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Investigation of a 10-Channel SiPM Module in a Neutron Beam at NPI of ASCR

A readout module developed and produced in LHEP JINR (Dubna, Russia) containing 10 channels of scintillators, SiPM photo-sensors, amplifiers and high voltage control circuit was investigated for two years at NPI of ASCR (Rez, Czech Republic) at a neutron source with a spectrum of 6-35 MeV.

The module was investigated for study the possibilities of SiPM applications in position-sensitive neutron detectors and for the study of radiation hardness of such photo-sensors in harsh environment of experiments at future accelerators.

Three experiments were carried out during 2015-2017. A period of a few months was allowed after every irradiation to reach maximum of self-annealing effect. After irradiation to the total fluence of about 10E13 n/cm2 all SiPMs became inoperable due to drastically increased noise and decreased light sensitivity, however amplifiers and bias voltage circuitries still operate reliably.

After final experiment all SiPMs were removed from the module and investigated in laboratory of NPI. Main attention was devoted to study of distribution of electric field within SiPM internal structure and changing of ratio of mean density of defects to mean time of life of minority carriers.

Electric field distributions for 10 SiPMs were obtained and compared to the results before irradiation. Analysis of changing of electric field distribution within SiPM volume and character of behavior of ratio of mean density of defects to effective time of life of minority carriers show that the main reason of increased noise is a result of changing of electric field distribution near surface, that decrease the efficiency of collection of charge of minority carriers that were generated by

short wave light.

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