

## **Clinical validation of a Monte Carlo dose calculation tool for radiotherapy treatment planing**

A Monte Carlo program, MCDOSE, was developed at Stanford for radiotherapy treatment planning (RTP). MCDOSE was designed as a dose calculation module for easy implementation into any RTP system. We have implemented MCDOSE on an existing commercial RTP system for conventional photon/electron beams and intensity modulated radiotherapy (IMRT) dose verification. Features of MCDOSE included a multiple-source model to reconstruct the beam phase space, inclusion of beam modifiers such as jaws, wedges, blocks, electron cutouts and bolus in the patient simulation, and the implementation of several variance reduction techniques. Vigorous testing and clinical commissioning of MCDOSE has been carried out. Photon and electron dose calculations using MCDOSE were tested for two Varian accelerators, a Clinac 2100C and a 2300C/D. Comparisons of the dose distributions for 4-15 MV photons and 6-20 MeV electrons calculated by MCDOSE and the well-benchmarked EGS4 user code DOSXYZ showed excellent agreement (within statistical uncertainty of 0.3%). The CPU time for a given calculation was generally a factor of 10 less for MCDOSE compared to DOSXYZ. The MCDOSE calculated heterogeneity correction factors for layered-lung or layered-bone phantoms were consistent with results from measurement to within 1%. Specifically designed inhomogeneous phantoms were used to test MCDOSE computed IMRT plans. The results showed that the dose calculated by MCDOSE agreed to within 3% measured results while the dose to critical structures was underestimated by a commercial inverse planning system by up to 100%.