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Studies of radiation damage by photons and neutrons of scintillator counters with WLS fiber and SiPM readout.

We have studied the rate dependence of the radiation damage of BICRON-408 (BICRON Co.) scintillator with Y11 WLS fiber and EJ-260 (ELJEN Co.) scintillator with O2 WLS fiber (Kuraray Co.). The doses were in the range from 4 to 25 Mrad and the dose rates varied from 2 to 600 krad/hour. We observed the light yield drop (measured in number of detected photoelectrons from a 60x12x4mm3 scintillator strip readout by via a WLS fiber by the HPK S12825-050C SiPM) by about a factor of 2 for the BICRON-408 with Y11 WLS fiber after 4Mrad at 2.8 krad/hour while EJ-260 scintillator with O2 WLS fiber reached a similar light yield drop only after 7 Mrad at the dose rate of 2.8 krad/hour. Irradiation of the Y11 fiber to 4 (7) Mrad resulted in the light yield drop of ˜ 30% (40%). No dependence of the fiber radiation damage on the dose rate was observed within the measurement errors. No light yield drop was observed in case of O2 fibers up to 7Mrad. Points from 15 to 25Mrad show about 10% drop in the light yield. The light yield drop due to the fiber irradiation is smaller than the drop due to the scintillator damage.
Radiation damage of scintillator, fibers and SiPMs was studied at the JINR IBR2 facility. O2 WLS fibers did not show any drop in the light yield up to 1 MeV equivalent neutron fluence of 2.6x1015 n/cm2. EJ260-O2 combination lost about 35% (48%) of the light yield after 8x1011 (2.6x1015) n/cm2. We also studied radiation damage of 15 micron pitch, 2.8 mm diameter Hamamatsu MPPCs S10943-4732 at fluences from 7.1x1011 to 2.6x1012 n/cm2. We compared different methods for breakdown voltage determination applicable after irradiation when individual photoelectron peaks are smeared out. We measured dark current, signal to noise ratio and dark current dependence on temperature from the room temperature till -300C.
Results of these measurements are being used for the development of the Scintillator Back Hadron calorimeter project for the high luminosity CMS upgrade.

Summary

The the rate dependence of the radiation damage of BICRON-408 (BICRON Co.) scintillator with Y11 WLS fiber and EJ-260 (ELJEN Co.) scintillator with O2 WLS fiber (Kuraray Co.) was investigated. The doses were in the range from 4 to 25 Mrad and the dose rates varied from 2 to 600 krad/hour. EJ-260 scintillator with O2 WLS fiber is more radiation hard.
Radiation damage of scintillator, fibers and SiPMs was studied at the JINR IBR2 facility. O2 WLS fibers did not show any drop in the light yield up to 1 MeV equivalent neutron fluence of 2.6x1015 n/cm2. EJ260-O2 combination lost about 35% (48%) of the light yield after 8x1011 (2.6x1015) n/cm2. We also studied radiation damage of 15 micron pitch, 2.8 mm diameter Hamamatsu MPPCs S10943-4732 at fluences from 7.1x1011 to 2.6x1012 n/cm2. We measured dark current, signal to noise ratio and dark current dependence on temperature from the room temperature till -30C.

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