Detailed Varian Clinac Accelerator Modeling for Calculating Intermediate- and Low-level Non-target Organ Doses from Radiation Treatments

by

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ABSTRACT

There is a serious and growing concern about the increased risk of radiation-induced second cancers and late-tissue injuries associated with radiation treatment. To better understand and to more accurately quantify non-target organ doses due to scatter and leakage radiation from medical accelerators, a Monte Carlo-based computational framework is needed. This dissertation describes the development, validation, and application of detailed accelerator models of the Varian Clinac operating at 6 and 18 MV beam energies. Over 100 accelerator components for each model have been defined and integrated into the Monte Carlo code MCNPX. A series of in-field and out-of-field dose validations were performed resulting in excellent agreement between calculated and measured in-field and out-of-field data. A computational framework was developed by integrating the accelerator models with anatomically-realistic patient phantoms to assess intermediate- and low-level organ-averaged equivalent doses to radiation therapy patients. To demonstrate the applicability of this framework, three treatment-specific examples were considered in this dissertation. These examples demonstrated that the computational framework presented in this dissertation provides a versatile and accurate approach to assess second cancer risk due to intermediate- and low-level equivalent doses to organs from different radiation treatments. This dissertation finally summarizes areas where future research can be performed including modifying the framework to make it more efficient and user-friendly and applying the framework to various other applications.