Quantitative imaging using high-energy X-ray phase-contrast CT with a 70 kVp polychromatic X-ray spectrum.

Abstract:
Imaging of large and dense objects with grating-based X-ray phase-contrast computed tomography requires high X-ray photon energy and large fields of view. It has become increasingly possible due to the improvements in the grating manufacturing processes. Using a high-energy X-ray phase-contrast CT setup with a large (10 cm in diameter) analyzer grating and operated at an acceleration tube voltage of 70 kVp, we investigate the complementarity of both attenuation and phase contrast modalities with materials of various atomic numbers (Z). We confirm experimentally that for low-Z materials, phase contrast yields no additional information content over attenuation images, yet it provides increased contrast-to-noise ratios (CNRs). The complementarity of both signals can be seen again with increasing Z of the materials and a more comprehensive material characterization is thus possible. Imaging of a part of a human cervical spine with intervertebral discs surrounded by bones and various soft tissue types showcases the benefit of high-energy X-ray phase-contrast system. Phase-contrast reconstruction reveals the internal structure of the discs and makes the boundary between the disc annulus and nucleus pulposus visible. Despite the fact that
it still remains challenging to develop a high-energy grating interferometer with a broad polychromatic source with satisfactory optical performance, improved image quality for phase contrast as compared to attenuation contrast can be obtained and new exciting applications foreseen.