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# IT-5-P-1533 Characterization of EDS Systems with respect to the Geometrical Collection Efficiency

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Characteristic parameters are needed to compare the performance of different energy dispersive X-ray spectrometers (EDS). The ISO 15632 standard defines parameters such as energy resolution as the FWHM for the K lines of C, F and Mn. Another crucial feature is the solid angle $\Omega$ available for photon collection ($\Omega=A/r^2$, A: active area of detector, $r$: distance between radiation origin and center of active detector surface). $\Omega$ is not an intrinsic spectrometer property. It can only be defined for a specific detector in combination with a specific system (e.g. SEM), since the minimal possible distance $r$ is determined by the particular detector/microscope geometry. An approach to obtain $\Omega$ it is to simply determine $A$ and $r$ but, this is difficult if respective information is not provided by the manufacturer.

For TEM/EDS, the solid angle can be estimated from the ratio of the measured to the theoretical X-ray net count number in a specific element line using a sample of well-known thickness at well-defined acquisition conditions [1]. Parameters such as the detector quantum efficiency, detector and sample geometry as well as electron beam current and quality need to be known for this approach to deliver results close to the real geometric solid angle. Otherwise the strategy can be used to determine just a performance parameter to compare to other TEM-EDS systems.

A similar approach for SEM/EDS systems is to acquire an X-ray spectrum under defined conditions, e.g. a spectrum of a pure Cu bulk sample at 20 keV and known beam current and measure the number of counts in the Cu-K peaks [2]. Using high energy lines reduces the influence of absorption effects, sample surface morphology and contamination. However, some SEMs don't provide the possibility to measure the beam current or don’t have a well calibrated ampere meter. Again, the quantum efficiency must be known. With a significant dead time the input count rate must be used.

A practical approach we suggest for the determination of the real detector-sample distance without need of knowledge of the beam current and detector efficiency is to measure the count rate in a defined energy region for various detector positions retracting the detector in known steps without altering the take-off angle. The count rate $I$ should be proportional to $1/r^2$ and therefore $1/\mathrm{sqrt}(I)$ vs. $r$ should be a straight line through the ordinate origin. This can be used to determine the absolute distance, see Fig. 1, but also to find possible problems with, e.g. shadowing and alignment, which can cause lower count rates, Fig. 2. For the active area A the nominal value can be used. An alternative (if possible) are measurements with apertures of known area placed onto the front of the EDS in a fixed measurement position [3].

Acknowledgement:

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[2] F Schamber, ISO/TC202, Boulder, CO, USA, 2013.

[3] M Procop, Microsc. Microanal, 10 (2004), p. 481.

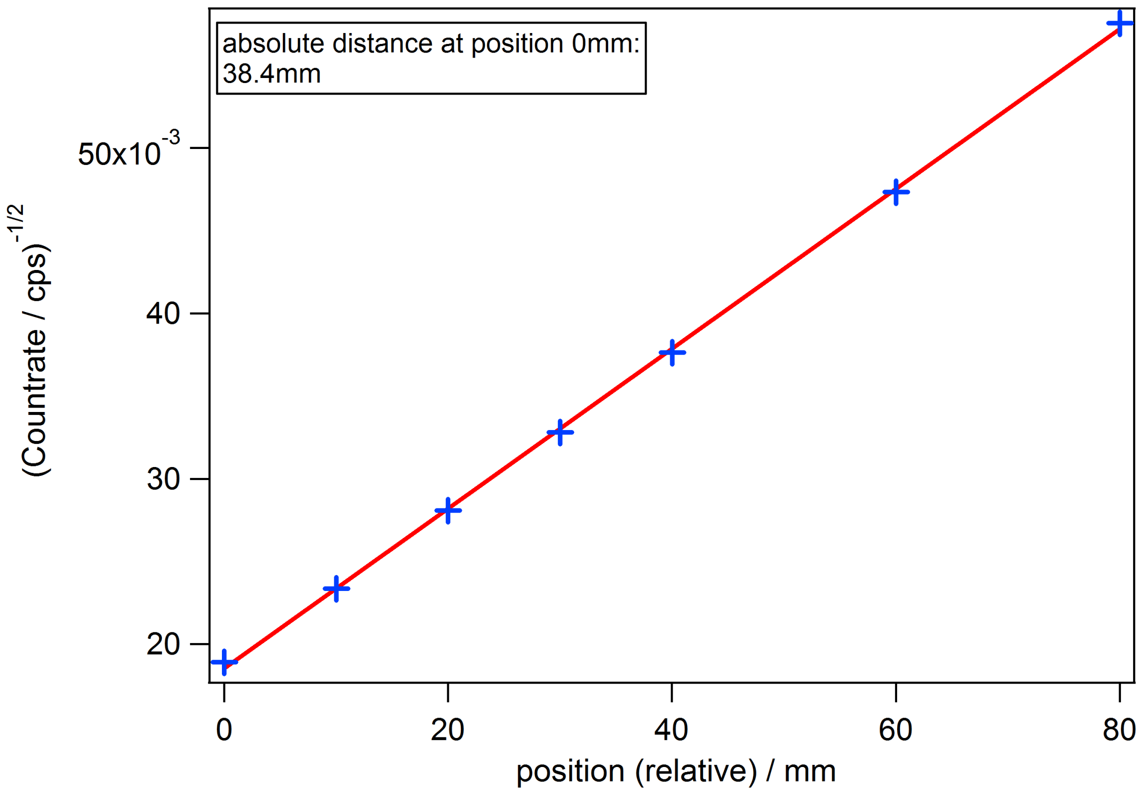

Fig. 1: Count rate parameter (expressed as cps$^{-1/2}$) in dependence on the relative position of the EDS for the calculation of the absolute distance from the radiation origin to the detector chip.

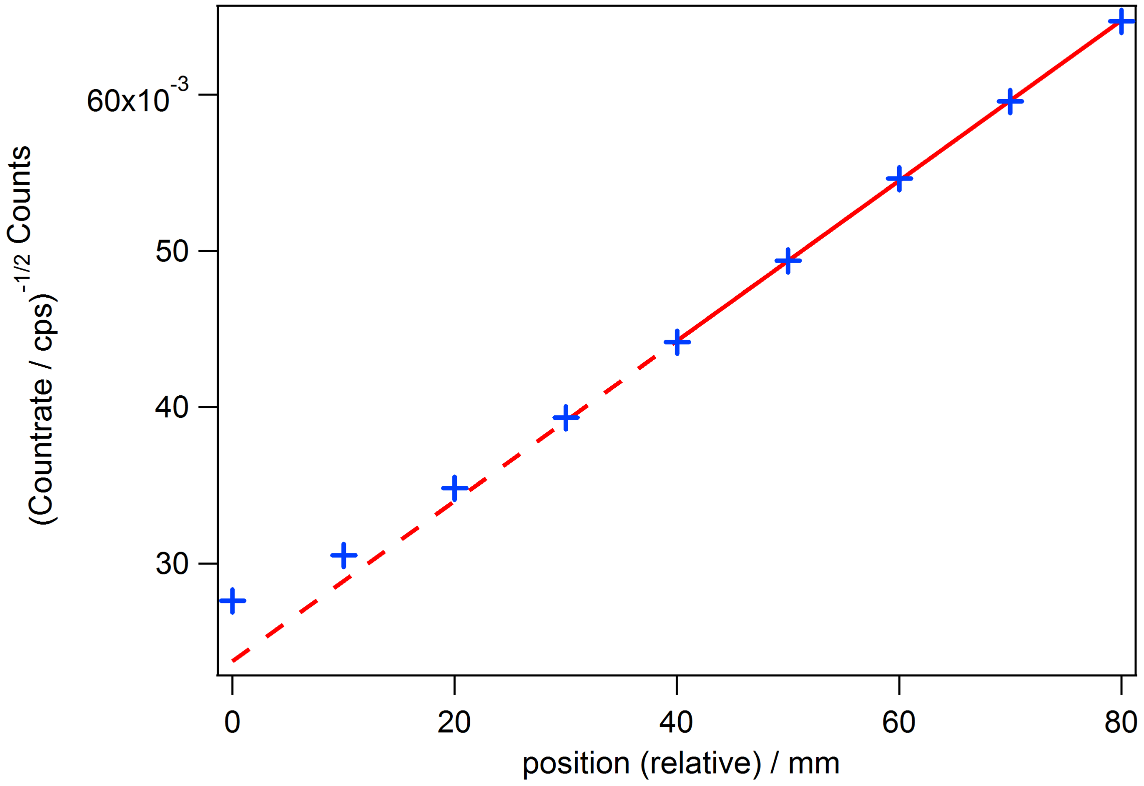

Fig. 2: Count rate parameter in dependence on the relative position of the EDS showing shadowing or misalignment leading to a non-linear dependence for small distances.