A SiPM-based optical readout system for the EIC dual-radiator RICH

Roberto Preghenella on behalf of the INFN EIC_NET dRICH Group

SiPMs are the baseline photodetector technology for the dual-radiator Ring-Imaging Cherenkov (dRICH) detector of the EPIC experiment at the future Electron-Ion Collider (EIC). SiPMs offer significant advantages being cheap devices, highly efficient and insensitive to the high magnetic field (~ 1.5 T) at the expected location of the sensors in the experiment. However, they are not radiation tolerant and one has to test whether the increase in Dark Count Rate (DCR) can be mitigated to maintain single-photon performance with current SiPM technology in a moderately hostile (< 10^{11} 1-MeV n_{eq}/cm^2) radiation environment. Several options are available to maintain the DCR to an acceptable rate (below ~ 100 kHz/mm^2) by reducing the SiPM operating temperature and by recovering the radiation damage with high-temperature annealing cycles. Moreover, by utilising high-precision TDC electronics the use of timing information can effectively reduce background due to DCR.

In this talk we present an overview of the current status of the R&D and the results of studies performed on significant samples of commercial and prototype SiPM sensors. The devices have undergone proton irradiation in two campaigns aimed at studying the device performance with increasing NIEL doses up to 10^{11} 1-MeV n_{eq}/cm^2, the device recovery with long high-temperature annealing cycles and the reproducibility of the performance in repeated irradiation-annealing cycles. It was also explored the use of Joule annealing as a potential way to perform high-temperature annealing in-situ. In October 2022 the sensors instrumented the optical plane of the dRICH detector prototype and were successfully tested with particle beams at the CERN PS accelerator. The results are obtained with a complete chain of front-end and readout electronics based on the first 32-channel prototypes of the ALCOR chip, a newly designed ASIC for SiPM readout.