Capitolo 5

Conclusions

In the chapter 3 I described the simulation work. Then in the chapter 4 I showed the work at Cern and the subseguent analysis. Now I'll compare the two results sets, to extract the best parameters for the simulation.

5.1 Comparison between simulated and real data

In this comparison I'll consider only the signal run analyzed in the paragraph 4.3.3, because it has all the data we need to change the beginning simulation parameters.

Comparing the strip signal distribution (figure 5.1) you can see that the master peaks have different positions and different width; also the threshold to cut the noise are different. The shape in any case is quite similar; you can recognize the master peaks due to teh charge collected by single strip, and the lower peaks due to the activation of more than one strip because of both the crossing of the particle in the middle of two strip and the capacitive effects. The different position of the peaks is due to the confersion factor from the number of electron/hole pairs to ADC channels. The different shape of the first two peaks is also due to capacitive coupling that increase the entries in the lowest channels.

The cluster signal distribution shows differences very similar to the ones found for the strip signal distribution. The position of the peaks are different and the histogram for the experimental data are wider than the simulated ones (figure 5.2). Both the posision of the peak and its width are due to the conversion factor. The noise, higher for experimental data, also affects the width of the distribution.

The cluster size is bigger for the real data than the simulated ones (see

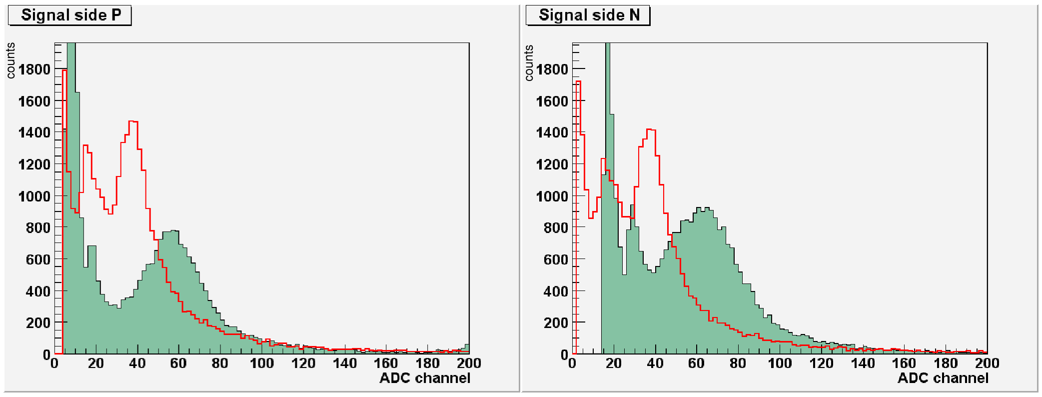

Figura 5.1: Single strip signal distribution histogram. The green histogram displays the results of beam test, the red ones the simulation results. The green histogram was renormalized to the integral of the simulation one, to allow the comparison.

figure 5.3). This happens because of the capacitive coupling; on P-side, in fact, there is a bigger difference between the simulated coupling adn the measured ones, and as a conseguence you can see a higher disagreement than N-side.

All these differences show we used bad paramenters in the simulation of the SSD module response. In the next paragraphs I'll analyze in detail each parameter; I'll extrat from the experimental data the best values for the parameters and I'll show the results of the simulation after the calibration.

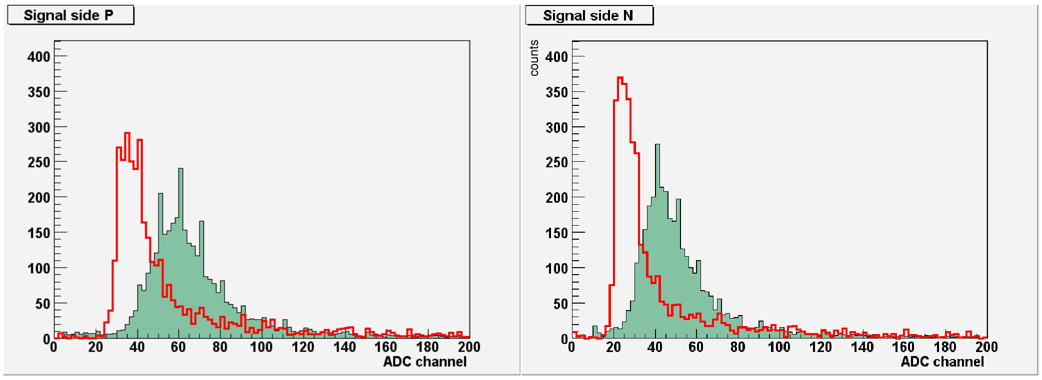

Figura 5.2: Histogram of cluster signal distribution.

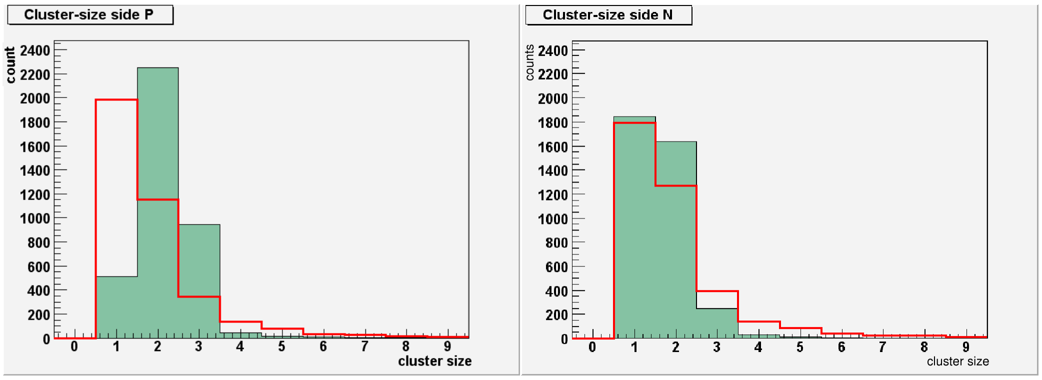

Figura 5.3: Cluster size histogram. The green one is for the beam test results, while the red ones is for the simulated data

5.1.1 Paramenter Calibration

Conversion factor and noise While converting the charge in ADC channels, the simuation uses a parameter that fixes which channel corrispond to the energy loss of a minimun ionizing particle in a detector; the energy is measured as produced electron/hole pairs and the peak of the Landau distribution shows the wanted energy loss. So I made the simulated position to agree whit the experimental one (from 40 to 65 in ADC channels). Also the noise values were been changed to make them equal to the experimental ones (see table 5.1). You can see the noise on N-side now is twice than the beginning values; as seen in the paragraph 4.3.1 this fact is due to the module characteristics.

side	starting noise		experimental noise	
	electronic pairs	ADC	ADC	electronic pairs
P	420	1.1	1.3	500
N	625	1.6	3.2	1231

Tabella 5.1: Noise parameters.

Capacitive coupling In the simulation the capacitive coupling is the charge ratio tha flows from a strip to the next two ones. This ratio can be obtained from the experimental data studying the shape of the cluster symmetric respect to a strip.

In the paragraph 4.3.3 we saw the shape of the cluster reconstructed starting with real data. The ratio between the charge collected by the central strip and the one collected by the nearest strips is the capacitive coupling percentage we wanted. The table 5.2 shows the starting couplings and the ones calculated from the beam test data.

	P-side		N-side	
	previous	next	previous	next
theoretical data	2%	2%	3%	2%
experimental data	5%	7%	3%	4%

Tabella 5.2: Capacitive couplings; theoretical and experimental percentages

The main peak of the strip charge distribution, obtained by the simulation after the paramenters upgrade, agrees with the exerimental one, while the lower peak doesn't still reach the right position, in particular on P-side (figure 5.4) and it is located around higher values. This can be due to a bad calibration of both the noise and the capacitive couplings, which cause a charge distribution unbalanced thow high values.

Using the new parameters, the charge distributions of the cluster overlap (figure 5.5); the table 5.3 show the fit parameters of a Landau distribution.

The differences among the cluster sizes (figure 5.6) are bigger on P-side, but now there is a better overlapping. The simulation still produces too many clusters of both only one strip or more than two ones; this fact can be caused by a bad calibration for noise and capative couplings.

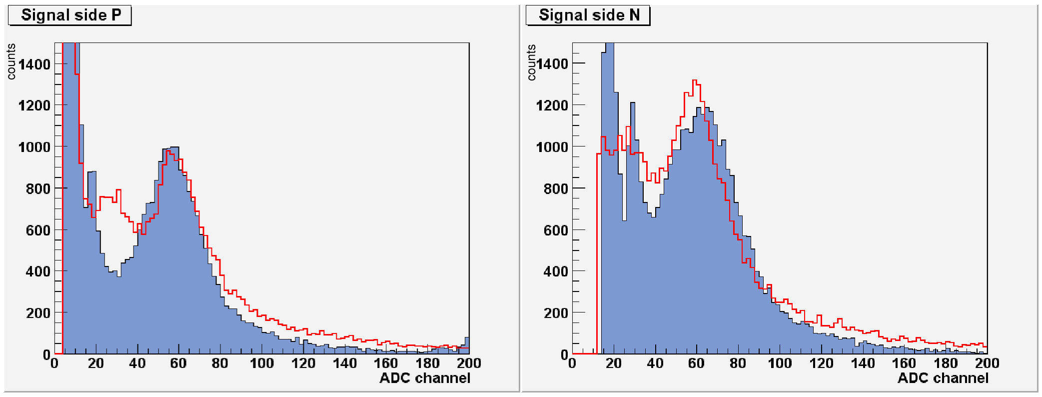

Figura 5.4: Charge distribution after parameters upgrade. The conversion factor reised from 40/25 000 to 65/25 000, while about the noise and the capacitive couplings see respectively table 5.1 and 5.2.

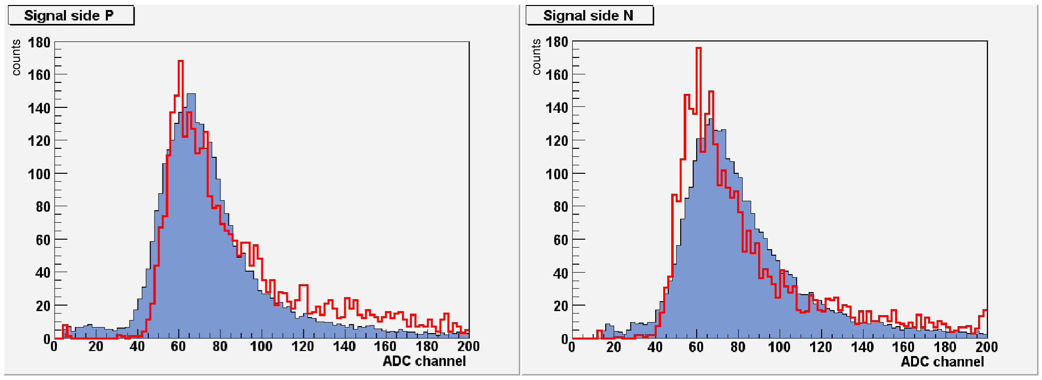

Figura 5.5: Energy distribution after parameters upgrade.

	P-side		N-side	
	mean	σ	mean	σ
simulation	65	9	62	8
experimental data	61	8	65	9

Tabella 5.3: Comparison among the fit parameters after the calibration of both the conversion factor and the noise.

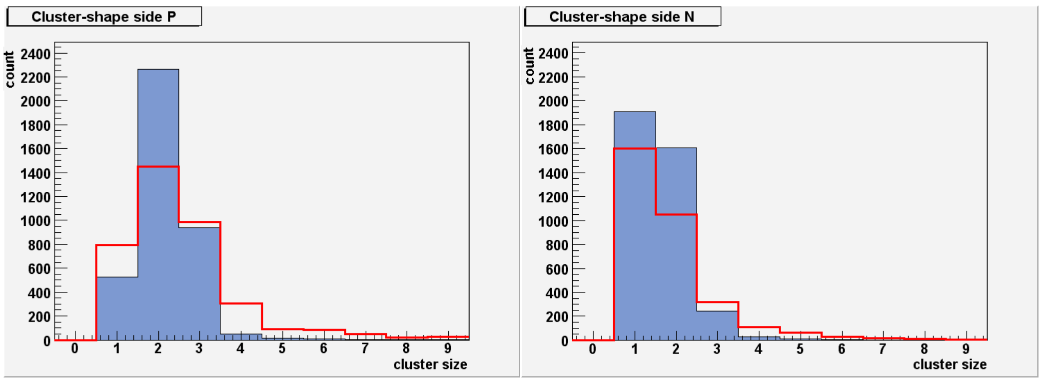

Figura 5.6: Cluster size after parameters upgrade.

The cluster charge distribution depends principally on the conversion factor of the electron/hole paris into a signal measured as ADC channels. The cluster size depends, instead, on both the noise and the capacitive couplings. The strip charge distribution depends on all the considered parameters. The bigger differences are present for the distributions which highly depend on the capacitive couplings, so these parameters must be stydied again. The results for the conversion factor of the electron/hole paris into a signal measured as ADC channels are, instead, good enough.

The noise, measured as ADC channels, was calculated starting from the experimental values and then it was converded into electron/hole paris using the new conversion factor. Therefore the cause of the differences is not here. We need study again the capacitive couplings, in fact the model used in the simulation could be too simple beacause it doesn't consider all the capacitive net, but only the first neighbour strips.

The other simulation parameters (drift speeds of the pairs and width of the charge dispersion Gaussian) were not considered in this work because already studied in the literature [14]. More over, the data from the beam tests are not enough to study these parameters.

5.2 Conclusions

The digitisation process simulation for a SSD module depends on some parameters shown in the chapter 3. The behaviour of the module was experimentally studied using a beam of minimum ionizing particles, as seen at the chapter 4.

More realistic parameters for the simulation were obtained analyzing the experimental data; the table 5.4 shows the simulation paramenters. In this way the simulated cluster charge distribution overlap the experimental progress, but this doesn't happen for cluster sizes and strip charge distributions. This fact suggest to study again the capacitive couplings, in particular the simualtion of the capacitive net. The problem should be studied carefully starting from the experimental behaviour of the modules, which differes from the previous beam tests[3].

Parameter	**Starting value**	**Final value**
ADC channels/electron/hole pairs	40/25 000	65/25 000
noise P-side	420	500
noise N-side	625	1231
coupling percentage	2%	from 3% to 7%

Tabella 5.4: Comparison among the simulation parameters