

AbstractID: 4646 Title: Effect of different physical processes and data sets on HVL calculations.

Purpose: To study the role of electron impact ionization (EII), Rayleigh scattering, and photo-absorption and bremsstrahlung cross-section selection in Monte Carlo half value layer (HVL) calculations.

Method and Materials: The NRC x-ray system is modeled using BEAMnrc to obtain phase space files for several x-ray beam qualities (between 135 kV and 200 kV). An EGSnrcMP user-code, cavity, is used to compute air-kerma ratios (with and without absorber) at 1 m from the source on a 5 mm radius scoring field. This user-code allows one to include several geometries in one run, which further reduces the uncertainty in the kerma ratios due to the strong correlations. These ratios are then used to obtain the HVL's from a quadratic fit of the simulated data.

Results: Excluding Rayleigh scattering produces a 6 % overestimation for all beam qualities. The effect of neglecting EII is energy dependent and overestimates the HVL by 1.5% at 135 kV and by 5% at 200 kV. Using Bethe-Heitler bremsstrahlung cross sections instead of the NIST cross sections causes an underestimation between 3% at 135 kV and 6% at 200 kV. Selecting the photo-absorption cross sections from the Storm and Israel tabulations instead of XCOM overestimates HVL's by 0.4%. EGSnrc reproduces the measured HVL's within 2% or better when the best cross-sections available are employed.

Conclusion:

EII and Rayleigh scattering have a significant impact and must be included in HVL calculations. HVL's in this energy range are not very sensitive to the selection of photo-absorption cross-sections. NIST bremsstrahlung cross sections should be used in order to achieve better agreement with the experiment. A 2% reduction of the photo-electric cross-sections or a slightly harder bremsstrahlung spectrum would remove the remaining discrepancies between calculated and measured HVL values. Such changes are within the reported uncertainties of these cross-sections.