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DynamiX: A charge cancellation ASIC for high-rate X-ray measurements using CdZnTe

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The DynamiX project is the development of a 2D pixelated hybrid X-ray detector suitable for the next generation of high-flux synchrotrons such as Diamond II in the UK.

DynamiX incorporates a CdZnTe sensor at a 100 μ m pitch in a 192x192 array with a 65nm CMOS ASIC operating at 533KHz framerate (one frame per turn of Diamond II) with single photon resolution at 25 keV, 3×10^9 photons/s/pixel. The ASIC features a two-stage direct-to-digital pixel architecture with adjustable charge removal per stage, allowing refinement for different energies or trade-off for maximum amplitude. In normal operation, a highspeed Aurora compliant readout system incorporating an array of 14Gbps CML serializers transmits data from the ASIC at 314.4Gbps. The ASIC operational sequence is SPI configurable and can be tailored to a specific application or instrument with a resolution of 2ns. Furthermore, the number of pixel-rows being measured can be reduced via SPI to boost the framerate past 534KHz. The ASIC uses a scalable architecture incorporating a single sub-design capable of servicing 16 columns and up to 192 pixel-rows. To build the full-size, the sub-design is instantiated 12 times along with basic interconnect routing and simple utility circuitry.

A reduced pixel-row-count sub-design (16x16 array ASIC) is scheduled to be manufactured in a Multi-Project-Wafer run this year. The manufactured ASIC will be bonded to a high-flux grade CdZnTe sensor for performance evaluation. A strong focus will be on evaluating the CdZnTe sensor performance and stability when operating at the very high very high fluxes of $\sim 3 \times 10^{11}$ photons/mm²/s and beyond.

In this contribution, we will present the current state of the project in greater detail and the entire architecture of the detector system.

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