ESRF	**Experiment title: Quantitative comparison of the in-line phase contrast method and Diffraction Enhanced Imaging for mammographic applications**	**Experiment number**: LS-2124
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Report:

This experiment constitutes a core part of the PhD thesis of Elodie Pagot. Two publications have been so far derived from it:

Publication submitted to Applied Physics Letter
A method to extract quantitative information in analyzer-based X-ray phase contrast imaging
E.Pagot, P.Cloetens, S.Fiedler, A.Bravin, P.Coan, J.Baruchel, J.Härtwig, W.Thomlinson

Analyzer-based imaging is a powerful phase-sensitive technique that generates improved contrast compared to standard absorption radiography. As shown by Chapman, combining numerically two images taken on either side at ±1/2 of the full width at half maximum (FWHM) of the rocking curve provides images of “pure refraction” and of “apparent absorption”. In this study, a similar approach is made by combining symmetrical images with respect to the peak of the analyzer rocking curve but at general positions, $\pm\alpha\cdot$FWHM. These two approaches do not consider independently the ultra-small angle scattering produced by the object, which can lead to inconsistent results. An accurate way to separately retrieve the quantitative information intrinsic to the object is proposed. It is based on a statistical analysis of the *local* rocking curve, and allows to overcome the problems encountered using the previous approaches.

Proceedings of the SPIE Medical Imaging Conference 2003 in San Diego (5030-27)
Quantitative comparison between two phase contrast techniques: Diffraction Enhanced Imaging and Propagation
Elodie Pagot, Peter Cloetens, Stefan Fiedler, Alberto Bravin, Jose Baruchel, Jürgen Härtwig, William Thomlinson

X- ray phase-sensitive techniques have recently demonstrated their important role in the improvement of contrast with respect to standard absorption radiography, especially for light materials such as soft tissues [1].

Two X-ray phase contrast imaging techniques are compared in a quantitative way for future mammographic applications: Diffraction Enhanced Imaging (DEI) [2] and Propagation [3]. The first uses an analyser crystal placed right after the sample that acts as an angular filter for the X-rays refracted by the sample. The latter simply uses the propagation or Fresnel diffraction of the monochromatic and partially coherent X-ray beam in free space over a distance ranging from a few centimeters to several meters.

In this study, the experimental parameters were varied and optimised with respect to the dose and signal-to-noise ratio, in particular, the energy, the analyser crystal position in the DEI case, and the sample to detector distance in the propagation case.

Depending on the intrinsic object properties, the two techniques present a difference in the area contrast (contrast produced by extended objects) and the edge visibility. DEI shows enhancement of the area contrast for positions corresponding to the tails of the analyzer rocking curve and a similar increase of contrast but inverted is also visible at the peak of the rocking curve. This effect is due to the contribution of scattering at very small angles. The area contrast can disappear for specific positions of the analyser when absorption and small angle scattering compensate each other. This is the case on the flanks of the rocking curve where the area contrast is weak. However, an enhancement of the edges of the object is clearly noticeable and this mainly corresponds to the refracted part. Propagation reveals an improvement of the edge visibility with the distance, the variation being nearly linear. In this case, area contrast is negligible for non-absorbing, large objects.