Radiation test of active LVDB component with ^{60}Co Gamma chamber and Neutron irradiation at VECC Cyclotron

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Introduction

A GEM based detector system is being developed at VECC, Kolkata for use as muon tracker in the Compressed Baryonic Matter (CBM) experiment at the upcoming FAIR facility at Germany [1][2]. The Muon Chambers (MUCH) consists of alternating layers of six absorbers and detector stations. The harsh radiation dose in CBM owing to high hadronic environment poses severe constraints on the design and selection of the electronic components to be used along with the detectors. To make sure that selected components will work in this environment, we have performed Gamma dose testing one of the proper component in ^{60}Co chamber at UGC-DAE Consortium for Scientific Research, Kolkata and with secondary neutrons by bombardment of proton on thick Ta target using Cyclotron at VECC.

Fig. 1 Gamma irradiation testing setup

a) Gamma irradiation test

The most upstream detector station of MUCH will receive highest dose of 300Gy/2months as was simulated by FLUKA calculation [3] and total CBM-MUCH operating period in 10 years is expected to be of 20 operational months [1], and therefore the CBM readout electronics are to be made to withstand the total dose of 315 KRad.

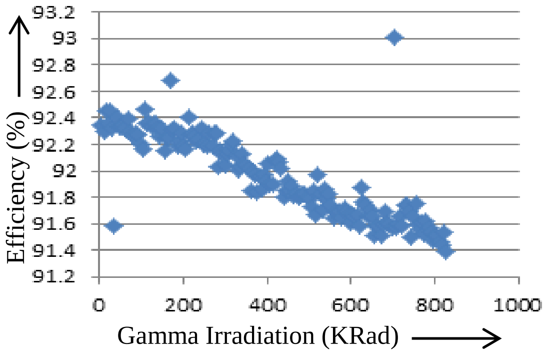

Fig.2 Efficiency vs. Gamma Dose

Fig. 1 shows the ^{60}Co Gamma chamber has been used as a irradiation source. The equivalent dose rate inside this chamber was of 3.1kGray/hour. Two number voltage regulators were inserted in this chamber, one with load and another without load. As the chamber was a closed enclosure, so there is a possibility of temperature rise due to load. Hence a small fan arrangement was made inside the chamber to run continuously and additionally we have taken out chamber every 10 minutes to further cool it down to ambient room temperature. Input and output voltages and currents were measured every 10minutes. The efficiency which is calculated by the ratio of output power to the input power of voltage regulator, was measured with respect to the cumulative gamma dose.

Gamma irradiation Results

Fig. 2 shows the efficiency of voltage regulator with cumulative gamma dose up to 8kGy. The efficiency of voltage regulator in the entire irradiation was dropped down from 92.5% to 91.5%, which is well within the acceptable range of current design of low voltage distribution board (LVDB) to be used for CBM-MUCH electronics.

b) Neutron irradiation test

MUCH adds to the neutron background immensely. As per FLUKA calculations [4], it is estimated that the electronics will have to withstand a high neutron dose of the order of 10^{11} Neq/cm^2 for lifetime of CBM-MUCH detector. It has thereby becomes important to study the behavior of the proposed electronic component to such a high flux of neutrons.

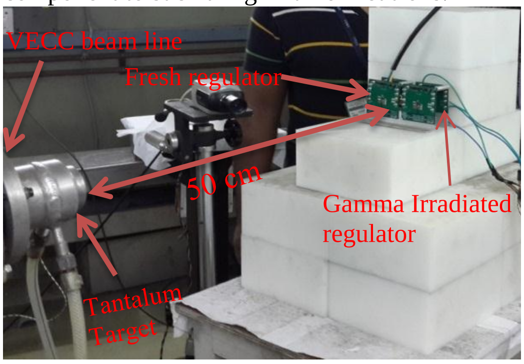

Fig. 3 Schematic of the neutron test setup at VECC Cyclotron

The aim of the neutron tests is to find any physical or characteristics damage on the regulator. In this direction, we conducted the first such test of LTC3605 voltage regulator in VECC cyclotron. As shown schematically in Fig.3, a 15 MeV proton beam with the beam current of 4uA average was bombarded on a thick Ta target to get the secondary neutron. This experiment was performed for about 10days to achieve the required neutron dose.

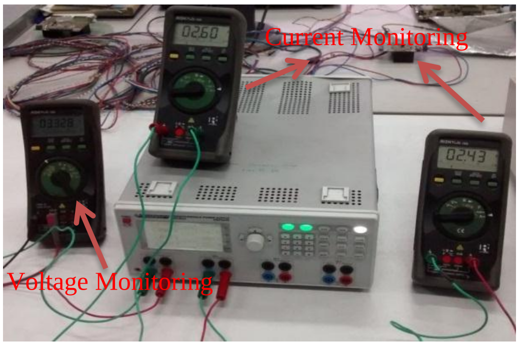

Fig. 4 Voltage and current monitoring setup

As shown in the Fig.3 voltage regulators (LTC3605) were placed 50 cm away from the Ta target. Here we used four voltage regulators, where two voltage regulators were gamma irradiated and two others were non-irradiated. To obtain the equivalent dose, current integrator was used to measure the primary bombarded particles on the target. Equivalent neutron dose was calculated [5] every two hours along with the Input output voltages and currents for efficiency calculations.

Neutrons test results

Fig.5 shows the efficiency of both Gamma radiated and non-irradiated voltage regulator with respect to number. of neutrons falling on the regulator. The plot shows that the efficiency of the regulator is almost stable throughout the irradiation of 7.1x 10^{10} neutrons/cm^2.

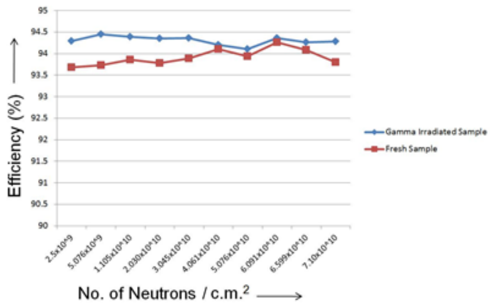

Fig.5 Efficiency vs. No. of neutrons/c.m.^{2}

Acknowledgements

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