Design modification of two high voltage pads connected to RPC detector in muon tomography system

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1. Introduction

In muon tomography system Resistive Plate Chamber (RPC) detectors can be used to track the muons trajectory. High voltage is applied between two bakelite electrode of an RPC in presence of continuous gas flow in the detector gas gap. Two pick-up strip boards are used to collect the signal. A very low voltage in millivolt range is induced in the pick-up strip. Therefore, good quality data depends on less electromagnetic interferences in the aforesaid boards. But a HV point is situated near the pick-up strip board which is a necessary part of the RPC detector. It has been observed that if high voltage pad overlaps any pick-up strip, then noise increases in that strip. A modification in the design has been initiated which is explained in the following process.

2. Modification Process

In muon tomography system two stacks of RPC detector are used to find the in and out tracklets of the atmospheric muon whenever it passes through all or most of the detector layers. Presently each stack has four RPC detectors. In each RPC detector two high voltage of opposite polarity are provided in two opposite outer surfaces of the detector. Therefore, two high voltage points are placed there, from which high voltage spreads throughout the two surfaces of the detector. A graphite coating is used at two outer surfaces of the Bakelite electrodes of the RPC detector. Preferably two opposite corners are chosen for this HV connection. At the same time two other corners are used to connect two pipes for inlet and outlet through the nozzles of the detector chamber for continuous gas flow. Positions of all four points i.e. two HV points and two gas flow nozzles, are associated with whole design of the muon tomography system. This is one of the standard design of a square shaped RPC detector of small size up to 60 cm x 60 cm. After fabricating the detector, two pick-up strip boards are placed in the way such that strips are positioned orthogonal to each other. The pick-up strips collect the signal as well as noise from the active detector chamber. In the earlier design, pick-up strip in the high voltage side and HV pad are overlapped as the HV pad crosses the end strip line of the last strip as shown in fig. 1.

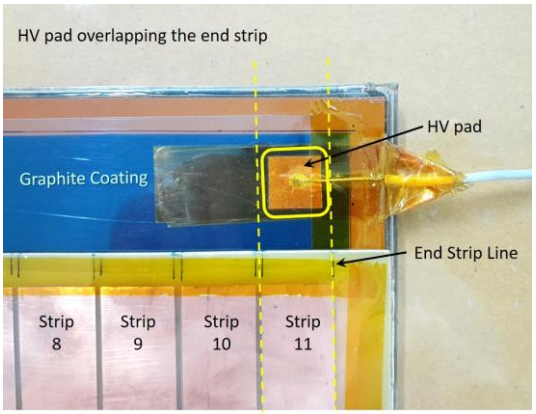

Fig. 1 HV pad overlaps the last pick-up strip

A necessary modification is required to reduce this noise in the edge strip near the HV point. But there is no extra space on the detector surface to move the HV point. Only two options are there; either size of the detector is required to be increased or the HV point is to be placed outside of the active strips area. It is not possible to increase the detector size at all, as the size of the detectors and all other parameters of the whole muon tomography system are interdependent to one another. So second choice was opted. Major components of a RPC detector hardware are two same sized square Bakelite sheets, side spacers, corner spacers, inlet and outlet nozzles etc.

Therefore, only side spacer or corner spacer area can be utilized for this purpose. So that active area of the detector as well as the pick-up strips area will not be affected for this movement of the HV pad. This time graphite coating area is extended up to the edge of the detector and this extra area is equal size of the HV pad area which is carefully chosen top of the side spacer near one of the corner. In this way pick-up strips area does not overlapped with the high voltage pad, which is shown in fig. 2.

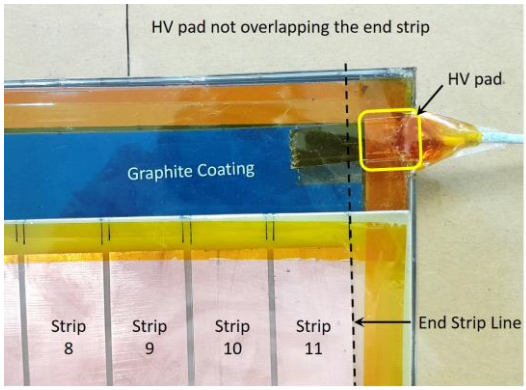

Fig. 2 HV pad does not overlaps the last strip

3. Result and Conclusion

During analysis of the data which is taken before the modification, it is observed that one extreme end strip situated near the high voltage pad, picks the noise more than that of other strips. Red triangles are shown in fig. 3 as mean noise and the value of strip-11 is near 60 Hz /cm^2.

After modification, once again the data has been collected and analyzed. It can be noticed that the noise reduces drastically as the HV pad does cross the end line of the last strip i.e. HV pad does not enter the active strip area. Now the result shows mean noise of strip-11 is reduced to near 5 Hz /cm^2 which is quite low as compare to earlier one. Blue squares shown in fig. 3 represent mean noise after moving the HV pad to its new position.

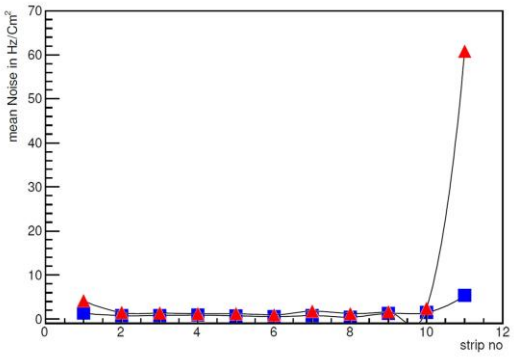

Fig. 3 Noise in all 11 strips before (red triangle) and after (blue square) modification

This modification has been made for the one RPC detector during test bench analysis. The HV pad was made very narrow for the above purpose due to insufficient space near border of the detector module. It will be better to leave some space (few mm) in advance in pick-up strip board for the HV point and rest area can be used to design the strips. If this design is applied to all the RPC detector along with pick-up strip board then alignment of all detectors and pick-up strips can be manageable easily. In muon tomography system eight or more number of RPCs are used to construct the incoming and outgoing tracklets of the muon. More good strips mean better accuracy in muon tracks.

References

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