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Testing Analytical Precision Using Adaptive Shaping at High Throughput

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All-digital pulse processing allows selection of the filtering time for each X-ray by the time intervals to the preceding and following X-rays. Adaptive shaping was first described by Koeman [1], and the first adaptive EDS system was introduced in 1993 [2]. Adaptive shaping allows the low dead time of very short filters with energy resolution intermediate between very short and optimal filtering [3]. The resulting peaks are sums of Gaussians with differing energy resolution. The effective resolution of the spectrum varies with count rate depending on the fraction of X-rays measured by each digital filter used. These proportions are recorded by the digital pulse processor (DPP) for peak modeling. Spectra were taken from NIST K412 glass using 3 fixed filter times and their adaptive combination. Throughput rates were 100 kcps and 200 kcps using a single SDD. Standards-based quantitative analysis was performed with DTSA-II. Adaptive standards were generated by blending fixed-filter spectra for each peaking time in proportion to their contribution to the "unknown" spectrum as reported by the DPP. Peaks in the glass spectra were fitted using the generated adaptive standards. Figure 1 plots linearity as (counts/live second)/nA on Cu Kα for fixed and adaptive filtering. In the mid-range from 13 kcps to 300 kcps incident count rate, deviations from the mean are a few tenths of a percent. At very low rate, the large deviation is not yet understood.

Ritchie, Newbury and Davis [4] showed that silicon drift detectors (SDDs) can produce quantitative results comparable to WDS, and that analytical precision is determined more by counting statistics than energy resolution. Using the method they described in [5], sub-sampled spectra were generated from the K412 data. The precision (inverse variance) of the DTSA-II result for 1600 Mg analyses per point is plotted vs. electron dose in Figure 2. For a given budget of deposited charge, precision improves with counts as shaping time (and thus dead time) is reduced. Adaptive shaping improves precision further relative to the shortest shaping time by providing better energy resolution for the same number of counts.

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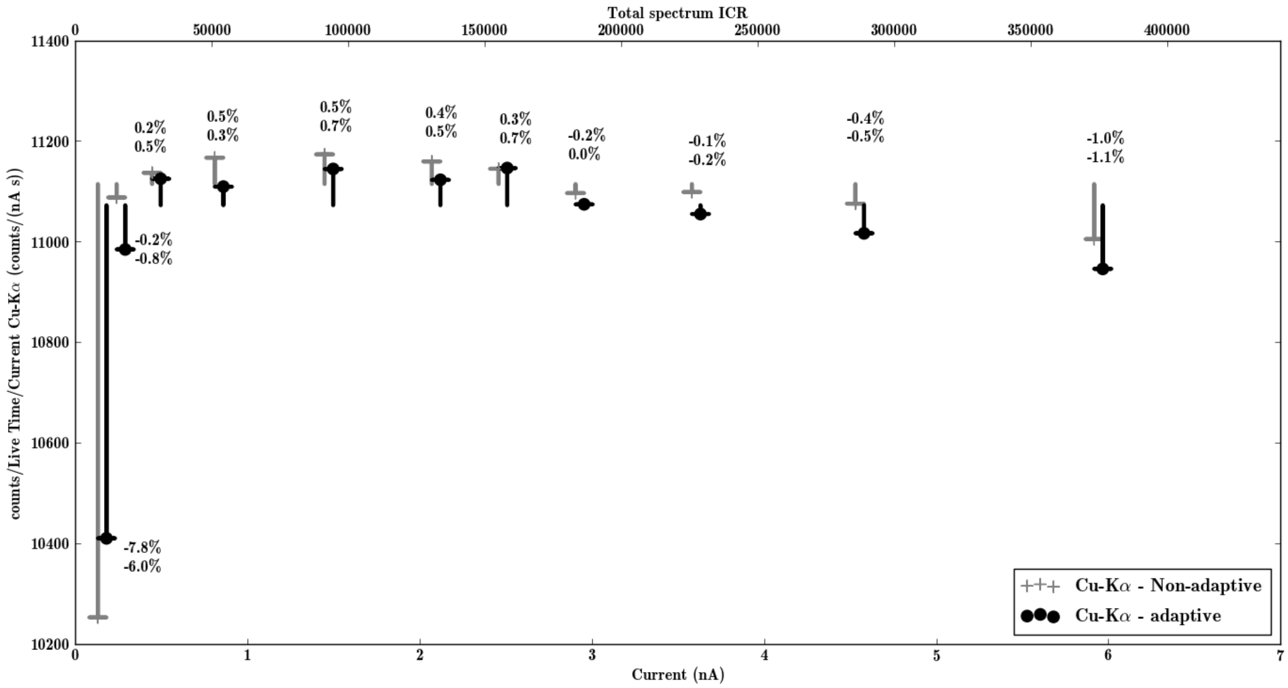

Figure 1. Linearity of net Cu Kα vs. beam current and incident count rate, in counts/live second/nA.

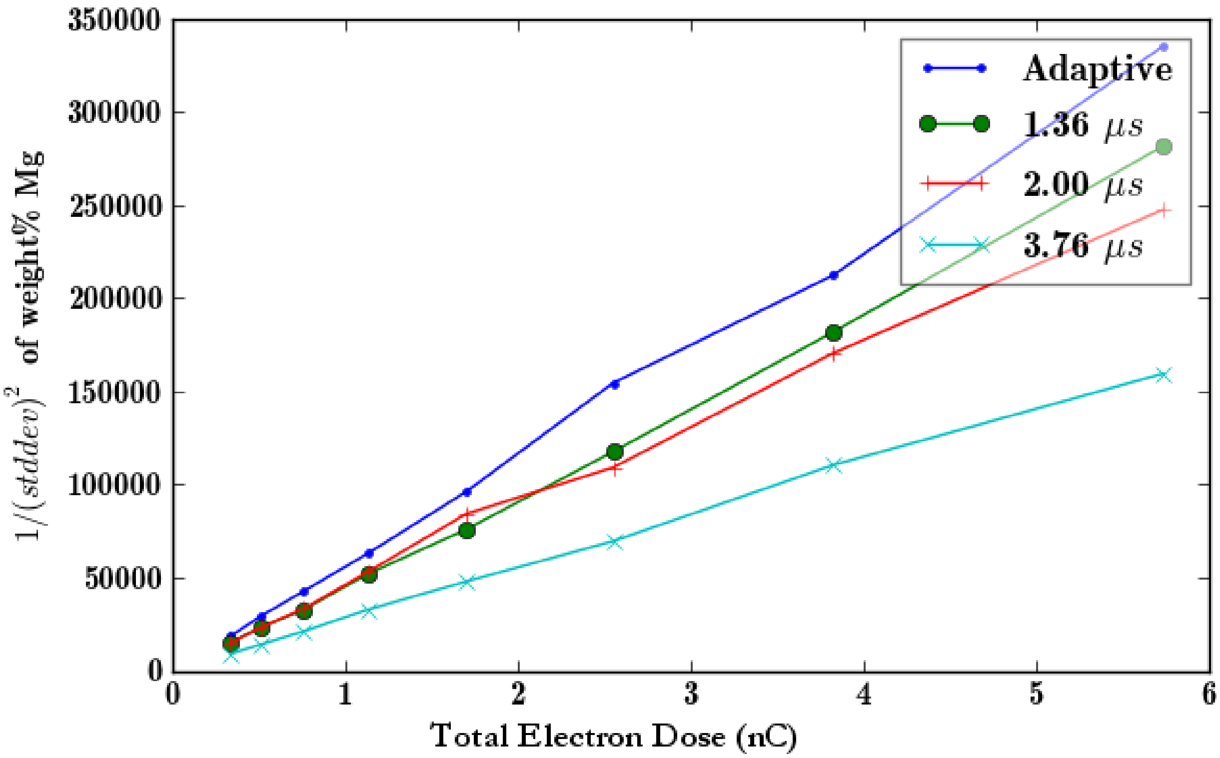

Figure 2: Precision of Mg analysis vs. electron dose for adaptive and 3 fixed filter times.

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