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First performances of EICROC ASIC to read-out pixelated AC-LGAD sensors for the Electron-Ion Collider (EIC)

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Finding the answers to the long-standing questions, such as, emergence of mass and spin of the proton from partons, saturation of gluon density, and gluon momentum distribution inside the proton and nuclei, motivated the EIC [1] to be developed at Brookhaven National Laboratory, USA. The first EIC detector, ePIC (electron Proton-Ion Collision experiment), is comprised of a central barrel detector, as well as extensive beamline detectors in the outgoing electron (far-backward) and hadron (far-forward) beam directions. The far-forward (FF) detectors include Roman pots, which are placed inside vacuum and are intended to detect protons and ions scattered at very small angles (~ 5 mrad) in the forward direction, at ~ 30 m downstream from the interaction point. The main goal of the FF detectors is to tag exclusive and diffractive events and to reconstruct their transverse momentum with a resolution of ~ 10 MeV/c. This is obtained by developing a new generation of 4D tracking sensors, pixelated AC-LGADs (capacitively-coupled Low-Gain Avalanche Diode, pixel of $500 \times 500 \mu\text{m}^2$) [2][3] capable of providing the required spatial (less than $50 \mu\text{m}$ relying on charge sharing among pixels) and timing (~ 30 ps) resolutions. After these AC-LGADs have been read-out using ALTIROC0 [4] as a first attempt, an optimized read-out chip, EICROC (32x32 pads), is being designed by OMEGA and the characterization of the first prototype, EICROC0 (4x4 pads) [5], coupled to an AC-LGAD sensor is being performed at IJCLab. The EICROC0 is a system-on-chip with analog and digital processing including for each of the 16 channels a fast low-noise trans-impedance preamplifier, followed by two paths: a fast path with a discriminator connected to a 10-bit Time-to-Digital Converter (CEA/Irfu) for time measurement (ToA) with a 25 ps accuracy; and a slow path with shaper connected to an 8-bit 40 MHz successive approximation Analog-to-Digital Converter (AGH Krakow) providing amplitudes. The performances of pixelated AC-LGAD sensors read-out by EICROC0, obtained from preamplifier as well as digital (TDC and ADC) data and relying on measurements with the internal charge injection system, a Beta source and an infrared laser, will be presented.

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