AbstractID: 12627 Title: On the use of unrestricted LET to estimate nanodosimetric parameters

Purpose: A large number of radiobiological models have been proposed that rely on micro- and nanodosimetric parameters. Calculation of such parameters is time-consuming as it requires event-by-event Monte Carlo simulations. Published data are limited and gaps in data impede development of models. In contrast, unrestricted LET is a well known and very convenient parameter. It, however, has not been widely used for modeling at nanoscale, because it does not account for straggling and energy transport by secondary electrons in and out the target volume. Nevertheless, LET does describe the average spatial density of deposited energy and, therefore, may correlate with nanodosimetric quantities. This study investigates the accuracy of linear models relating the frequency-averaged linear energy, Y_F, with LET for nano-volumes.

Method and Materials: We used a Monte Carlo data set for protons and alpha particles reported by Charlton et al (Monograph 85/1, MRC Radiobiology Unit, Chilton, UK, 1985). Proton energies were in the range 0.3-4 MeV with LET from 8.8 to 59.2 eV/nm. The respective values for alpha particles were 1.2-20 MeV and 32.3-230.2 eV/nm. Target volumes were cylinders of diameter 1 to 500 nm. We used a subset of the data comprised of cylinders with height equal to diameter. Two-parameter, $Y_F=a\times LET+b$, and one-parameter, $Y_F=a\times LET$, linear models were tested.

Results: The two-parameter model predicted Y_F for protons with the root mean square errors in the range from 1 to 7% depending on the size of target volume. The respective values for alpha particles were higher, 10-28%, owing to a greater scatter of Monte Carlo data points rather than to any nonlinear trend. The one-parameter model worked only for protons and volumes larger than 10 nm. The errors were in the range of 2-15%.

Conclusion: Unrestricted LET can be used to predict the frequency-averaged linear energy within approximately 10%.