

Purpose: To extend the versatility and simplicity of external beam Monte Carlo (MC) methods within BEAMnrc/DOSXYZnrc with the introduction of a new universal DOSXYZnrc source for multi-field simulations.

Methods and Materials: A single DOSXYZnrc source, capable of simulating all types of external beam radiotherapy, was developed as an extension to the standard set of sources. The source incorporates dynamic movement of components such as MLC leaves, jaws, gantry, collimator and couch. This was achieved by coupling the field index between the BEAMnrc components with the field index of the DOSXYZnrc components through the LATCH variable, transferred from BEAMnrc to DOSXYZnrc via the phase space information. This allows the state of the accelerator (such as MLC leaves, jaw positions and angles of incidence) to be changed for each history, effectively simulating coupled time-dependent geometries. The process for RapidArc is as follows. RapidArc fields are defined within the control points of the DICOM plan file. Each point defines a MLC pattern and gantry angle. Within the MC simulation, the MLC pattern was defined in BEAMnrc, while the gantry angles were defined in the new DOSXYZnrc source. Control points for Tomotherapy are defined with the XML and sinogram files. In addition, IMRT and conformal treatments such as SBRT, which are comprised of 1-7 beams, can be merged into a single simulation. For practical considerations, it is more efficient to run a single MC simulation than to manage the submission of multiple beams and recombining them afterwards. We tested the new source within the context of the MMCTP system.

Results and Conclusion: This source has enabled MC plan verification of RapidArc and Tomotherapy and simplified the MC calculation of IMRT and SBRT into a single simulation for efficient QA. The new source adds much needed functionality to the existing set of DOSXYZnrc sources.