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Effects of the interstrip gap on the efficiency and response of Double Sided Silicon Strip Detectors

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Highly segmented double sided silicon detectors (DSSSD) are widely used in nuclear physics to perform accurate measurements of angular distributions, or to study reactions where coincidences of different particles are required to fully characterize the final state of the interaction process. It is well known that when a particle hits the SiO2 insulating interstrip region, one can observe, in the two adjacent strips, signals with an amplitude which is different than the full energy one including opposite polarity signals [1-5]. For this reason, when analysing data gathered by using DSSSDs, it is very important to reject interstrip events by selecting only the ones producing the correct full energy signals. This results in an efficiency for full energy detection less than 100%.

For the first time, we performed [6] a systematic characterisation of DSSSDs response as function of the incident ion, energy, and polarization voltage, trying to identify an appropriate selection procedure of events which allows to maximize the efficiency for the full energy reconstruction. First tests, using 7Li and 16O beams at different energies, showed that the efficiency for full energy detection depends on the energy of the detected ion and on the applied bias voltage. Moreover, it was observed that the measured efficiency is different than the one extracted by simply considering the geometrical width of the SiO2 zone. This means that the effective width of the inter-strip region is different than the geometric one declared by the manufacturer. In addition, systematic measurements of the effective width of the inter-strip gap were performed by scanning the front and back inter-strip regions using proton micro-beams at different energies and for different detector bias [7]. Results show that both front and back effective inter-strip width can be much larger than the nominal geometric width of the SiO2 zone and that both depend on the DSSSD type, and operating conditions. The results were interpreted by a simplified model based on the Shockley-Ramo-Gunn framework, it show that assuming the buildup of positive charge at the SiO2 interface one can obtain a satisfactory reproduction of all the observed interstrip effects.

In conclusion, the front and back effective interstrip width, which in turn is related to the DSSSD efficiency for full energy detection, depends on the DSSSD type, on its polarization voltage, and on the energy and charge of the detected ions. Therefore for those experiments aiming to measure, for instance, absolute cross-section with high precision, a complete characterization of the used DSSSDs is desirable.

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