Purpose: To investigate the potential of using low-spatial resolution (LR) correlated-sampling Monte Carlo (CMC) to implement rapid high-resolution (HR) dose computation in heterogeneous media for low-energy brachytherapy- seed planning.

Methods: An in-house MC engine (PTRAN) was used to simulate a prostate patient case using 78 I-125 Model 6711 seeds. CMC, which scores the dose difference, DD, between highly correlated histories in homogeneous and inhomogeneous geometries, was previously shown to improve efficiency by factors of 5-10. A CMCLR DD solution on a LR 2x2x2 mm grid was interpolated onto a HR 1x1x1 mm grid, on which the homogeneous water TG-43 solution was computed. This summation of the CMCLR and HR TG-43 solutions, CMCLR-HR, was evaluated against the conventional HR Monte Carlo heterogeneous dose simulation (MCHR). Both voxel-by-voxel differences between CMCLR-HR and MCLR and impact on prostate CTV dose-volume histograms (DVH) were quantified for a non-water prostate tissue assignment and for voxel-to-voxel tissue variations typical of a post-implant CT.

Results: The CMCLR-HR and MCHR DVHs agreed within 2% for both prostate assignments. 57.6%, 79.7, and 93.9% of the voxels had percentage errors relative to MC¬HR within 1%, 3%, and 5%, respectively, for uniform CTV media compared to 29.7%, 45.3%, and 59.5% voxel frequencies using post-implant voxel assignments. Regions with errors exceeding 3% in the uniform medium case corresponded to high dose-gradients contrasted with a spatially random distribution of errors for the non-uniform prostate.

Conclusions: CMCLR-HR is accurate within 3% for regions with uniform-like tissues and small dose-gradients. CMCLR-HR duplicates DVHs within 2% suggesting application that CMCLR-HR is would be useful in Monte Carlo brachytherapy plan optimization.

Funding Support, Disclosures, and Conflict of Interest:

Supported by Grant R01-CA46640