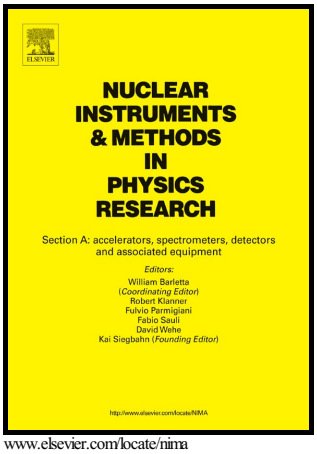
Simulation study of an X-ray diffraction system for breast tumor detection

F. Marticke, G. Montemont, C. Paulus, O. Michel, J.I. Mars, L. Verger



www.elsevier.com/locate/nima

PII: S0168-9002(17)30477-1
DOI: http://dx.doi.org/10.1016/j.nima.2017.04.026
Reference: NIMA59814

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date: 4 July 2016
Revised date: 19 March 2017
Accepted date: 16 April 2017

Cite this article as: F. Marticke, G. Montemont, C. Paulus, O. Michel, J.I. Mar and L. Verger, Simulation study of an X-ray diffraction system for breast tumo detection, *Nuclear Inst. and Methods in Physics Research, A* http://dx.doi.org/10.1016/j.nima.2017.04.026

Simulation study of an X-ray diffraction system for breast tumor detection

F. Martickeª,ᵇ, G. Montemontª, C. Paulusª, O. Michelᵇ, J. I. Marsᵇ, L. Vergerª

ª *Univ. Grenoble-Alpes, F-38000 Grenoble, France*
CEA, LETI, Minatec Campus, F-38054 Grenoble, France
ᵇ *Univ. Grenoble-Alpes, Gipsa-Lab, F-38000 Grenoble, France*
CNRS, Gipsa-Lab, F-38000 Grenoble, France

Abstract

X-ray diffraction (XRD) is a powerful technique used to determine the molecular structure of biological tissues. In breast tissues for example, the scattering signatures of dense fibroglandular tissue and carcinoma have been shown to be significantly different. In this study, XRD was used as a second control level when conventional mammography results were unclear, for instance because of overly high breast density. A system optimized for this issue, called multifocal XRD, was developed combining energy dispersive spectral information at different scattering angles. This system allows depth-imaging in one go but needs an x,y-direction scan to image the region conventional mammography identified as suspect. The scan-time for about 10 cm^3 with an incident flux of about $4.8{\cdot}10^7$ photons per second would be around 2 seconds. For this study, breast phantoms with and without cancerous nodule were simulated to assess the separation power of the method and to determine the radiation dose required to obtain nearly ideal separation. For tumors situated in the center of the breast, the required dose was only about 0.3 mGy, even for breasts with high density. The tumor position was shown to have a low impact on detectability provided it remained in a zone where the system was sufficiently sensitive. The influence of incident spectrum maximum energy was also studied. The required dose remained very low with any of the incident spectra tested. Finally, an image slice was reconstructed in the x-direction and showed that the system can detect the

Email address: fanny.maricke@gmail.com (F. Martickе)
Preprint submitted to Nuclear Instruments and Methods in Physics Research Section April 17, 2017