Abstract

MEASUREMENT OF ENERGY DEPOSITION DISTRIBUTIONS
PRODUCED IN CYLINDRICAL GEOMETRY BY
IRRADIATION WITH 15 MeV NEUTRONS

by

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Cellular survival experiments have shown that the biological damage induced by radiation depends on the density of energy deposition along the trajectory of the ionizing particle. The quantity L is defined to measure the density of energy transfer along a charged particle's trajectory. It is equal to ε/ℓ , where ε is the energy transferred to a medium and ℓ is the path length along which the transfer takes place. L is the stochastic quantity whose mean value is the unrestricted linear energy transfer, L_∞ .

Measurements of the distribution of L in a thin medium by secondary charged particles from fast neutron irradiation were undertaken. A counter operating under time coincidence between two coaxial cylindrical detectors was designed and built for this purpose. Secondary charged particles enter a gas proportional counter and deposit some

energy ε . Those particles traversing the chamber along a radial trajectory strike a CsI scintillator. A coincidence between both detectors' signals selects a known path length for these events, namely the radius of the cavity.

Measurements of L distributions for $\ell = 1\ \mu m$ in tissue were obtained for 3 and 15 MeV neutron irradiation of a tissue-equivalent target wall and for 15 MeV neutron irradiation of a graphite wall. Photon events were corrected for by measurements with a Pb target wall and 15 MeV neutron irradiation as well as exposure to a pure photon field. The measured TE wall distributions with 15 MeV neutron bombardment show contributions from protons, α-particles, ^{9}Be and ^{12}C recoils. The last three comprise the L distribution for irradiation of the graphite wall.

The proton component of the measured L distributions at 3 and 15 MeV was compared to calculated LET distributions. The comparison at 15 MeV shows the importance of statistical fluctuations in the energy loss process and the need of including such effect in any accurate calculation.

In its present form, this counter offers unique possibilities for microdosimetry measurements. Particle identification and measurements of the secondary charged particle spectra are easily foreseen. These measurements are the closest ever done of the relevant physical parameter for the understanding of biological radiation damage: the density of energy deposition along the ionizing particle trajectory.