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A large-area SiPM readout plane for the ePIC dRICH detector at the EIC: realisation and beam test results

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The ePIC experiment at the Electron-Ion Collider (EIC) includes a dual-radiator RICH (dRICH) detector for PID in the forward region. The dRICH will be equipped with 3x3 mm^2 silicon photomultipliers (SiPM) for Cherenkov light detection over a surface of $\sim$ 3 m^2 ($\sim$ 300k readout channels), representing the first HEP application of SiPMs for single-photon detection. SiPMs are chosen for their low cost and high efficiency in magnetic fields ($\sim$ 1 T at the dRICH location). However, as SiPMs are not radiation hard, attention and careful testing is required to preserve single-photon counting capabilities and maintain the dark count rates (DCR) below $\sim$ 100 kHz/mm^2. DCR control can be achieved with operation at low temperature and recovery of the radiation damage via high-temperature annealing cycles. The integration of the SiPMs precise timing with fast time-to-digital converter (TDC) electronics helps to reduce further the effect of DCR as background signal.

In this talk we present the current status of the R&D performed for the ePIC-dRICH detector at the EIC. A special focus will be given to the beam test results obtained with the dRICH prototype SiPM optical readout. A large-area readout plane consisting of a total of 1280 3x3 mm^2 SiPM sensors was built and tested with particle beams at CERN-PS in October 2023. The photodetector is modular and based on a novel EIC-driven prototype photodetection unit (PDU) developed by INFN, which integrates 256 SiPM pixel sensors, cooling and TDC electronics in a volume of $\sim$ 5 x 5 x 14 cm^3. The data have been collected with a complete chain of front-end and readout electronics based on the ALCOR chip, developed by INFN Torino. This presentation will highlight the features of the PDU and the performance of the full dRICH SiPM prototype system that successfully recorded Cherenkov photon rings.

Authors: RIGNANESE, Luigi Pio (Universita e INFN, Bologna (IT)); Mr RUBINI, Nicola (Universita e INFN, Bologna (IT)); PREGHENELLA, Roberto (INFN, Bologna (IT))

Presenter: PREGHENELLA, Roberto (INFN, Bologna (IT))

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