AbstractID: 4540 Title: Fast multifield optimization of the biological effect in IMRT with ion beams

Purpose: To investigate a new technique for multifield optimization of the biological effect (relative biological effectiveness times dose) for intensity modulated radiotherapy with scanned ion beams and to compare this method to an existing planning system for ions.

Method and Materials: Our approach is based on the mixed irradiation formalism of the linear-quadratic model using dose averaged mean values of alpha and sqrt(beta). We employ a novel objective function to directly optimize the biological effect rather than the physical dose. It is based on constraints in biologically effective dose for targets and organs at risk in close analogy to inverse planning for photons. The required biological input data are reduced to a minimum and are completely independent from the optimization itself. They can be derived from any radiobiological model or even from directly measured data. The new optimization method is fully integrated into the inverse treatment planning tool KonRad.

Results: Comparisons with the TRiP98 treatment planning code are shown for spread-out Bragg peaks as well as for three-dimensional treatment plans for carbon ions, where all fields are optimized separately. While the agreement between both planning systems is very good, the calculation time is substantially reduced in KonRad. By enabling the multifield optimization in KonRad, the quality of the treatment plans and the sparing of healthy tissues can be clearly improved, which is demonstrated on several examples. Depending on the number of beam spots used, typical optimization times are between 10 and 60 minutes.

Conclusion: The proposed system offers complete and fast inverse treatment planning for ions. Simultaneous multifield optimization of the biological effect can considerably enhance the resulting plans since it makes the best use of all possible degrees of freedom.

Conflict of Interest: Research sponsored by Siemens Medical Solutions corporation.