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A Novel Optical Communication Scheme for a New Clock-less Q-Pix Detector Design (for Q-Pix Collaboration)

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We present a novel optical communication system that can overcome the limitations of conventional wire-based readout. We have coupled this system to a novel clockless Q-Pix design built using Commercial Off-The-Shelf (COTS) components. In Q-Pix, charge is read out using a charge-integrate-replenishment circuit that provides replenishment pulses corresponding to the time when a particular amount of charge is collected. In standard Q-Pix schemes, the time at which the replenishment occurs is produced using a local clock. However, in the scheme presented here, we employ basic digital logic components to produce a time-delayed pulse that resembles a clock. This pulse determines the replenishment charge per pixel, as well as the timing circuitry. This pulse is used to control an LED which is then read out using a spatially and electrically separated SiPM and Schmitt Trigger. This is expected to reduce the noise injected from the environment into the charge readout plane and thus can achieve a better Signal-to-Noise Ratio (SNR) than wire-based communication. We present a general design outline and results of bench-testing that compares the wire-based communication scheme to our optical scheme. We will discuss the expected improvements in SNR in a large-scale pixel readout system that employs this optical scheme.

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