AbstractID: 3894 Title: Beam-weight optimization for the field-in-field treatment-planning technique using fuzzy logic

Purpose: The field-in-field treatment-planning technique is commonly used in tangential-field irradiation of breast cancer, but it can also applied to other sites, eliminating the need for wedge filters in the treatment plan. The purpose of this work is to investigate an efficient and reliable method that employs fuzzy logic to optimize the beam weights for treatment plans that utilize the field-in-field treatment-planning strategy.

Method and Materials: Three tumor sites were considered, one in the breast, one in the brain, and one at the skull base. Four beam segments were used for the breast plan, and 8 segments were employed in the brain and skull-base plans. The Pinnacle^3 treatment-planning system was used to design the beam apertures in all cases. The dose per monitor unit (MU) delivered by each beam separately, calculated at a selection of points within the target volume using the Pinnacle^3 planning system, served as input to the optimization procedure. In the optimization process, relative cold- and hot-spot volumes within the target were defined as fuzzy variables. Development of a fuzzy rule set to determine how to adjust the number of MU delivered through each segment was simplified by dividing the target volume into sub-volumes associated with each beam segment. The change in the number of MU was a fuzzy variable, which was de-fuzzified using the center-of-mass method.

Results: The field-in-field plans developed using fuzzy logic were comparable to standard plans employing wedges developed by experienced dosimetrists. The fuzzy optimization was also fast, requiring only seconds to complete. For both the fuzzy-optimized and standard plans, the relative cold-spot volume within the target was between 0 and about 6%, and the hot-spot volume was less than 1%.

Conclusion: Fuzzy optimization theory can be successfully applied to optimize the beam weights for field-in-field treatment planning.