MS42. Imaging and tomography techniques by neutrons and X-rays

Chairs: Vincent Favre-Nicolin, Alessia Cedola

MS42-O1 Frontiers of phase-contrast computed tomography

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Background: X-ray imaging has been the most important and widespread diagnostic tool in Medicine over the last century. Despite its huge success, for example in imaging bone structure, X-ray diagnostics ultimately reaches its limits in the examination of soft tissues, such as small tumours in healthy tissues, lungs or articular cartilage. Moreover, medical diagnostic imaging requires high contrast at low radiation dose: a condition that often limits the sensitivity of the method. In this scenario, the application to biomedical imaging of coherent X-ray phase-contrast imaging (PCI) methods, which explicitly utilise the wave character of X-ray light, has attracted a vivid interest in medical imaging.

Material and methods: PCI employs the dual property of X-rays of being simultaneously absorbed and refracted while passing through a tissue. Different PCI modalities have been developed (based on X-ray interference or diffraction mechanisms). The produced image contrast is a combination of X-ray absorption, refraction and ultra-small angle scattering. Whole or portions of human tissues such tumour-bearing breasts, pathological livers and osteoarthritic joints provided by the Ludwig Maximilians University (LMU, Phatology and Forensic medicine departments) were imaged in computed tomography (CT) mode. Blinded radiologists quantitatively evaluated the visual aspects of the PCI-CT images with respect to sharpness, contrast and the discrimination of different structures/tissues. IRB-approval for this study was granted by the ethics committee of the LMU.

Results: Low dose, high resolution PCI-CT images of clinically interesting specimens were obtained. Comparative studies in which PCI images were correlated to results produced with clinical diagnostic imaging tools (i.e. CT scans, magnetic resonance imaging, histology). The radiological blinded evaluation showed a statistically relevant difference in image quality in PCI-CT against conventional diagnostic images.

Conclusions: PCI-CT enables depiction of fine tissue changes previously not detectable by conventional diagnostics techniques. Results suggest that PCI-CT has the potential of becoming a valuable method in clinical imaging providing a 3D investigation of whole specimens and quasi-histological information of tissues at clinically compatible doses. In addition, PCI may represent a powerful tool in animal models investigations allowing for the longitudinal follow up of cancer evolution or therapeutical effects.

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