

Characterization of the ColorPix-2 ASIC Hybrid Pixel Readout Chip with CZT Sensors

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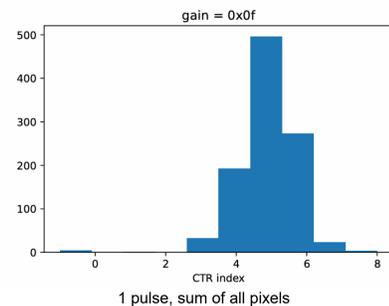
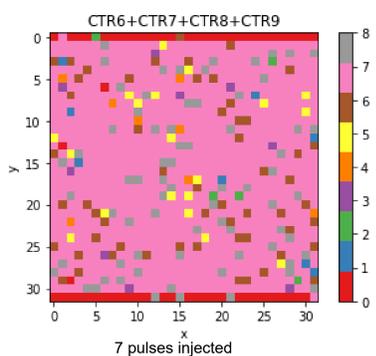
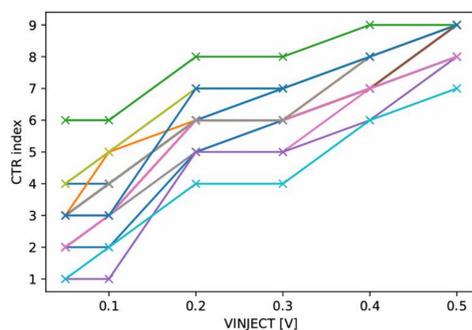
INTRODUCTION

- ❑ We present the characterization of the ColorPix-2 ASIC communicating with the UniCORN readout interface.
- ❑ ColorPix-2 is the ASIC designed for high-resolution, position and color sensitive X-ray imaging.
- ❑ The ASIC acquires data in terms of hit counting across 10 settable energy levels.
- ❑ Due to the device tolerance, several DACs are needed to be tuned prior to measurements.
- ❑ We describe the equalization procedure, including threshold scanning or pixel offset compensation, energy level calibration, and measurement under the X-rays exposure.
- ❑ The measurements validated the intended functionality of the chip.
- ❑ Finally, we summarize the implications for the upcoming ColorPix-3 revision.

INJECT MEASUREMENTS

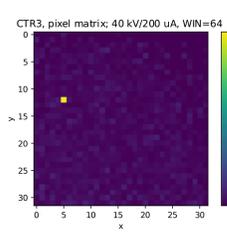
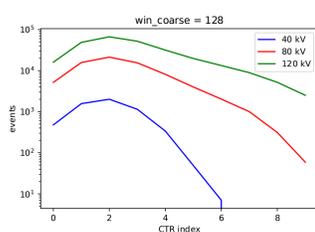
- ❑ The voltage has been injected through the capacitor, which simulated events corresponding to different counter values. The charge injected is $Q = C_{inj} U$, where $C_{inj} = 5$ fF.

Dependence of the active counter index on V_{INJECT} , 1 inject pulse,
VTH_COARSE = 70, WIN_COARSE = 128, x = 0.31, y = 5



X-RAY MEASUREMENTS

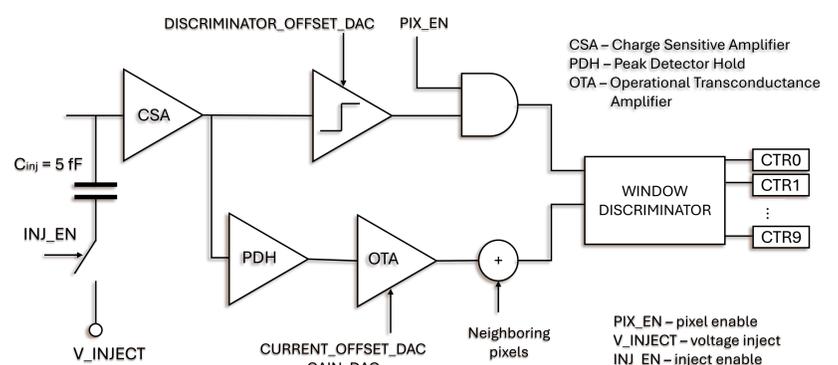
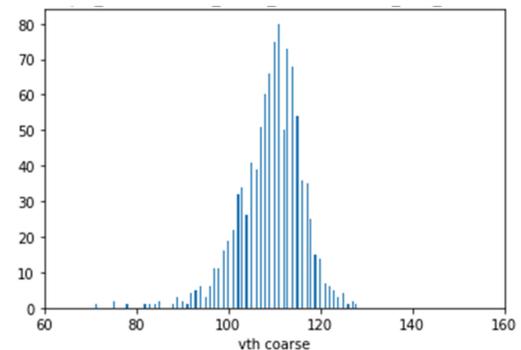
- ❑ The chip was irradiated with the X-ray tube. We show the summation of all pixel events vs the counter index, which corresponds to the energy spectrum. The energy of 10 keV per counter was applied.
- ❑ The second image shows a matrix plot for the selected counter, where we can identify a noisy pixel.



DACs calibration

- ❑ DISCRIMINATOR_OFFSET_DAC – a parameter of the pixel discriminator. If the signal is below the configurable offset threshold, the signal is blocked
- ❑ CURRENT_OFFSET_DAC – adds the settable current in the OTA output, effectively shifting the signal level within the counter thresholds.
- ❑ GAIN_DAC – defines the gain of OTA.
- ❑ Range of DISCRIMINATOR_OFFSET_DAC is given by VBN_DISC_DAC

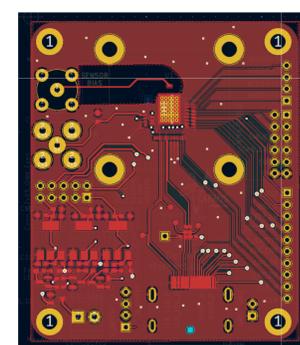
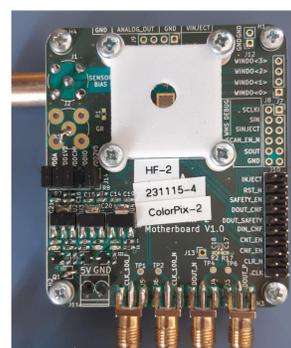
HF-1, DISCRIMINATOR_OFFSET_DAC = 31, VBN_DISC_DAC = 255



Simplified pixel structure

COLORPIX-2 OFFERS

- ✓ Measuring X-rays within a pixelated matrix of 32 x 32 pixels of 70 μ m a pitch
- ✓ Use hit-counting mode and set the shutter time accordingly
- ✓ Acquire data divided into 10 equidistant energy bins.
- ✓ Use 12-bit counters for each energy bin per pixel.
- ✓ Configure the energy window size per bin up to 40 keV, with a configurable baseline offset from 0 to 70 keV
- ✓ Exploit the full range of 0–200 keV per pixel, baseline up to 70 keV
- ✓ Operation in the MONOCHROMATIC mode (1 active counter), or COLOR mode (10 active counters)



[1] J. Jirsa et al., Monte-Carlo simulation of charge sharing in 2 mm thick pixelated CdTe sensor. Journal of Instrumentation. 2023, C02033.
[2] J. Jirsa et al., Multi-threshold window discriminator based on SAR logic. Journal of Instrumentation, 2022, C01042.
[3] J. Jirsa et al., Winner-Leader-Follower a Novel Hit Allocation Algorithm for Pixel Detectors. IEEE Transactions on Nuclear Science, 2024