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Measuring the transverse diffusion of electrons in noble gasses: A laboratory-scale demonstration of the physics capabilities of Q-Pix.

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We report measurements of the transverse diffusion parameters of electrons through P10 gas (90% Ar, 10% CH4) in a laboratory-scale time projection chamber (TPC) using a novel pixelated signal capture and digitization method. The method, Q-Pix, consists of a precision switched integrating trans-impedance amplifier whose output is compared to a threshold voltage by a comparator. The comparator sends a 'reset'signal that discharges the integrating capacitor when the output of the integrator reaches the preset threshold. The time difference between the successive resets, the reset time difference (RTD), is inversely proportional to the current at the pixel, and the number of resets is directly proportional to the total charge collected at the pixel, enabling a pixel-based readout of the ionization signals using either the RTDs or the number of resets. Here, the constant of proportionality, depending on the voltage threshold and the value of the integrating capacitor, represents the minimum charge required for a single reset. We used a 16-channel Q-Pix readout fabricated using commercial off-the-shelf components and coupled them to 16 concentric anode rings to measure the spatial extension of the electron swarm that reaches the anode after drifting through an electric field of $\sim$ 500V/cm in P10. The macroscopic electron swarm is produced at the Au photocathode using pulsed VUV photons. We obtained a reasonable fit to the swarm diffusion profiles extracted from the pixelated anode plane at various operating pressures ($\sim$ 250 Torr - 2200 Torr). Our results demonstrate that a Q-Pix readout can successfully reconstruct geometric properties of ionization events in a TPC.

Early Career

Yes

Primary authors: HOCH, N. (Physics Department, Wellesley College,); SEIDEL, O. (Department of Physics, University of Texas at Arlington)

Co-authors: KEEFE, K. (Department of Physics, University of Texas at Arlington); ENRIQUEZ, A. B. (Department of Physics, University of Texas at Arlington); PARMAKSIZ, I. (Department of Physics, University of Texas at Arlington); MCDONALD, A. D. (Department of Physics, University of Texas at Arlington); CHIRAYATH, V. A. (Department of Physics, University of Texas at Arlington); MAHDY, H. (Department of Physics, University of Texas at Arlington); ROOKS, M. (Department of Physics, University of Texas at Arlington); BATTAT, J. B. R. (Physics Department, Wellesley College,); ASAADI, J. (Department of Physics, University of Texas at Arlington)

Presenter: CHIRAYATH, V. A. (Department of Physics, University of Texas at Arlington)

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