Contribution ID: **164** Type: **Oral Contribution**

Experimental study of a discretized position circuit (DPC) network using an array of SiPMs

Tuesday, 25 October 2022 15:50 (20 minutes)

To simplify data acquisition electronics when using detectors composed of tens of SiPMs, and still being able to reconstruct positioning information, it is still very common to employ a resistor network. Good results are obtained with the DPC (Discretized Positioning Circuit) configuration, in which each SiPM of the array is connected to one node in a row of resistors, with a column of resistors at each end that connects the rows. Although this is the simplest topology and yields very good peak/valley ratios, it has the disadvantage that the charge division is asymmetric in X and Y directions, and that the different paths of the signal to reach the output, depending on the position of the event, introduce a barrel distortion in the image when the number of rows grows beyond, say, four lines. This can be minimized with a non-homogeneous choice of resistors in the network. We have developed a framework to optimize resistor values of DPC configurations for any number of rows, further imposing that all the SiPMs in the network 'see'an impedance to ground as similar as possible, in order to keep the shape of the pulse signal irrespectively of the position of the event. We simulate the DPC circuit and explore in the computer thousands of resistor combinations, looking for a distortion-free flood field image. The optimal combination found in the computer are then implemented in the laboratory, confirming the results of the simulation. In addition, we have verified that this optimized DPC preserves the pulse shape to the extent that a phoswich configuration of LYSO and GSO crystals can be read and disentangled.

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Session Classification: P1 Accelerators and Instrumentation

Track Classification: P1 Accelerators and Instrumentation