Scanning Transmission X-ray Microscope with Three Axes Laser Interferometer at the NSLS

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Soft x-ray spectromicroscopy frequently involves the acquisition of a large number of images of the specimen over a spectroscopic energy range [1] which places strong demands on the reproducibility of the scanned image field. Previous approaches for ensuring scan field reproducibility have included the use of custom-built laser interferometers [2] and capacitance micrometers [3]; more recently, Kilcoyne *et al.* have shown excellent results using a commercial 2-axis laser interferometer with improved precision [4]. We describe here the retrofit of a 3 axis laser interferometer system onto the hardware of an existing scanning microscope [5], and an all-new scan control system. The use of an interferometer on a third axis allows one to correct for thermal drifts of the focus position (of special importance in differential phase contrast using a segmented detector [6]), and to maintain the beam at the proper focus while acquiring point spectra.

Our system uses an Agilent differential interferometer system to measure the position of the scanning stage relative to the zone plate. The 'actual' position information from this system as well as the 'commanded' positions – also used as pixel advance clock - are streamed as parallel data to a digital servo controller (PMAC2 by Delta Tau). In closed loop the positions are controlled to coincide within 0.3 nm resolution. High resolution scans using piezos are acquired by digitally streaming a set of (x,y) positions from the scan control computer to the digital servo controller; the streamed positions can incorporate the entire scan field, thus eliminating any computer delays that would otherwise occur at the end of every scan line. The scan control computer communicates using a client-server protocol with a graphical user interface on a separate computer which can include a microscope user's own laptop.

Recent applications of the new microscope will be shown, highlighting its improved performance. We gratefully acknowledge support from NASA, DoE, NSF, and NIH, and many helpful conversations with A. Kilcoyne and T. Tyliszczak.

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