One of the major problems in radiotherapy is to deliver a known dose of radiation to cancer tissues while minimising the dose to normal tissues, and especially sparing critical tissues adjacent to the target volume. A new, Monte Carlo-based inverse planning algorithm (MCI) has been developed, which combines arguably the best current dose calculation method (Monte Carlo particle transport) with a ’guaranteed’ optimisation method (simulated annealing).

The dose distribution from each beam element from a number of fields is pre-calculated using Monte Carlo. A distribution of photons is specified in the tumour volume, from which photons are transported using an adjoint calculation method to outside the patient surface to build up the initial phase space which is used as input to the optimisation algorithm. Simulated annealing is then used to find the optimum weighting of each beam element.

MCI plans have been generated in various theoretical phantoms and also real patient geometries. These plans show confirmation of the dose to the target volume and the avoidance of critical structures.

MCI can be used as a benchmark with which to test the convergence to the real solution of optimisation algorithms used in radiotherapy, and also dose calculation algorithm accuracy for clinically relevant examples. Because of its generality it can be used for other particle types as long as an appropriate Monte Carlo transport code is available. A limitation of MCI is the long computation time required for the calculation of the individual beam elements, and for the annealing routine.