AbstractID: 7502 Title: Uncertainty of dose calculations with Pencil Beam and Convolution Superposition Algorithms for stereotactic treatment of lung lesions

Purpose: Tissue heterogeneity perturbs the electron fluence at heterogeneity interfaces. Thus, the dose delivery to lung lesions ranging from 6 mm up through 30 mm in diameter is compromised since the dimensions of the lesions are comparable to the range of the secondary electrons in lung and air. Dose perturbations are evaluated for a range of lesion diameters in lung equivalent phantom material. The impact of the dose algorithm limitations on RTOG protocol requirements is addressed.

Methods and Materials: Spherical lesions of 6.4, 12.5, 19.7, and 25.4 mm in diameter and unit density were inserted into lung equivalent material (0.3 g/cm^3). The dose distributions were measured with film densitometry and calculated with the dose calculation engine of the ADAC Pinnacle system and the Analytical Anisotropic Algorithm (AAA) and PB algorithm implemented in Varian's Eclipse (v. 7.3.10) treatment planning system (TPS). The Pinnacle TPS uses the adaptive convolution superposition algorithm, which rigorously reproduces x-ray beam attenuation, and the electron fluence changes at tissue heterogeneity interfaces.

Results: The spherical tumor phantoms were irradiated with beam margins of 0, 7, 10, and 25 mm. Dose volume histogram analysis was performed to determine the minimum dose delivery to each lesion as a function of margin size. The pencil beam algorithm overestimates the minimum tumor dose by 5-10%. The Pinnacle and AAA dose calculations agree with the film dosimetry.

Conclusion: It was determined that a 7 mm margin for all lesion diameters delivers a minimum tumor dose of 94 % of the prescribed isocenter dose for all lesion diameters. The pencil beam algorithm overestimates the PTV dose by 20% whereas the adaptive convolution superposition and AAA algorithms satisfy the requirements of RTOG 0236.