

SANTA CRUZ-1: Microdosimetry and BNCT

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Microdosimetry is a suitable tool for understand outcomes in those cases where average quantities, like absorbed dose or LET do not provide suitable explanations for the observed effects. Microdosimetry evolved during the decades from its first conception, providing a robust and appropriate framework to formulate biophysical models of radiation action and measuring techniques useful for performing quality control tests of radiation fields (1). Almost always differences in the acquired or calculated microdosimetric spectra are associated with variations in radiobiological properties of the radiation fields.

The complexity of the radiation field in BNCT is not only related with the common conception of a mixed uncharged neutron-photon primary field, but also poses a fundamental problem, i.e., the small number of secondary high-LET particles needed to deposit therapeutic doses (2). For instance, 1 Gy of macroscopic boron absorbed dose involves only 3 or 4 short-range reactions produced per cell. These “small numbers” and the inherent statistical Poisson fluctuations are responsible for very broad deposited energy distributions, meaning that cells even subjected to a “uniform” KERMA distribution will experience very different number of hits. A non negligible fraction of tumor cells will remain “untouched” by boron capture reactions, even at therapeutic doses. Moreover, the short ranges, comparable to the size of the sensitive structures of the cell and the strong variations of deposited energy along the particle path prevent the use of LET as a quantity for calculating deposited dose (3). The additional complexities like non uniform distributions of boron concentrations (4) contribute to additional discrepancies when calculating KERMA based quantities and employing them to explain observations.

In this work we will review the stochastic aspects of BNCT based on the concepts and formalisms provided by microdosimetry, including some approaches suitable for deriving BNCT microdosimetric quantities considering data derived from BNCT irradiations and from heavy ion experiments as well (5).

REFERENCES

1. H. H. Rossi and M. Zaider, *Microdosimetry and its Applications*. Springer, Berlin Heidelberg and New York (1996).
2. G. A. Santa Cruz, “Microdosimetry: Principles and applications”, *Reports of Practical Oncology and Radiotherapy*, 21 (2016) 135–139.
3. A. M. Kellerer and D. Chmelevsky, “Criteria for the applicability of LET”, *Radiat. Res.*, 63, pp. 226–234 (1975).
4. G. A. Santa Cruz and R. G. Zamenhof, “The Microdosimetry of the ^{10}B Reaction in Boron Neutron Capture Therapy: A New Generalized Theory”, *Radiation Research*, 162 (6), pp.702710 (2004).
5. G. A. Santa Cruz, “Microdosimetric derivation of inactivation RBE values for heavy ions using data from track-segment survival experiments”, 12th IRPA Congress, 19-24 October 2008, Buenos Aires, Argentina.