Integration of Dose Measurements and Mode-Based Treatment Planning Algorithms

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December 22, 2002

The objective of radiation therapy is to deliver a lethal dose of radiation to the diseased target while minimizing dose to healthy tissue. This goal constantly motivates the development of treatment modalities which can deliver dose more conformally. In turn, the advances of modern radiotherapy necessitate new methodologies to maximize the precision of dose measurements and the accuracy of dose computation algorithms.

Presently, the output of an external beam radiotherapy source is qualified using reference point dose measurements. This thesis advocates explicitly including energy fluences as an integral aspect of output calibration to compliment conventional dose calibrations. Energy fluence based calibration requires both accurate measurements and mode-based dose calculations. The dose is measured and computed under identical conditions, yielding a "dose pair" which is used in the calibration calculation.

For this thesis, a standard cobalt-60 beam is calibrated in terms of energy fluence. A full Monte Carlo model of the UW ADCL cobalt beam is presented, and the theory and methodology of energy fluence calibration is illustrated with this beam is presented, and the theory and methodology of energy fluence calibration is illustrated with this beam. Moreover, the output of a standard radiotherapy linac 6MV photon beam is also calibrated in terms of energy fluence. Energy fluence calibration is independent of the depth in phantom at which the "dose pair" is considered. This is proven with both the linac and cobalt beams. The robustness of the method was tested by calibrating the linac beam with dose values after it had been filed with metal plates.

An advantage of energy fluence calibration is its inherent independence of the material in which the dose pair is obtained. This aspect is illustrated by calibration in an aluminum phantom. Phantom independence may be advantageous for calibration measurements for non-standard treatment modalities with small field sizes, and may allow for utilization of new dosimeters and phantoms. The use of an extended length ionization chamber is also presented as a tool for modern radiotherapy.