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Analytical modeling of pencil beams to include Compensator-related beam perturbations

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Compensators can be utilized as radiation beam intensity modulators. In order to use it effectively, aspects like beam hardening and compensator-induced scatter should be taken into account in dose calculations. The shape of the compensator for IMRT purposes can be realized through inverse planning techniques from a weight matrix. The BEAM MC code was used to generate three phase-space files located above the jaws for generic accelerators based on Philips SL6 and SL25 machines with beam energies of 6, 8 and 15 MV. Each beam energy spectra was extracted with the BEAMDP code and were used in parallel beam source models in the DOSRZnrc MC code. Pencil beam dose distributions were scored in a cylindrical water phantom model. A series of simulations were performed where, each time, the PB was allowed to traverse a different slab thickness (0, 1, 2, 3 and 5 cm) of compensator material located at 33 cm above the water phantom model. The simulations were repeated for different materials that include wax, aluminum, copper, brass and lead. In this study it is shown how the change in the PB dose profiles at each depth can be analytically modeled so that it can be predicted as a function of material thickness. The effect of these corrections are evaluated against full Monte Carlo simulations and were found to replicate CAX depth dose curves within 1.5 percent in most cases. The inclusion of compensator effects in the PB model can then be utilized as a tool to derive the shape of a compensator from a desired dose profile in an efficient way.