Reduction of Pile-up Spectra at High Input Count Rates – Mandatory for Trace Element Analysis

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Modern SDD's and digital pulse processors (DPP) allow input count rates of 2.000.000cps and more. Using optimized excitation conditions such high input count rates are applied for the detection of traces in geological or organic materials. Detection limits <0.1µg/g were achieved. Additionally, the high intensity of the Compton scattered Co K_α line of the used CoPd tube enables the use of this information for analysis, e.g. for the calculation of oxygen concentrations in biofuel.

The rise time of the voltage pulse at the output of the preamplifier is the limiting factor for suppression of pile-up effects by using optimized pile-up rejection algorithms within the DPP. In an ideal case the rise time is identically to the charge collection time of the detector for a given X-ray energy. Therefore, increasing input count rates will cause an increased portion of pile-up effects within the measured spectra in the square. The resulting increased probability for overlaps between characteristic X-ray lines of interesting trace elements with pile-up lines caused by characteristic X-ray lines of two major elements will limit improvements of the detection limits by an increased input count rate, considerably. Also overlaps between Compton scattered lines, used for quantitative analysis, and pile-up effects has to be considered.

An efficient opportunity to reduce the probability of pile-up effects in the neighborhood of interesting traces or Compton peaks and methods to describe and to remove the residual effects from the measured spectra are discussed at some applications.