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STXM With A Segmented Detector: Imaging Modes And Phase Retrieval

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Introduction: In scanning transmission X-ray microscopy (STXM), x-ray detectors with a large area are employed for incoherent bright field detection. This imaging mode is appropriate for quantitative absorption contrast measurements as needed for x-ray absorption spectroscopy. Detectors with segmentation can be used to implement phase contrast and dark field imaging [1,2], but limitations in available detectors prevented routine use of these imaging modes.

Methods and Materials: We developed a charge integrating silicon detector with segmentation, which records both absorption, phase and darkfield information simultaneously and furthermore extends the x-ray photon flux detection limit beyond the capability of counting detectors. The detector has annular shaped segments divided in quadrants, matching the rotational symmetry in STXM. The extremely low noise of the detector (5 photons RMS per integration per segment) combined with a DQE exceeding 90% for 520 eV photons makes this detector superior in STXM for all but the lowest photon rate experiments.

Results: Experiments have been carried out demonstrating the capability of recording bright field, differential phase contrast and dark field images simultaneously. In addition to the display of differential phase contrast, we also investigated using a complex specimen reconstruction algorithm [3] to recover an estimate of the scalar amplitude and phase modulation. This Fourier filtering technique has been employed successfully with a germanium test pattern [Fig. 1].

Conclusions: We have commissioned a novel integrating solid state detector with segmentation which is capable of high photon flux measurements. Dark field, differential phase contrast and bright field contrast images can be collected simultaneously with this detector.

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References:

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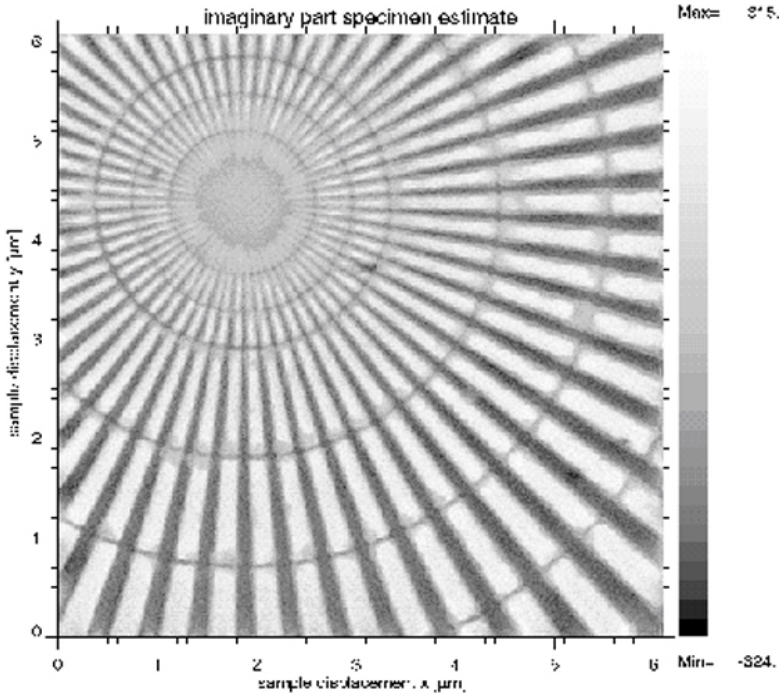

Figure 1: A reconstruction of the imaginary part of the refractive index of a germanium test pattern.