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Characterization of SiPM radiation hardness for application in hadron calorimeters at FAIR, CERN and NICA

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Silicon Photomultipliers (SiPMs) are an excellent choice for the scintillator light readout at modern hadron calorimeters due to their insensitivity to magnetic fields, low operating voltages, low cost, compactness and mechanical endurance. They are already successfully utilized in Projectile Spectator Detector (PSD) of NA61@CERN, and will be utilized soon in PSD of CBM@FAIR, Forward Hadron CALorimeters (FHCALs) of NICA and BM@N heavy-ion collision experiments. All of those are compensating lead-scintillator calorimeters designed to measure the energy distribution of the forward going projectile nucleons and nuclei fragments (spectators) produced close to the beam rapidity. The main issue of SiPM application at such facilities is degradation of their characteristics within high neutron fluence that can reach up to 2E11 n_{eq}/cm^2 per year of the experiment operation. Multiple irradiation tests of SiPMs produced by Ketek, Zecotek, Hamamatsu and Sensl manufacturers were conducted at the cyclotron of NPI Rez with a "white" (from thermal up to 34 MeV) neutron spectrum and total fluences in the wide range of 6E10 - 9E12 n_{eq}/cm^2. Detailed SiPM characterisation was performed based on dependencies of capacitance on voltage, capacitance on frequency, dark current on voltage and signal/noise on voltage. Results of these measurements before and after SiPMs' irradiation as well as main parameters variability and self-annealing after irradiation will be discussed. Performance of the PSD calorimeter module equipped with irradiated SiPMs in CERN during the beam scan with 2–10 GeV/c protons will be overviewed.

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