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Utilizing Neuronal Networks to Enhance the Application of Metallic-Magnetic Calorimeters for X-ray Spectroscopy

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Metallic-magnetic calorimeters (MMCs) - like the maXs-detector series developed within the SPARC collaboration - have become a promising new tool for high precision X-ray spectroscopy. Because of their unique working principles, MMCs combine several advantages over conventional energy- and wavelength-dispersive photon detectors. They can reach spectral resolving powers of up to $E/\Delta E \approx 6000$ (at 60 keV) [1] and at the same time, cover a broad spectral range of typically $1 - 100$ keV. Combined with their excellent linearity [2] and a sufficiently fast rise time - e.g., for coincidence measurement schemes [3] - they are particularly well suited for fundamental physics research in atomic physics.
However, because of their high sensitivity, external sources of noise like physical vibrations lead to substantial measurement artifacts [5] and a shift from traditional analog to a digital signal processing was necessary to mitigate these effects. During several successful benchmark experiments [3, 4, 5, 6] a comprehensive signal analysis software framework was developed. Though, the setup and operation of the detectors, as well as the analysis of their signals using our software, requires a per pixel optimization of a multitude of parameters. Several steps cannot be automated by conventional means and require manual tuning. As future development of MMCs entails the addition of more and more pixels, this approach is no longer applicable.
Research in the field of artificial intelligence offers a plethora of novel solutions that could help simplify and improve the measurement scheme of MMCs on both the hardware and software level. In this work we present first results from the application of neuronal networks (NNs) for raw MMC pulse processing. Based on first experiments, we expect NNs to at least be on par with feature extraction capabilities of the currently used finite response filters, without extensive manual fine-tuning and in a wider range of applicability.

References

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