Modeling Multileaf Collimators with the PEREGRINE Monte Carlo System

Multileaf collimators (MLCs) are becoming increasingly important for beam shaping and intensity modulated radiation therapy (IMRT). Their unique design can introduce subtle effects in the patient/phantom dose distribution. The PEREGRINE 3D Monte Carlo dose calculation system predicts dose by implementing a full Monte Carlo simulation of the beam delivery and patient/phantom system. As such, it provides a powerful tool to explore dosimetric effects of MLC designs. We have installed a new MLC modeling package into PEREGRINE. This package simulates full photon and electron transport in the MLC and includes tongue-and-groove construction and curved or straight leaf ends in the leaf shape geometry. We tested the accuracy of the PEREGRINE MLC package by comparing PEREGRINE predictions with ion chamber, diode, and photographic film measurements taken with a Varian 2100C using 6 and 18 MV photon beams. Profile and depth dose measurements were made for the MLC configured into annulus and comb patterns. In all cases, PEREGRINE modeled these measurements to within experimental uncertainties. Our results demonstrate PEREGRINE's accuracy for modeling MLC characteristics, and suggest that PEREGRINE would be an ideal tool to explore issues such as 1) underdosing between leaves due to the 'tongue-and-groove' effect when dose from multiple MLC patterns are added together, 2) radiation leakage in the bullnose region, and 3) dose under a single leaf due to scatter in the patient.