Purpose: Micro CBCT scanners have a broad spectrum of applications in medicine and material science. However, CBCT suffers from scatter radiation and spectral effects such as beam hardening (BH). In this work an iterative BH- and scatter-correction algorithm was developed using Monte Carlo (MC) methods.

Methods: Two ÂµCBCT scanner models (XtremeCT and ÂµCT100 from SCANCO Medical AG) were simulated using EGSnrc/EGS++. The scanner measures the attenuation of X-rays passing through the phantom and interacting in a scintillating detector. The MC method is used to characterize the influence of the scattering and BH-effects. In addition, an analytical model is developed in order to correct for the scattering effect. For this purpose, by using MC methods, different scatter components were analyzed with respect to the number of scatter interactions within the given geometry. For the BH-effect, after assessing the detector response for an equivalent mono-energetic and scatter-free system using MC methods, an analytical correction model was developed. Both correction methods were implemented as an iterative reconstruction correction algorithm and were tested for various phantoms.

Results: MC simulations show that the amounts of correction for the scattering and BH-effects are in the same order of magnitude. The correction term for scattering effects is a function of the scatter to primary ratio only and is mainly due to single scattered particles. The contribution of multiple scattered particles to the total scatter signal is small and can be approximated by a constant. In all cases tested, the reconstructed linear attenuation coefficients converge to the mono-energetic reference values after 2-3 iteration steps with a deviation of about 1%.

Conclusions: By using an iterative correction algorithm using single scatter approximation, BH- and scatter correction can be performed accurately for ÂµCBCT scanners.

Funding Support, Disclosures, and Conflict of Interest:
This work was supported by CTI-10629.1 and SCANCO Medical AG.