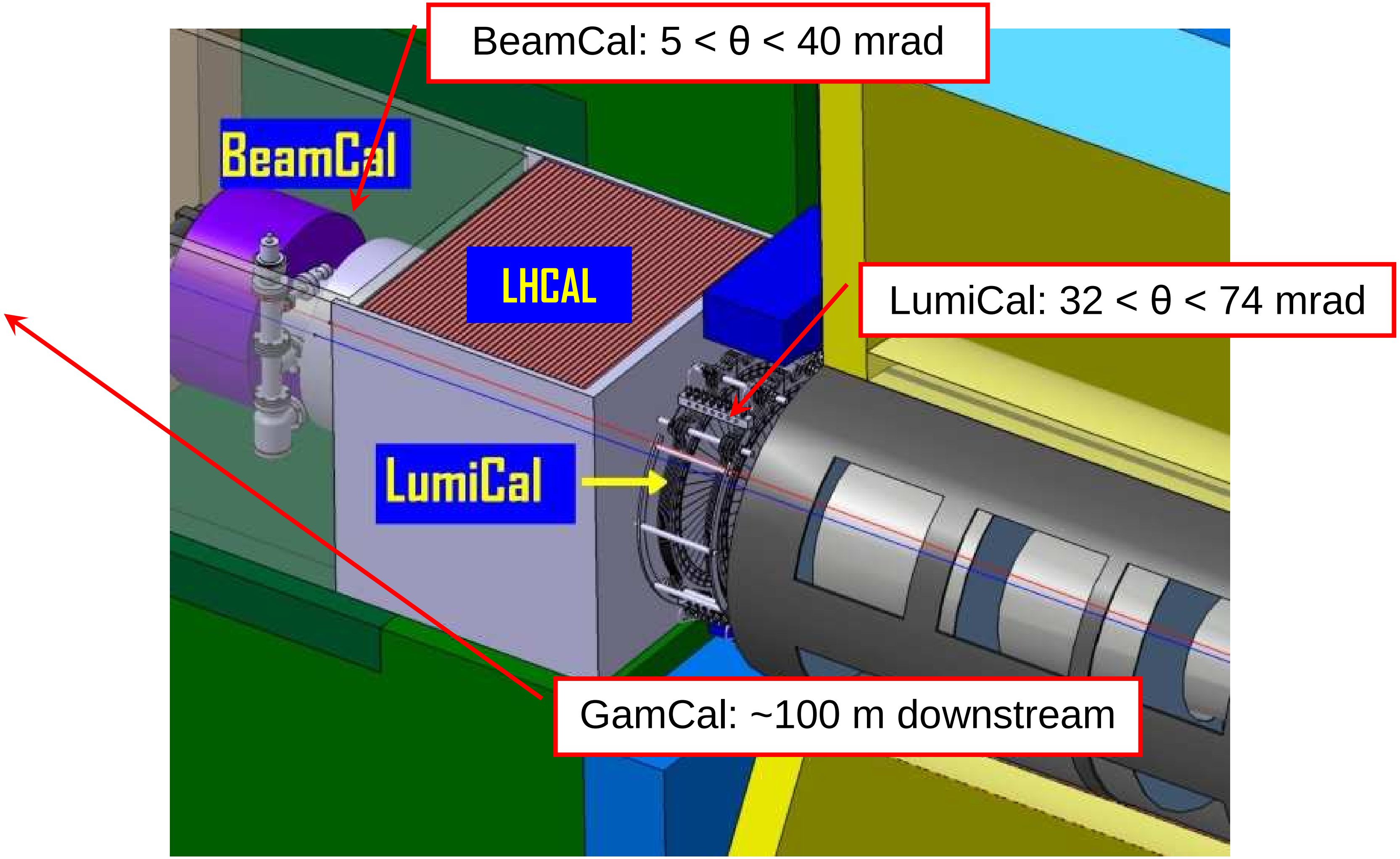
Overview

- The very forward region of an ILC detector.
- Beam Cal reconstruction algorithm – a short reminder.
- Background subtraction procedure implemented in Marlin.
- Marlin processor for the Beam Cal reconstruction.
- First results.

Very Forward Region



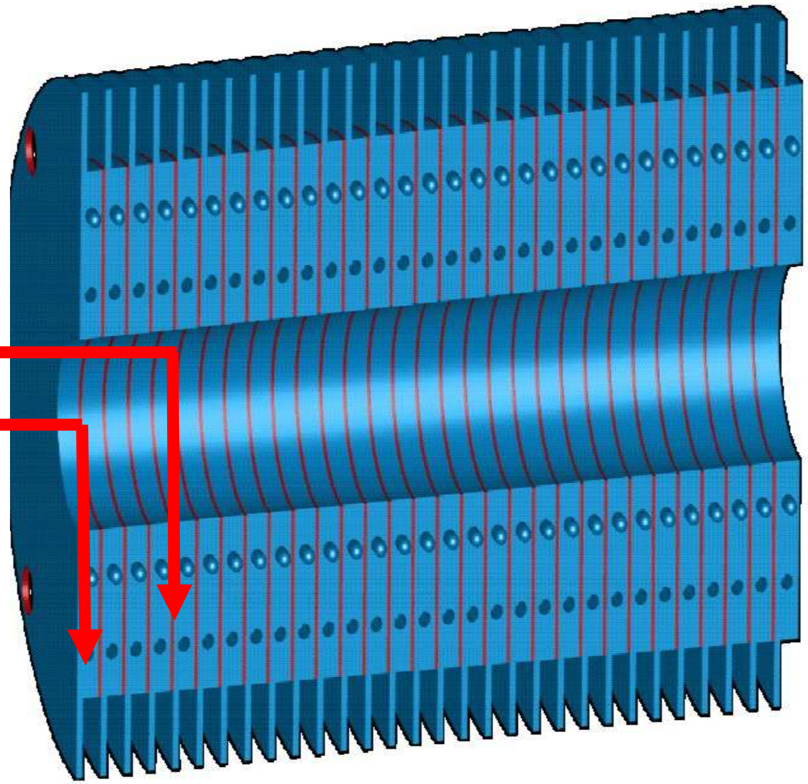
Very Forward Calorimeters

- LumiCal:
  - Accurate measurement of the luminosity by using Bhabha events (very high mechanical precision needed).
  - Extend coverage of the ILC detector.
- Gamcal
  - Beam diagnostics from beamstrahlung photons.
- BeamCal:
  - Shielding of inner detector.
  - Beam diagnostics from beamstrahlung electrons/positron pairs.
  - Detection of electrons/photons at low angle.

Beam Cal: W-Diamond Sandwich

Length = 30 layers each with a thickness of 1 X_0

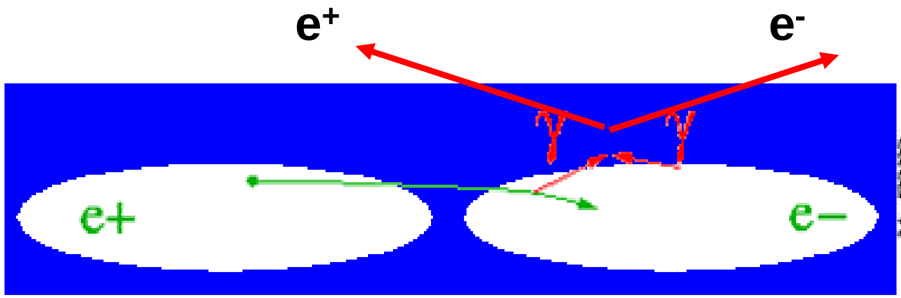
(3.5mm W + 0.5mm diamond sensor)



~2 cm < R < ~15 cm

~ sensor segmentation ~8x8 mm^2

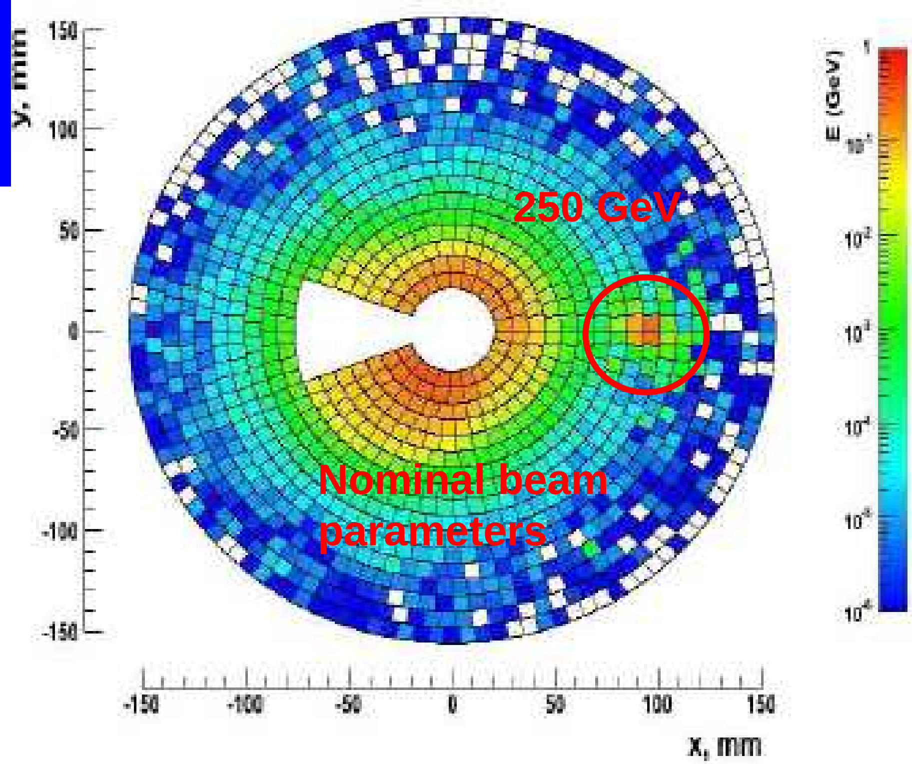
Electron Reconstruction in Beam Cal



e^+e^- pairs from Beamstrahlung are deflected into the Beam Cal

High energy electrons are detected on top of the spread background from the Beamstrahlung pairs:

- Background subtraction
- Shower search

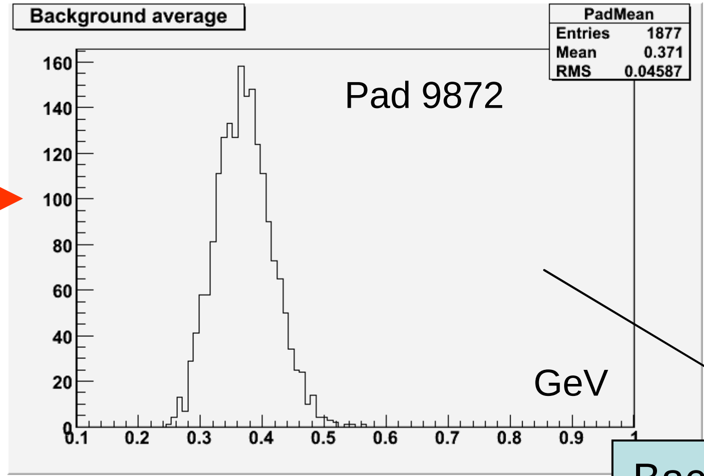


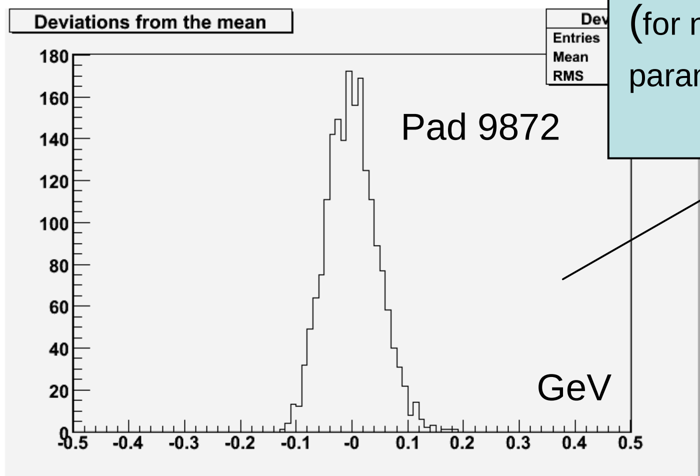
Background Subtraction

Background fluctuates from one BX to the other.

1877 BX

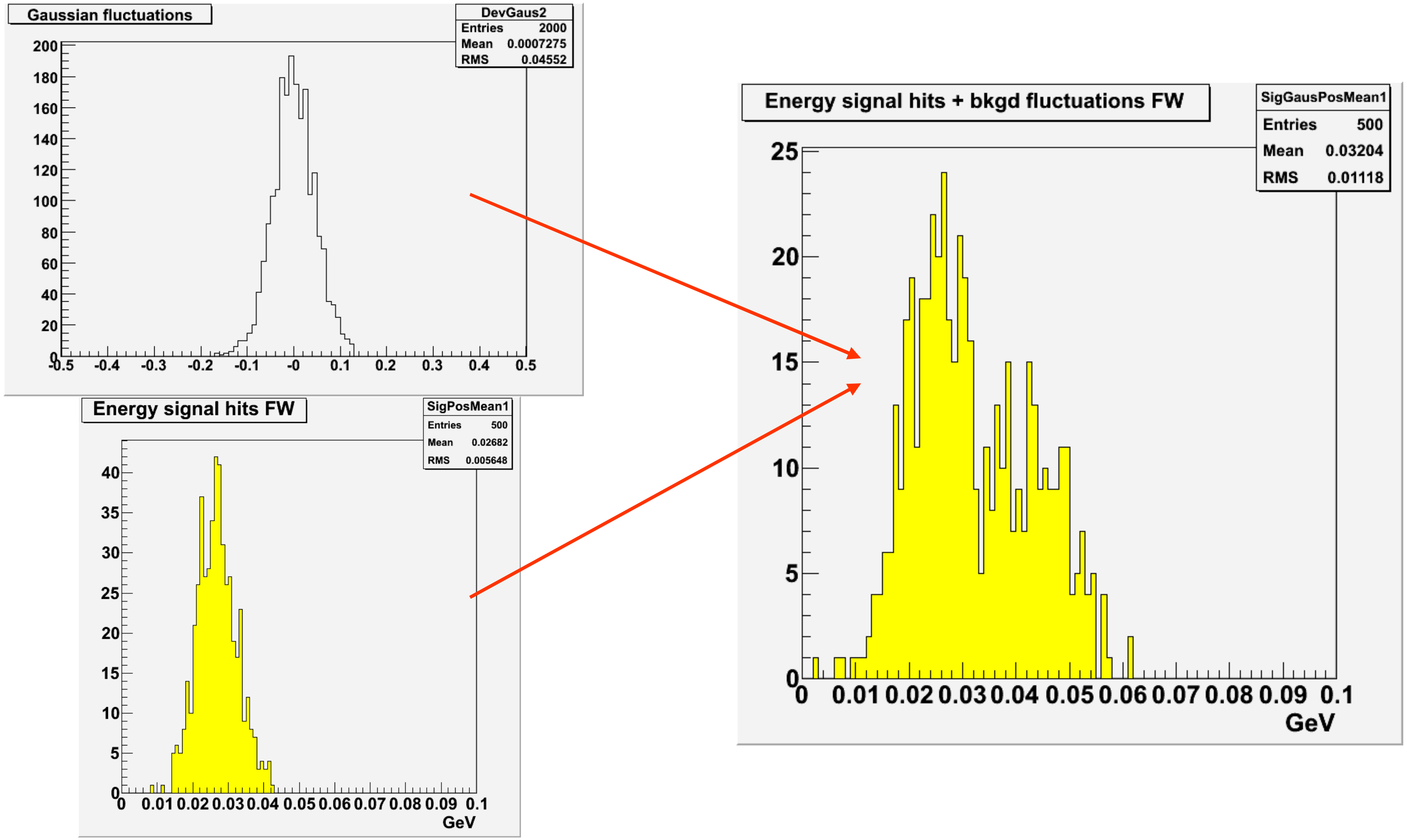
- Calculate average and rms of the background energy deposition on each detector pad and produce a map of the background depositions;
- Subtract the value of the average background energy from the total deposition on each pad;
- Equivalent with adding background fluctuations to the signal energy deposition.





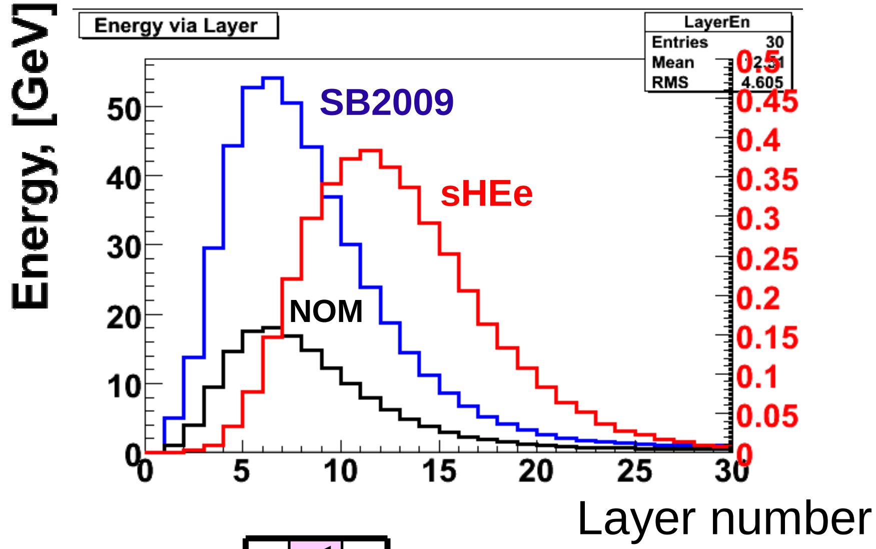
Background Map (for nominal beam parameters)

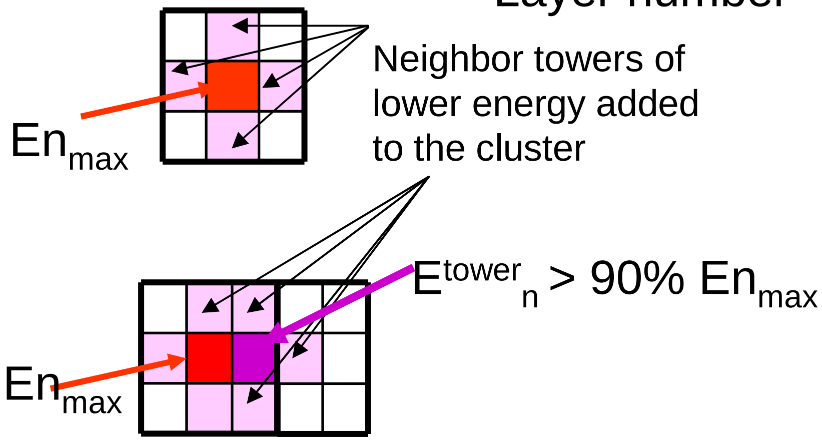
Background Subtraction, cont.



Shower Search

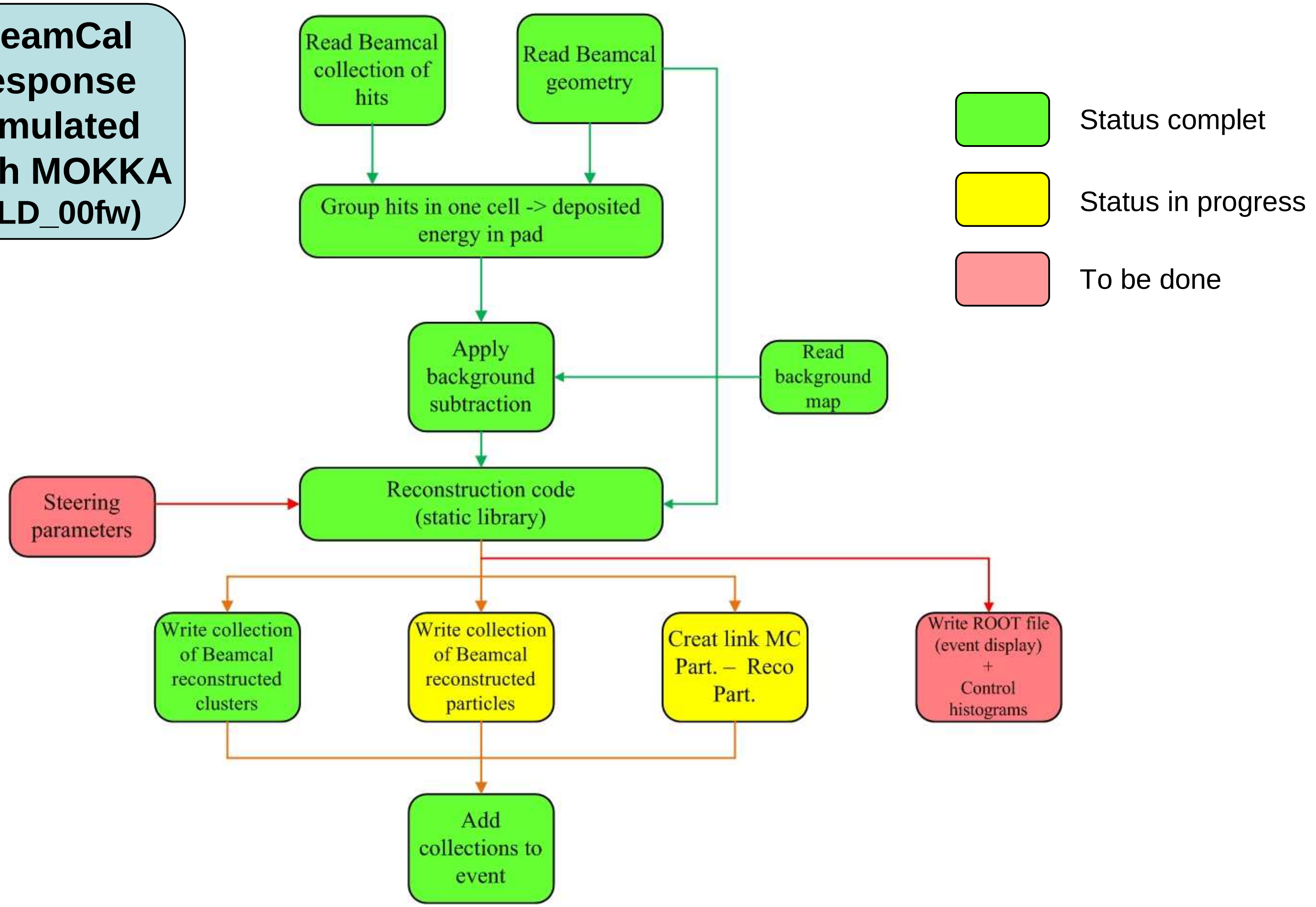
- Start from 5-th to 30th layer.
- Identify chains of 10 consecutive fired pads; energy deposition in each pad should be higher than 1 SD of the background.
- Find the tower with the maximum deposited energy;
- Add all neighbor <u>towers</u> adjacent to the tower with the highest energy;
- If such a neighbor tower has an energy larger than 90% of the energy of the central tower, add this tower neighbors as well;





Implementation into Marlin

BeamCal response simulated with MOKKA (ILD_00fw)



New Marlin Processor

- New Marlin processor, BCalReco, to perform the following tasks:
  - reads the Beam Cal collection of hits and puts the information into a 3D dynamic array of structures, CellType ***info_detector:
    - typedef struct {

      double sRin,sRout,sZstart,sZend,sSphi,sDphi,sEdepNeg,sEdepPos;

      int sPos[3];

      } CellType;
  - calls the reconstruction code, BCalReconstruction:
    - bcal_reco = new BCalReconstruction();
    - bcal_electron = bcal_reco->GetReconstrCoordinates(nLayers,nRings,nbPhis,cells);
  - outputs the relevant collections (clusters, reconstructed particles)
- Included in MarlinReco as part of ilcsoft v01-12

Redesign of Reconstruction Code

- No essential changes to the old shower search algorithm.
- Re-organize the code as a class, BCalReconstruction:
  - Destructor: ~BCalReconstruction()
  - Functions:
    - RecCorr GetReconstrCoordinates (int number_layers, int number_rings, int number_pads[], CellType ***info_detector);
      - typedef struct {

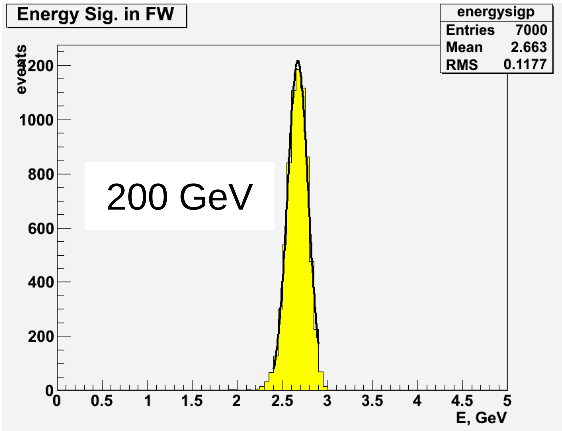
        int side; // 0,1,-1 -> no, FW, BW reconstruction

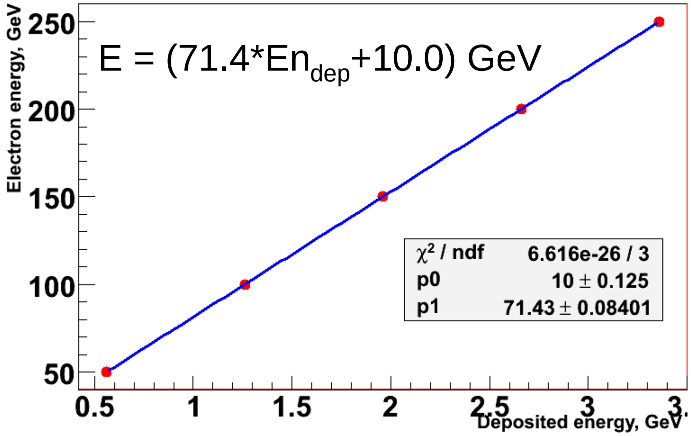
        double RecEne, ErrEne, CoordX, CoordY, CoordZ, RecRad, RecPhi;

        } RecCorr;
  - Protected member functions:
    - vector SearchTowers (int the_Chains[maxrings][maxphis][maxlayers]);
    - RecCorr SearchClustersFW (CellType ***info_detector), RecCorr SearchClustersBW() ;
    - double GetEnergyCalib (double energy);
    - double GetCoordRotX (int ring, int pad, float IP, float angle), double GetCoordRotZ() ;
    - double GetCoordY (int ring, int pad);
    - void Free2DArray (int **p2DArray), void Free3DArray (CellType ***p3DArray);

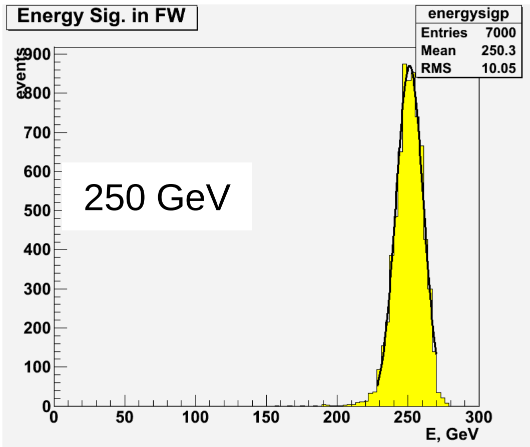
Beam Cal Performance

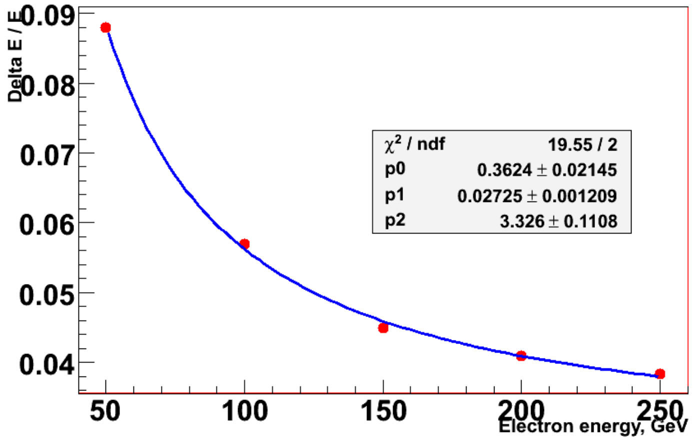
Single electrons generated with energies between 50 and 250 GeV, using the Particle Gun implemented in Mokka





Calibration curve



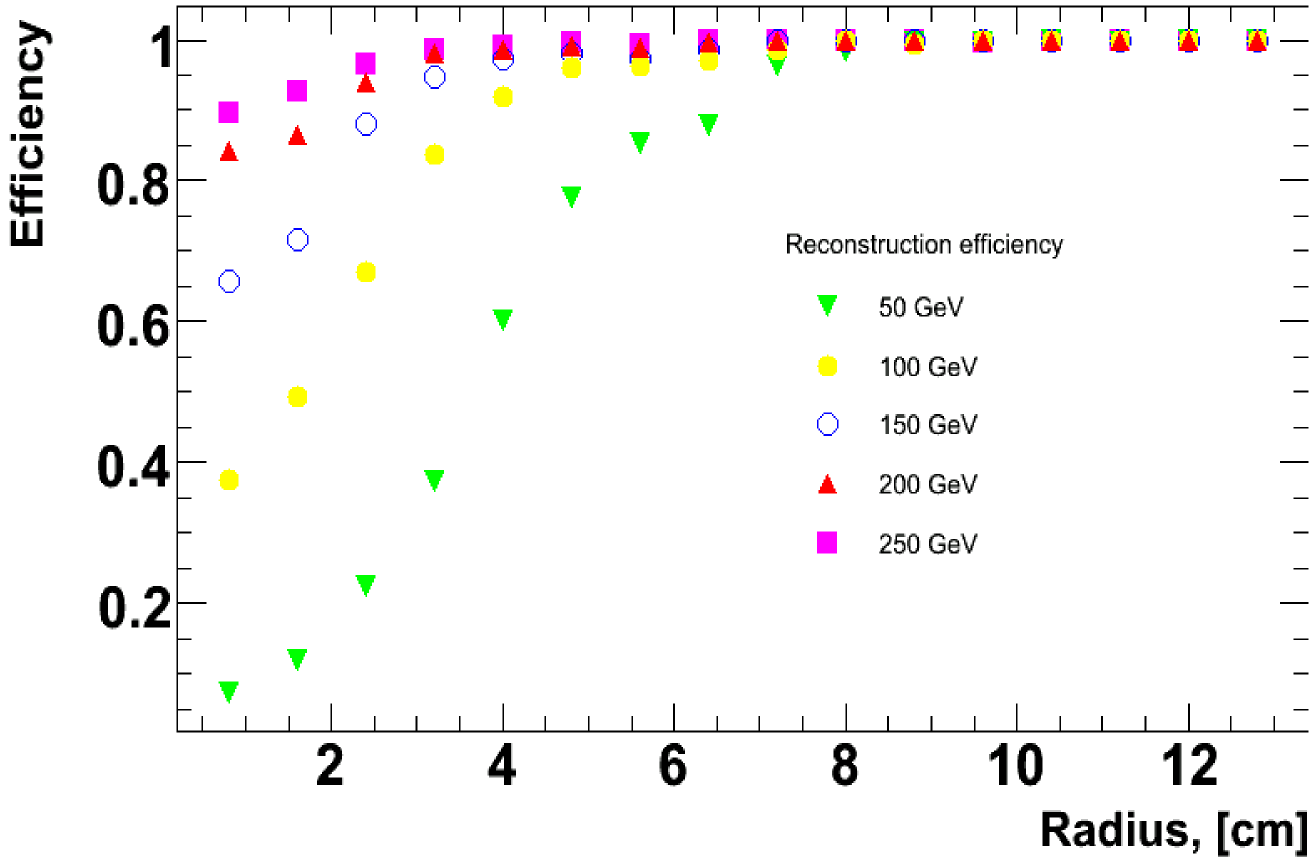


Energy resolution

$$\frac{\sigma}{E} = \frac{36\%}{\sqrt{E}}$$

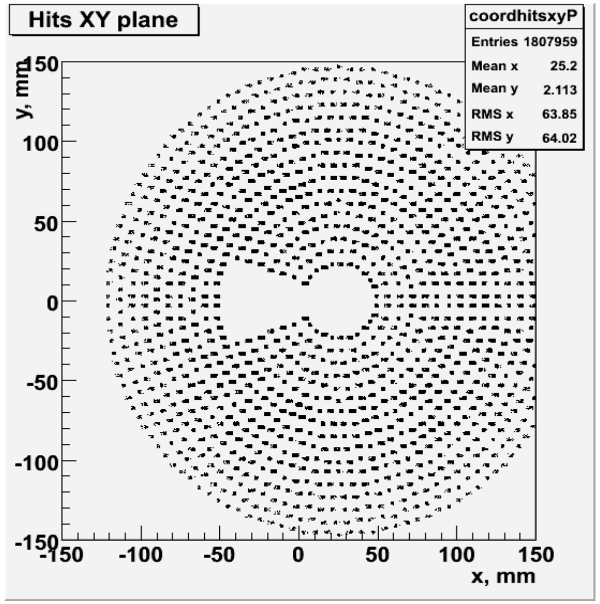
Reconstruction efficiency

Not yet an update

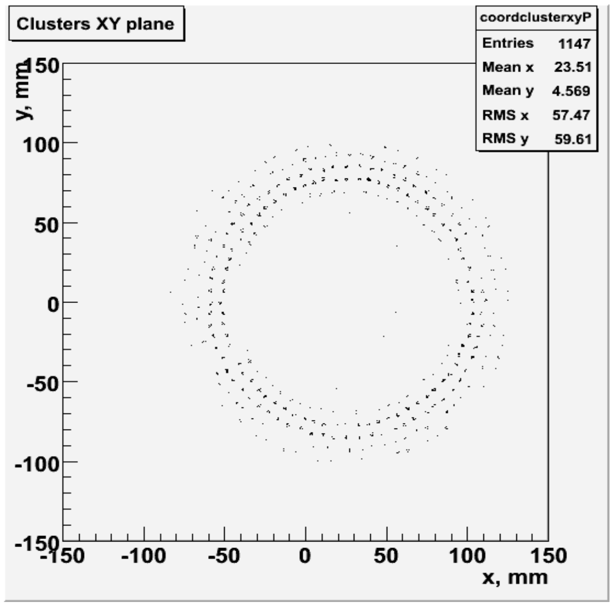


Bhabha Electrons in Beam Cal

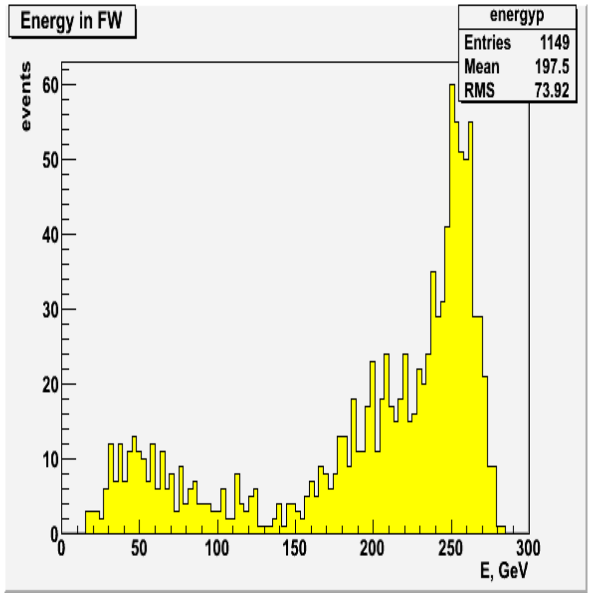
Bhabha electrons generated with BHWIDE in the polar angle range between 20 and 150 mrad.



X-Y Coordinates of hits



X-Y Coordinates of clusters



Electron energy

Summary

- The first release of BCalReconstruction and its associated Marlin processor, BCalReco, is now available in ilcsoft v1-12.
- We reproduced some of the results obtained with the standalone code, for instance the linearity of Beam Cal response and the energy resolution.
- Immediate plans now regard studying the reconstruction efficiency with different beam parameters, magnetic field configurations and sensor segmentations.