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Phase-contrast tomography for breast cancer imaging at Imaging and Medical Beamline of the Australian Synchrotron

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Abstract

Breast cancer is one of the two leading causes of cancer fatalities among women in most industrialized countries. This type of cancer is very aggressive, with success of the treatment depending heavily on early detection. Health authorities in most countries recommend regular screening of women over a particular age, with 2D X-ray mammography being the main screening and diagnostic technique. Unfortunately, mammography produces a relatively high percentage of both false-positive and false-negative results. In this research, we aim at defining and developing a practical imaging setup for whole breast imaging using propagation-based phase-contrast computed tomography (PB-CT) in such a way that, compared to the best presently utilised medical X-ray imaging techniques: (a) the quality and the diagnostic value of the obtained 3D images are higher, (b) the delivered radiation dose is lower and (c) the need for painful breast compression is removed. To date, we have imaged 95 unfixed complete mastectomy samples with and without breast cancer lesions using absorption-only CT and PB-CT techniques at the Imaging and Medical Beamline (IMBL) of the Australian Synchrotron. The radiation doses delivered to the mastectomy samples during the scans were comparable to those approved for mammographic screening. Physical characteristics of the reconstructed images, such as spatial resolution and signal-to-noise ratio, and radiologic quality were assessed and compared to conventional absorption-based CT. Our results demonstrate that PB-CT holds a high potential for improving on the quality and diagnostic value of images obtained using existing medical X-ray technologies, such as mammography and digital breast tomosynthesis. When implemented at IMBL in 2021, PB-CT will be used to complement existing medical breast imaging modalities, leading to more accurate breast cancer diagnosis [1, 2].

[1] S.T. Taba et al., Am.J.Roentgen., 211, 133-145 (2018).

[2] T.E. Gureyev et al., Med.Phys., 46, 5478-5487 (2019).

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