

AbstractID: 13604 Title: An analytical LET model for fragmenting ion beams

Purpose: To provide a fast analytical model to calculate the dose and the dose-averaged linear energy transfer (LET) of fragmenting ion beams.

Method and Materials: An analytical model to calculate the stopping power of primary ions and their fragments was derived. It is based on a power law for the range of protons as a function of their energy and was derived both with and without consideration of nuclear interactions in terms of depth straggling. Two major assumptions were made: (1) fragments are always remnants of primary ions and not of target atoms and (2) the energy per nucleon is preserved during fragmentation. Cross sections for the fragmentation are not provided but were derived from Monte Carlo simulations. Dose and LET are calculated for primary ions and each isotope created in the fragmentation process individually.

Results: The depth dose curves of the analytical model could reproduce those of a Monte Carlo simulation for a primary carbon ion beam and all its fragment elements but hydrogen. A previously published analytical LET model confirmed the LET calculations of fragments in depths less than the depth R_f of the peak dose. Including straggling introduces distinct changes in the LET of fragments at depths greater than of R_f . The changes in the LET at smaller depths than R_f and in the dose at any depth are marginal.

Conclusion: The novel analytical model provides a fast way to calculate the dose and the LET for fragmenting ion beams. Several profound assumptions had to be made to obtain an analytical solution. The agreement of our dose calculations with Monte Carlo simulations showed that these can be justified. The LET calculations are sufficiently accurate for their use in modeling of biological effects.