Scattered Radiation Grids for Micro Computed Tomography

Bernhard ILLERHAUS^{*}, Siegfried ARNOLD^{*} * BAM Bundesanstalt für Materialforschung und –prüfung, Berlin, email: bernhard.illerhaus@bam.de ** PerkinElmer, Walluf, email: siegfried.arnold@PerkinElmer.com

Abstract. Diffuse scattered radiation can extensively deteriorate images from 3D-CT. A correction by software methods is possible but relies on undefined estimated values. Therefore we have tested mechanical scattered radiation grids, as they are used in medical imaging systems, in front of the detector. Measurements with concrete cylinder of 70mm diameter showed a high suppression of the scattered radiation. A beam hardening correction without the assumption of a scattered radiation background was possible. Thus a big disadvantage of 3D-CT is slipped.

Measurements

Medical devices for imaging use mechanical radiation grids since some time. Figure 1 gives the principal set up: closely adjacent lamella of highly absorbing material are focused to a point F. Radiation grids are produced with different focal lengths and different sizes [1].



We have tested a grid with focal length of 1050mm. It was mounted in centric position on the front side of the detector. (Usually the grid will be mounted inside the detector granting that it is centred exactly.)

The correct position of the scattered radiation grid was reached by shifting the detector. A cylindrical concrete sample of 70mm diameter was imaged and the relation between un-

Abb. 1. Principle of a scattered radiation grid with focal length f and focal point F

attenuated radiation and attenuated radiation behind the cylinder was measured. The measured maximum was defined as best detector position (Fig. 3).

To proof the reduction of scattered radiation, the concrete cylinder was measured by CT under the same conditions with (811dm) and without (810dm) the scattered radiation grid. The effect of reduced scattered radiation is not simply given by the reduction in the radiation behind the object, because the grid changes also spectra and intensity of the useful radiation.





Fig. 2. Different types of Siemens scattered radiation grids.

Therefore the calculation of the beam hardening correction was used: From the averaged projections of the cylindrical sample the parameter of the beam hardening correction were calculated in comparing with a calculated theoretical attenuation profile of cylinder а for monochromatic radiation (810dm Fig.4). The parameters are given within the graph and the drawn line is the relation curve with this parameters. There is a residual background of 3.5e+3. Doing the same with the 811dm data (Fig.5), with grid, showed, that the best fitted curve for beam hardening crosses zero; there is no background left. In this graph an further measurement is shown by red colour. Here the concrete was soaked with water, which enhances the scattered radiation (812dm).

Schwächungsverhältnis



Fig.3. The correct position of the scattered radiation grid was reached by shifting the detector.

Aufhärtungskorrektur 810dm



Fig.4. Beam hardening correction without scattered radiation grid.



Aufhärtungskorrektur 811dm / 812dmwasser

Fig.5. Beam hardening correction 811dm / 812dm water blue sample as above red soaked with water.



Fig. 6. concrete cylinder without radiation grid and without beam hardening correction.

Fig. 7. concrete cylinder with radiation grid and with beam hardening correction.

Figure 6 shows a reconstruction of the concrete cylinder without scattered radiation grid and without beam hardening correction. With grid the beam hardening can be corrected (Fig. 7). Please considre that a form depending correction as in [2] shown was not used. Tomographic measurements were done at 270kV using only the 0.2mm thick copper window of the micro focus tube as filter. As detector a PerkinElmer XRD1620AN15 CS with DRZ Standard scintillator (Fig. 8) was used.



Résumé

In using a mechanical scattered radiation grid the diffuse scattered radiation can be suppressed significantly, also in micro-CT measurements. The beam hardening correction gets independent of estimated values.

Fig. 8. PerkinElmer detector of the 1620 series with power supply and PC-card.

References

[1] http://www.siemens-oem-imaging.com/file/gr.pdf

[2]B. Illerhaus, Y. Onel, J. Goebbels, "<u>Correction techniques for 2D detectors to be used with high energy X-ray sources for CT, part II</u>," in Developments in X-Ray Tomography IV, ed. By Ulrich Bonse, Proceedings of SPIE Vol. 5535 (SPIE, Bellingham, WA, 2004) 329-334.