

AbstractID: 2793 Title: Using X-ray Spectrometry to Quantify the Effects of Emission Anisotropy on Air-Kerma-Strength Measurements of Prostate Brachytherapy Seeds

Purpose: To utilize the results of prostate brachytherapy seed x-ray spectrometry to quantify the effects of emission anisotropy on air-kerma-strength measurements.

Method and Materials: Air-kerma strength was calculated from x-ray spectra measured with a high-purity germanium detector with the seed rotated at 90-degree intervals about an axis perpendicular to the mid-point of the long axis of the seed. The “air-anisotropy ratio”, α_s , was formed by taking the quotient of the air-kerma strength of the seed with the long axis perpendicular to the detector face and the air-kerma strength of the seed with the long axis parallel to the detector face. The resulting quantity α_s is a quantitative measure of in-air anisotropy, which has a significant effect on the relative responses of secondary-standard well chambers and the National Institute of Standards and Technology (NIST) Wide-Angle Free-Air Chamber (WAFAC) primary standard.

Results: Values of α_s for various seed models are influenced by the presence of end welds, seed internal geometry, and the incorporated radionuclide. In comparing α_s among seeds, a lower value indicated that the output of the seed was more directional (along the transverse axis), such that less emission was “missed” by the WAFAC (8 degree half-angle) that was detected by the well chamber (approximate 4π geometry).

Conclusion: The quantity α_s has proven to be a useful parameter for explaining differences in well-chamber response observed for different seed models having the same emergent spectrum on their transverse axis. It also has been used to identify aberrantly produced seeds that are not representative of those calibrated previously by NIST. Characterization of seed anisotropy is necessary in order to maintain accuracy in the transfer of air-kerma-strength standards from NIST to the AAPM Accredited Dosimetry Calibration Laboratories and to seed manufacturers.