# LumiCal at ILC - backgrounds and Occupancy with the DBD beam parameters

**Itamar Levy**

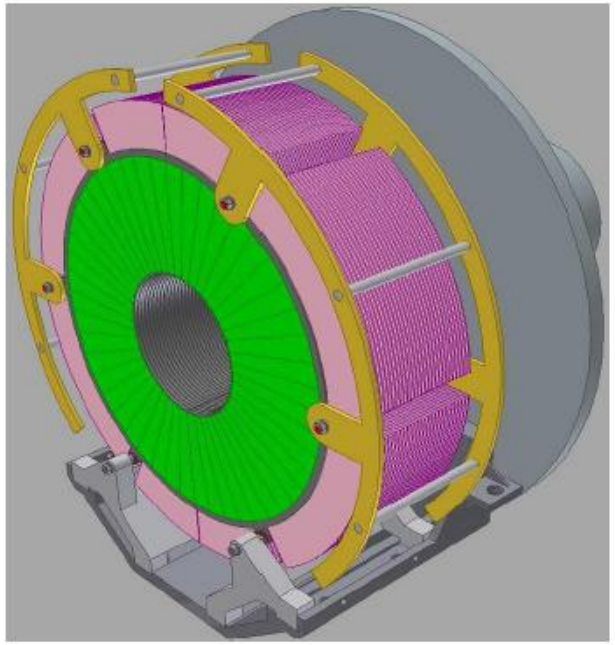
Tel Aviv University


November 2012

# Introduction

In the detector concepts foreseen for the ILC, LumiCal design as specialized calorimeters in the very forward region design for precise measurement of the luminosity.

LumiCal current design :



- 2500 mm from the IP
- Radius Inner - 77 mm outer 196 mm
- 48 azimuthal & 64 radial divisions
- 30 layers of Tungsten (3.5 mm)

  and Silicon (0.32 mm)
- 3.5° azimuthal rotation (every second layer)

As part of the DBD new beam parameters Proposed for the ILC, this work aim is to investigate the occupancy and backgrounds in LumiCal with the new beam parameters.

# Beam parameter

The new beam parameters proposed for the ILC are:

| | | | |
|---|---|---|---|
| CMS | GeV | 500 | 1000 |
| Collision rate | Hz | 5 | 4 |
| N bunches | nb | 1312 | 2450 |
| bunch population | N [10^10] | 2 | 1.74 |
| bunch separation | ns | 554 | 366 |
| Luminosity | 10^34 cm^-2 sec^-1 | 1.47 | 4.32 |

# Data sets (1)

For this study 3 data sets were in use. The data for the two background process were taken from the reconstruction result of the central production for the ILC DBD, (@http://ilcsoft.desy.de/dbd/generated/ ).

The Beam-strahlung pairs samples were generated with “GuineaPig” (v1.4.4), and reconstructed with “Mokka” (ILC software v01-14-p00) using the “ILD_o1_v05” detector module. 2650BX were produce (job id I36137) and 798BX from it included here.

The low $p_T$ gamma gamma samples were generated with “Whizard” (v1.95 – job id I36137) and reconstructed with “Mokka” (ILC software v01-14-p00 – job id I106472) using the “ILD_o1_v05” detector module. This job contained 2332500 events in 933 files that produced in L=0.002923122 and $\sigma = 8.19 \times 10^8$ *fbarn*

This sample took into account also 80%R(e) and 20%L(p) polarization.

# Data sets (2)

For comparison, a 10k sample of single electrons were produced, with energy of 500 GeV and a uniform distribution in θ (inside the fiducial volume $41_{mrad} < \theta < 69_{mrad}$) and φ.

The sample was reconstructed with “Mokka” (ILCsoft v01-14-p00), and decoded with the “Marlin” processor from the same version.

The two background samples were decoded with the latest version of the ILCsoft (v01-16).

# Base of comparison

The base of comparison will be a single BX, since the Bhabha event-rate is as follows:

$$R_{bha} = L\sigma_{bha}$$

and as a first approximation the Bhabha cross section is:

$$\frac{d\sigma_{bha}}{d\theta} \approx \frac{32\pi\alpha^2}{S}\frac{1}{\theta^3}$$

therefore $R_{bha} \approx 8.6Hz$ .

For the gamma gamma low $p_T$ sample, the cross section can be determined from the process luminosity L, and N number of particles that hit LumiCal :

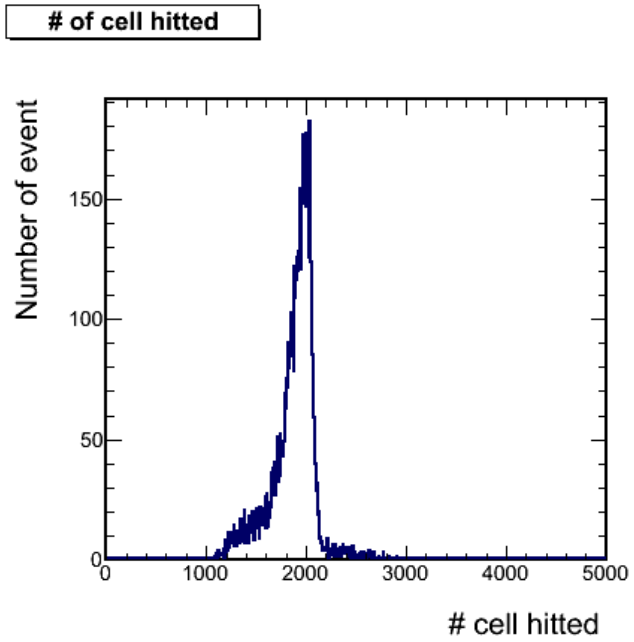
$$\sigma = \frac{N}{L} \rightarrow \overline{R_{\gamma\gamma}} \approx 4.8kHz \rightarrow \overline{R_{\gamma\gamma}} \approx 0.49event / BX$$

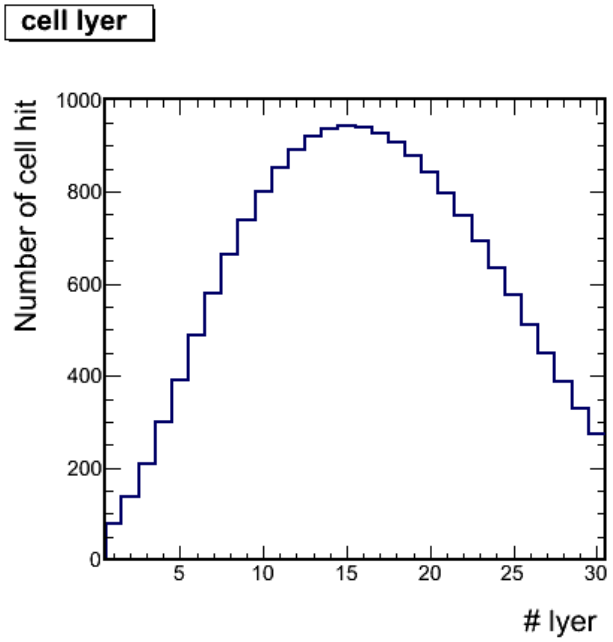
The Beam-strahlung pairs samples divided in to single BX

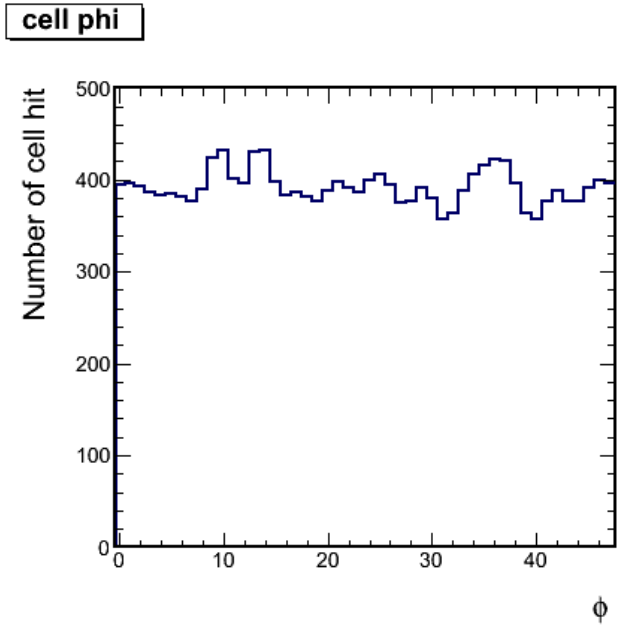
# Single electron(1) – cell hits

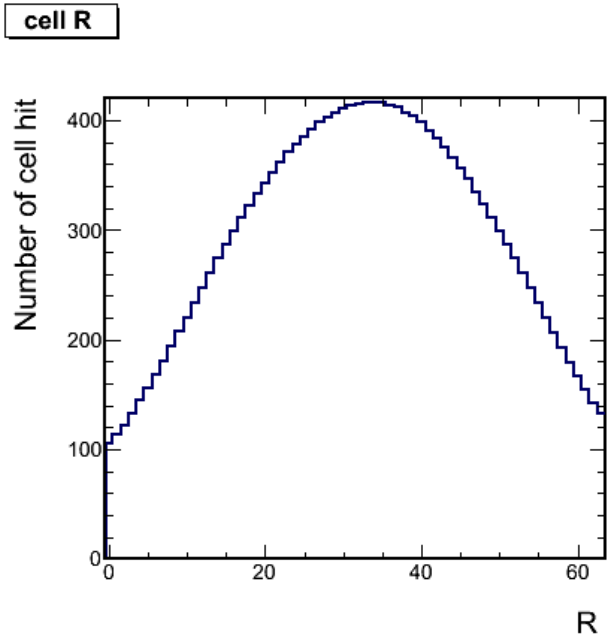
The single electron sample , is normalized to the number of events in the sample (10k).

The average number of cells hit is 1882.



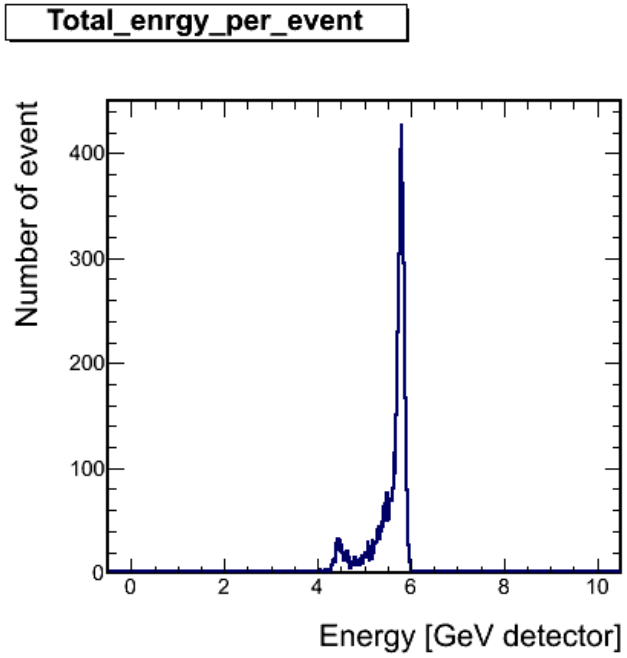



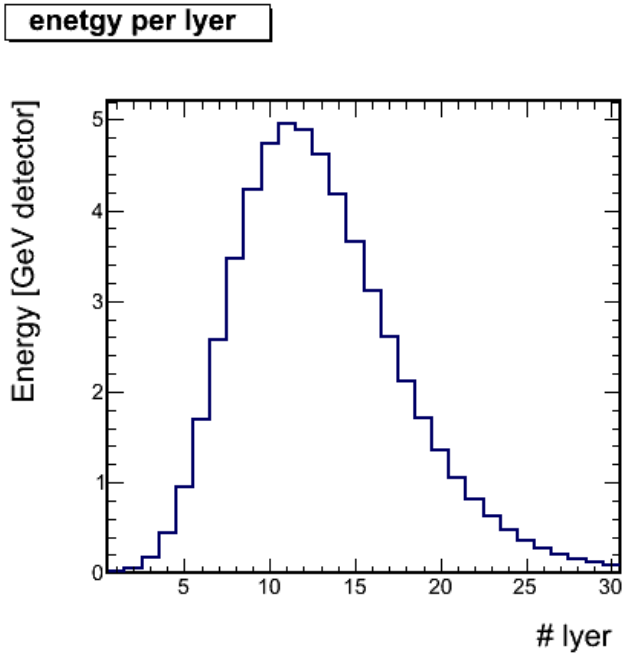
# Single electron(2) – energy deposit

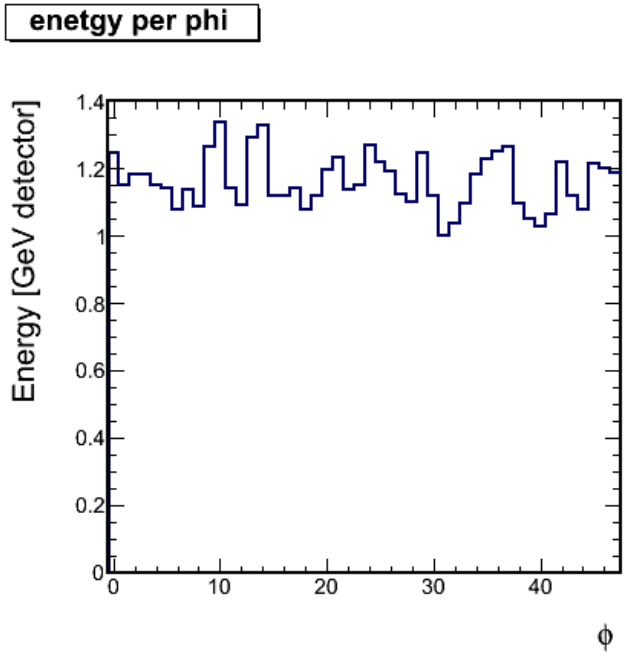
In the total energy plot the decrease seen is due to the tail gap.

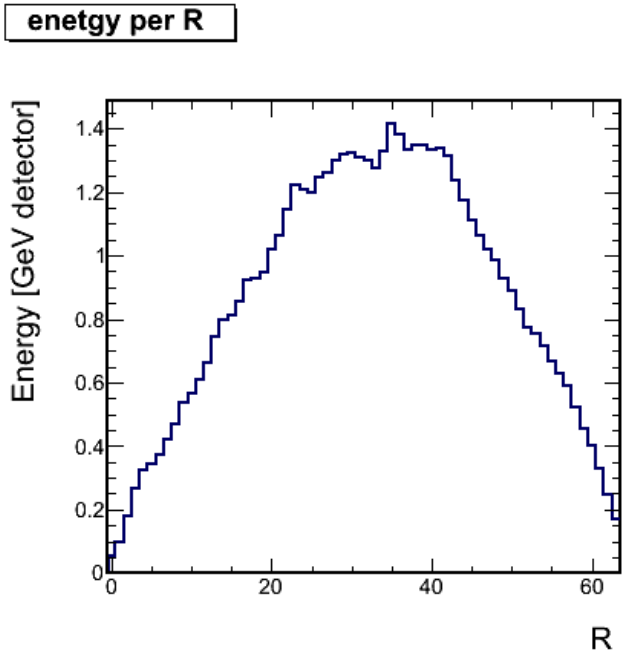
we can change the energy scale to the amount of charge produce by using the factor :

$$S[fC] = \frac{1.6\times10^{-4}}{3.67} S[eV]$$



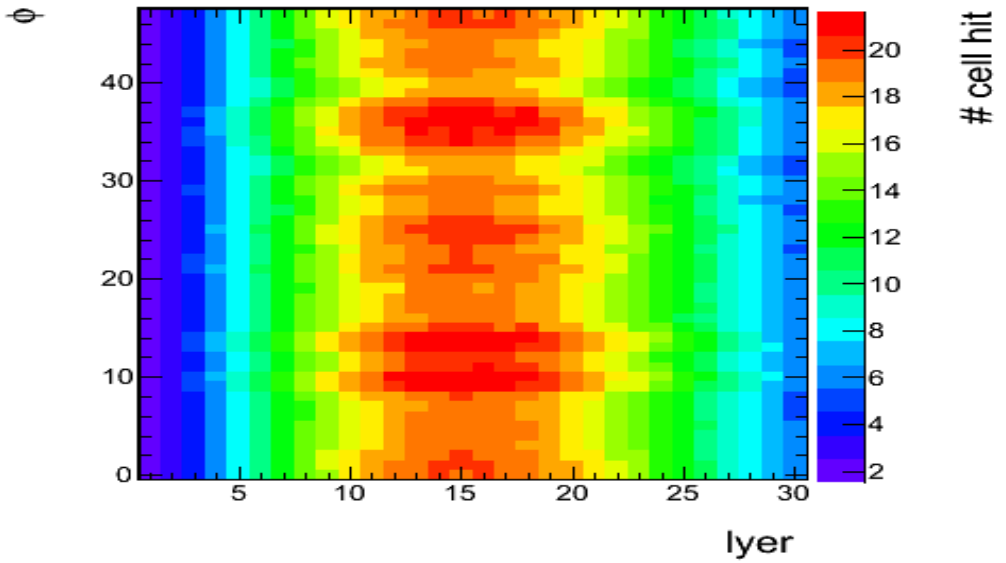



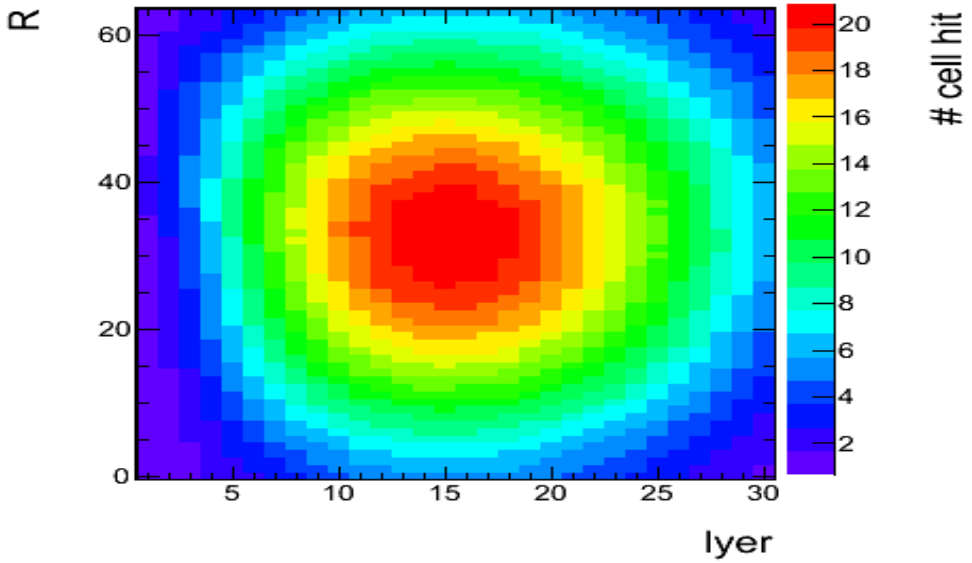



# Single electron(3) – cell hit map

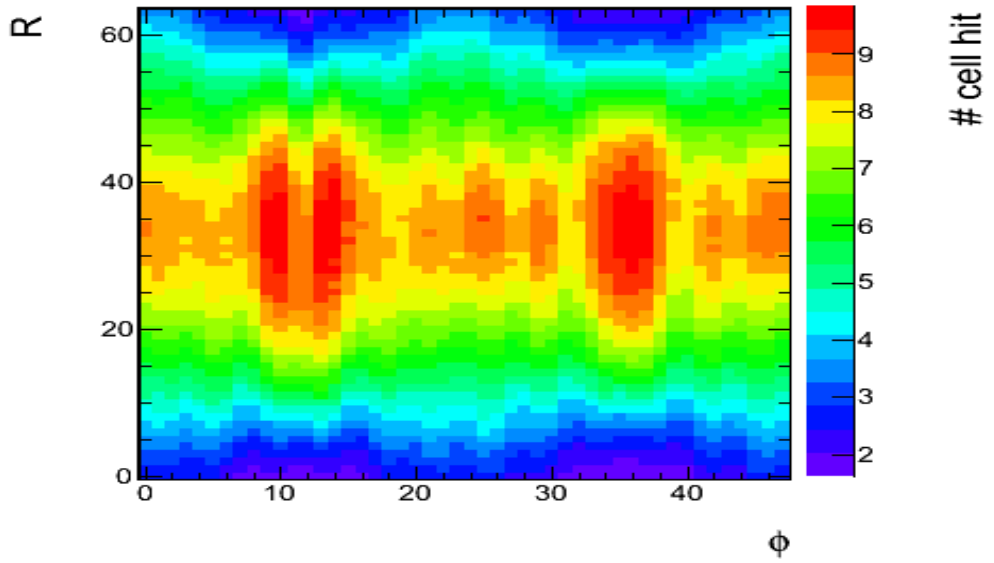
cell_hit_lyer_phi




cell_hit_lyer_R

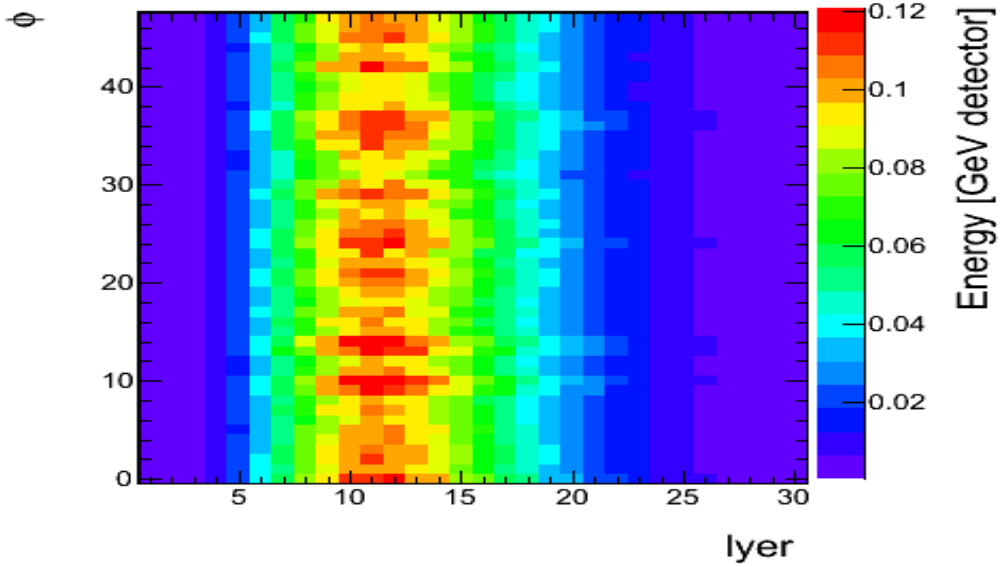



cell_hit_phi_R

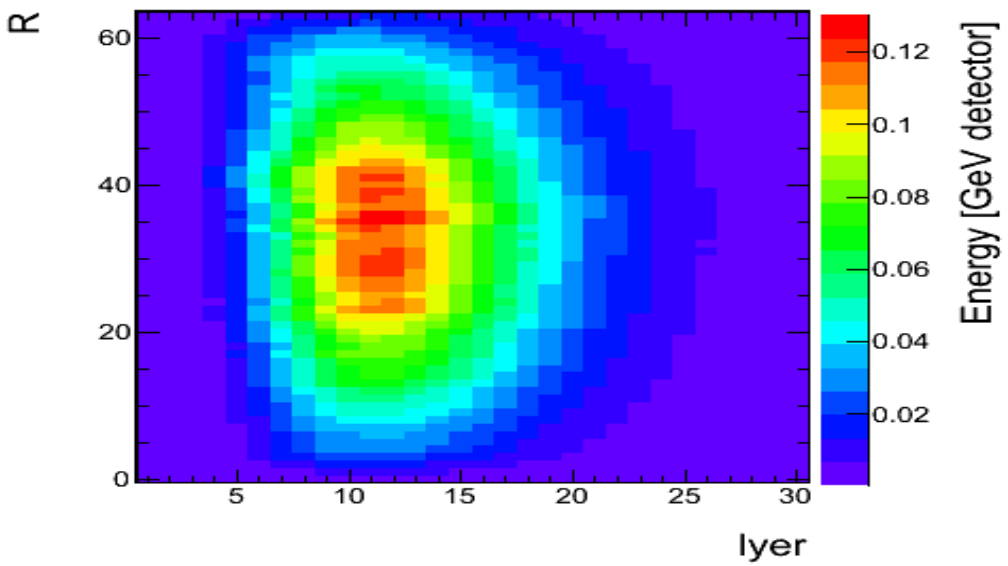


# Single electron(4) – energy deposit map

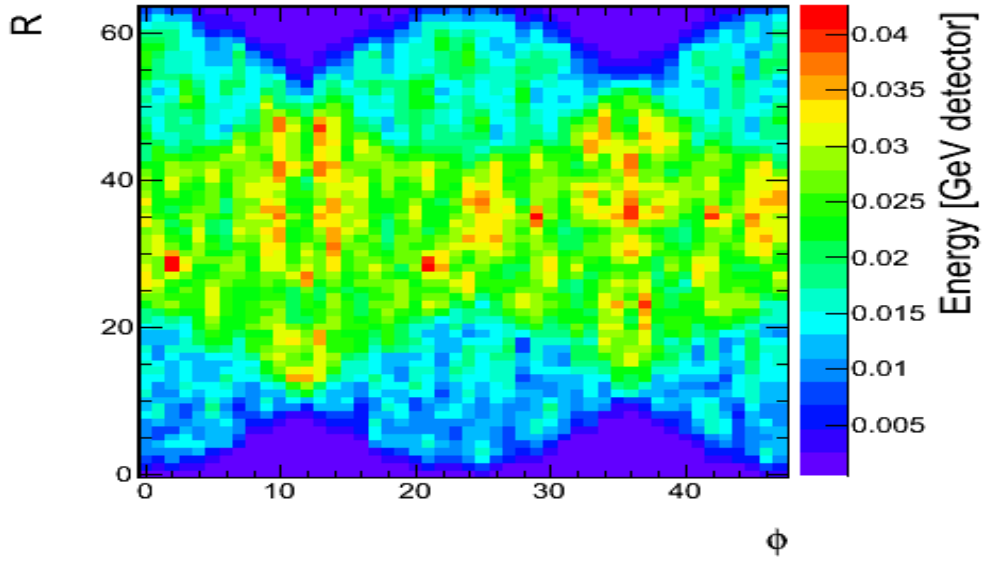
energy_sum_per_lyer_phi




energy_sum_per_lyer_R



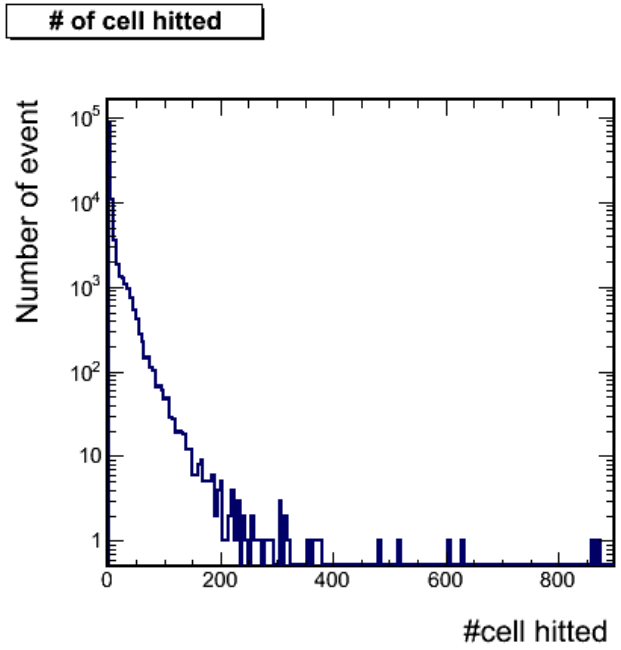

energy_sum_per_phi_R

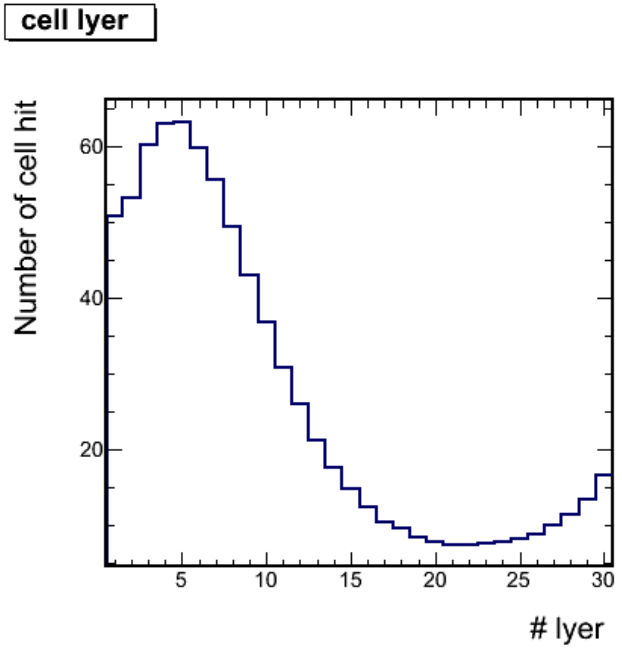


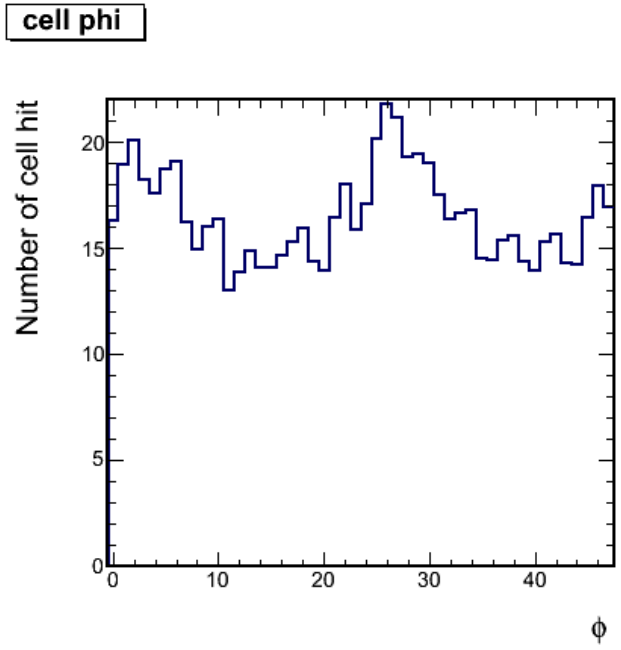
# pairs(1) – cell hits

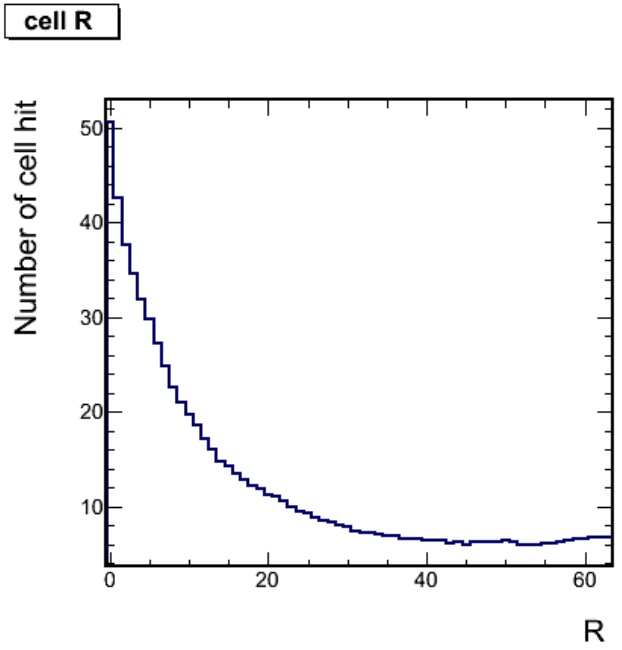
The Beam-strahlung pairs sample is normalized to the number of BX used in the sample (798BX).

The average number of cells hit is 792.



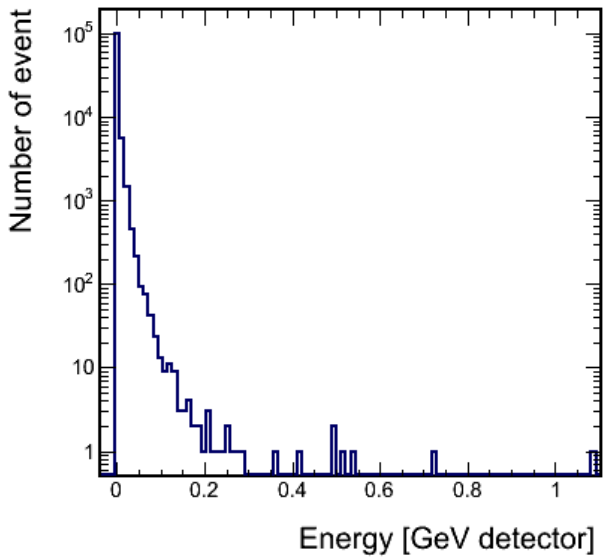



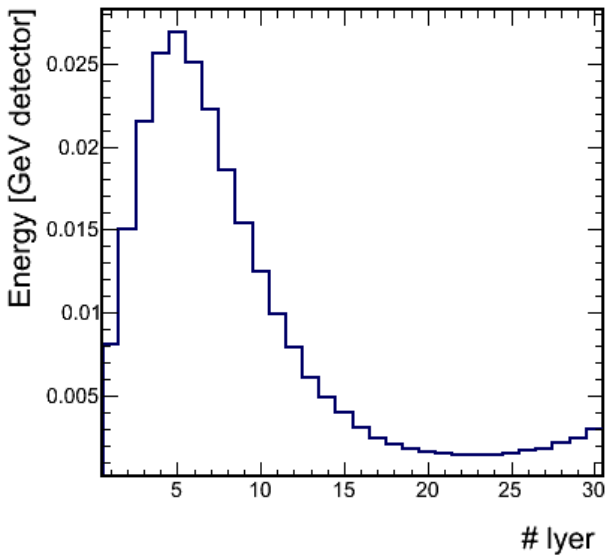
# pairs(2) – energy deposit

- 

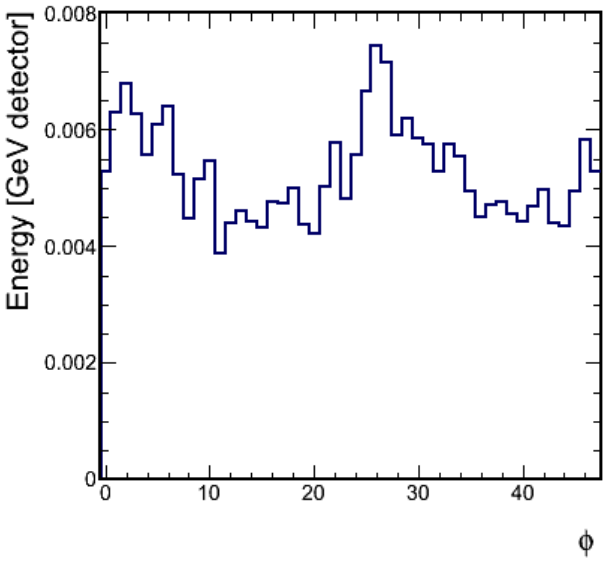
Total_enrgy_per_event



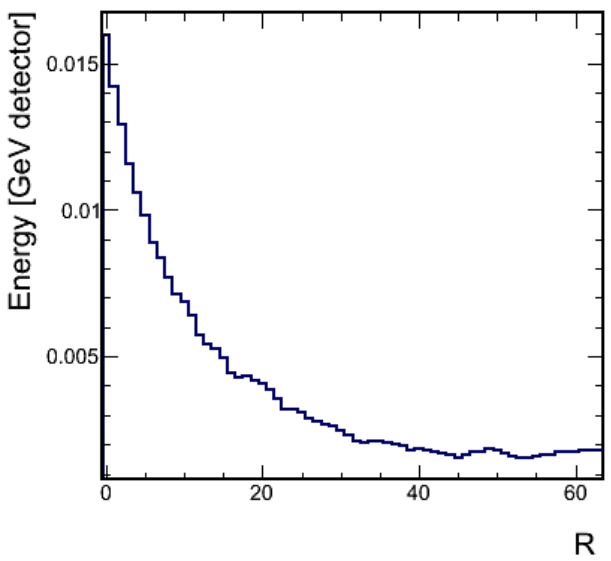

enetgy per lyer




enetgy per phi

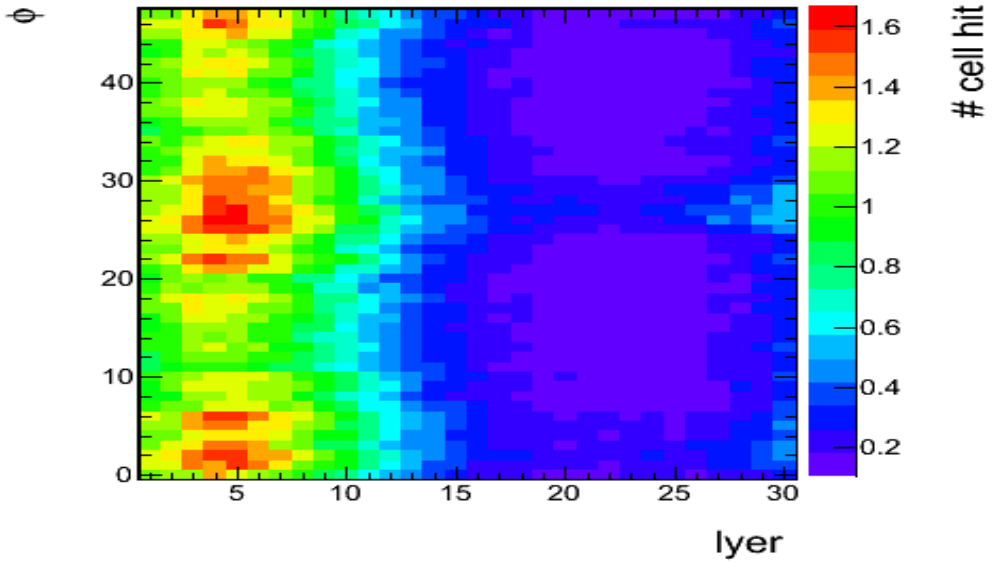



enetgy per R

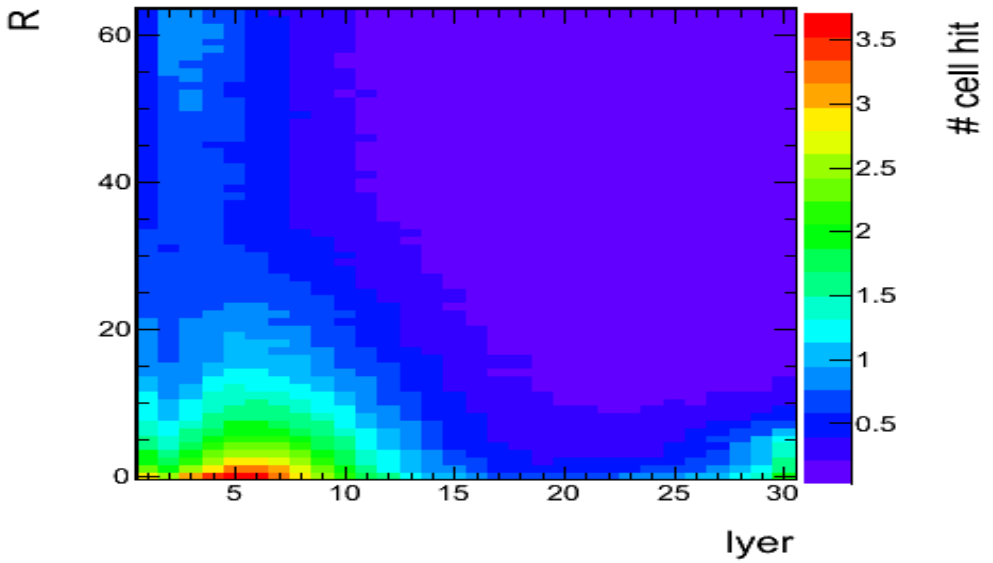


# pairs(3) – cell hit map

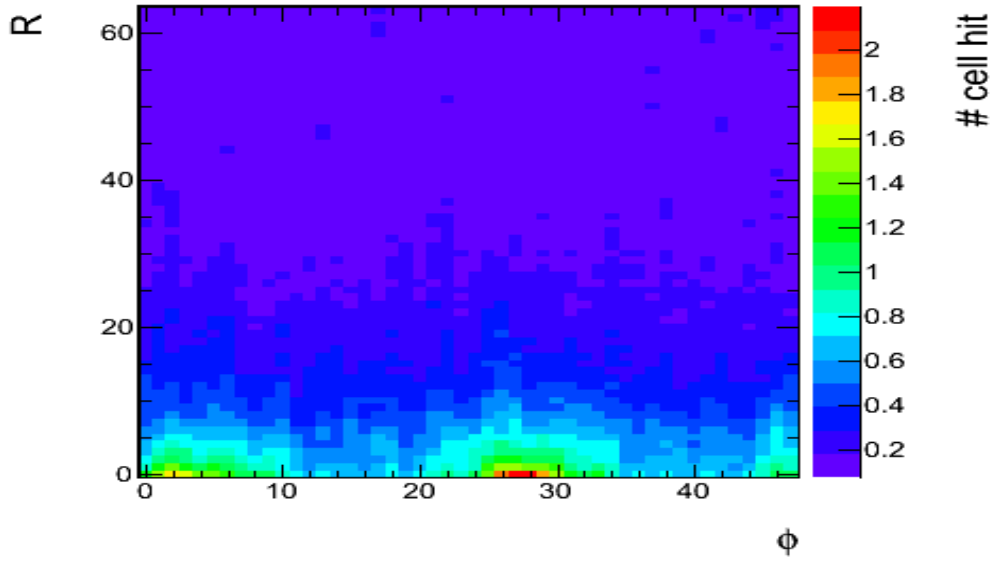
cell_hit_lyer_phi




cell_hit_lyer_R

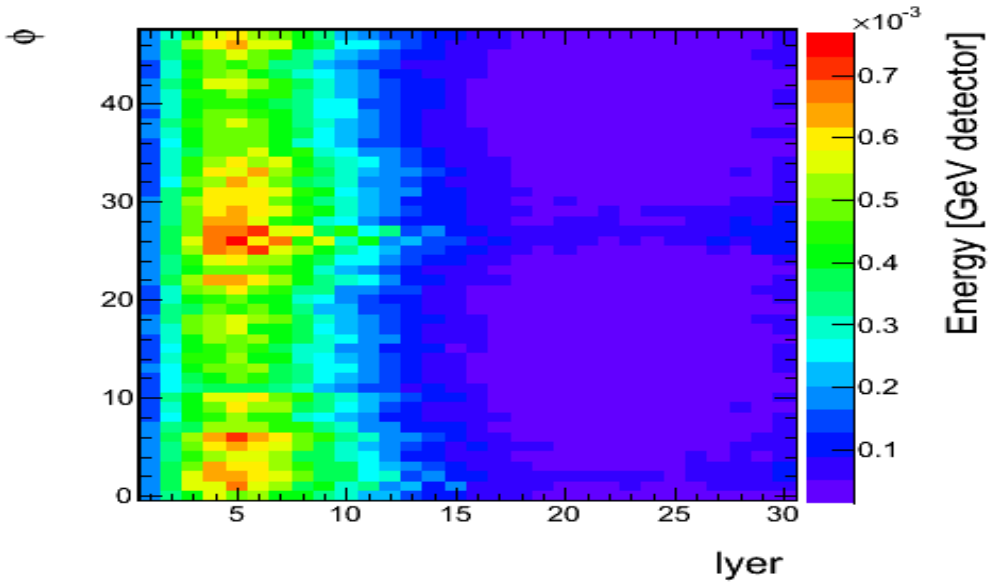



cell_hit_phi_R

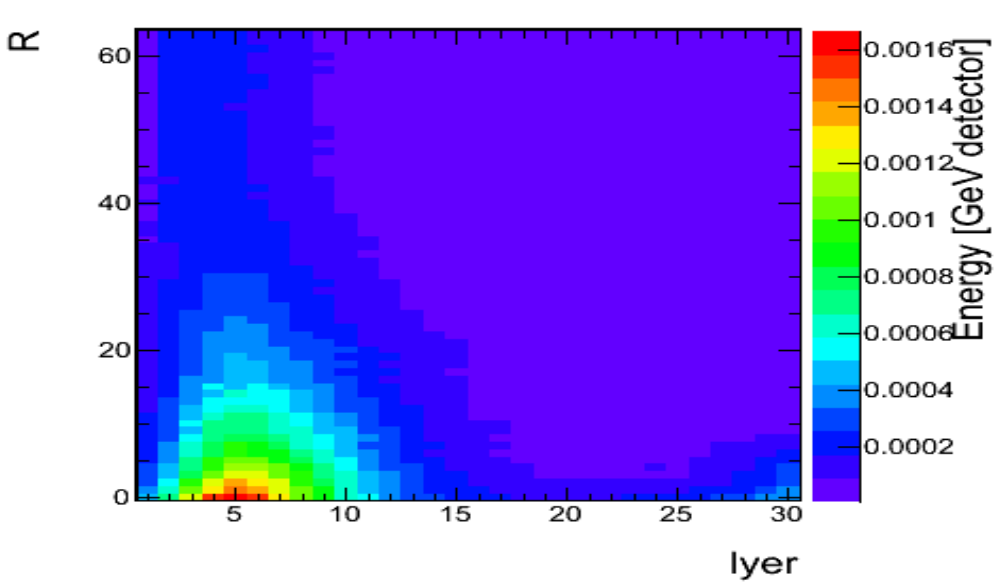


# pairs(4) – energy deposit map

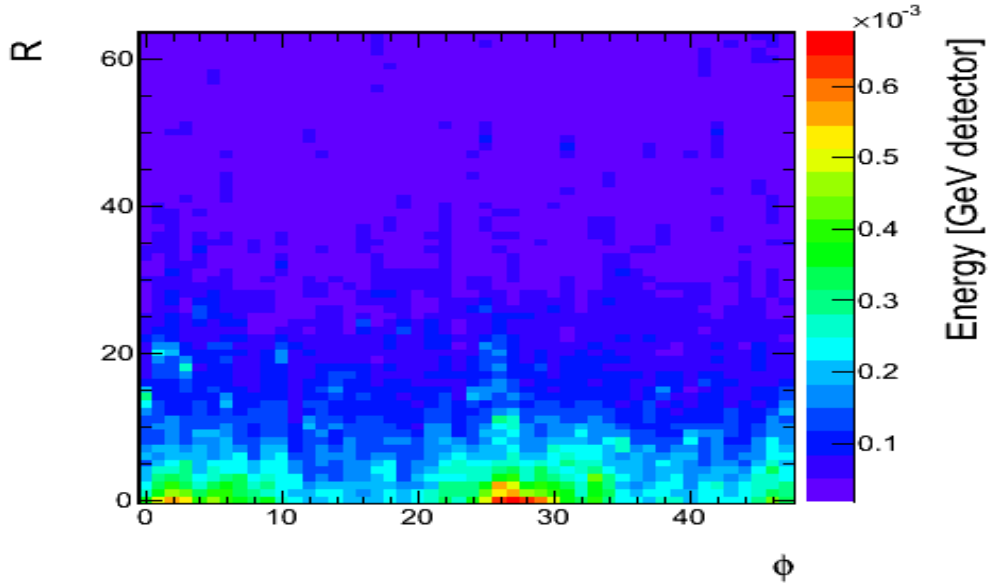
energy_sum_per_lyer_phi




energy_sum_per_lyer_R



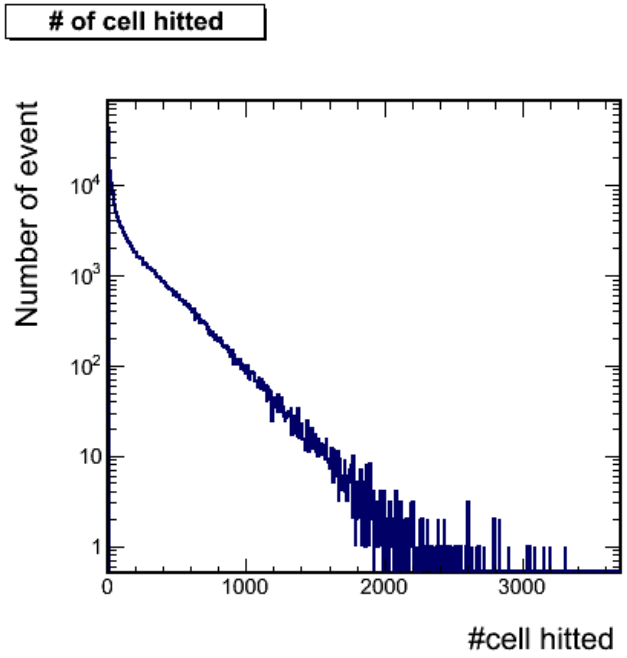

energy_sum_per_phi_R

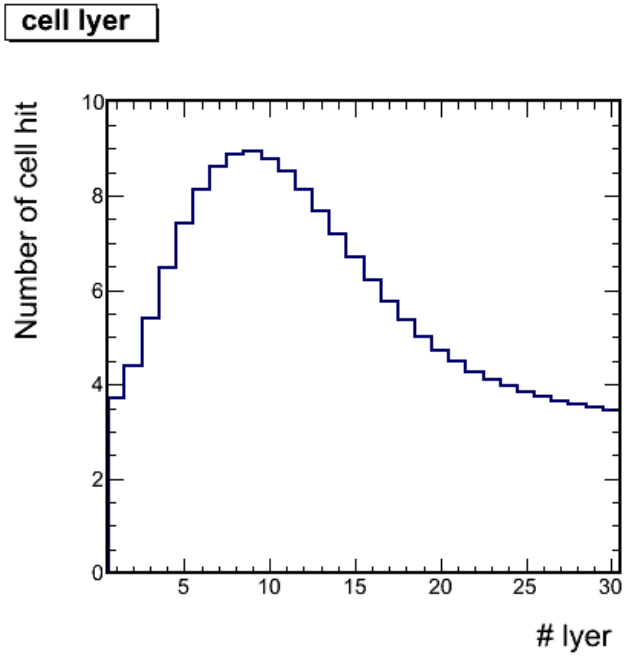


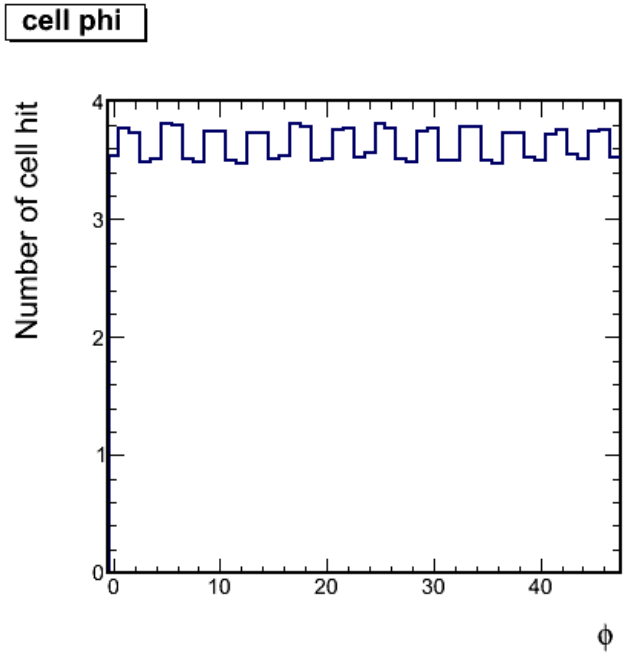
# γγ at low Pt(1) – cell hits

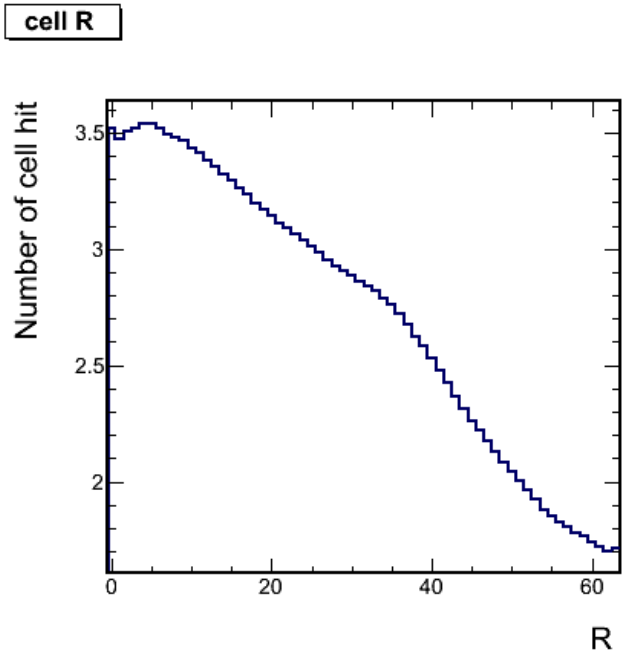
The gamma gamma at low $p_T$ samples , is normalized to the number of events used in the sample (330k).

The average number of cells hit is 174.



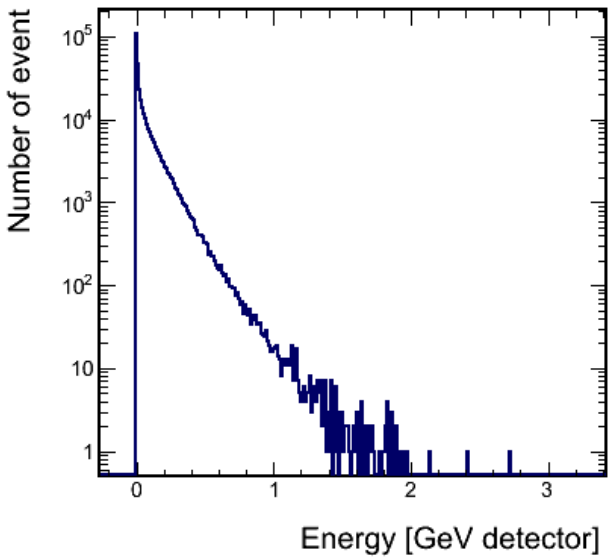



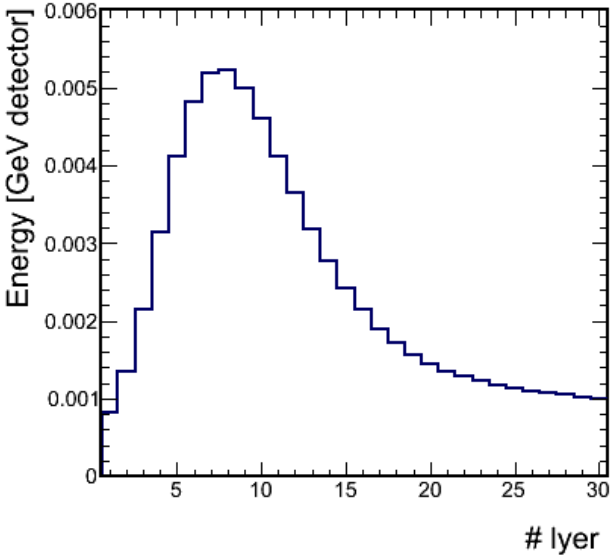
# γγ at low Pt(2) – energy deposit

- 

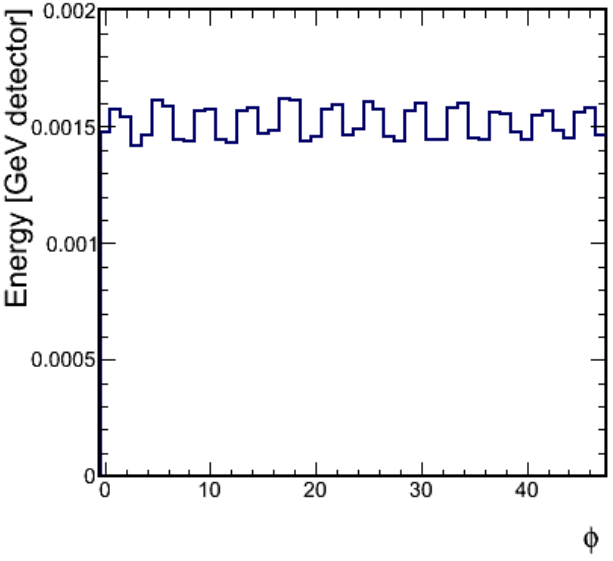
Total_enrgy_per_event



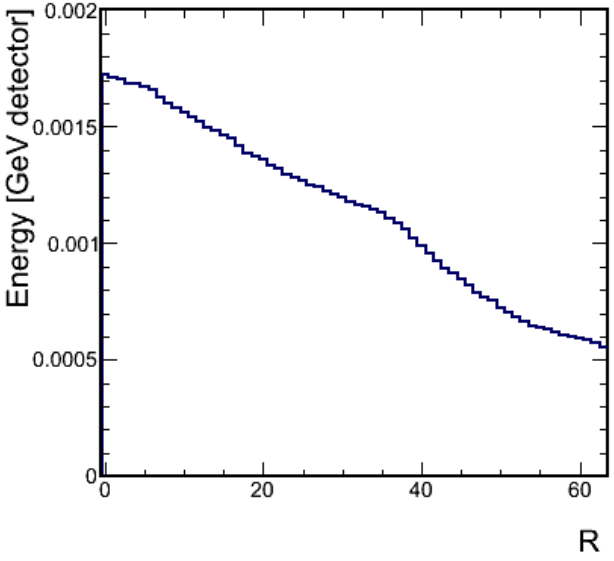

enetgy per lyer




enetgy per phi

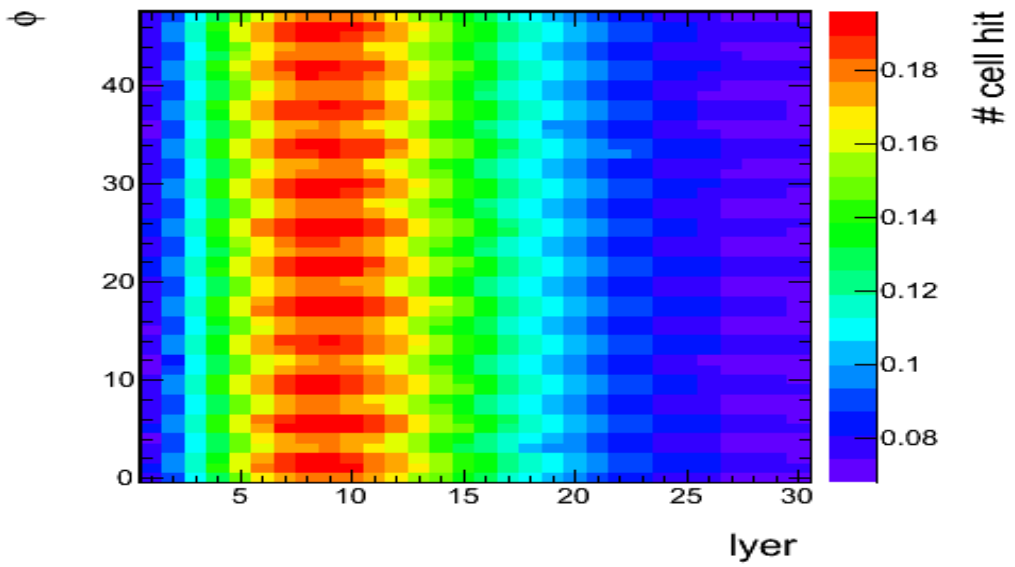



enetgy per R

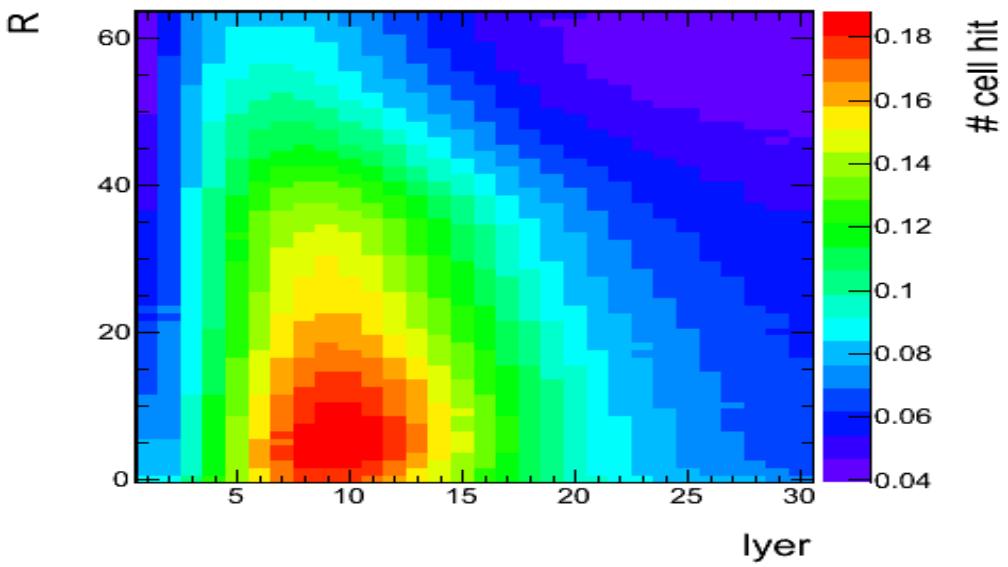


# γγ at low Pt(3) – cell hit map

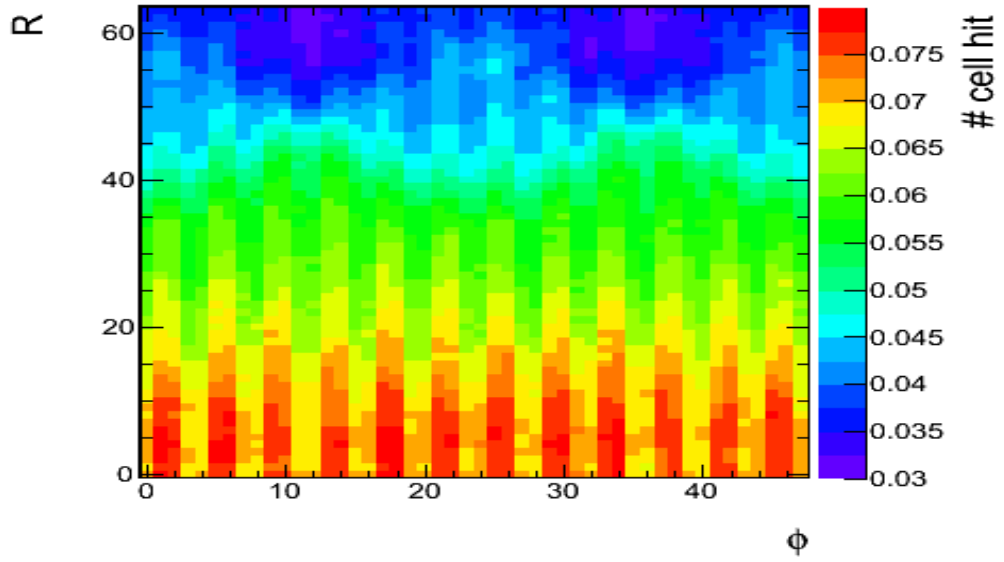
cell_hit_lyer_phi




cell_hit_lyer_R

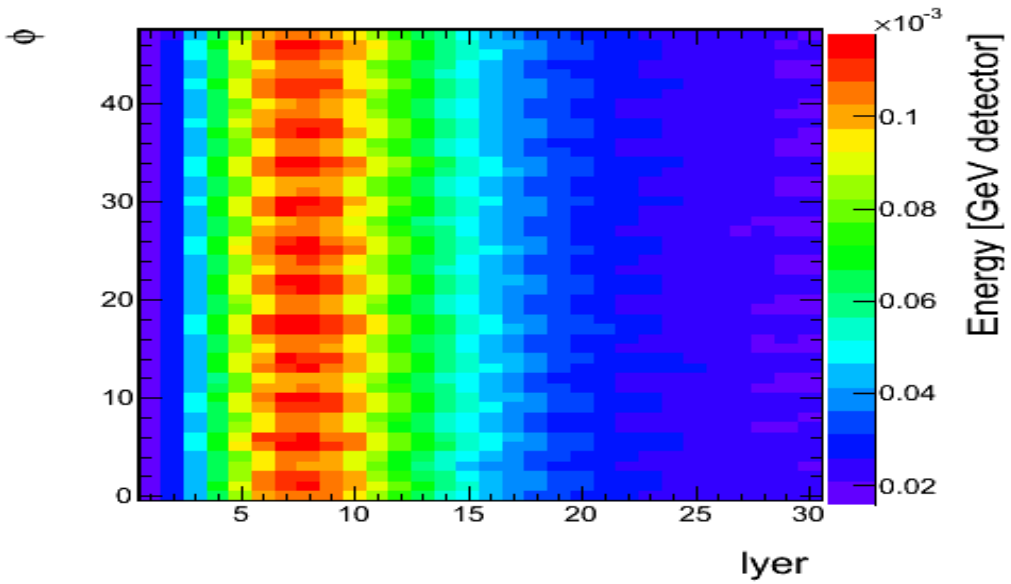



cell_hit_phi_R

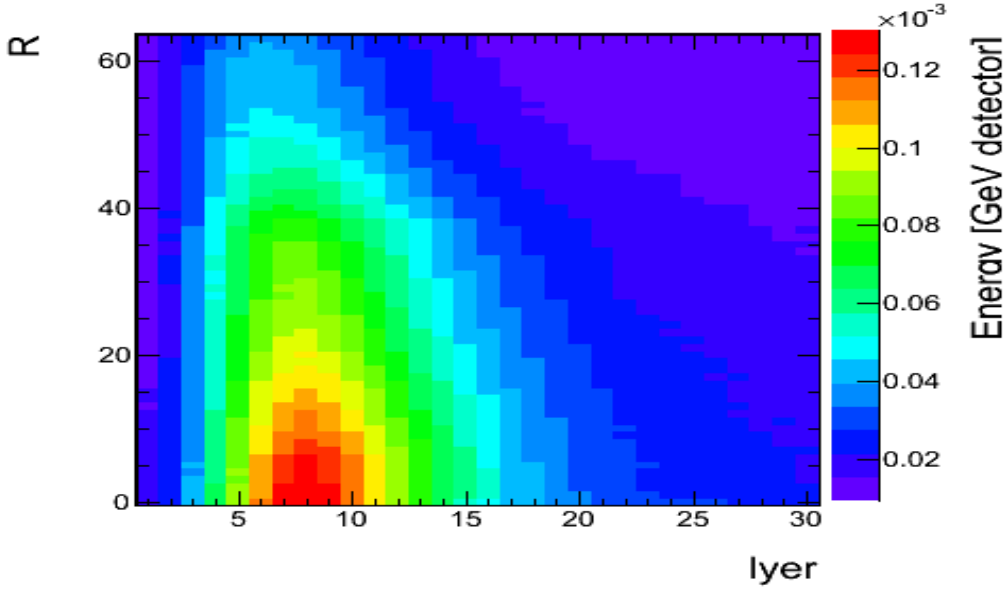


# γγ at low Pt(4) – energy deposit map

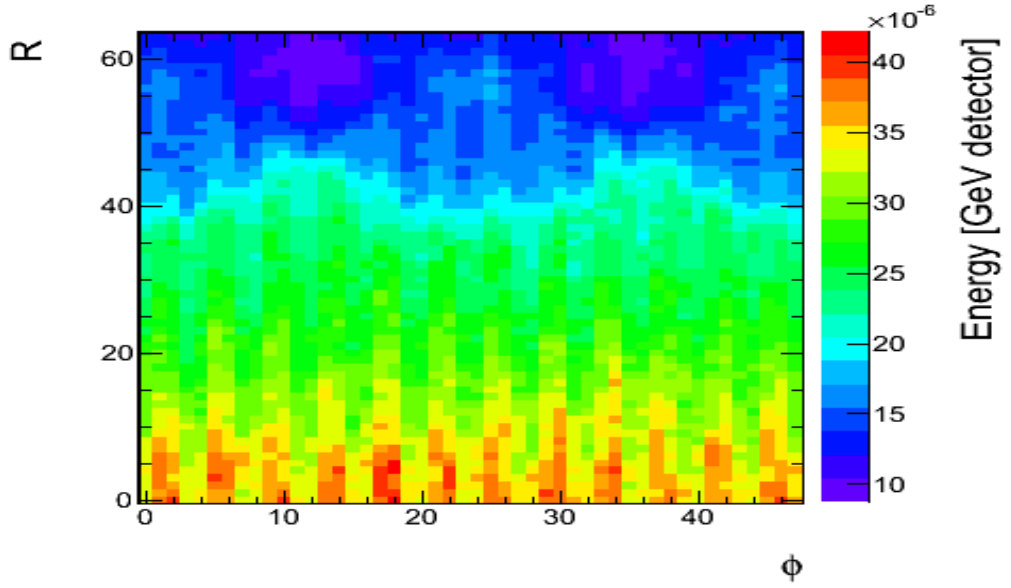
energy_sum_per_lyer_phi




energy_sum_per_lyer_R




energy_sum_per_phi_R



# Summary

We showed here preliminary result of backgrounds and occupancy estimation with the DBD beam parameters for the LumiCal detector.

We can see from thus data set that the occupancy (number of cell hit) per BX is low in the order of less then 1%.

Same of the result is different between similar data set.

More work to undusted the result and explore all of the data set available is needed

Thank you