EXPERIMENTAL VERIFICATION AND REFINEMENT OF THE PROJECTIVE PHOTON BEAM MODEL AND EXTENSION TO ELECTRON AND NEUTRON BEAMS

POCHENG CHENG

A number of analytical functions were proposed to describe the absorbed dose distributions in patients resulting from a clinically relevant radiation beam. A problem with the representation of absorbed dose cross-beam profiles is that their shape is co-determined by the manufacturer design and construction of the machine. It is not feasible to fit the cross-beam profiles for all different machines with a general analytical function.

The van de Geijn photon beam model provides a powerful solution to this problem. In this model a single directly-measured photon cross-beam profile with a suitable field size at a reference depth is taken as input data. Then the influence of the various physical and geometric parameters, such as field size, depth, and source-to-surface distance (SSD) is relatively small in magnitude, and can be described adequately by relatively simple analytical functions with a small number of model parameters. Since the special characteristics for each individual machine are already included in the directly-measured cross-beam profile, a general correction function may then be suitable for different machines. Since only a small set of directly-measured data and model parameters are needed, the data acquisition and storage are relatively simple. The same principles can also be applied to electron and neutron beams.

The work in this dissertation was the experimental verification and refinement of the van de Geijn proton beam model, and its extension to high energy electron and neutron beams. Based on measurements of cross-beam profiles for both photon and electron beams, this photo beam model was improved. It was found that the correction functions devised for photon beams can be applied to electron beams with some modifications. From the investigations of the Fermilab neutron beam data, it was also found that the projective photon beam model can be successfully applied to fast neutron beams as well. Finally, a unified formalism to describe the three-dimensional dose distributions for all three modalities was obtained, which is very convenient and attractive as a basis for computer assisted multi-modality treatment planning.