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P1.60: Hybrid Pixel Array Detector for Time-resolved and Imaging Applications with 56,000 fps Sustainable Frame Rate

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It has been more than ten years since HPAD (Hybrid Pixel Array Detectors) had been widely utilized as X-ray diffraction and imaging detectors. Thanks to its single photon counting capability, HPAD shows images without background noise and wide dynamic range. Due to limitations of the fabrication process, most HPADs are made with monolithic sensor and tiled readout ICs. In conventional HPAD, there were so-called “inter-chip pixels” on the edges of readout ICs. These inter-chip pixels have 1.5 times or wider width and/or height than non-inter-chip pixels. This means, we are losing position information of a hit of photons on those pixels.

We have successfully dealt with this inter-chip pixel problem by use of re-distribution layer on the Silicon sensor. So, in our new detector, non-uniformity in a single sensor module is eliminated.

This new detector is designed based on UFXC32k IC [1] designed by AGH University of Science and Technology and named XSPA-500k [2]. XSPA-500k detector consists of 16 UHXC chips tiled and 1024 x 512 76 μm sq. pixels per module. No inter-chip pixels in between ROICs which terribly suffer the image quality.

XSPA-500k is aiming not only for X-ray imaging but also for time-resolved X-ray measurements. Dealing with “inter-chip pixels” is our main feature for imaging, and for time-resolved measurements we understand that frame rate is as important as the size of the pixels and the area of the detector. Thanks to UFXC32k IC’s high count-rate and fast operation capability, combined with our high data throughput backend circuits, XSPA-500k is capable of up to 56,000 fps with full-frame readout and 100,000 fps with 100 lines ROI in the center of the modules with continuous exposure (zero-deadtime mode operation with 2-bit counter/pixel.) If the non-continuous exposure (burst-mode operation [3]) is allowed, it can achieve over 970,000 fps with approximately 2 % duty ratio.

REFERENCES

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Primary author: NAKAYE, Yasukazu (Rigaku Americas Corporation)

Presenter: NAKAYE, Yasukazu (Rigaku Americas Corporation)

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