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MULTI-MODAL X-RAY FLUORESCENCE DETECTION AT THE ID21 X-RAY MICROSCOPY BEAMLINE

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The ID21 ESRF beamline is dedicated to micro-X-ray fluorescence (µXRF) and micro X-ray absorption spectroscopy (µ-XANES) in the X-ray energy domain between 2 keV and 7 keV [1]. The scanning x-ray microscope enables the localization and speciation of trace elements down to the ppm range with a submicrometer beam size. It provides access to the absorption edges of a wide range of elements of interest in the areas of Environmental Sciences, Earth and Planetary Sciences, Life Sciences and Cultural Heritage. Recently, several developments in the field of x-ray detection have been made to enlarge the measurement possibilities available at the beamline and to improve the detection limits for x-ray fluorescence.

The scanning X-ray microscope (SXM) of ID21 was completely refurbished in 2008. It is now a highly versatile instrument in terms of focusing optics, detectors, and sample environment [2]. The X-ray beam spot size ranges from ~20 µm (obtained with a polycapillary optics) to ~500 nm (obtained with focusing zone plates or a Kirk-Patrick Baez mirror system). The SXM employs several detectors, which are complementary in terms of count-rate throughput, solid-angle collection efficiency and spectral resolution. For experiments demanding high sensitivity, a single- or a seven-element Ge detector provide large fluorescence detection solid angle, absence of detector K-escape peak contributions, and detector peak-to-valley ratio >5 k. For the case of highly concentrated samples, or for samples where the matrix signal dominates the fluorescence signal, either 30 mm^2 or 100 mm^2 silicon drift diode (SDD) detectors can be used at count rates approaching 1 Mcps. Finally, in order to resolve overlapping or closely spaced fluorescence lines, a polycapillary optic based, scanning wavelength-dispersive spectrometer (WDS) has been developed [3]. In many applications the WDS makes possible detailed elemental and chemical analyses that are simply not accessible with the lower resolution solid state detectors.

We present the operational characteristics, the construction details and the performance achieved with the detectors of ID21. In particular the throughput count rates, spectral resolutions and achievable detection limits are compared. We describe the application of different detection systems for two-dimensional elemental mapping and micro-XANES analysis. The x-ray fluorescence spectra obtained are compared to theoretical simulations and discussed in terms of absorption, re-absorption and scattering phenomena.

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