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Phase sensitive mammographic imaging at the SYRMEP beamline

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The phase sensitive imaging methods can be assigned to one of three broad categories namely, x-ray interferometry, diffraction-enhanced imaging (DEI), and in-line phase-contrast imaging (PhC). Using these techniques the gradient or the Laplacian of the x-ray phase is acquired and therefore the density variation and interfaces are emphasized. Phase maps can be obtained by some methods. Soft tissue imaging is very challenging in x-ray radiology as mammography that is an essential tool for breast cancer diagnosis. Therefore improving mammography image quality can have a significant impact on early cancer detection. In medical imaging large field of view and short acquisition time are necessary, moreover phase sensitive techniques require high degree of beam coherence. Considering these constraints the synchrotron radiation (SR) sources are the best choice for these studies.

At the SYRMEP beamline of Elettra, the SR laboratory in Trieste (Italy) both phase-contrast and DEI techniques are studied. The application in the field of breast imaging has been carefully evaluated and the first PhC mammography clinical study was performed. We are using different detectors, screen-film system, CCD, photostimulable phosphor imaging plate (IP), silicon pixel detector and we have verified that PhC and DEI techniques have different constraints about detector performance.

In PhC imaging, contrast is generated from the interference among parts of the wave fronts that have experienced different phase shifts and it helps to improve the visibility of the borders of structures. In our experience to detect the edge enhancement, the spatial resolution has to be better than 100 micron. In our clinical studies we used both a mammographic screen-film system and a high resolution IP system suitable for clinical mammography. More than 70 patients underwent to SR PhC mammography at our beamline.

The DEI technique permits less stringent requirements on the spatial resolution and in the meantime it allows to obtain a set of images with different contrast of the same sample, increasing the amount of information about the sample composition.

Very exciting results in the field of phase sensitive imaging have been obtained with the PICASSO detector, a silicon microstrip system (50 micron strip pitch) working in single photon counting mode (using Mythen II ASICs) and used in "edge-on" geometry, under development by our group.

Primary author: Prof. LONGO, Renata (Università di Trieste - Dipartimento di Fisica)

Presenter: Prof. LONGO, Renata (Università di Trieste - Dipartimento di Fisica)

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