Effects of Parasitic Capacitance in Strip type Triple GEM Read-Out

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Introduction

The read-out design of the Triple Gas Electron Multiplier (GEM) detector consists of a multi-layer PCB having 256 x-axis strips on one plane and 256 y-axis strips on another in a 10×10 cm^2 region [1]. For testing purpose the detector is divided into four sectors as all 128 strips are shorted to each other to get a test signal pulse as shown in Fig. 1. The signal is formed due to induction during the movement of electrons and ions [2].

In order to measure the test signal pulse from the LEMO connector, an impedance matching is required. If the LEMO test pulse is used without proper impedance matching, the reflection caused due to impedance mismatch affects the signal in the nearby parallel strips. These pick-up strips can belong to the same layer, or be situated in diffrent layers, causing signals in the non-active areas where no avalanche has taken place.

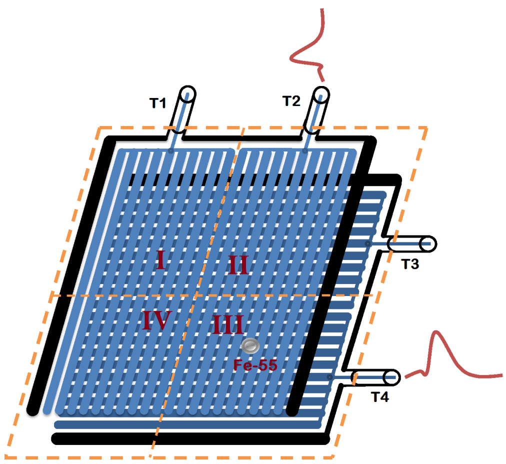

FIG. 1: Schematic diagram of the read-out strips.

Usually, a 120 kΩ resistance is used in the path of signal pulse to the ground for impedance matching while measuring the signal pulse. This resistance works quite well but, gives a small amount of same layer and layer to layer induction. In order to study and reduce the effect of parasitic capacitance induction, we designed few experiments to see effects due to impedance variation.

Experimental setup & Results

The applied voltage to the Triple GEM was -3.9 kV with a current value of 749 μA in gas mixture Argon-Carbon dioxide 70-30 by volume.

The effect of impedance variation on the signal of ^{55}Fe source was measured using a Mixed Signal Oscilloscope (MSO) after amplification with CAEN A1422 charge sensitive pre-amplifier as shown in Fig. 2. The pre-amplified signal is then amplified using a CAEN 968 spectroscopic amplifier and Amptek MCA-8000A was used for getting a histogram as shown in Fig. 3.

To see the reflection due to variation in impedance, we placed a ^{55}Fe source at the centre of sector III as shown in Fig. 1. The signal was observed using the MSO after amplification and shaping through pre-amplifier. At first, all the connectors were connected to 120 kΩ resistance to the ground and the observed signals are shown in Fig. 4 (Please note the signal nomenclature from Fig. 1). The signals can be observed in test connector T2 and T4 since, they are in the active region (the re-

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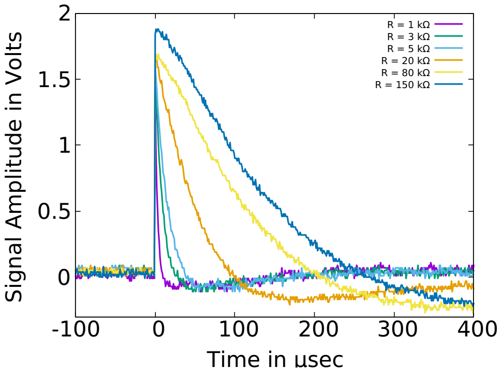

FIG. 2: Pre-amplifier output at different impedance values.

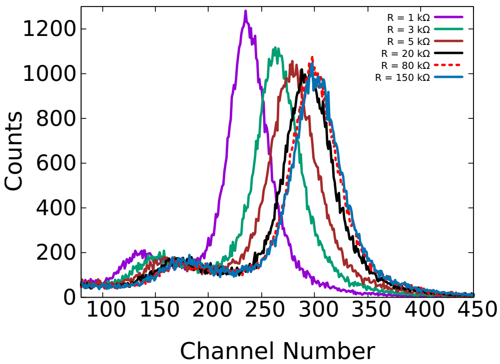

FIG. 3: Histogram of ^{55}Fe at different impedance, having Argon escape peaks.

gion in which avalanche occurred), while the other connectors T1 and T4 have very little or no signal. Now, if the connection of T2 is removed leaving only 120 kΩ resistance to the ground, the signal starts reflecting back due to impedance mismatch causing cross-talk in T1 and plane induction in T3 as shown in Fig. 5.

Conclusion

The above results show the importance of the impedance matching while taking the signals from Triple GEM detector and also tell us about the problems that could occur if it is not done properly. After studying the effects of impedance on the signal, now we are looking forward to design an experiment for

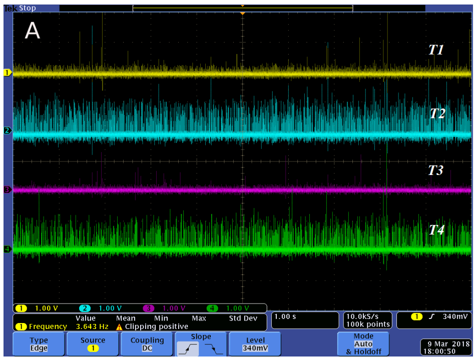

FIG. 4: Signals when all connectors are connected to the pre-amplifier, T2 and T4 have signal peaks since they are in the active region of the detector.

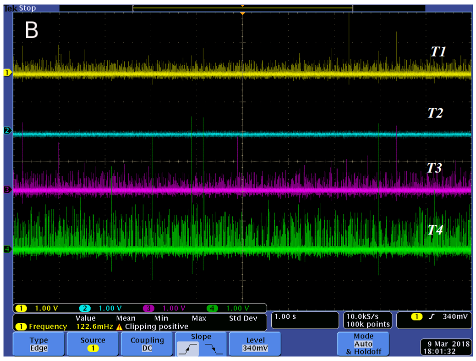

FIG. 5: Signals when T2 is disconnected from the pre-amplifier, T1 and T3 have signal peaks due to cross-talk and plane induction respectively.

impedance matching and finding a suitable solution reducing same layer and layer to layer induction.

Acknowledgments

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References

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