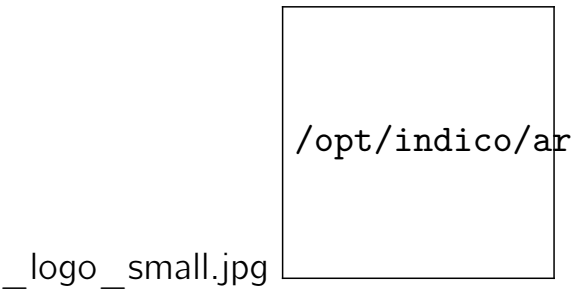

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Radiation Hardness tests with neutron flux on different Silicon photomultiplier devices

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Content

Radiation hardness is an important requirement for solid state readout elements operating in high radiation environments common in particle physics experiments. The MEG II experiment at PSI, Switzerland, investigates the forbidden decay $\mu+ \rightarrow e+ \gamma$. exploiting the most intense muon beam of the world. A significant flux of non-thermal neutrons (kinetic energy Ek $\geq$ 0.5 MeV) is present in the experimental hall produced along the beamline and in the hall itself. We present the effects of neutron fluences comparable to the MEG2 expected doses on several Silicon PhotoMulitipliers (SiPMs). The tested models are: AdvanSiD ASD-NUV3S-P (the same model used in MEG II), AdvanSiD ASD-RGB3S-P, Hamamtsu s12571-050P and Excelitas C30742-33-050-x. The neutron source is the thermal Sub-critical Multiplication complex (SM1) moderated with water, located at the Department of Chemistry University of Pavia (Italy). We report the change of SiPMs most important electric parameters: dark current, dark pulse frequency, gain, direct bias resistance, as a function of the integrated neutron fluence.

Summary

The MEG detector was designed to measure the lepton flavour violating process $\mu + \rightarrow e + + \gamma$. The detector consisted of a spectrometer for measuring the positron trajectory made of a set of drift chambers, a timing counter based on scintillating bars read out by PMTs, divided in two sectors, inside a gradient field magnet and a large homogeneous liquid xenon calorimeter for measuring the γ energy, timing and position. In order to improve the limit set by MEG by an additional order of magnitude, the collaboration designed an upgraded version of the experiment, MEGII The upgraded version consists of, between other items, a new timing counter using Silicon Photomultipliers (SiPMs) for readout of small scintillator plates. In the experimental hall a significant flux of non-thermal neutrons (kinetic energy Ek $\geq$ 0.5 MeV) is present and could degrade the performances of SiPMs. We investigate this effect on several kinds of devices (AdvanSiD ASD-NUV3S-P, AdvanSiD ASD-RGB3S-P, Hamamtsu s12571-050P and Excelitas C30742-33-050-x) using the thermal Sub-critical Multiplication complex (SM1) moderated with water located at the Department of Chemistry, University of Pavia (Italy). The fuel is natural uranium in metallic form arranged in 206 Aluminum-clad fuel elements with an inner diameter of 2.8 cm and a length of 132 cm. Fuel elements are assembled in a hexagonal prism geometrical configuration with a radial dimension of 114 cm and a height of 135 cm. Located at the centre of the SM1 core, a PuBe neutron source has an emission rate equal to ![enter image description here][1]8.9 $\times$ 10^6 n/s over the full solid angle. We present the effects of neutrons on the most important SiPMs characteristics.

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