6.4.2-Difu-Dilu grid

Figure 31 shows Δ in function of the Difu and Dilu parameters.

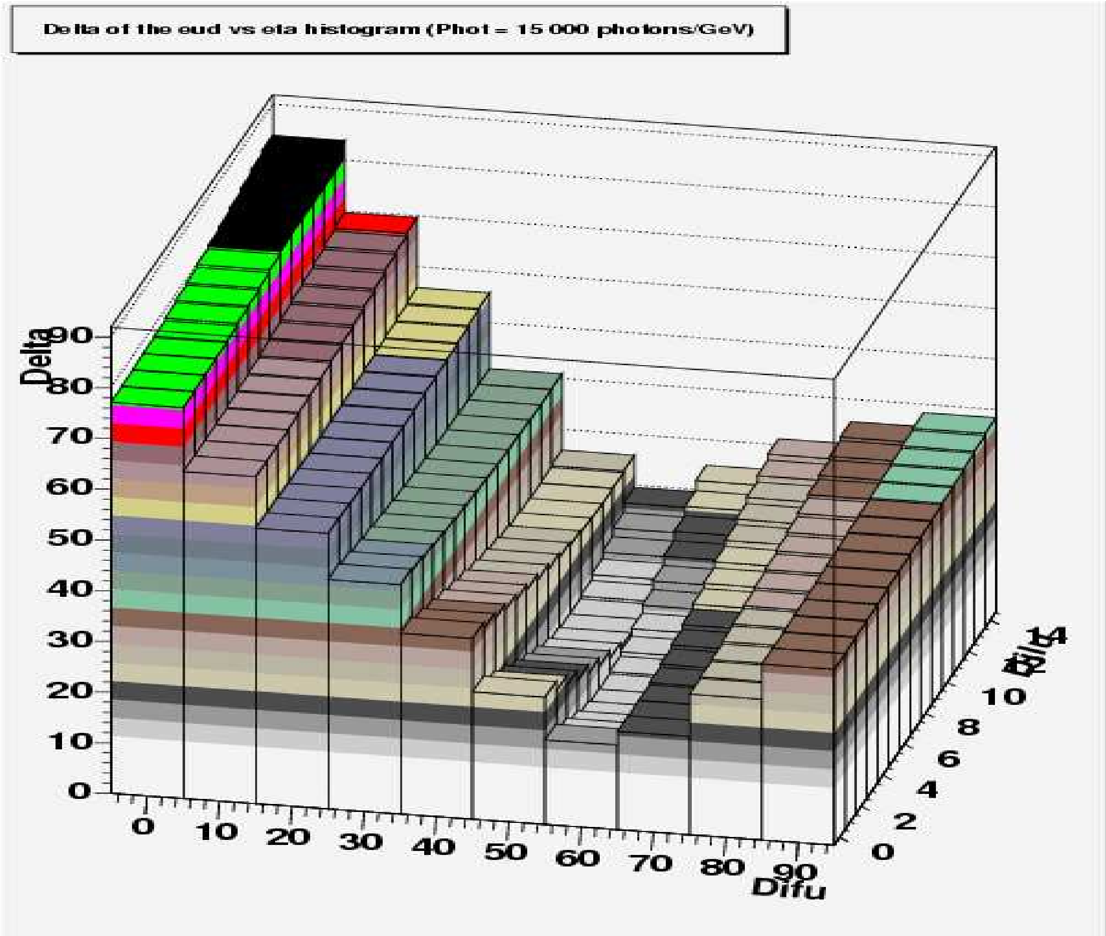

Figure 31: Δ in function of Difu and Dilu (Phot = 15 000 photons/GeV). The best combination is (60, 5, 15 000) and gives Δ = 11.30. Notice however that our original default combination, (60, 4, 15 000) gives the second smallest Δ with Δ = 11.35.

We observe that this time, we get only one minimum. This is due to the fact that we don't only optimize eud as in the Difu-Phot grid, but we also optimize η trough the parameter Dilu. Since Dilu is the only parameters with an influence over η, we can conclude that Dilu must be set around 5%. However, the difference between the Δ of the combination (60, 5, 15 000) and (60, 4, 15 000) is not big enough to suggest to change of our defaults parameters, Δ = 11.30 vs Δ = 11.35.

We finally conclude from the optimization analysis, that the combination (60, 4, 15 000) give one of the best representation of the real TPOL data and that there is no need to change it. However, we should keep in mind that a lot of other combinations of the parameters Difu and Phot could reproduce the same data for a fixed Dilu ≈ 5%. It is thus impossible to do an absolute calibration only by the mean of the comparison of the real eud vs η histogram. In order to give a visual appreciation of the accuracy of the MC to reproduce the real TPOL data for the eud vs η histogram (figure 29); figure 32 shows the histogram for the defaults combination we use (60, 4, 15 000).

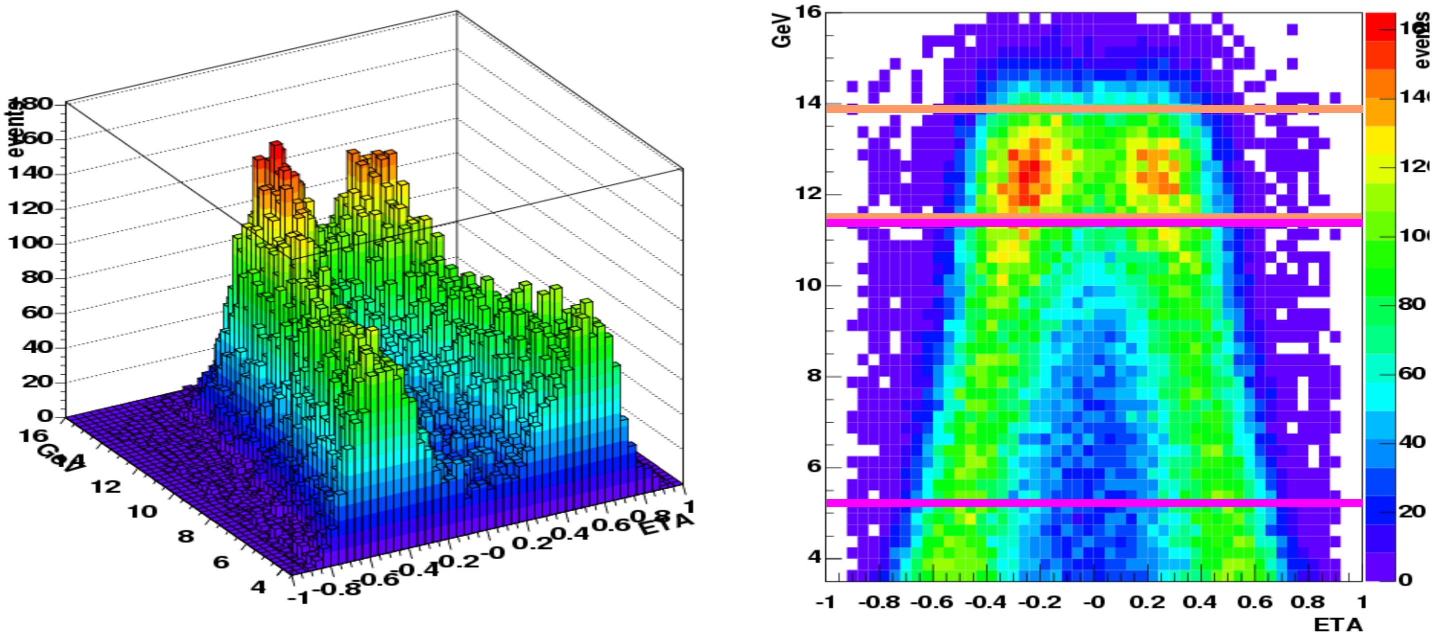

Figure 32: Eud vs η histograms for the default combination (60, 4, 15 000). The left graph shows the side view and the right graph shows the top view. Notice that this histogram is normalized to have the same amount of events than the histogram of the real TPOL data (figure 29). The purples lines show the energy cut for the AP (equation 5) and the orange lines show the energy cut for the focus (equation 6).

7-The effect of the backsplash

Another thing we can do with the MC simulation is to study the importance of some effects which can occur in the polarimeter. One of this effect is the backsplash (bs). The backsplash occur when the electromagnetic shower pass trough the silicon detector, hit the calorimeter and some of the particles bounce back on the silicon detector instead of being absorbed in the calorimeter. This should probably induce false informations for the y position of the photon measured from the silicon detector.

The way we can study the importance of this effect is to remove the backsplash in the MC simulation and to compare the results with a normal run which has a backsplash effect. The way we implement the backsplash/off (bs/off) simulation is the following. As soon as the particle(s) exit the silicon detector, the boolean "never_cross" change from true to false. Once never_cross = false, there is no more energy deposition recorded in the silicon detector. Notice also that for now on, when we refer to backsplash/on (bs/on) we refer to a normal run.

The first consequence we might think that the backsplash could have is to create more than one cluster in the silicon detector. The following histogram confirm this expected behavior of the backsplash (figure 33):

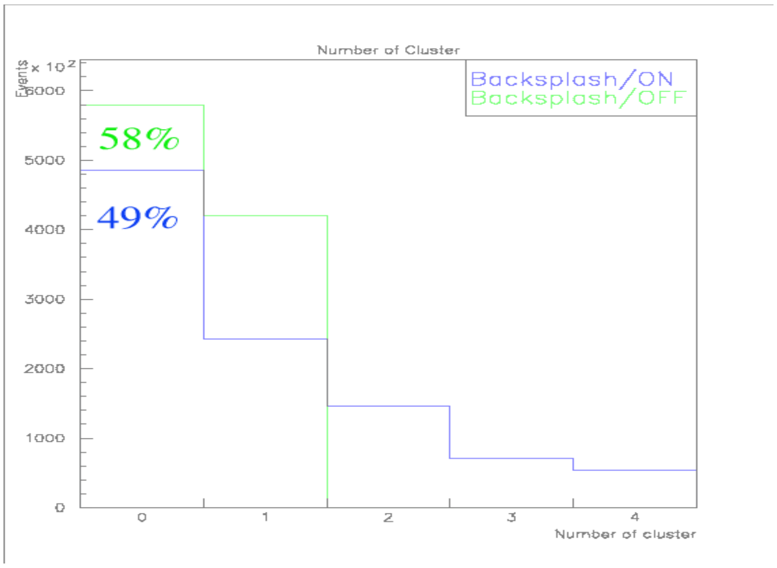

Figure 33: Histogram of the number of clusters detected in the y-silicon detector. In blue is a normal run (backsplash/on) and in green is a run in which the backsplash has been removed (backsplash/off). The percentage of events with no cluster is written in both case.

We indeed observe that in the case of backsplash/off, there is never more than one cluster formed. On the other hand, when the backsplash in on, we see that we sometime time have 2, 3 or 4 clusters. Figure 33 also inform us that in 58% of the time, the photons of the Compton beam don't convert in the converter or do not have enough energy to create a cluster, since in 58% of the time there is no cluster for BS/OFF. However, when we put BS/ON, the number of events with no cluster drop to 49%. That mean that there is 9% of events (out of 58%) that create clusters when they should have not. That is, ~16% of the time the backsplash is significant enough to create a totally independent cluster.

Up to now, the way we were use to deal with the backsplash was to apply a cut to our data requiring that our events created only one cluster (ncy = 1), otherwise we wouldn't use these events in our analysis. Let's see if this is really efficient to remove the effect of the backsplash using the histogram of the y distribution (figure 34):

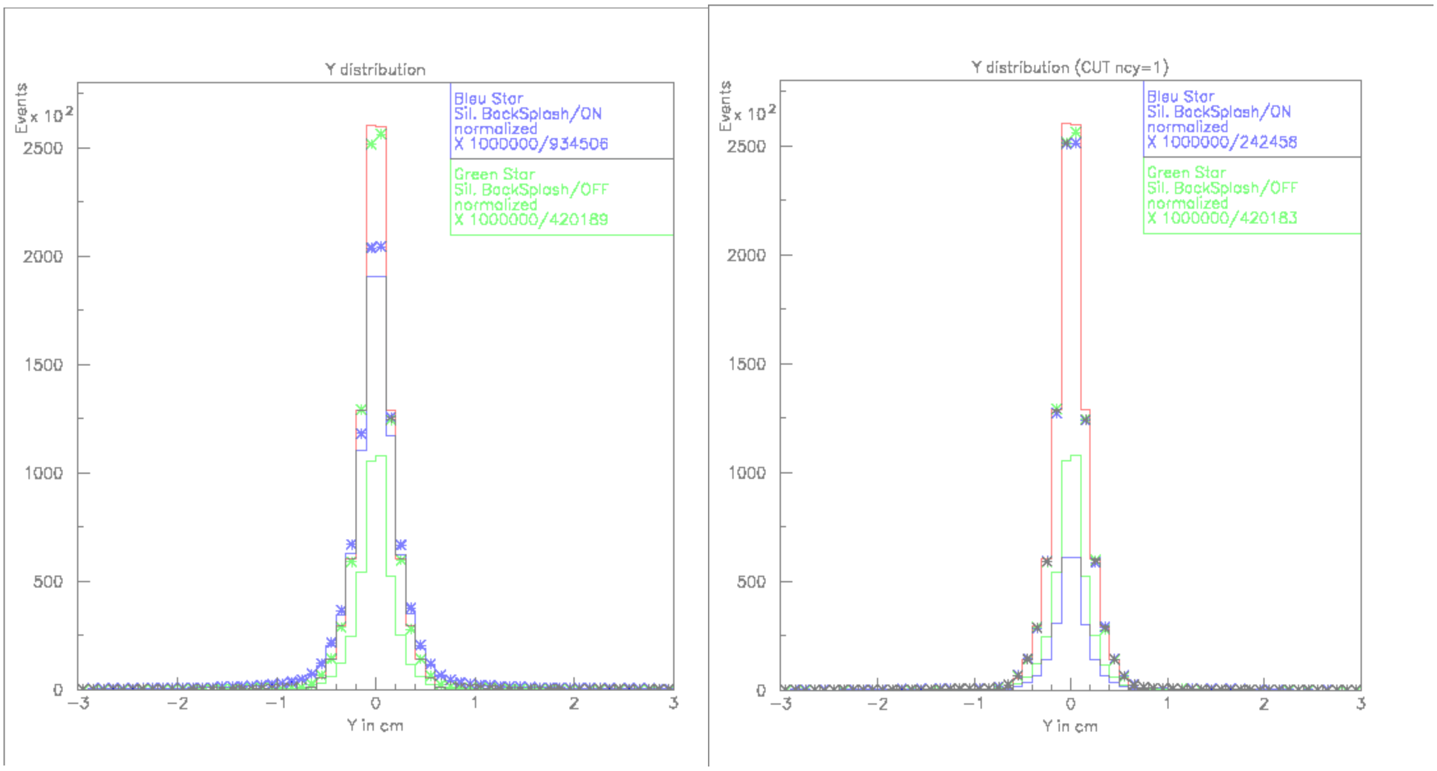

Figure 34: The six histograms , separated in two different graphs, show the number of events with a given y-position. In red are the y-real position of the events[24], in blue are the events with BS/ON and in green are the events with BS/OFF. The stars are the normalized histograms, which mean that they have all the same amount of events than the y-real histogram. The left graph has no cut and the right graph has the cut (ncy = 1).

If we first analyze the graph with no cut, we see that the y distribution of bs/off (green stars histogram) fit very well the y-real distribution (red histogram). On the other hand, the y distribution of the bs/on (blue stars) doesn't fit properly the y-real distribution. When we turn our attention on the graph with the cut (ncy = 1), we see that both bs/on and bs/off fit properly the y-real distribution. This is a first indication that the cut (ncy = 1) can be use to remove the unwanted effects of the backsplash.

24 The y-real is the position y where the photon should hit the calorimeter extrapolated from the Compton scattering. This is the "real" y we would like to measure in the silicon detector. In the reality, it is unfortunately impossible to know y-real.

We can observe something really interesting when we zoom the end of the y distributions (figure 35):

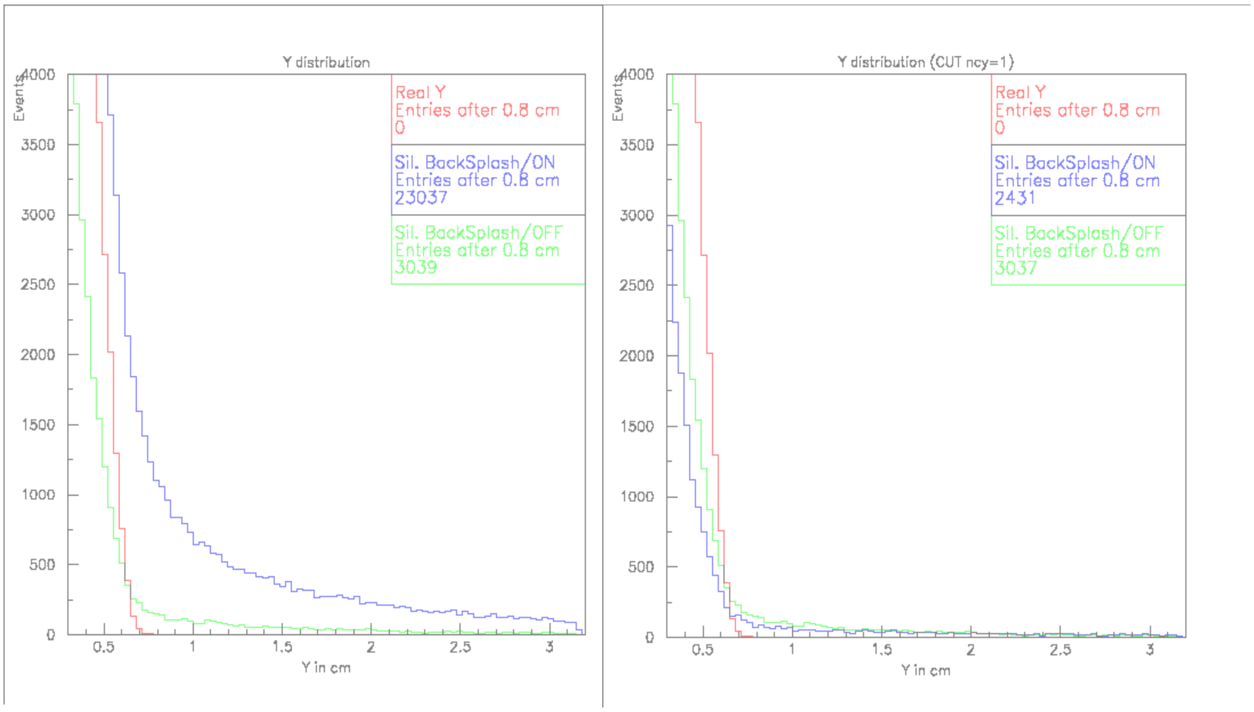

Figure 35: These two graphs are a zoom of the end of the graphs of figure 34 without normalization. The number of events with y > 0.8 cm for each distribution is output on the graph.

There is a big disagreement in the end of the y distributions. Even if the cut (ncy = 1) make agree very well the distributions bs/on and bs/off, both really don't agree with the y-real distribution: their should be no data recorded after 0.8 cm. It is really troubling that even when the backsplash is removed, there is events recorded at some “random” positions. It should be point that this noise would represent ~1% of the data if it is uniformly distributed over the position y.

The more important issue of the effect of the backsplash is to see how it can affect the η-y curve. The figure 36 shows the plot of η-y curve with and without backsplash and also shows the plot of the η-y curve using the y-real:

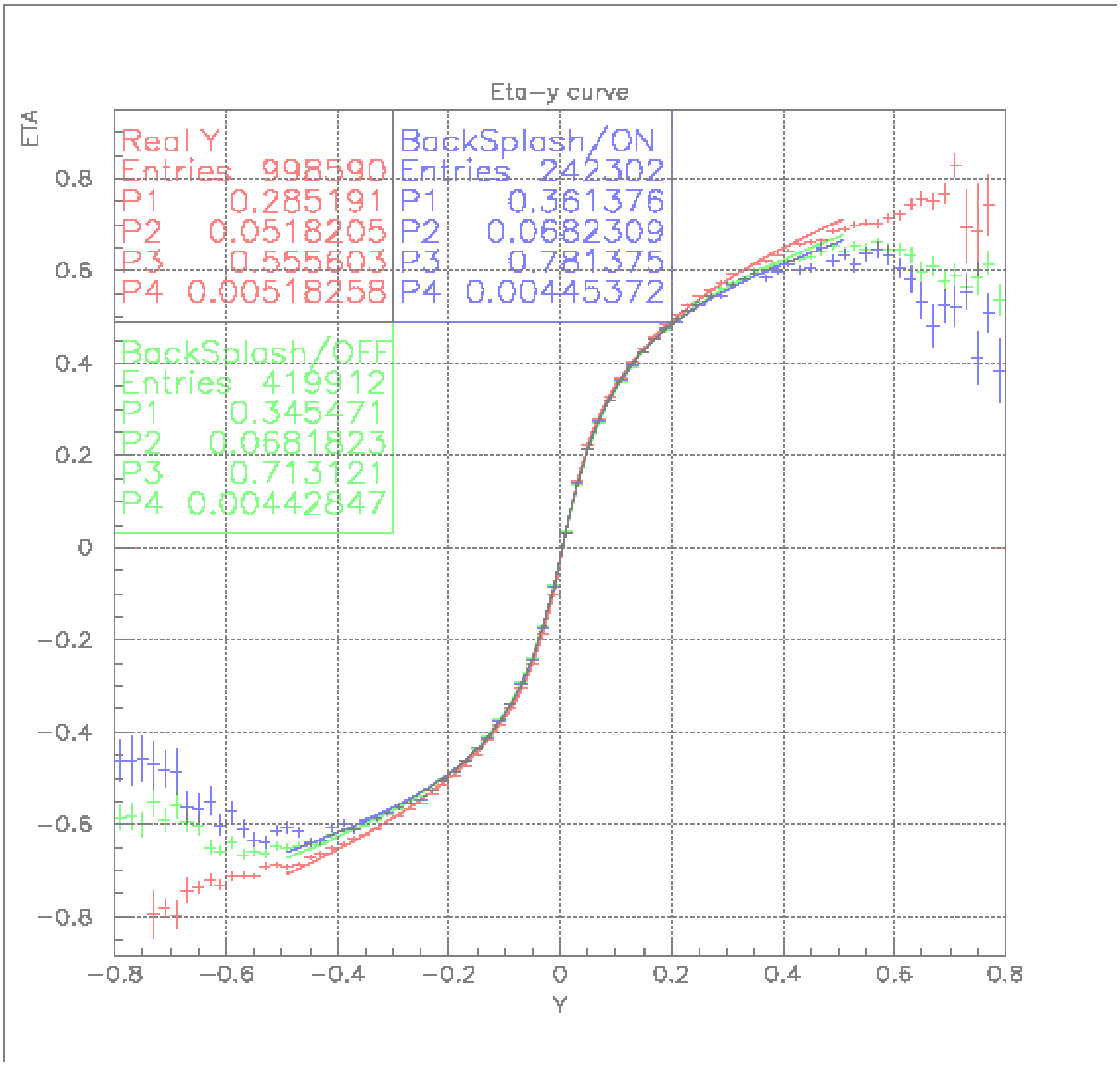

Figure 36: This graph shows the η-y curve from 3 different y: the y-real are in red, the y-silicon with bs/on are in blue and the y-silicon with bs/off are in green. The cuts (ncy = 1) and (E < 16 GeV) are applied. Notice that for the y-real the cut (ncy = 1) is not applied. The 4 parameters function shown in equation 11 is fitted in the range y=[-0.5; 0.5]:

$$\eta = \frac{|y-p(4)|}{(y-p(4))} \cdot \left\{ -p(1) \cdot \exp\left(\frac{-|y-p(4)|}{p(2)}\right) - (1-p(1)) \cdot \exp\left(\frac{-|y-p(4)|}{p(3)}\right) \right\} \tag{11}$$

We would first like to point out that each dot on the graphs of figure 36 are the average value of η in each y-bin[25]. If we don't do that, we get a graph like figure 37 and it is then almost impossible to get interesting observation.

25 This is called a profile histogram.

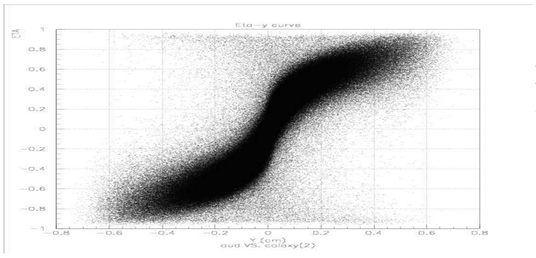

Figure 37: Scatter plot of the η-y curve (not a profile histogram).

Let's go back to figure 36. We can see that the 3 different curves agree very well in the central region. However, when we go at large value of y ($|y| > 0.4$ cm), we observe a clear divergence between the “real” MC data and the data from the silicon detector. The data from the silicon with bs/off (green) seem to have a slightly better agreement with the “real” MC data (red) than does bs/on (blue), but both follow the same divergence at large $|y|$ from the “real” η-y curve. It can be partially explain by the incoherence of the y distribution at large $|y|$ which we will elaborate in more details later. This is a really big issue, since if this effect really does occur in the reality, we don't record the good η-y curve!

We finish our discussion about the backsplash by confirming that indeed the cut (ncy = 1) seems to remove most of the unwanted effect of the backsplash. However it must be point out that we pay heavily on the statistic using this cut. The table 1 resume the effect of this cut on the percentage of statistic we keep:

% of event collected by the silicon detector	BS/OFF	BS/ON
No cut	42.02%	51.42%
Cut (ncy=1)	41.99%	24.23%

Table 1: This table summarize the percentage of events detected and kept by the silicon detector. The relevant informations are that the silicon detector could detect 42.02% of the events, but when we use the cut (ncy=1) to a normal run we keep only 24.23% of the events.

We lose close to 50% of the detectable events using the cut (ncy = 1). However, we haven't found any other efficient way to remove the effects of the backsplash in the real polarimeter TPOL, and thus the cut (ncy = 1) still be our best option.

8-Divergence in the eta-y curves

8.1- Correlation y-real and y-silicon

In order to explain the divergence between the "real" eta-y curve and the silicon eta-y curve (figure 36), we plotted the graph of the y-real vs the y-silicon shown in figure 38:

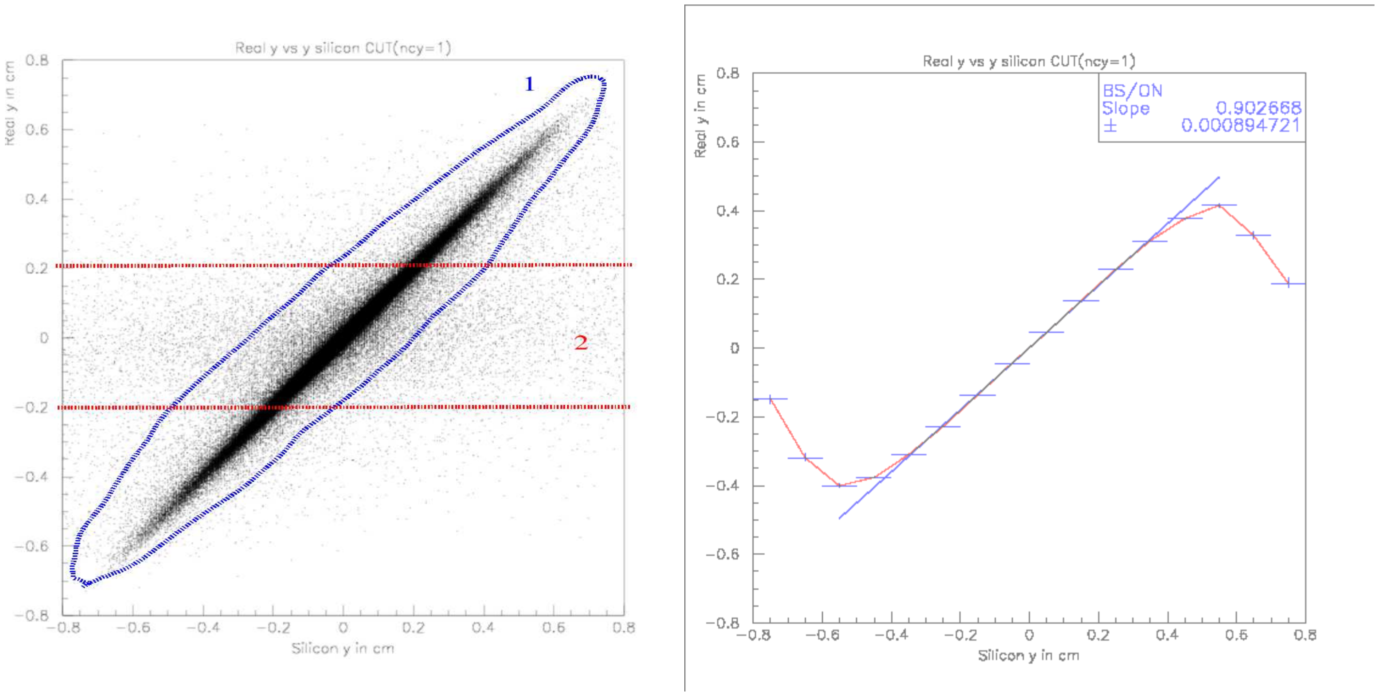

Figure 38: This figure shows the correlation between the y-real and the y-silicon. The left graph is a scatter-plot while the right graph is a profile histogram. The scatter-plot is divided in two region: region 1 is delimited in blue and region 2 is delimited in red. A linear fit of the profile histogram is done between y = -0.5 cm and y = 0.5 (blue). The slope of the linear fit is (0.903 ± 0.001).

In theory, the scatter-plot graph should give a perfect thin line with slope = 1. This is however not the case. The slope of the profile histogram is (0.903 ± 0.001). Thus, there is lot of events that have a large disagreement between their y-real and their y-silicon (left graph). We will refer to these events as noise.

We can separate the events with y-real ≠ y-silicon in two groups. The one that