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LightPix-v3: Improvements in scalable readout for silicon photomultipliers in cryogenic environments

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The LightPix application-specific integrated circuit (ASIC) is designed for amplification, triggering, digitization, and multiplexed readout of high-channel count silicon photomultiplier (SiPM) systems, particularly within cryogenic environments. Here we report on performance measurements using LightPix-v3 which includes a variety of enhancements relative to the previous version. A new custom very-low-power (O[100]-uW) front-end amplifier enables use of larger-area (>10 mm2) SiPMs and delivers sufficient bandwidth to a TDC with O[1]-ns precision. This version also adds an 8-bit SAR ADC to each input channel, for better calorimetric performance in higher-occupancy applications. The LightPix system leverages the scalable readout techniques and digital back-end components from the related LArPix effort, which has been demonstrated in multiple liquid argon detectors with >10^5 channels. LightPix also features programmable multi-channel hit-coincidence logic to mitigate high dark count rates, facilitating use in non-cryogenic detectors.

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