AbstractID: 4363 Title: Adaptive diffusion smoothing: A novel method to control IMRT field complexity based on the diffusion equation

Purpose: To introduce and evaluate adaptive diffusion smoothing (ADS), a novel procedure designed to preferentially reduce IMRT beam complexity based on any case related parameter inside the optimization.

Method and Materials: The diffusion equation was used to develop a procedure in which IMRT beams are smoothed using coefficients defined for each beamlet. The coefficients can be a function of any parameter and dictate the degree of smoothing allowed for each beamlet. The ADS procedure was incorporated into our optimization system as a weighted objective function penalty and several possible ADS coefficient definitions were investigated. Coefficients were designed to promote 1) uniform smoothing everywhere, 2) smoothing based on beamlet intensities, and 3) smoothing based on beamlet gradients with respect to the plan objectives. The method has been validated on a phantom and studied in clinical sites including prostate.

Results: The addition of the ADS penalty in the objective function, for all three coefficient types, produced plans with reduced modulation and minimal dosimetric impact in the phantom. Each ADS coefficient definition had merit, but gradient-based coefficients showed the most potential for reducing beam modulation without affecting dosimetric plan quality. For example, in a prostate plan, this method reduced MU 40% while preserving full target coverage and increasing mean normal tissue doses by less than 2.2 Gy.

Conclusion: A unique method based on the diffusion equation and used within the objective function has been developed to control IMRT beam complexity. This method, called adaptive diffusion smoothing, has been applied to phantom and clinical cases, and was able to reduce modulation significantly while preserving dosimetric plan quality. Adaptive diffusion smoothing is a promising tool for ensuring that only the necessary amount of beam modulation is used, promoting more efficient and accurate IMRT planning, QA, and delivery.

Supported in part by NIH Grant P01-CA-59827