MONTE-CARLO SIMULATIONS FOR EVALUATION OF DIFFERENT INFLUENCES ON PROJECTIONS IN COMPUTED TOMOGRAPHY

B. Chyba, M. Mantler
Technische Universität Wien, Austria
M. Reiter
Fachhochschule Wels, Austria

Computed tomography (CT) has become a widely-used technique for non-destructive material testing in industry. A common setup of a CT device consists of an x-ray tube utilizing a cone beam and a matrix scintillation detector to record 2D projections. A set of projections is used to reconstruct a 3D image for visualisation of the sample. Aside from the advantage of image magnification, CT in cone beam geometry leads to difficulties in the quality of the back-calculated image due to the complex mathematical reconstruction process. It is therefore highly sensitive to artefacts caused by physical interactions of x-rays with the sample, and x-rays with the detector components respectively. An accurate investigation of these interactions may be most helpful to understand and optimize measurement parameters and to develop correction algorithms for the back-calculation.

In this work Monte-Carlo simulations have been made for all stages of the creation process of 2D projections in a CT device: creation of angle dependent tube spectra, interaction of x-rays and secondary photo electrons with a simple inhomogeneous sample (an aluminium cube with a cylindrical hole filled by air or steel), interaction of x-rays and photo electrons with the components (thin layers) of a matrix scintillation detector. The simulations were calculated using custom software (proposed at DXC 2007) running on up to 50 nodes of a computer cluster. Comparative calculations were also made using a public available software package (MCNP). Tube spectra were calculated with algorithms proposed by H. Ebel (DXC 2005).

Measurements for the chosen setup made with an available CT device were in relatively good agreement with calculated results. Calculated tube spectra were compared to results gathered by the MCNP code. It was shown that good knowledge of the tube spectra would be of importance, but most differences between resulting projections and measurement are caused by uncertainties concerning detector response due to light yield of the scintillator and internal scattering effects within the thin detector layers which lead to spreading of a detected point signal on the detector matrix into neighbouring matrix elements.