

**Purpose:** The commercial release of volumetric modulated arc therapy techniques and the growing number of helical TomoTherapy users have triggered renewed interest in dose verification methods for exploring the impact of patient motion on dose distributions without the need to approximate time-varying parameters such as gantry position or MLC leaf motion. To this end we have developed a Monte Carlo-based calculation method capable of simulating a wide variety of treatment techniques without the need to resort to discretization approximations. The method was applied to VMAT and TomoTherapy stereotactic radiotherapy lung treatments to study the effect of breathing motion interplay and dose calculation discretization errors.

**Methods:** The ability to perform complete position-probability-sampled Monte Carlo dose calculations was implemented in BEAMnrc/DOSXZYnrc user codes. The method includes full accelerator head simulations of TomoTherapy and Elekta linacs, and a realistic representation of beam delivery continuous motion via the interactive sampling of geometry parameters using a random time variable associated to each simulated particle. Patient motion is simulated by selecting the appropriate voxelized 4D-CT breathing phase for each particle using the provided treatment breathing curve. Ten different patient anatomies (7 clinical cases, 3 phantoms) were planned for Elekta VMAT (Monaco) and helical TomoTherapy (Hi-Art). Breathing frequency was varied from 2 to 8 seconds and amplitude ranged from 3 to 15 mm.

**Results:** Results show that breathing motion is properly addressed with the ITV method for most cases studied. Minor dose discrepancies were observed with both systems under relatively unusual clinical conditions.

**Conclusions:** We have developed a Monte Carlo-based calculation method capable of simulating a wide variety of treatment techniques without the need to resort to discretization approximations. The method was applied to VMAT and TomoTherapy stereotactic radiotherapy lung treatments to quantify breathing interplay effect and dose calculation discretization errors

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