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Dual Energy X-ray Analysis Using Synchrotron Computed Tomography at 35–60 keV

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Dual energy X-ray analysis (DEXA) uses CT measurements of the X-ray linear attenuation coefficient at two photon energies to characterise materials; electron density and statistical measure of elemental composition, related to the concept of effective atomic number.

Phantoms were prepared as liquid samples of known density and composition including ethanol-water mixtures and salt solutions (NaCl, NaH2PO4, MgCl2, MgSO4, KCl, KH2PO4 and CaCl2). The phantoms and an ex-vivo laboratory animal underwent mono-energetic CT at 35–60 keV using the Australian Synchrotron Imaging and Medical beamline and a CCD camera optically coupled to a luminescent screen.

The CT data for the phantoms provided coefficients that describe attenuation as measured by the beamline, and expressed as elemental cross-sections. The phantom data underwent DEXA, and the accuracy of the analysis was quantified as a function of mean beam energy, dual energy separation, and elemental composition. The CT data for ex-vivo samples was spatially co-registered, subjected to DEXA, and the results were used to create volumetric maps representing the X-ray linear attenuation coefficients and energy absorption coefficients for photon energies of 10 keV to 10 MeV.

The DEXA technique was successfully demonstrated using samples of known density and composition, and factors that affect accuracy were identified. An important application of the method, the prediction of photon interaction coefficients at other beam energies for attenuation correction and radiation dose calculations, was investigated for the biological specimen.

Keywords or phrases (comma separated)

synchrotron CT, electron density, composition, attenuation correction, radiation dosimetry

Summary

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