Characteristics of Clinical Electron Beams: Current and Optimal

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ABSTRACT

This thesis presents the results of two investigations into the characteristics of electron beams for application in radiation therapy. The first investigation involves the modelling of the interactions between the tertiary collimation system (applicator) of a Siemens Mevatron KD2 linear accelerator, and the electron beam produced by that accelerator. EGS4 Monte Carlo code is used to simulate the transport of 6 MeV, 12 MeV and 18 MeV electron beams from the accelerator waveguide, through the electron scattering foils and air to the applicator assembly, in order to determine primary beam electron and photon spectra. Narrow beams are then simulated incident on sections of applicator trimming plate edges (edge elements) in order to investigate the characteristics of scattering off these edges. It is found that electron scattering is dependent on the energy of the primary beam and the material of which the edges are made, as well as the angle of incidence of the primary beam to the edge. Primary beam photons are scattered minimally. A model for scatter from irregular apertures is developed based on a superposition of scatter *kernels* from edge elements. This model is evaluated using several regular and a single irregular applicator/cutout combinations, and found to give central-axis depth dose and profile data consistent with measured results. The model is also used to obtain detailed information of the characteristics of particles scattered from the electron applicator.

The second investigation involves evaluating the characteristics of electrons in an electron beam which would produce dose distributions in homogeneous media which most closely approximate specified dose distributions. For this purpose, optimal electron beam properties are determined by inversion of desired dose distributions using a simulated annealing optimisation method. This technique is used for several regular desired dose distributions, and various intuitive results are obtained regarding the effects electron energy and angular modulation have on resulting dose distributions. The technique is also used for several complex desired dose distribution, indicating the relative influence energy and angular modulation can have on dose conformation with electrons. For a suitably selected electron energy, modulation of electron incidence angle can be used to control the variation in dose with depth in order to increase dose conformity, and to reduce dose deposition within desired low-dose regions adjacent to and underlying desired high-dose regions.

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