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The MYTHEN III single photon counting detector for powder diffraction

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After more than 12 years of users operation, the MYTHEN II single photon counting microstrip detector has been upgraded in order to cope with progresses in the detector and data acquisition technology. MYTHEN III presents the same geometry as its predecessor (50 μm pitch 8 mm long strips, 6.4 mm wide modules), but it provides an enhanced performance.

In particular, a new readout chip has been developed by the SLS detector group in 110nm UMC technology. Every readout channel features a double polarity preamplifier and shaper with variable gain and shaping time. The shaper output is fed to three independent discriminators, each one having a dedicated threshold, trim bit set and enable signal. The outputs of the three discriminators are processed by a counting logic that, according to the selected mode of operation, generates the increment signals for the three following 24-bit counters. The new readout chip features an improved noise of 115 e⁻ ENC and a threshold dispersion of about 20 eV RMS [1]. The maximum frame rate is up to 300 kHz with no dead time between frames, and the count rate capability can reach up to 3.5 MHz per strip with 90% counting efficiency. Moreover, it is possible to exploit the three counters per strip with independent thresholds and gates not only for energy binning and time resolved pump-probe applications, but also to push the count rate capability to above 20 MHz per strip with 90% efficiency, thanks to the possibility of counting piled-up photons [2]. Finally, we implemented an innovative digital communication logic between channels, which allows charge sharing suppression and improves the spatial resolution beyond the strip pitch, as a first demonstration of on-chip interpolation in a single photon counter detector.

A 48 modules MYTHEN III detector is under commissioning and the first 14 modules recently started users operation at the powder diffraction end station of the Swiss Light Source.

We will present the architecture of the new detector, starting from the readout chip, as well as the first results of its performance characterization.

[1] Andrä M, The MYTHEN III Detector System - A single photon-counting microstrip detector for powder diffraction experiments, DISS. ETH NO. 27290, doi: 10.3929/ethz-b-000462676.

[2] Andrä M, et al. Journal of Instrumentation. 2019, 14(11): C11028. doi: 10.1088/1748-0221/14/11/C11028

Author: DINAPOLI, Roberto (Paul Scherrer Institut)

Co-authors: ANDRAE, Marie (Paul Scherrer Institut); BARTEN, Rebecca (Paul Scherrer Institut); BERGAMASCHI, Anna (PSI); BRÜCKNER, Martin (PSI - Paul Scherrer Institut); CHIRIOTTI ALVAREZ, Sabina (PSI - Paul Scherrer Institut); FRÖJDH, Erik (Paul Scherrer Institute); GREIFFENBERG, Dominic (PSI - Paul Scherrer Institute); HINGER, Viktoria (Paul Scherrer Institut); KING, Thomas (Paul Scherrer Institut); KOZLOWSKI, Pawel (PSI - Paul Scherrer Institut); Mr LOPEZ CUENCA, Carlos (Paul Scherrer Institut); MEISTER, Dominik (Paul Scherrer Institut); Dr MEZZA, Davide (Paul Scherrer Institut); MOZZANICA, Aldo (PSI - Paul Scherrer Institut); RUDER, Christian (Paul Scherrer Institut); THATTIL, Dhanya (Paul Scherrer Institut); VETTER, Seraphin (Paul Scherrer Institut); ZHANG, Jianguo (Paul Scherrer Institut); SCHMITT, Bernd (Paul Scherrer Institut)

Presenter: DINAPOLI, Roberto (Paul Scherrer Institut)

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