Modeling and Commissioning Clinical Photon Beams for Monte Carlo Treatment Planning

Accurate Monte Carlo treatment planning dose calculation requires accurate beam information as input. In the present work we propose a three-source model to characterize clinical external photon beams and a method to commission the model using a standard set of measured data. The model contains a point source for primary photons, an extrafocal source for scattered photons, and an extended source for contaminant electrons. For primary photons we use different energy spectra every 2 cm away from the central axis to account for the beam softening effect. For either scatter photons or contaminant electrons only one energy spectrum is used. All the spectra are first obtained by simulating a reference accelerator using the Monte Carlo method, and then adjusted to match the measured data for an accelerator to be commissioned. The relative weight and intensity distribution for the extrafocal source are determined by fitting the calculated head scatter factors with the measured ones. The extended electron source is obtained by matching the difference between the measured dose distributions and the calculated photon dose distributions. The current model has been implemented into a Monte Carlo treatment planning system, MCDOSE. Extensive experiments have been performed to validate the model and the commissioning procedure. Good agreement (within 2% for dose distributions and within 1% for output factors) has been achieved, which indicates that our work provides an accurate and practical way to derive accurate beam data for Monte Carlo treatment planning.