Purpose: AAPM TG43, the low dose rate (LDR) brachytherapy dosimetry protocol, ignores the effects of tissue composition and densities. Given the photoelectric effect's dominance at the low photon energies in use, the dosimetry is dependent on the elemental composition of tissues. AAPM TG186 was mandated to investigate model based dose calculations (MBDC) such as Monte Carlo (MC) simulations as an alternative to TG43. In MBDC, tissue densities and composition are extracted from single energy CT (SECT) data, which can lead to tissue missassignment. The novel dual energy CT (DECT) technology which is now becoming available may improve tissue segmentation. The study aim is to assess the dose calculation accuracy improvement provided by DECT based tissue segmentation compared to SECT.

Methods: A Siemens DECT scanner was modelled with ImaSim, a novel CT image simulation tool. Density and atomic number maps of a virtual phantom containing 23 human tissues were extracted from DECT images taken at 80 kVp and 140 kVp. SECT images taken at 120 kVp were also used for segmentation using 3 and 7 tissues. MC dose calculations were performed with 103-Pd and 125-I seeds inserted in the phantom for the three segmentation schemes and compared to a reference calculation.

Results: SECT segmentation with 3 tissues performs better than the TG43 approach but does not provide adequate dose calculation accuracy. Increasing the number of tissues to 7 significantly improves accuracy, although errors of more than 10% are observed for certain missassigned tissues. Using DECT segmentation brings accuracy within ±5%.

Conclusions: DECT provides superior tissue segmentation resulting in high dose calculation accuracy. While SECT segmentation is outperformed by DECT, dose calculation accuracy is found to be tolerable when using seven tissues, supporting the implementation of MBDC based on widely available SECT.