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## Pixelated AC-LGAD sensors for the Electron-Ion Collider (EIC): read-out performances with EICROC0\_v0 ASIC

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] under construction at Brookhaven National Laboratory, USA. The first EIC detector, ePIC (electron Proton-Ion Collision experiment), consists 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 ( $\sim 5$  mrad) in the forward direction, at  $\sim 30$  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  $\sim 10$  MeV/c. This is obtained relying on 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  $50 \mu\text{m}$  from charge sharing among neighboring pixels) and timing ( $\sim 30$  ps) resolutions. To read-out these novel LGADs exploiting their charge sharing capability, an optimized read-out large scale chip, EICROC (32x32 pads), is being designed at OMEGA. The first ASIC prototype, EICROC0\_v0 (4x4 pads) [4], 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 performance results obtained at IJCLab with pixelated AC-LGAD sensors read out by the EICROC0\_v0 ASIC, including preamplifier response and digital data from the TDC and ADC, will be presented. These results rely on measurements performed using the internal charge injection system and a beta source. Special emphasis will be placed on quantifying the charge-sharing ratio between adjacent pixels. Perspectives of characterization response of EICROC0\_v0 relying on an infrared laser, as well as next EICROC0 chip iterations will also be discussed.

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### References:

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- [4] A. Verplancke et al., "EICROC: an ASIC to read-out the AC-LGAD sensors for the Electron-Ion Collider (EIC)", contribution to the proceedings of the Topical Workshop on Electronics for Particle Physics, Sept. 30th –Oct. 04th, 2024, Glasgow, UK, JINST 20 C04014.

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### Topic

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