AbstractID: 4495 Title: Patient Modeling and Organ Dose Calculations Using Monte Carlo Methods

The risk for a patient to develop secondary cancers from non-target exposures can be assessed from the equivalent doses to various radiosensitive organs. To determine organ doses, a computational model or physical phantom that represents the whole patient anatomy must be used. Physical phantoms (such as the RANDO and ATOM phantoms) have tiny cavities on each of the tissue-equivalent slices for inserting TL and MOSFET dosimeters. When beam is delivered according to a patient's treatment plan, the dosimeters are processed to provide organ dose information. The experimental procedures can be time-consuming and expensive, especially when various patients and treatment plans are studies. Virtual patient models, on the other hand, can be combined with a Monte Carlo code to simulate the transport of radiation in the body. These models cover the entire body and typically contain a large number of defined organs. Coupled with a model of the accelerator, one can calculate detailed information about secondary dose distributions in the patient body. Whole-body models are classified into three types: 1) Stylized models that are based on surface equations, 2) Tomographic models that are derived from medical images, and 3) Hybrid equation-voxel models that describe organ boundaries using advanced primitives such as the NURBS for realtime deformation (4D simulations). To date, more than 20 tomographic models have been developed for radiation protection and nuclear medicine applications. An international consortium on computational human models (www.virtualphantoms.org) has been recently formed to promote research in this area. A team of researchers from Rensselaer, Vanderbilt, University of Florida, Massachusetts General Hospital and Johns Hopkins University is working on a project to standardize a library of age- and gender-specific models.

This lecture presents the current status of patient modeling and the application of various tools to study secondary doses from radiation treatment involving both photons and protons. Detailed information on the VIP-Man model developed from the Visible Human Project is presented. Segmentation of more than 80 organs, including the red bone marrow, and the implementation of the VIP-Man model into EGS, MCNP/X and GEANT4 are discussed. Finally, organ doses and effective doses for proton treatment plans using various adult and pediatric patient models are presented.

Educational Objectives of this symposium are:

1. Understanding new tools of Monte Carlo-based patient and accelerator modeling for secondary dose studies
2. Understanding the effective dose data for various modalities