

Microdosimetry in Synchrotron-Based Binary Radiation Therapy

R.P. Hugtenburg[1,2], A.E.R. Baker[1] and S. Green[2]

1. School of Physics and Astronomy, University of Birmingham

2. Queen Elizabeth Medical Centre, University Hospital Birmingham NHS Trust

Synchrotron light offers new radiation treatment strategies, including binary therapies such as photoactivation therapy (PAT) where the photoelectric interaction in a high-Z material leads to a localised source of high LET particles, e.g. Auger electrons. Microdosimetry is used to assess the efficacy of mixed field and binary radiation treatments and describes the clustering of radiation damage on the micron scale due to particles of differing type, energy and origin. The modeling of microdosimetric distributions in varying treatment scenarios, however, relies on accurate electron physics at sub-micron dimensions, challenging the capabilities of current Monte Carlo codes. The intercomparison of measured and modeled microdosimetric spectra from monochromatic X-rays therefore provides a test of electron transport algorithms and fundamental cross-section data. Microdosimetric spectra from monoenergetic X-ray beams have been obtained with a tissue equivalent gas proportional counter (TEPC) and compared to Monte Carlo calculations based on atomic and molecular models of the solid and gaseous components of the detector, and to spectra calculated in a water medium. Microdosimetric models have been derived from experiments that show substantial variation in the photon radiobiological effect (RBE) for end-points such as cell death and transformation. The modeling indicates that with careful tuning of the synchrotron energy, a radiobiological advantage can be achieved in photoactivation therapies that goes beyond simple dose enhancement.

KEYWORDS: microdosimetry, radiation oncology, binary therapy