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Optimising the design of small pitch Hybrid Pixel Detectors with MÖNCH04

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MÖNCH (Micropixel with enhanced pOsition rESolution usiNg CHarge integration) is a 25 μm pixel pitch charge integrating hybrid pixel detector with analogue readout designed at the Paul Scherrer Institut to explore the limits of the technology for high-resolution imaging at synchrotrons and XFELs (X-ray Free Electron Lasers) [1]. The latest prototype, MÖNCH04, features an array of 400 x 400 pixels separated in 19 variants for either soft X-ray synchrotron or XFEL applications. Most of the variants also include very high configurability to optimise the readout scheme and to isolate sections of the pixel. Testing independent elements will permit the selection of the optimal components and designs to fit in the small pitch for a large-scale MÖNCH detector.

The characterisation of the pixel variants optimised for the lowest noise and highest responsivity have demonstrated an improvement in noise performance, down to 21.5 electrons rms. The improvements are especially visible with the spectral response (Figure 1) when comparing the reference design to the super high gain variant (SHG).

In this paper, we will first introduce the MÖNCH detector and its applications as well as the benefits of using small pixels. We will then give an overview of the different pixel designs incorporated in MÖNCH04 with an emphasis on the available testing capabilities implemented. The characterisation results of full pixel variants and specific design elements will finally be presented to support the design of the next generation MÖNCH detector.

[1] A Bergamaschi et al., (2018) The MÖNCH Detector for Soft X-ray, High-Resolution, and Energy Resolved Applications, Synchrotron Radiation News, 31:6, 11-15.

Primary authors: Dr HEYMES, Julian (Paul Scherrer Institut); Dr BERGAMASCHI, Anna (Paul Scherrer Institut); Dr CARULLA ARESTE, Maria del Mar (Paul Scherrer Institut); Dr DINAPOLI, Roberto (Paul Scherrer Institut); Dr FRÖJDH, Erik (Paul Scherrer Institut); Dr GREIFFENBERG, Dominic (Paul Scherrer Institut); Dr HINGER, Viktoria (Paul Scherrer Institut); Dr MEZZA, Davide (Paul Scherrer Institut); MOUSTAKAS, Konstantinos (Paul Scherrer Institut); Dr MOZZANICA, Aldo (Paul Scherrer Institut); Dr SCHMITT, Bernd (Paul Scherrer Institut); Dr ZHANG, Jianguo (Paul Scherrer Institut)

Presenter: Dr HEYMES, Julian (Paul Scherrer Institut)

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