

Intensity-modulated radiation therapy can be realized by a number of different techniques, such as compensators, scanned beams and segmented or dynamic multileaf collimation. This work is concerned with segmented multileaf collimation, which has several advantages compared to other modulation techniques in terms of availability, flexibility and quality assurance.

Conventionally, segmented multileaf collimation is obtained in a two-step process: (i) optimization of a technique independent modulation matrix, followed by (ii) a translation of the modulation matrix into collimation segments. Translation is approximate, it is generally not possible to completely reproduce the technique independent modulation with segmented collimation. If large approximations occur in critical regions, the outcome may be severely degraded as a result of the two-step process.

To overcome this problem, the translation is embedded in the iterative, gradient-based optimization algorithm. In each iteration step, the modulation is first modified on the basis of the objective function gradient. Second, the modified modulation is translated into collimation segments for which a realizable modulation matrix is calculated. The iterative step is completed by calculation of the objective function and its gradient using the realizable modulation matrix. The optimization procedure is contained in a treatment planning system, and the system's pencil-beam dose algorithm is used to calculate the dose distribution required for evaluation of the objective function and its gradient. It is shown that the proposed method generates more optimal solutions than the two-step process, and that the time of optimization is not substantially prolonged with the new approach.