Calice Summer Project 2005

ECAL Prototype Study

Mark Stockton

University Of Birmingham

mcs287@bham.ac.uk

www.ep.ph.bham.ac.uk/user/stockton/

CALICE-UK Meeting, Cambridge, 09/09/05

Project Details

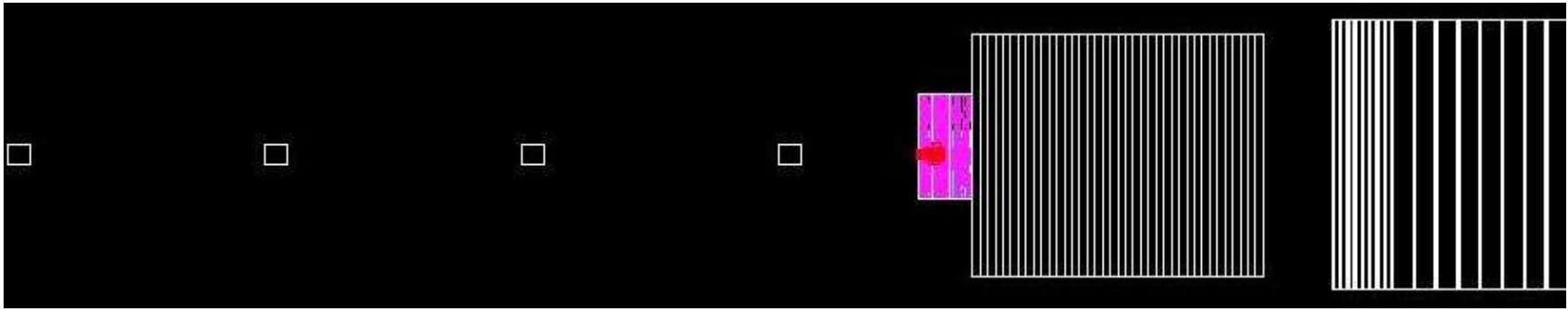
- Using MARLIN and JAS 3 with LCIO files
- Using MAGIC to look at clusters
- Using CGA for defining detector geometry
- Analysis of test beam data and mokka simulations
  - Leakage Estimates
  - Position Resolution
  - Energy Resolution
- Comparisons between centre and edge of wafer
- The test beam wafer layout was:

6	**5**	**4**
3	**2**	**1**

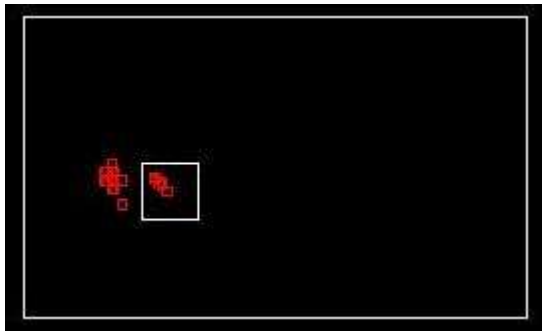
Wafer	1245	1	2	3	4	5	5	5	6
Run	100137	100131	100127	100128	100132	100122	100123	100134	100121

Jas

- Jas is a useful program as it can:
  - view histograms, tuples, data points and other Aida plots
  - use an event browser to look at the hits
  - use Wired to view an event showing the detector model



- Although a feature of the model used in Wired means that it takes no account of the movement of the ecal

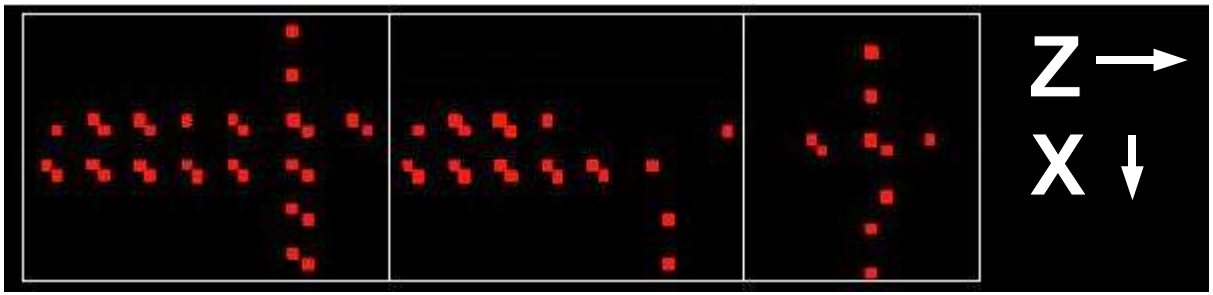


Marlin

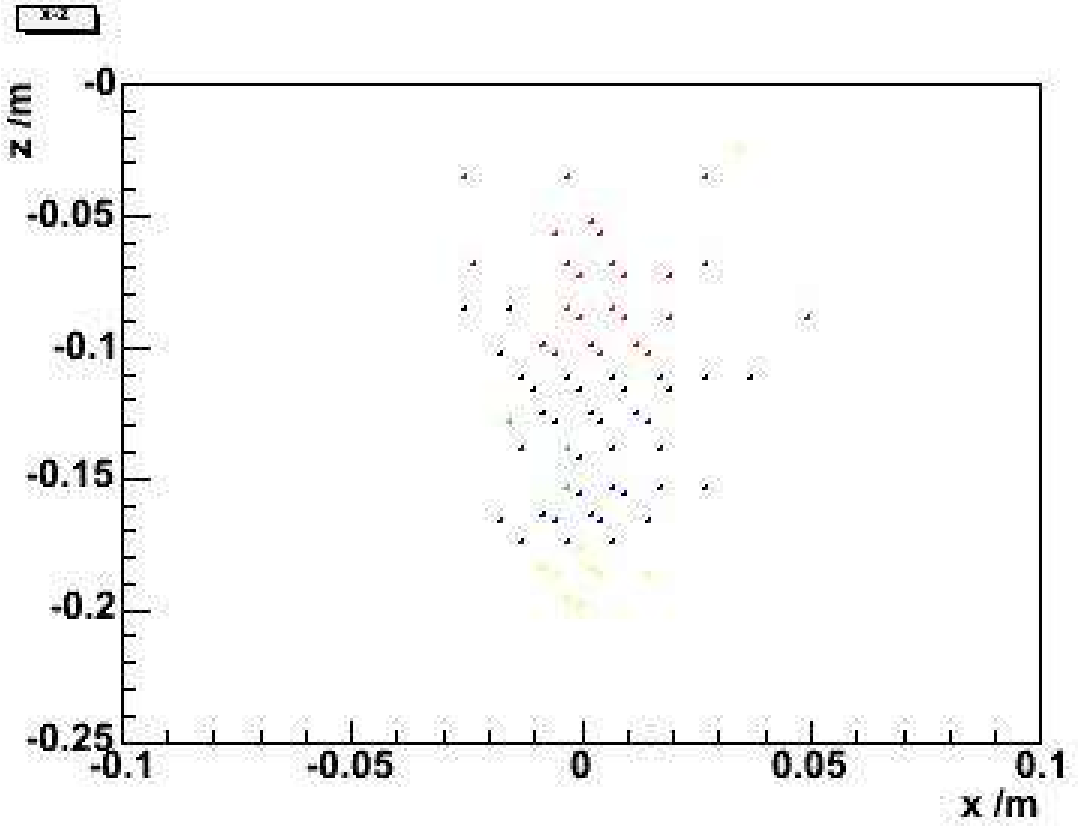
- Marlin runs using a steering file which defines the processors to use along with the input variables
- These processors are located in or linked to a packages folder in the Marlin directory.
- Processors can be created to read information from the data and then use Aida to fill histograms or tuples.
- Two examples of these processors I have used are:
  - MAGIC which is to look at the clusters in each event by looping over layers
  - CGA to define the geometry of the detector without user input into the program code

MAGIC

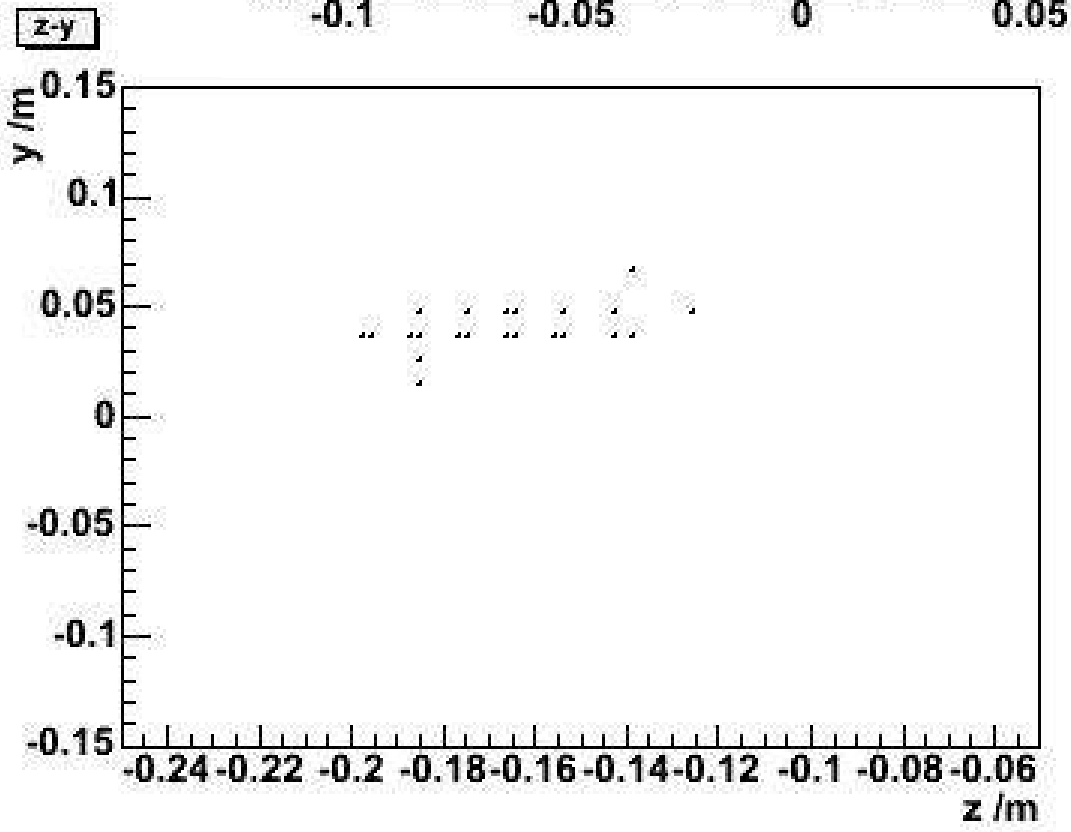
- Magic loops over layers in the detector looking at each hit and comparing it to hits/clusters already found in previous layers. These are then assigned to new or existing clusters.
- By using the steering file all the parameters can be set apart from the detector geometry which has to be entered into the code by hand at present.
- By defining these correctly in the latest version can apply the same code to simulations and data with little to change
- Using this output of clusters I used Marlin to store each one separately so they can be viewed in Wired singly for easier visual analysis of the clusters



Several clusters found without corrections to steering file



Single cluster found with corrections to steering file



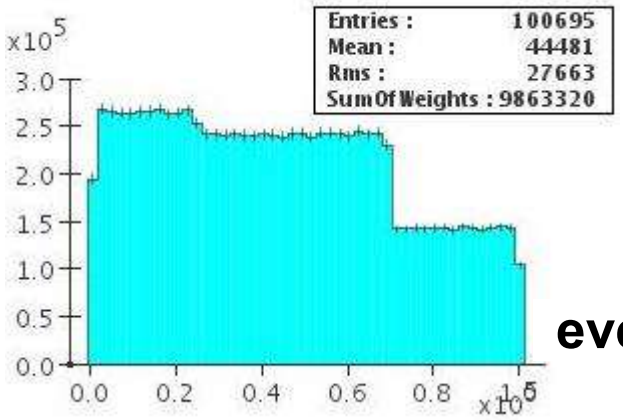
CGA

- To save having to enter the geometry by hand the CGA marlin package supplied with the latest version of mokka can be used instead
- It needs to have CGAinit run through the steering file and stored in the packages folder, this selects the model allowing the geometry to be accessed by another processor
- The makefile needs to include many Geant 4, Mokka, Clhep and Mysql libraries
- CGA has many functions I used the WhereAmI function which gives the volume name for a given 3D coordinate
- By looping over the detector volume searching for a volume name the layer positions can be found and used.
- I have emailed Chris Ainsley the code I have use to put into his MAGIC code.

Original problems

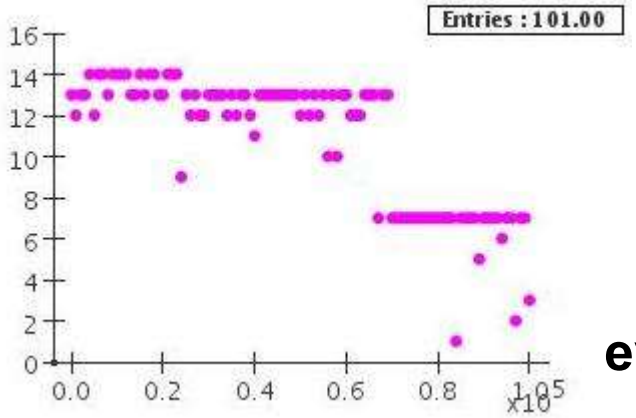
- The data to begin with had several problems with the energy of each event not being constant
- This was due to the amount of layers hit in each event not being at a constant level

energy weighted hits



event

number of layers hit

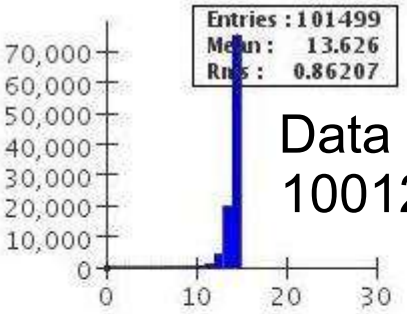


event

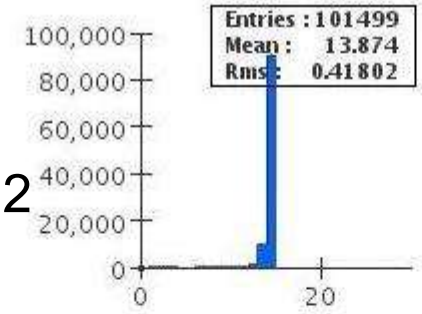
- After George gave me new files I began my analysis

Particle leakage

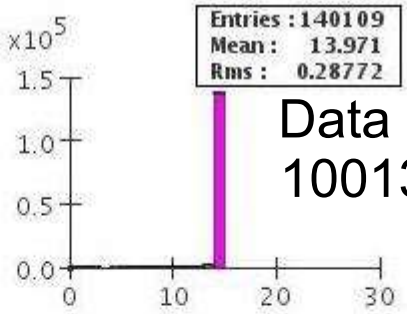
- The ecal in the test beam only had 14 layers so the detector did not pick up the full shower of the electron
- The furthest layer hit in the detector is greater than the number of layers hit which suggests the particle missed layers on the way through the detector



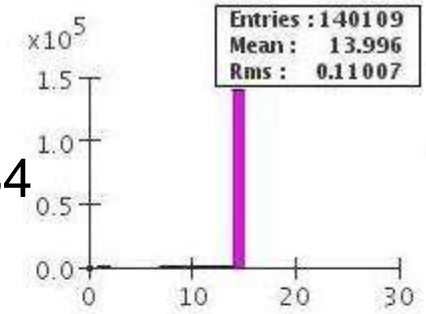
Data 100122



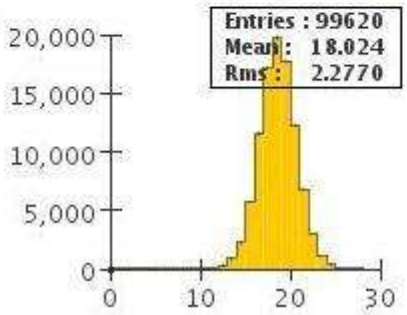
Number **Maximum**

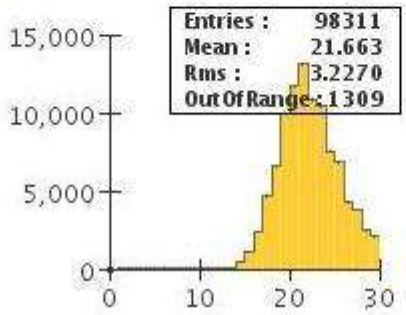


Data 100134

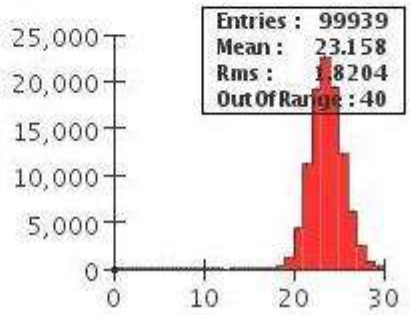


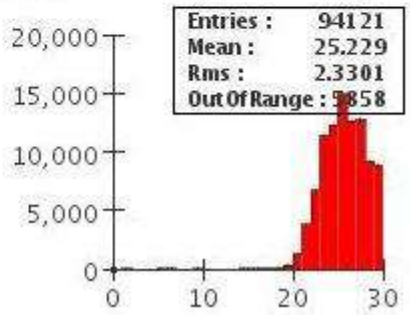
Number **Maximum**





Simulation 100122





Simulation 100134

Particle leakage

- By looking at the first 14 layers in the simulations I created matching the 9 runs I had I could see how much of the event was contained in these layers
- For the 1 GeV runs it seems to be about 80% of the hits and 86% of the energy and no different for the run not at the centre of a wafer (100137)
- For the runs with increasing energy the amount measured drops but not by a constant amount (run 100123 and 100134 have energies 2GeV and 3GeV respectively)

Run	100121	100122	100123	100127	100128	100131	100132	100134	100137
% of hits	80.47	79.8	70.03	79.69	80.4	79.64	79.67	64.06	79.72
% of energy	86.25	85.83	80.68	85.81	86.28	85.81	85.72	77.33	85.74

- The hits weighted by energy shows that the data does follow the same trend as the full detector simulation

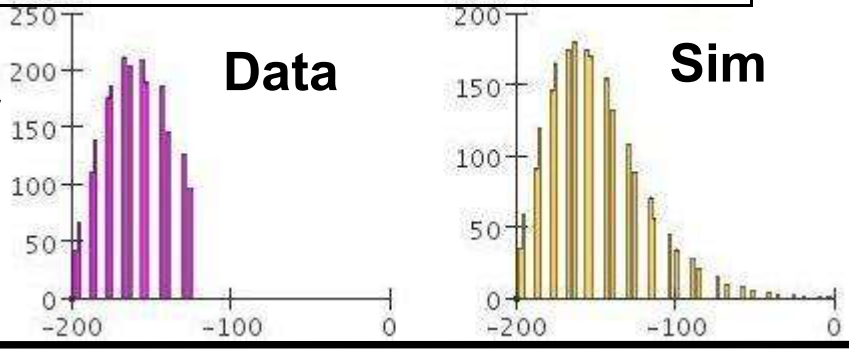
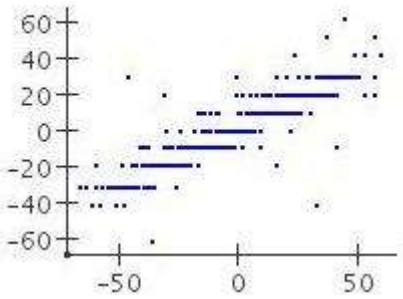


Table and actual position

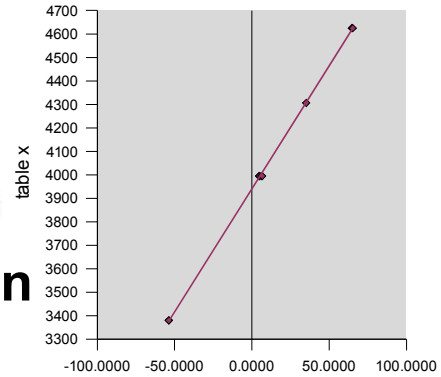
- When the table of the ecal is moved I need to find the relation of this to the actual position of the hit in the ecal
- I plotted the x and y actual impact point against the predicted point from fitting a line through the 4 drift tubes
- By the plotting the average actual impact point against the wafer position I made corrections for x and y
- I then put these corrections into my program and added user defined wafer x and y positions to the steering file

Predicted X



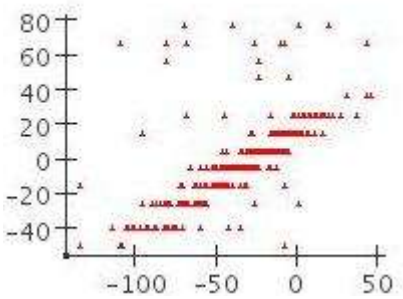
actual X position

table X



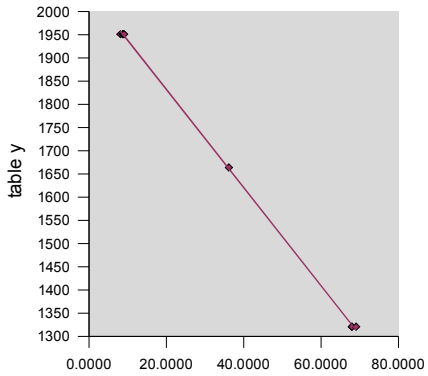
X position

Predicted Y



actual Y position

table Y



Y position

Position resolution

- Using the fit of the line through the 4 drift tubes I made a predicted impact point in each layer
- By then averaging all the hits in a layer and converting the position I could look at the position resolution in each layer
- As expected the rms increases later in the detector
- For the simulations that passed through the drift tubes in the layout of model TB05 (those at wafer 5) the rms was larger compared to the matching data runs but still showed the same trend of increasing later on in the detector
- I also noticed in the x position in data that there was an offset in alternate layers
- I looked at the simulation and the version of ecal I was using seemed to have several layers with offsets but this does not show up in the position resolution

Data position resolution plots

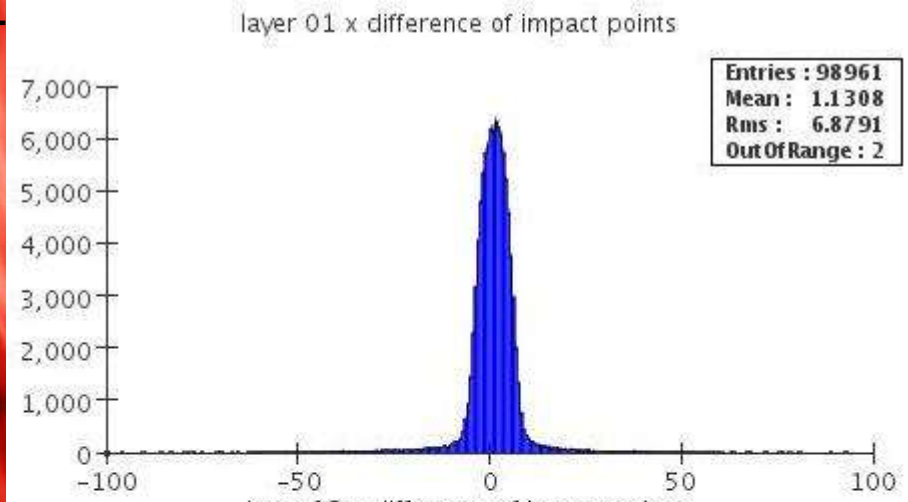
Layer

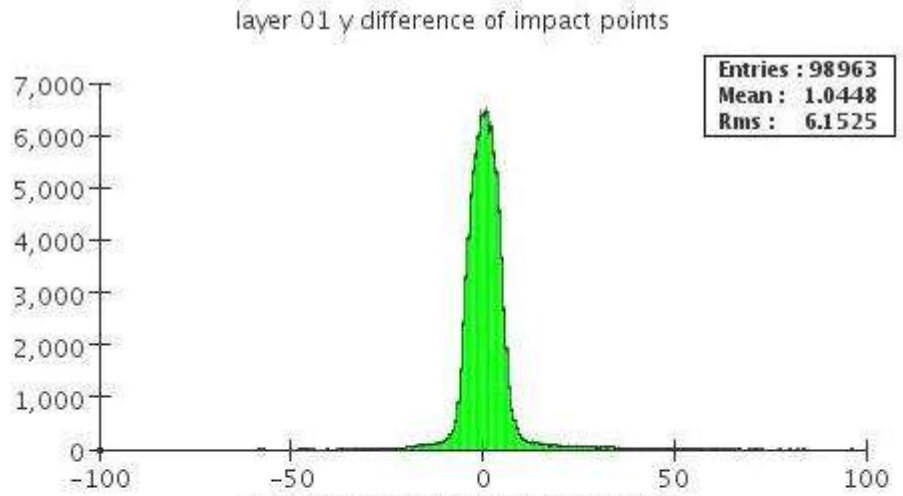
1

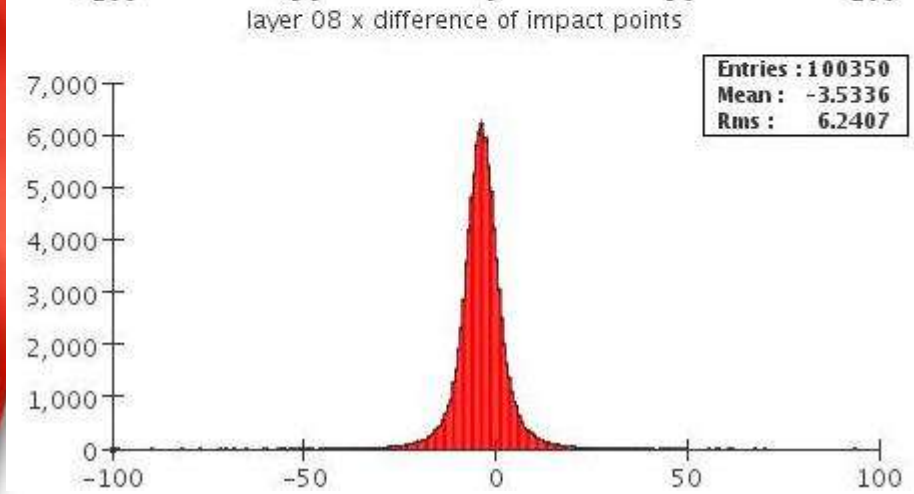
8

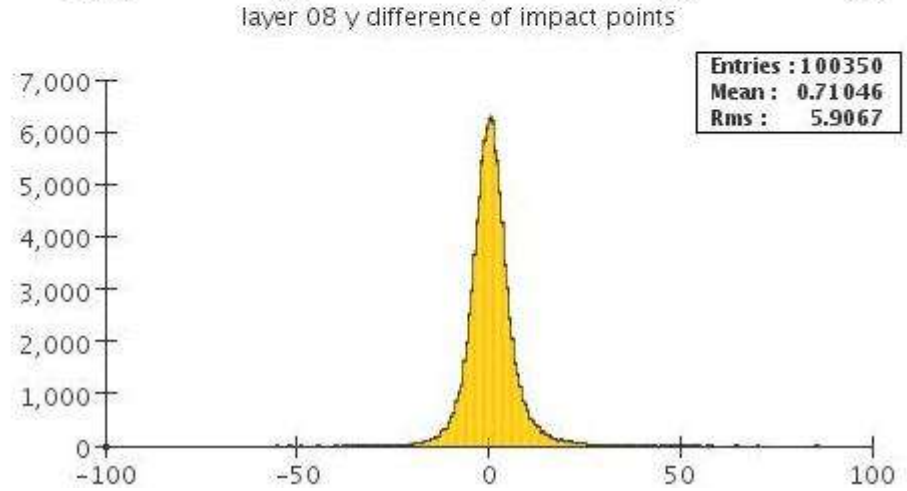
X

Y









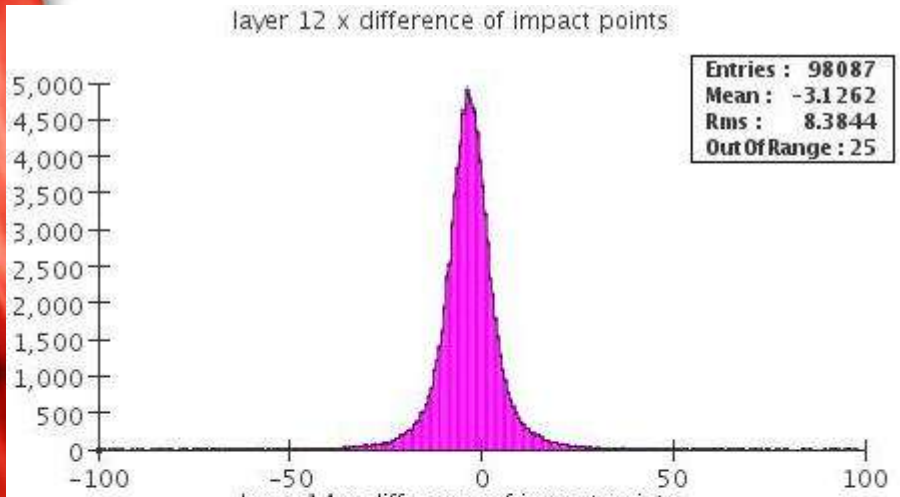
Data position resolution plots

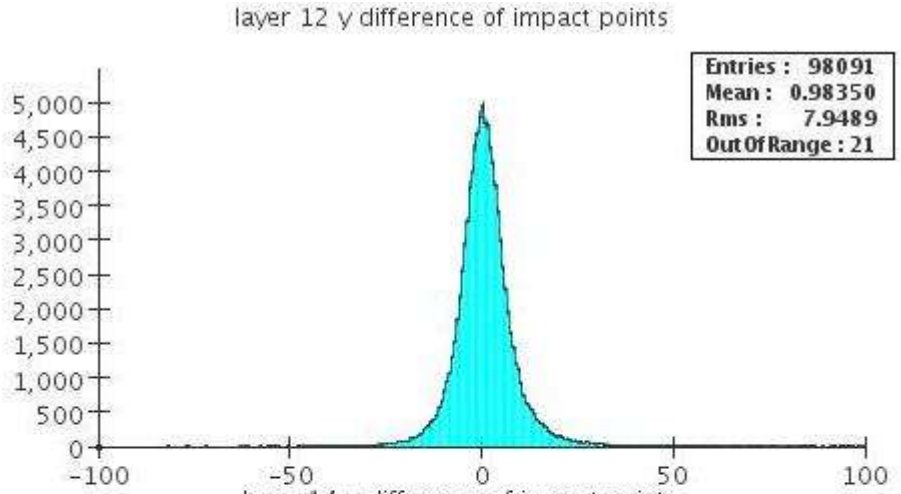
Layer

X

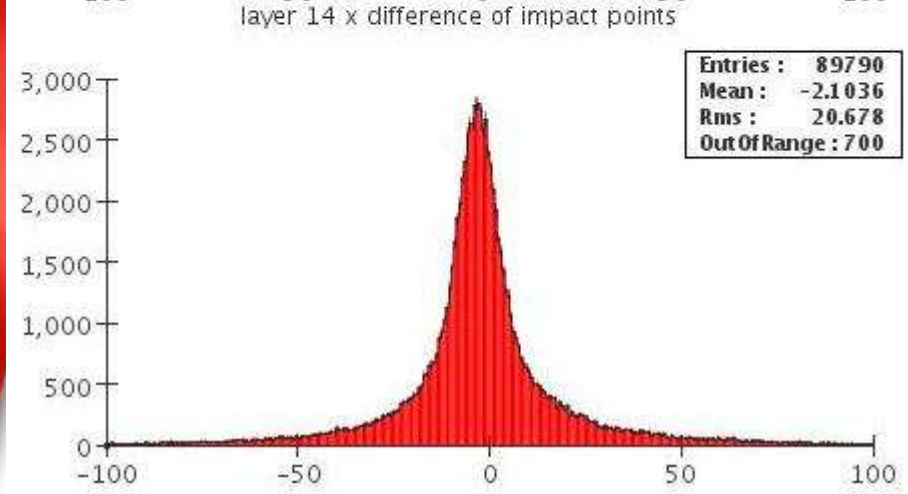
Y

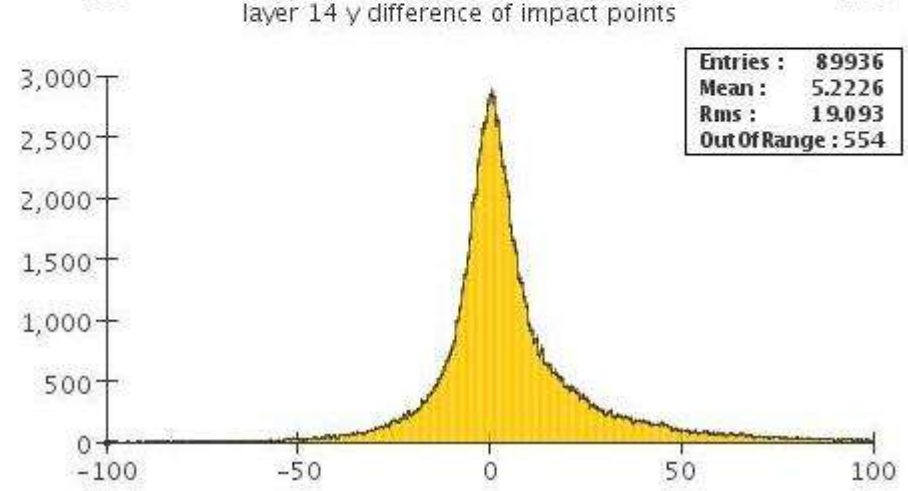
12





14





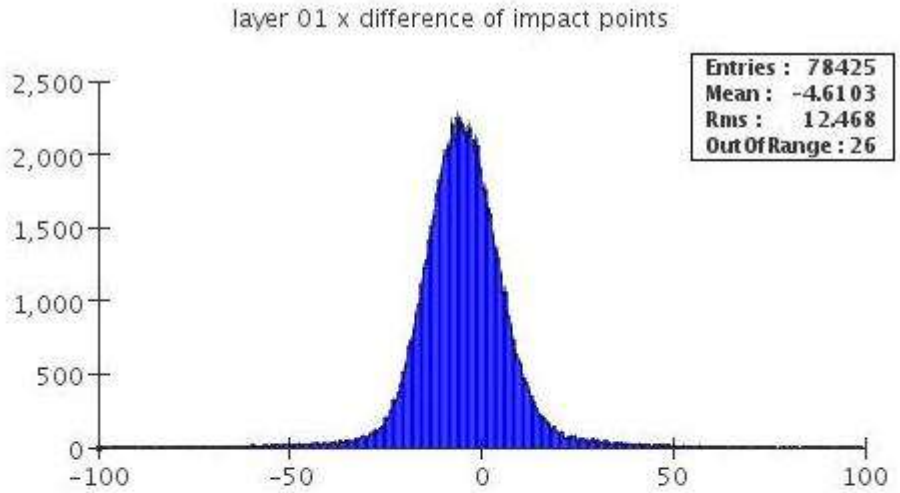
Sim position resolution plots

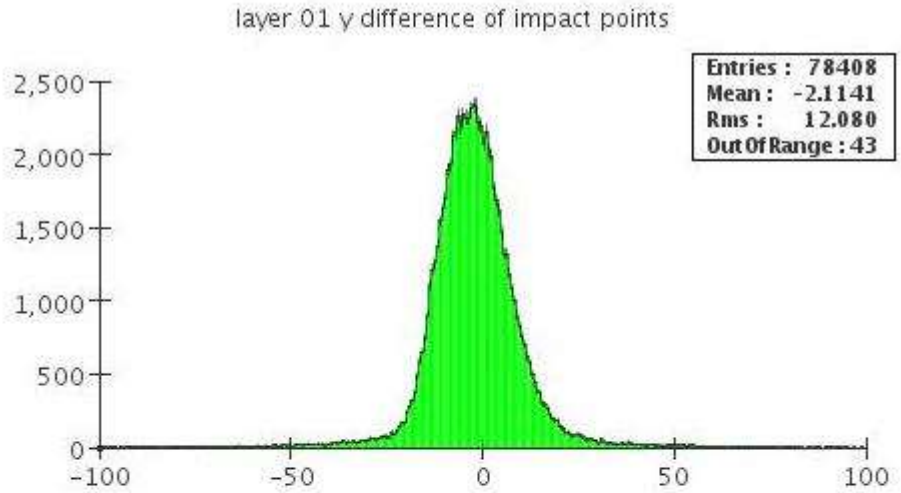
X

Y

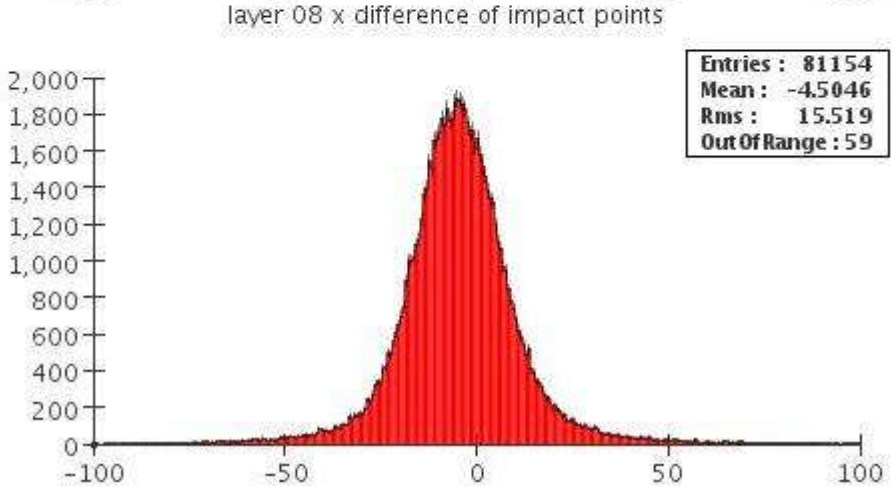
Layer

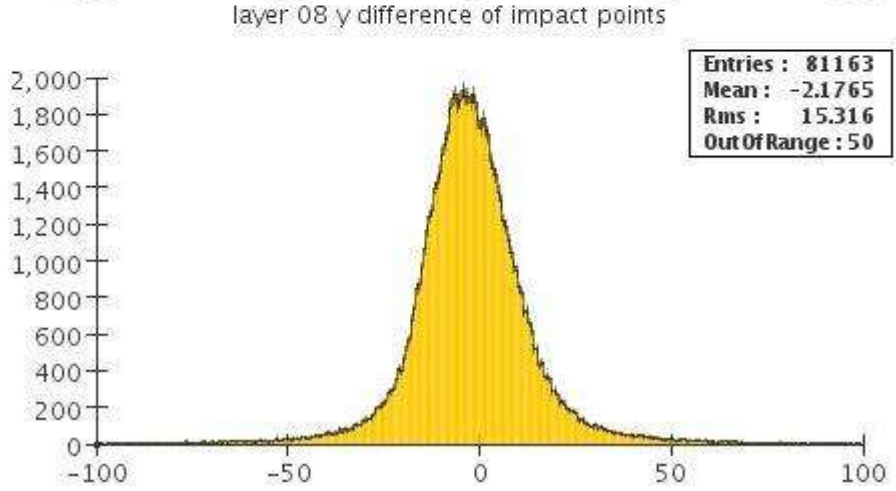
1





8





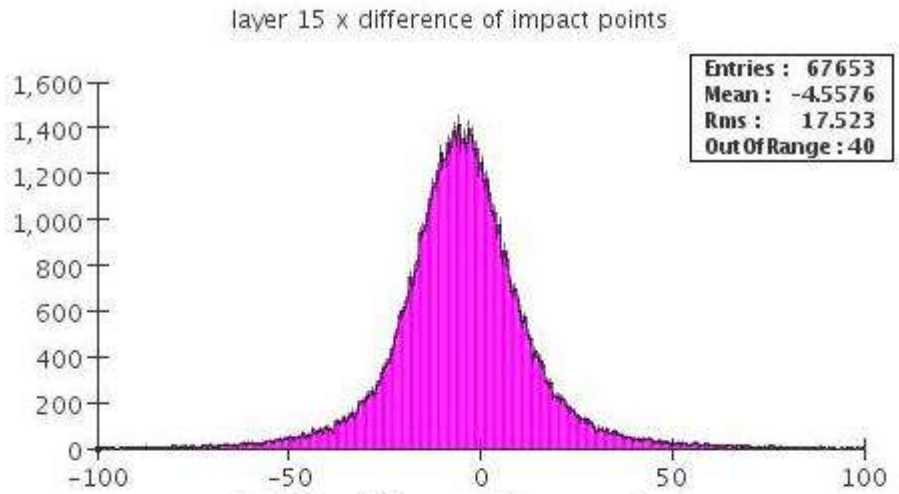
Layer

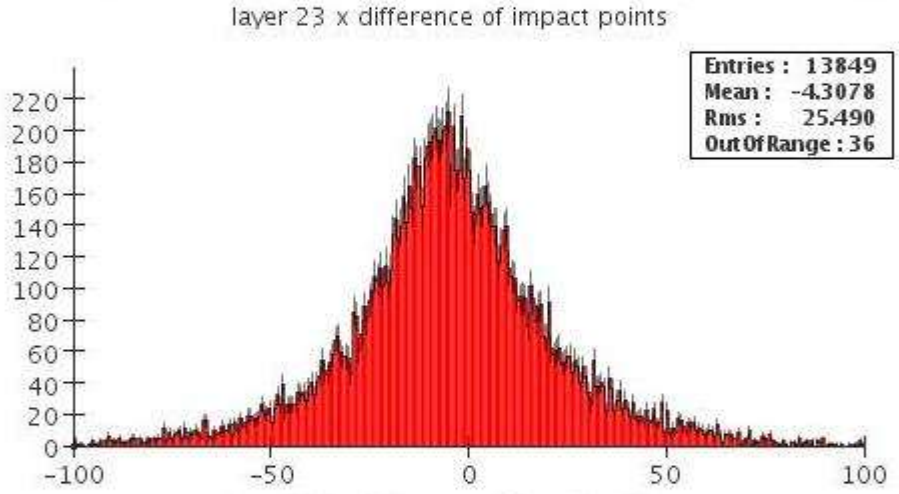
15

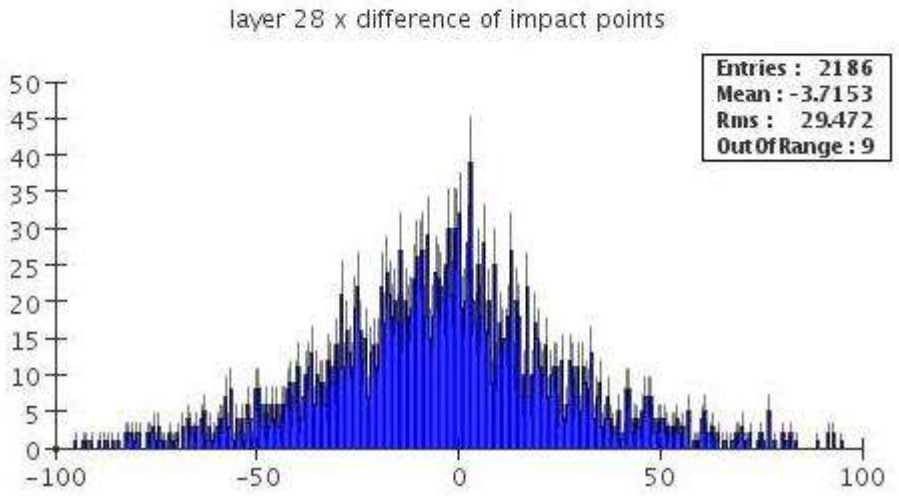
23

28

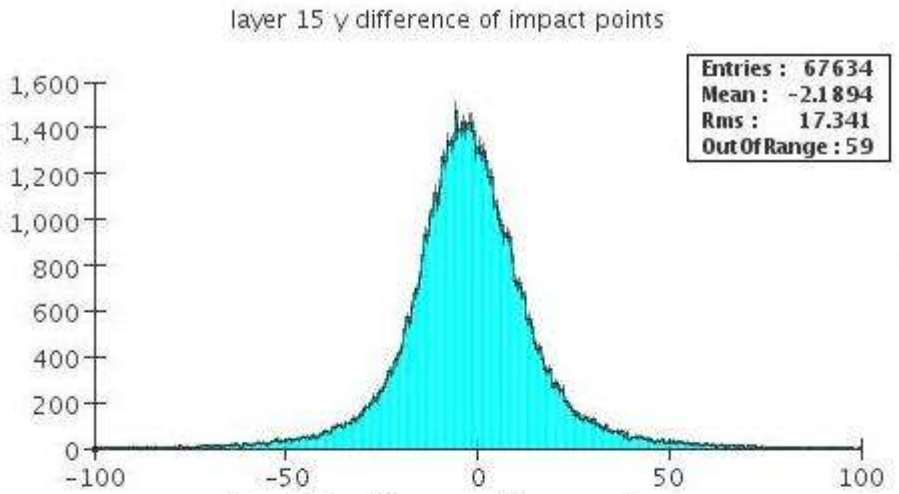
X

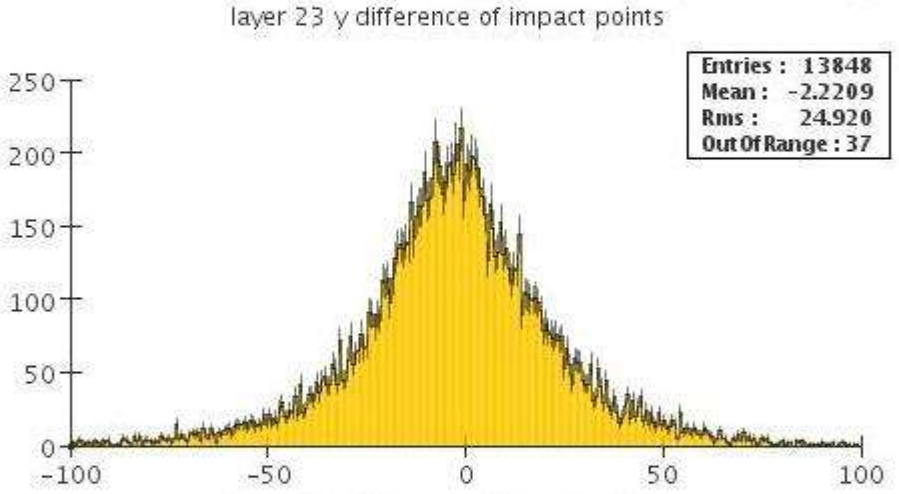


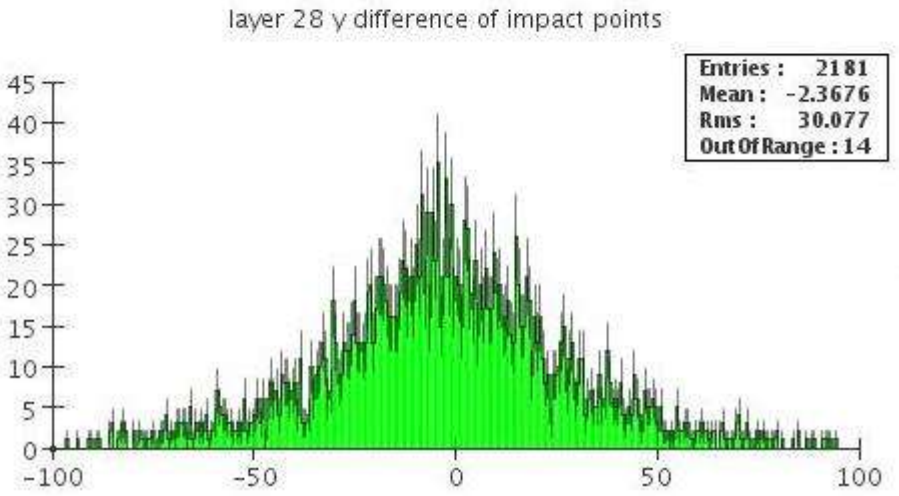




Y







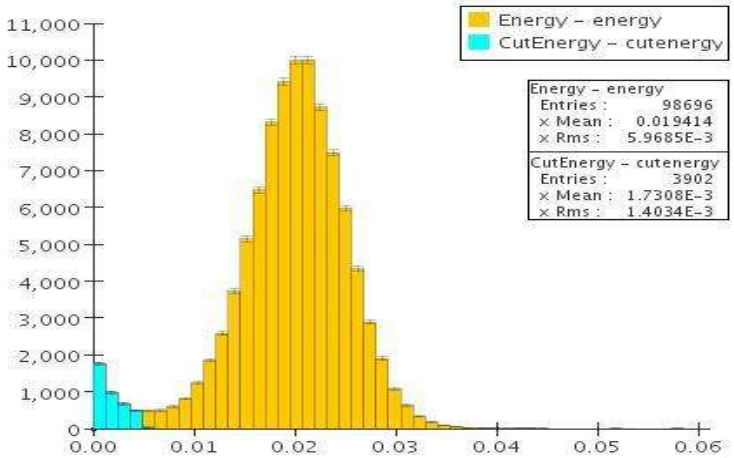
Energy resolution

- When I made plots of the energy for each event I found a low peak near to 0 in some of the data runs and more prominent in some of the simulation runs.
- The solution could be that the electron must be interacting in air and that the drift tubes are absorbing this low peak
- Here is what I have found out:
  - **Low energy peak is from low peak in number of hits**
  - **The peak disappears in simulations through drift tubes**
  - But appears for:
    - **runs in data at bottom row of wafers**
    - **and is more prominent in simulations for these runs**
  - With no drift tubes:
    - peak disappears when beam start just in-front of ecal
    - reappears when started at proper beam start point
    - **except is not increased for runs at wafer 5**

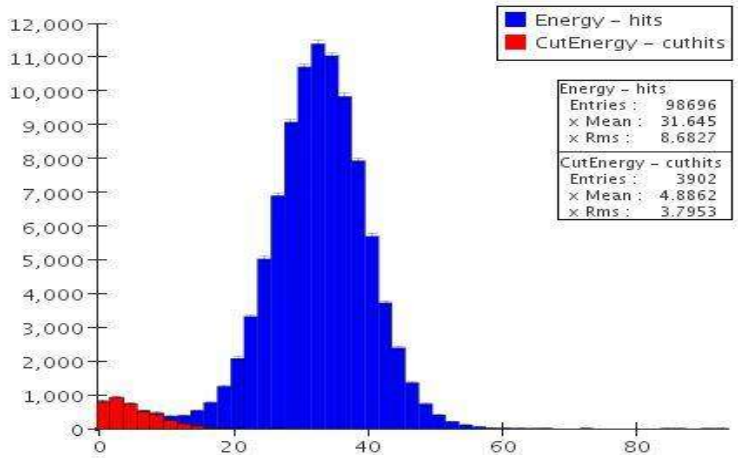
Plots of energy resolution

- energy plots showing low peak and number of hits peaks

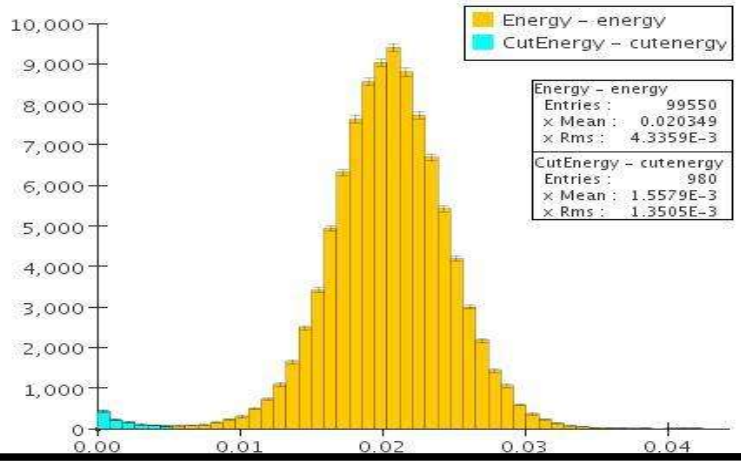
Energy 100127 Data



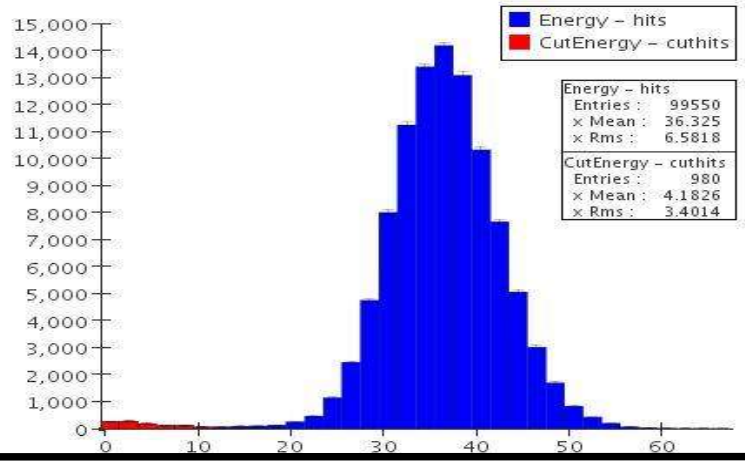
Hits 100127 Data



Energy 100137 Sim



Hits 100137 Sim



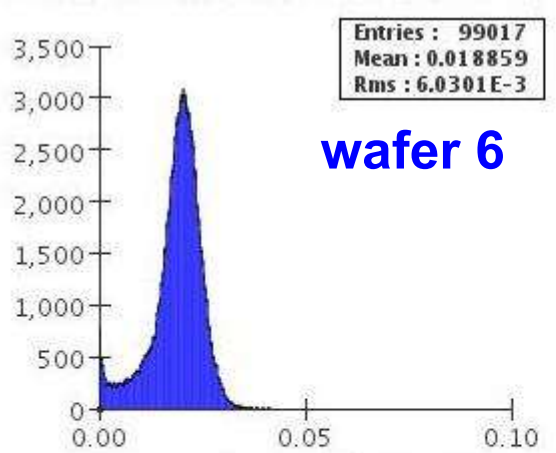
Energy in GeV

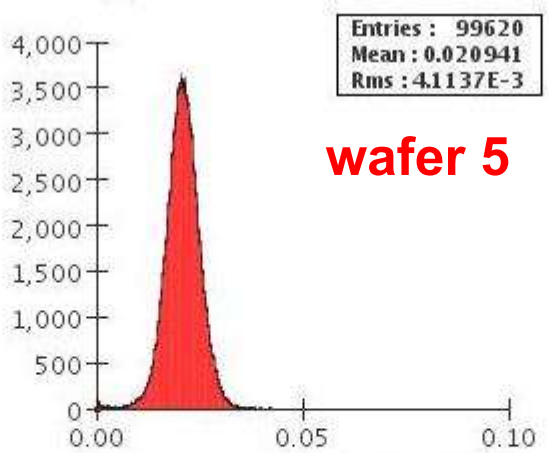
wafer 6 5 4
layout 3 2 1

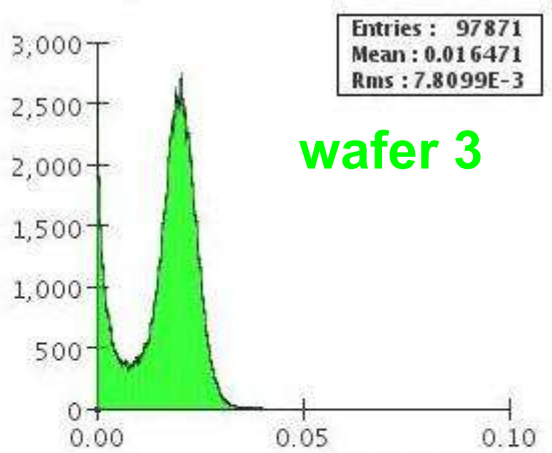
Original

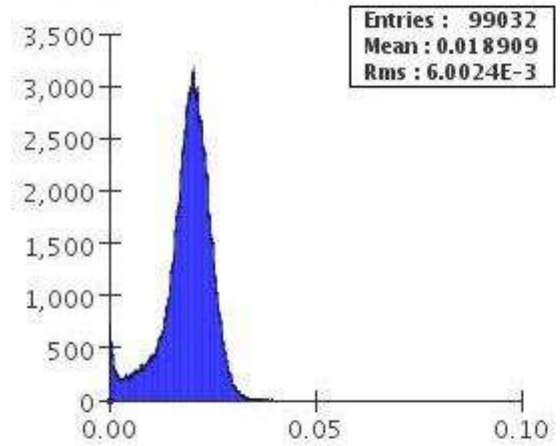
No Drift tubes

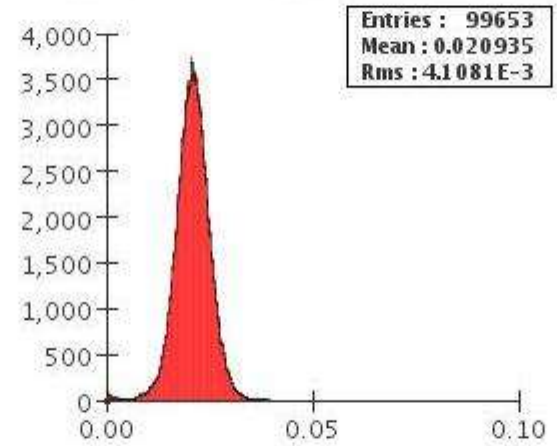
Just in front of ecal

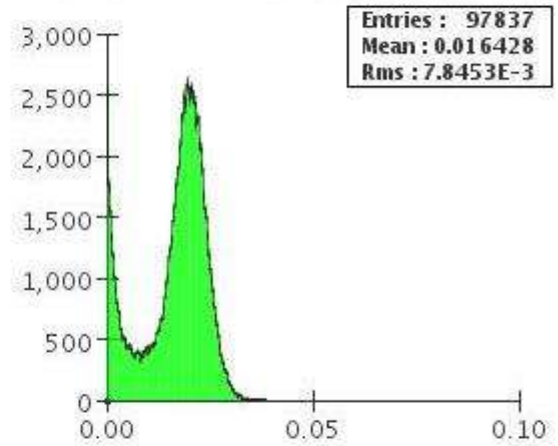


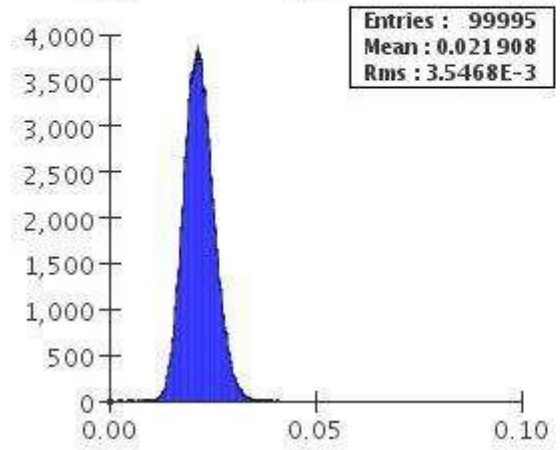


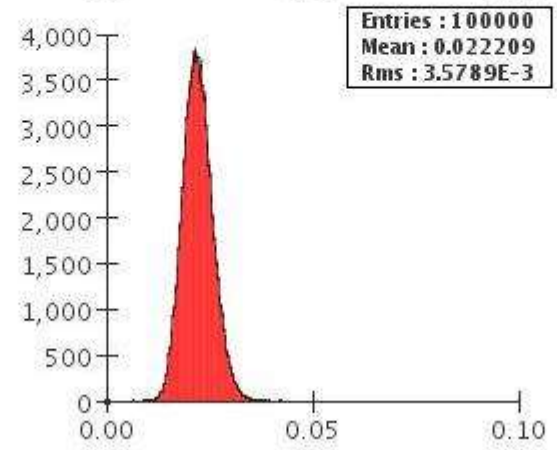


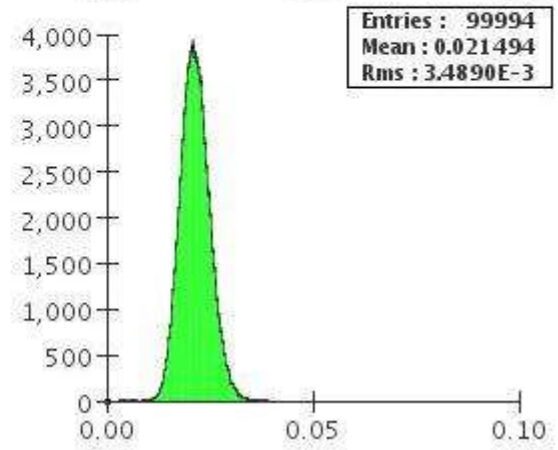












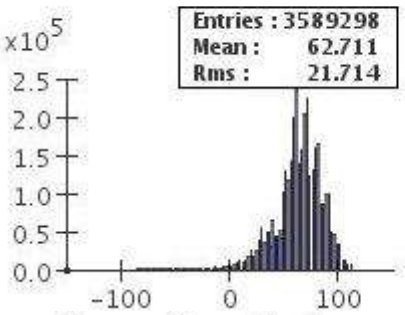
Not centre of wafer

- In the data files I have I only have one run not at the centre of a wafer 100137
- As I already mentioned there appears no difference from the simulation in the amount of leakage out of the back of the detector
- The energy resolution also has a similar mean and rms compared to the other 1 GeV runs
- It also has the low energy peak in the simulation like the other runs not at wafer 5
- Most importantly though the position resolution also shows no difference compared to the other rows

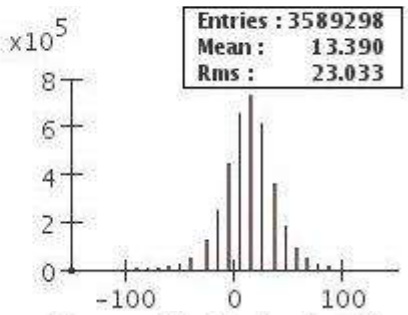
Selection of other plots

- Here are some other plots which I have created:
- x position and y position
- x v y position on first layer and for first hit
- number of hits per event and an approximation of the total energy in an event

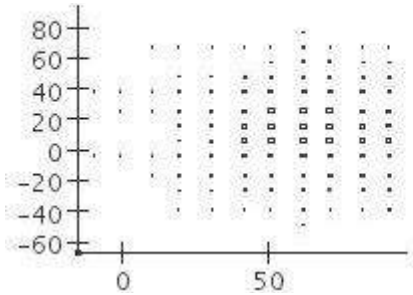
X position



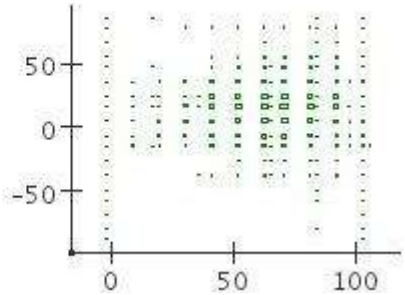
Y position



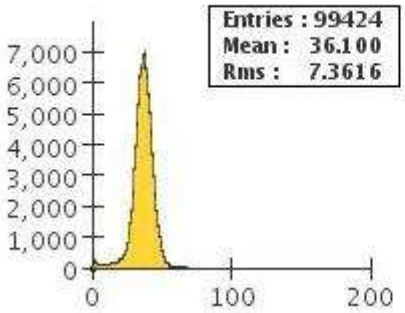
X v Y first layer



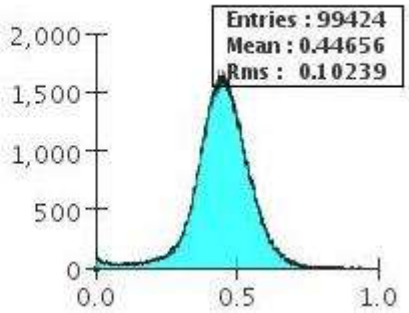
X v Y first hit



Hits per event



Total Energy



Summary

- I have managed to:
  - Use MAGIC and CGA through my knowledge of MARLIN
  - Understand how to use the different Aida functions to create different types of plots
  - Look at the leakage along with the position and energy resolutions.
  - Find no difference in the run not at the centre of a wafer

- Unfinished work:
  - Reason for low energy peak
  - Better comparisons of non centre of a wafer
  - Implementation of CGA into MAGIC
  - Improve the calculation of the fraction of energy measured in the silicon compared to that in the tungsten