AbstractID: 5699 Title: Advanced Integral Method for the Simulation of Diagnostic X-ray Spectra

Purpose: To create a fast and accurate computer algorithm for simulating the emission x-ray spectra from diagnostic tubes as a function of tube voltages, target material, and take-off angles.

Method and Materials: The method uses an integral model to determine the radiative losses from an electron as it slows down in arbitrary media. The effect of self-absorption and backscatter is accurately described by distribution functions for electron number, electron depth, and angular distribution that are functions of electron slowing down energy. The Monte Carlo program PENELOPE was used to determine these three distribution functions. An exact accounting of electron orientation was found necessary due to large variations in the Bremsstrahlung cross-section as a function of emission angle. These are accounted for in the integral model by pre-computing tables based on the Kissel Bremsstrahlung shape function. Characteristic x-ray emissions as a function of over-voltage are described using Monte Carlo results for both direct and indirect production. The computer algorithm is implemented as a part of a larger program for computationally simulating x-ray production, transmission, scattering, and detection for imaging systems (XSPECT, V4.0).

Results: We compared our program to the measured x-ray spectra of Mercier, and spectral computations of PENELOPE. We found good agreement and an improvement over prior semi-empirical estimates (Birch & Marshall, Tucker, Storm).

Conclusion: We have developed a program that can simulate x-ray spectra from tubes of arbitrary anode materials (including alloys), and target angles for tube voltages of 1 to 400 kV. After generation of target specific tables, the x-ray spectra can be computed in a few seconds. The results are equivalent to Monte Carlo estimates that require days to compute a single spectra.