

Seminar

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Department of Physics, room U2-02

From pre-clinical phase-contrast X-ray radiography and CT to clinical MRI-only workflow in radiation therapy planning

Clinical mammography based on X-ray absorption is the primary method for early breast cancer detection; however, this examination is limited by insufficient contrast, with over 10% of palpable cancers not visible. Pre-clinical phase-contrast X-ray radiography and computed tomography (CT) offer a transformative solution by utilizing refractive index variations rather than simple absorption. The use of highly collimated, monochromatic beams and advanced diffraction optics offers potential improvements over existing mammography by enhancing soft tissue contrast, rejecting scatter, and reducing radiation dose. These advancements enable better differentiation between tumors and healthy tissues at optimal energy levels, both in radiological diagnostics and in radiation therapy (RT) planning.

The most common workflow for using magnetic resonance imaging (MRI) in clinical RT planning is based on co-registration of CT and MRI images. This allows the use of additional anatomical information provided by MRI, although the dose calculation is based on the electron density information provided by CT. The MRI device located at the RT department of Turku University Hospital in Finland has been equipped since 2017 with software capable of producing so-called synthetic CT images based on MRI data. RT planning based on MRI alone offers advantages such as time and cost savings, reduced patient dose, and improved tumor visualization due to different imaging contrasts. This approach also minimizes uncertainties in the registration of MRI and CT images by using MRI as the sole imaging modality, facilitated by an MRI scanner capable of positioning the patient in the RT position. Geometric distortions inherent in MRI always require 3D distortion correction for accurate RT planning. Device requirements include good geometric accuracy, a wide bore, a flat RT-indexed couch top, and an external laser system for patient setup. It is quite evident that the use of clinical MRI-only workflow in RT planning is expanding beyond pelvic anatomy to areas such as the brain and head and neck.