One major benefit of Silicon Drift Detectors (SDD) with count rates of X-ray acquisition was already highlighted with a high speed 250 kcps map in first publication about application for Scanning Electron Microscopes [1]. The high count rates are usual with X-ray spectral imaging in each SEM lab more than 15 years later. The modern SDD spectrometers are able to process high count rates without significant deterioration of their basic spectrometric properties. It will be given a short overview about state of the art.

In the past, analysts have acquired single EDS spectra after selecting objects. This is now performed already with scanning the electron beam across entire specimen surface, which is usually very heterogeneous. A complete spectrum is acquired at each point. The count rates vary about a high range, depending from different specimen composition and topography. Reaching very high count rates of about 200 kcps and more are usual in daily praxis. Despite all SDD electronics are equipped with X-ray coincidence rejection logics, so called pile-ups will pass and are then in spectrum as artefacts. This is very fundamental, with all systems and does not depend from vendors, never possible to neglect. The artificial counts will produce mistakes in qualitative and quantitative analytical results if not considered. An outline will be given about the effects and how to process (Fig 1) [2]. It will be demonstrated the quantitative results are stable up to 200...300 kcps, if a pile-up consideration is applied (Fig 2) [3].

But correction comes with higher result uncertainties and detection limits. Also, the pile-up consideration is with limits, e.g. the entire region must be homogeneous, were all X-rays in a spectrum came from [5]. Otherwise fundamental assumption about pile-up consideration with random emission was violated. It is not satisfied if the electron beam excitation involves areas of different specimen constituent. Phase determination by independent Principle Component Analysis (PCA) is useful to identify homogeneous specimen regions to avoid qualitative and quantitative analytical errors. This would be if total spectrum was taken from inhomogeneous area (Fig 3) [5]. Specialized single pixel spectra evaluation strategies are required for full quantitative maps.

References
Fig. 1: The results of automated qualitative analysis [4] with two spectra of same specimen (a low; b very high count rate) are similar due to internal pile-up consideration (pile-up distribution is not included in reconstruction, blue line). This is despite big differences are visible in both spectra caused by pile-up artefacts (example from [2]).

Fig. 2: The quantitative results vary with count rate, if pile-up was not considered (a). They are much more stable with using pile-up consideration method (b) (example from [3]).

Fig. 3: Phase map of Kiruna mineral with very high count rates. Different phase areas indicate from which pixel regions sum spectra are possible to gather without analytical evaluation issues. The spectrum is from an inhomogeneous area to demonstrate the qualitative analysis challenge, even if the pile-up consideration was applied (example from [5]).