Fully-fractionated microprobe analysis

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Microprobe data acquisition is intrinsically serial, with each 'pixel' of measurement collecting information of a certain kind (transmission, fluorescence, etc) from one location in a generalised parameter space (position, energy, angle). Rate-limiting bottlenecks in the serial acquisition process generally result in the need to compromise between per-pixel sensitivity and pixel sampling interval. This compromise is often made to optimise sensitivity and sampling requirements for one particular signal emanating from a specimen, and so may not be optimal for other signals. This situation represents a compromise to the extraction of information from the specimen, and a significant inefficiency in overall measurement practice.

The 'fractionation' [1] of a measurement describes the apportionment of the total measurement statistic across a number of sampling intervals, with a higher degree of fractionation sampling the parameter space more finely, though with reduced statistical precision. A measurement might be said to be 'fully fractionated' if the sampling interval is sufficient to extract 'all' of the information content from a specimen, in accord with the principles of sampling theory.

Recent developments of overhead-free data-streams [2] and fully-optimised scanning sequences (eg [3], in preparation) have significant impact on the rate limiting bottlenecks, and so open up the possibility of acquiring fully-fractionated data at all times. Here we discuss fully-fractionated data acquisition as applied to three axes within the overall parameter space: angle, sample number (population statistics) and the spatial domain, and outline significant advantages, particularly with regards to subsequent statistically-sensitive data analyses.

[2] R Hegerl and W Hoppe, Zeitschrift für Naturforschung, 31a, 1976, 1717.
[2] R Kirkham et al, AIP Conference Proceedings 1234, 2010, 240.
[3] MD de Jonge et al, Spiral scanning x-ray fluorescence tomography, (in preparation).