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Characterisation of MÖNCH 0.5, a 25 µm pitch prototype charge-integrating hybrid pixel detector

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MÖNCH is a charge-integrating hybrid pixel detector readout ASIC with 25 µm pitch, currently in the advanced prototyping phase.The small pixel pitch offers excellent native spatial resolution performance which has been demonstrated with several applications such as, full-field fluorescence imaging, computed tomography, and ptychography. With the combination of low noise and charge sharing effects, interpolation algorithms allow spatial resolution enhancements by assigning the signal into virtual subpixels. This improvement can be of prime importance for several applications such as X-ray emission spectroscopy, full-field transmission X-ray microscopy, and resonant inelastic X-ray scattering. The interpolation technique has not only been demonstrated with standard silicon sensors but also with low-gain avalanche diodes (LGADs) and high-Z sensors, making interpolation with MÖNCH suitable for photon energies ranging from 500 eV to 60 keV.

Current developments are oriented towards providing a full-scale detector system which requires the design of a fast (2 kHz), large-area (2.56 × 1.92 cm^2; 1024 × 768 pixels), at least one-side buttable, and low-noise (< 80 e^- at 500 µs exposure time at room temperature) readout ASIC. The most recent prototype, MÖNCH 0.5, has been designed to explore the feasibility of satisfying all of these aspects. The readout ASIC features an active area of 160 × 150 pixels split into 6 different designs, with one specifically focusing on reducing static power dissipation. A newly designed analogue readout chain has also been implemented to confirm the ability to read out the full-scale chip at the expected rates.

The first results of MÖNCH 0.5 show that the implemented changes should satisfy the requirements. Noise levels of 53 e^- at 500 µs exposure time have been achieved in the low-power pixel variant. Also, a pixel design with maximised gain demonstrated under 20 e^- noise at 10 µs exposure time. The results of the pixel and analogue chain characterisations will inform the design of the full-scale readout chip with the ultimate goal of providing detector modules by 2027.

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