The collapsed cone algorithm calculates the dose by distributing energy deposited at each grid point by kernel integration along a predefined set of discrete directions. An accurate calculation of dose requires that beam quality changes from beam hardening and off-axis softening are properly considered.

In the current work the terma is separated into collision kerma $P(\mathbf{r})$ describing the primary interactions and a distribution $S(\mathbf{r})$, equal to the difference between terma and collision kerma, describing the scattered photons. Each of these components has its own kernel, which is assumed invariant with position. The distributions of P and S inside the patient are determined separately by ray tracing in a voxel matrix derived from CT images of the patient.

Beam hardening effects for both P and S are taken into account by using effective attenuation coefficients which are precalculated from the spectrum of the beam and mono-energetic attenuation data for the tissue. The cumulative effect of the beam hardening is obtained by proper summation over all voxels passed by the ray.

Off-axis softening is considered by varying the attenuation coefficient with distance from the beam axis. The parameters of this description can be obtained from measurements in the clinical beam.

The values of P and S are proportional to the incident energy fluence distribution, including both the primary photon fluence and the head scatter fluence. The effects of the collimation and the modulation of the beam are incorporated in the description of the incident fluence.