

Recently, a x-ray imaging technique has been developed that exploits x-ray refraction and scattering as sources of image contrast in addition to absorption, the conventional source of radiographic contrast. This technique, Diffraction Enhanced Imaging (DEI)¹, uses perfect crystals of silicon to prepare and “analyze” a highly collimated x-ray beam from a synchrotron source. DEI allows for independent images of the object’s x-ray refraction gradient and absorption to be obtained. The refraction gradient images are sensitive to edge structures in the object and give a natural edge enhanced image. The absorption images include an enhanced contrast arising from the very high scatter rejection afforded by the perfect crystal analyzer (extinction contrast).

DEI and conventional radiographs of phantoms, test objects, animals, and tissue samples have been acquired and will be presented as examples of the applications of the technique. The primary focus of the presentation will be on images of breast tissue samples with cancer, a project to optimize DEI parameters, and the prospects of developing a laboratory or clinical source.

Educational Objectives:

The attendee will be instructed on:

- 1) the Diffraction Enhanced Imaging (DEI) x-ray technique.
- 2) the experimental setup and parameters to apply DEI.
- 3) x-ray refraction as a source of radiographic contrast (refraction gradient contrast).
- 4) ultra-small angle scattering as a source of radiographic contrast (extinction contrast).
- 5) how to uniquely determine the refraction gradient image from the combined absorption and extinction image.
- 6) how the DEI images are affected by setting of the analyzer angle, the imaging energy, and the order of the crystal reflection.
- 7) how DEI images are useful in the possible detection of cancer in breast tissue.
- 8) how DEI images may be used in other areas of radiography.

¹*Diffraction enhanced x-ray imaging*, D. Chapman, W. Thomlinson, R.E. Johnston, D. Washburn, E. Pisano, N. Gmur, Z. Zhong, R. Menk, F. Arfelli, D. Sayers, *Physics in Medicine and Biology* **42** (1997) 2015-2025.