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Digital Signal Processing and Its Applications for the Energy Dispersive X-Rays Detectors

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In todays advanced and digital world traditional analog signal acquisition and processing are gradually shifting to digital domain to meet the needs of the hour. In the field of energy dispersive x-rays detectors traditional analog signal processing involves a pre-amplifier to amplify the signal, a shaping amplifier to detect the energy of the incident photon, and a multichannel analyzer (MCA) to generate the energy spectrum.

The use of digital signal processing allows to enhance the system, achieve more flexibility, reduced noise by adding advanced digital and faster data processing methods, which will enable higher counting rates above million counts per second.

With digital signal processing the output of the preamplifier is digitized and all further processing is done in a field programmable gate array (FPGA).

Currently available devices in the market perform the signal processing step either in digital signal processors (DSPs) or FPGAs. Most of these devices such as the Struck SIS3302 use trapezoidal filtering, which gives good energy resolution at large shaping times.

In our presentation, we will show different algorithms for data preprocessing, shaping and postprocessing. We will show that by preprocessing the data, we can get better energy resolution at shorter shaping times; thus, it will allow good energy and time resolution at high count rates. To enhance the quality of signal, signal preprocessing methods such as moving average filter, savitzky-golay filter and others will be shown. For signal shaping, methods such as trapezoidal filter, triangular filter and postprocessing methods such as deconvolution will also be demonstrated. To enhance the detection of photon arrival, machine learning algorithm such as Artificial Neural Network (ANN) will be discussed. The results of the methods will be compared by applying them to identical experimental raw data. Based on theoretical and experimental results an analytical comparison of the methods will be carried out for the implementation. We will also show the Graphical User Interface (GUI) for the hardware to communicate with the MicroTCA crate.

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