Invited Lecture

Evolving Mythen system for powder diffraction

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X-ray powder diffraction measurements and experiments at synchrotron sources keep pushing the boundaries of the technique and require ever increasing performance from source, optics and, crucially, detectors. Large area detectors are now commonly employed due to their ease of usage and more efficient detection of the scattered signal, nevertheless one-dimensional strip detectors still have the advantage in resolution, frame rate and are fundamental to the development of novel detection technologies. This was the case for the Mythen detector system for the family of photon counting detectors [1], the last iteration of which is now installed at the ADDAMS beamline of the SLS-2 synchrotron.

The system itself is installed at several facilities because it offers big advantages with respect to crystal analyzers, both in terms of time resolution and for radiation damage. In fact, it acquires simultaneously a large angular range. Best practices have been learned on how to perform excellent measurements and experiments, which will be discussed in details, including failures and pitfalls. Data quality is in fact unrestricted by the detector, but rather by acquisition time or wrong procedures/corrections. At the same time several techniques have been developed to obtain, for different purposes, the best characteristics in terms of angular resolution, instrumental resolution function, counting statistics etc., both as powder diffraction detector and as a beam monitor.

The last iteration, named Mythen III, offers different advantages with respect to the previous model. The new Application Specific Integrated Circuit offers an improved readout speed and three separate counters. This enables energy windowing, stroboscopic pump-probe experiments with up to three time slots or an improvement in the count rate capability as pile-up of signals at high photon fluxes can be tracked [2]. Very relevant is its lower electronic noise and improved threshold dispersion, which allow data to be collected directly on an elemental edge. While with its predecessor the X-ray fluorescence would have created non-statistical noise, due to the different sensitivity of channels/modules towards different energies, the Mythen III does not suffer largely from it and can therefore be used for multi-energy measurements across elemental edges.

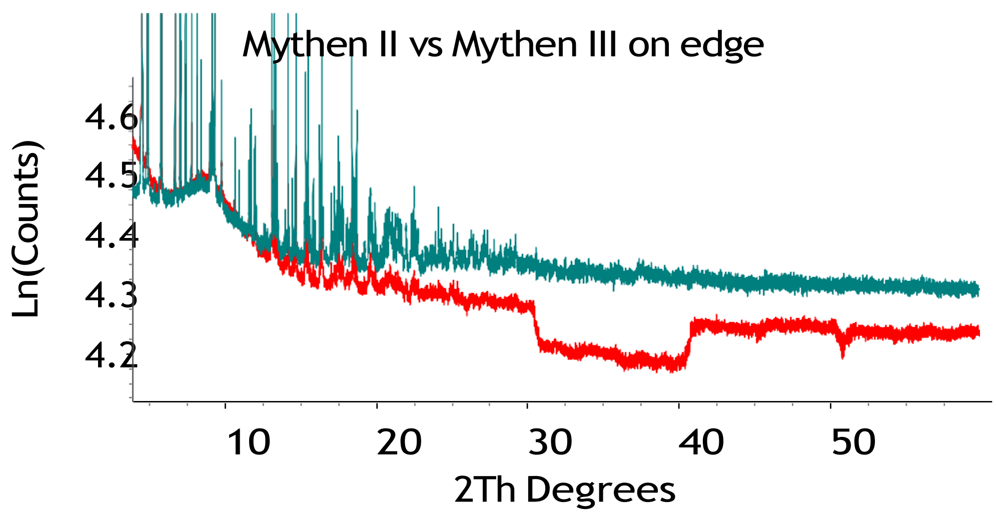

Figure 1. Comparison of data similarly collected on the Mo Kα edge for a Mo acetate sample with Mythen II (red) and Mythen III (green). The different background can be easily appreciated, with non-statistical noise as part of the red data.

[1] Bergamaschi, A., Cervellino, A., Dinapoli, R., Gozzo, F., Henrich, B., Johnson, I., Kraft, P., Mozzanica, A., Schmitt, B. & Shi, X. (2010).
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[2] Andrä, M., Barten, R., Bergamaschi, A., Brückner, M., Casati, N., Cervellino, A., Chiriotti, S., Dinapoli, R., Fröjdh, E., Greiffenberg, D., Lopez-Cuenca, C., Meister, D., Meyer, M., Mezza, D., Mozzanica, A., Redford, S., Ruder, C., Schmitt, B., Shi, X., Thattil, D., Tinti, G., Vetter, S. & Zhang, J. (2019). *Journal of Instrumentation*, **14**(11), C11028–C11028.

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