Spark protection of the DAQ and Electronics of the Photon Multiplicity Detector in ALICE

Jogender Saini*, R.N. Singaraju, Shuaib A. Khan, Tapan K. Nayak
Variable Energy Cyclotron Centre, Kolkata - 700064, INDIA
**email: jsaini@vecc.gov.in*

Introduction

The Photon Detector (PMD) [1,2] has been operational in the ALICE experiment for the last three years. The PMD has taken data for proton-proton collisions at 0.9, 2.76, 7 and 8 TeV; Pb-Pb collisions at 2.76 TeV and proton-Pb collisions at 5.02 TeV. PMD is a fully Indian detector in ALICE from its conception to construction, commissioning and data taking responsibilities. PMD comprises of large arrays of hexagonal gas cells, where a honeycomb structure forms the cathode and a gold plated tungsten wire at the center of each honeycomb acting as the anode. The detector operates at a voltage of -1300V with Ar and CO2 gas mixture in 70:30 proportions by weight. Installation and commissioning of ALICE-PMD in ALICE-cavern was done in 2009 [3] and PMD is running successfully with other ALICE-detectors since then. PMD, being a gas-based detector, is prone to sparks. The generated sparks can get injected to the electronics, which can cause damages or can cause single event upsets in electronics circuitry. In addition to PMD, ALICE comprises of 18 other detector systems with very complex arrangements of electronics readout schemes and grounding arrangements. Thus during the actual running of the experiment, the spark in the PMD cells can have severe consequences on the overall data taking of the experiment. A spark protection circuitry had been already implement for the PMD as reported earlier [4]. In this abstract, we discuss additional measures taken for the spark protection, which had been proven to be most effective so far.

Address/data loss due to spark

It has been observed that when a spark occurs within the detector, front end electronics and the MARC ASIC (which is used in the PMD) loses its address and the stored data does not have the required zero suppression. This results in enormous increase in data volume and data becomes unusable for that particular electronics chain.

To analyze the effect of spark, a test setup was made at VECC with a PMD module, along with electronics. Sparks were injected forcibly into the chamber. The test setup consists of 12 FEE boards mounted on the section of detector with each FEE board consisting of 64 channels. While injecting the sparks we have acquired the data and captured signals on the scope as shown in ADC plot in Fig.1. It can be seen from this ADC plot, that first 64 channels shows higher ADC channel which is representing the configuration data loss in the middle of the run. Analyses of the oscilloscope waveforms shows that reset and trigger lines are changing their logic state momentarily with spark. With further study, it was found that synchronous signals were not affecting any data integrity with these sparks, while asynchronous reset line was making the MARC to reset resulting in all the configuration data loss.

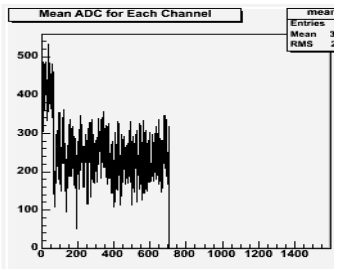

Fig.1 Effect of spark on the first 64 channels out of 768 channels. Those have higher ADC values due to address loss in middle of the run.

With the removal of termination resistors and putting a capacitor of 100nf/10nf to ground in reset line, we found that with lots of spark also, no configuration data loss errors were seen. However with 100nf it was disturbing the normal reset mechanism. There was a detailed study done during PMD test-beam taken at CERN using CROCUS with 10nf and it was found that 10nf is the most suitable value and finally it was installed in all the modules in the ALICE-cavern. After this implementation there was no address and configuration data loss reported.

CROCUS Busy/Reset

It is seen that PMD runs very well in standalone and technical runs with HV for long time. However during data taking with all other ALICE detector, we could not run PMD for long time. The reason was being, interruption from CROCUS (PMD-DAQ) going in error state. When this happens, the data taking had to be stopped causing time loss for data taking for full ALICE experiment. The reason was not known for quite some time and detailed investigation led us to believe that the sources could be arising mostly from external disturbances. It was also observed that there was a rise of current during presence of beam. We took two measures to deal with this problem. Firstly we put the Transient voltage suppressor (TVS) diode on FRT and CRT of CROCUS to protect the spikes coming from the PMD detector itself as shown in Fig.2. Secondly we put the filter circuit and TVS diode at the supply input of the CROCUS to deal with the spikes coming due to external sources as shown in Fig.3.

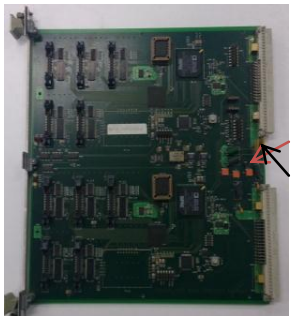

Fig.2 Additional TVS diode put on FRT

This modification was done in the Dec-2012 and after this modification in pA run in Jan-Feb, 2013 there were minimal stop of run due to PMD DAQ reset/busy.

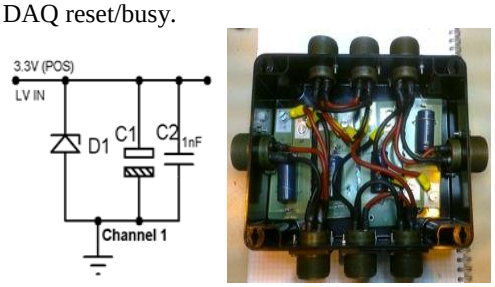

Fig.3 Filter circuit used for spike protection

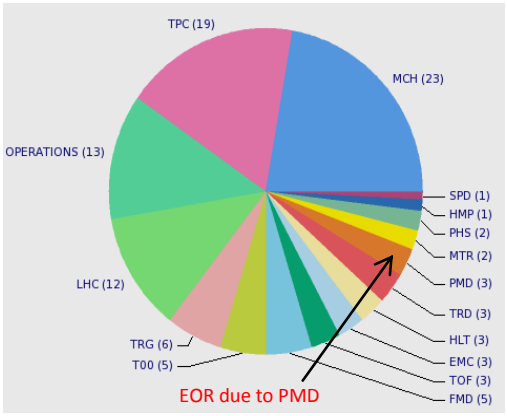

Fig.4 Performance of PMD in pA run of Jan-Feb, 2013

Results

The graph in Fig. 4 (taken from the slides of ALICE run coordinaton), shows that the End of Run (EOR) due to PMD is just 3-times in the full run time of pA data taking during Jan-Feb, 2013.

The detailed testing procedure and analysis results will be presented.

References

[1] Photon Multiplicity Detector Technical Design Report CERN/LHCC 99-32 (1999)

[2] M.M. Aggarwal et al., Nucl. Instr. and Methods, A499 (2003) 751.

[3] T. K. Nayak et al, Proceedings of DAE Symp. On Nucl. Phys. 55(2010) pg 694-695

[4] Jogender Saini et al, Proceedings of DAE Symp. On Nucl. Phys. 55(2010) pg 764-765