International Workshop on Advances in X-ray Imaging
ICTP, Trieste, Italy / 11-12 December 2014

Low dose phase contrast tomography for biomedical applications

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Biomedical diagnostic imaging requires high contrast at low radiation dose: a condition that often limits the sensitivity of conventional radiology. In this scenario, the application of coherent X-ray phase-contrast imaging (PCI) methods, which explicitly utilise the wave character of light, has attracted a vivid interest over the past years. A remarkable improved image contrast and sensitivity are provided by PCI against standard diagnostic techniques. However, the actual advantage in terms of radiation dose is not clear yet, in particular when whole and large organs are imaged and computed tomography (CT) is performed. In-vivo applications present stringent requirements in terms of exposure and CT acquisition time posing important technical challenges which need to be addressed by using a multifaceted approach. Recent optics and setup developments allowing for the use of 50-100 keV X-rays combined with new low dose CT reconstruction algorithms have considerably increased the potential of PCI-CT. In this presentation, the feasibility of low dose, high energy and high resolution PCI-CT and its sensitivity for imaging clinical-like human specimens will be discussed and demonstrated. PCI-CT results of whole human knees and tumour bearing breasts at clinical compatible doses will be shown and compared with clinical images. The image quality and the sensitivity of the technique were qualitatively and quantitatively assessed as very good by radiologists. These results suggest that the PCI-CT technique has the potential of becoming a valuable method in biomedical imaging providing a 3D investigation of whole specimens and quasi-histological information of tissues while limiting the radiation dose deposition. Consequent benefits are attainable for both clinical and animal-based investigations for high sensitive longitudinal follow up of pathologies and therapies.

Keywords: phase contrast imaging, low dose and fast computed tomography, high resolution imaging, biomedical imaging