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Use of a novel Controlled Drift Detector for Diffraction Enhanced Breast Imaging

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Although conventional mammography is currently believed to be the most effective breast screening tool, alternative techniques are being sought for those cases in which a second-stage examination is required.
Diffraction Enhanced Breast Imaging (DEBI) is a promising alternative, as the difference in the diffraction profiles of healthy breast tissue and of carcinoma is much more significant than the difference between the X-ray attenuation coefficients of the two, determining the contrast in conventional mammography [1].
In particular, the maximum differences in signal from the two tissue types are detected when the momentum transfer (⊠=1/⊠ sin (⊠/2), where ⊠ is the beam wavelength and ⊠ is the scattering angle) is ⊠ =1.1 nm-1 or ⊠ =1.7 nm-1; in the first case the signal from normal tissue is about twice the signal from carcinoma, while in the second case the diffracted intensity from carcinoma is about 1.5 times higher than that from healthy tissue. The signal intensities are comparable at ⊠ =1.4 nm-1.
Due to the low scattered photons yield, a detector with a very low noise is needed. A good candidate is a Controlled Drift Detector (CDD) developed at Politecnico di Milano, featuring a very low noise level and spectroscopic capabilities [2,3].
This paper presents the preliminary results obtained using a CDD for the acquisition of diffraction images using monochromatic X-rays.

Materials and Methods
A prototype of CDD with a sensitive area of about 6 mm x 4 mm and a pixel size of 180 µm was used.
Monochromatic synchrotron radiation beams from the ELETTRA synchrotron radiation souce were used with an energy of 18 and 26 keV. Both transmission and diffraction images were acquired. For the latter, a multihole collimator was used and the detector was tilted at 9°, hence detecting diffracted X-rays with a momentum transfer of 1.1 nm-1 or 1.7 nm-1 when using 18 keV or 26 keV beams, respectively.
Images of test objects and of meat samples were acquired.
Images were reconstructed by integrating either the whole spectrum detected from each pixel, or only the main peak.

Results and discussion
All diffraction images showed an increase in contrast with respect to the transmission images acquired at the same energies, thus proving the suitability of the CDD for DEBI applications.
No significant difference was found in the peak images with respect to the full-spectrum images; however, the spectroscopic capability appears a promising characteristic for using the CDD with

conventional X-ray sources.

References
[1] G Kidane et al. Phys Med Biol 1999: 44; 1791-1802.
[2] A Castoldi et al. Nucl Instrum Meth in Phys Res A 2003: 512; 250-256.
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