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Cryogenic operation of neutron-irradiated SiPM arrays from FBK and Hamamatsu

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The LHCb experiment at CERN has been upgraded for the Run 3 operation of the Large Hadron Collider (LHC). A new concept of tracking detector based on Scintillating Fibres (SciFi) read out with multichannel silicon photomultipliers (SiPMs) was installed during its upgrade. One of the main challenges the SciFi tracker will face during its operation is the high radiation environment due to fast neutrons, where the SiPMs are located. In view of LHCb Upgrade II in 2033, the radiation levels will increase significantly and the SciFi tracker must undergo a major upgrade. By the end of the lifetime, the expected radiation fluence reaches $3E12$ neq/cm² at the SiPMs location. To cope with the increase in radiation, cryogenic cooling with liquid Nitrogen is being investigated as a possible solution to mitigate the performance degradation of the SiPMs induced by radiation damage. Thus, a detailed performance study of different layouts of SiPM modules produced by FBK and Hamamatsu is being carried out. These detectors have been designed to operate at cryogenic temperatures. Several detectors were irradiated at Ljubljana at different neutron fluences and tested in a dedicated cryogenic setup down to 100K. Key performance parameters such as breakdown voltage, dark count rate, photodetection efficiency, cross-talk, and after pulsing are characterized as a function of the temperature, over-voltage, and neutron fluence. The main results of this study are going to be presented.

Primary experiment

LHCb

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