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Balancing gain and dynamic range in a 25 µm pitch hybrid pixel detector

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MÖNCH is a hybrid pixel detector featuring 25 µm pixel pitch and analogue readout for X-ray imaging at synchrotron radiation (SR) facilities. Sub-pixel spatial resolution has been demonstrated using charge sharing and interpolation algorithms [1]. The current prototype version, MÖNCH0.4, features 19 different pixel architectures to assess the design choices and components for an optimised architecture to be used at SR facilities, and to explore the potential use of dynamic gain switching in fine pitch pixels for applications at X-ray free electron lasers (XFELs).

Previous characterisation results of the pixel architectures without dynamic gain switching have shown noise levels as low as 21.7 e^- r.m.s. [2], which have now been pushed to sub-20 e^- r.m.s at room temperature using standard 300 µm-thick silicon sensors. Achieving low noise values however requires high conversion gain and necessitates design choices such as the simplification of the pixel architecture (e.g. by limiting the available choice of in-pixel gains). These compromises ultimately restrain the available dynamic range and prevent the use of MÖNCH with LGADs [3] or high-Z sensors because of the large signals (internal amplification and high photon energies, respectively) and of large leakage currents.

In this presentation, we will introduce the MÖNCH project followed by a description of the current prototype along with characterisation results of the pixel architectures without dynamic gain switching for synchrotron applications with an emphasis on noise and dynamic range. These experimental results will be used to fine-tune the design of MÖNCH0.5 to validate the final pixel design. This small prototype should also include additional features from the continuous developments of the PSD detector group towards a full-scale 2 × 3 cm^2 MÖNCH1.0.

[1] A. Bergamaschi *et al.*, Synchrotron Radiation News 31:6 (2018), 11-15
[2] J. Heymes *et al.*, Poster presented at: 23 rd iWoRiD. 27 June 2022; Riva del Garda (IT)
[3] J. Zhang *et al.*, JINST **17** C11011 (2022)

Primary authors: Dr HEYMES, Julian (Paul Scherrer Institut); BARUFFALDI, Filippo (Paul Scherrer Insitut (Switzerland)); BERGAMASCHI, Anna; CARULLA ARESTE, Maria del Mar; DINAPOLI, Roberto (Paul Scherrer Institut); FRÖJDH, Erik (Paul Scherrer Institut); GREIFFENBERG, Dominic; Dr HINGER, Viktoria (Paul Scherrer Institut); Dr MEZZA, Davide (Paul Scherrer Institut); MOUSTAKAS, Konstantinos; MOZZANICA, Aldo; PATON, Kirsty (Paul Scherrer Institut); SCHMITT, Bernd; XIE, Xiangyu (Paul Scherrer Institut); ZHANG, Jiaguo (Paul Scherrer Institut)

Presenter: Dr HEYMES, Julian (Paul Scherrer Institut)

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