Effect of LET and track structure on the statistical analysis of chromosome aberrations:

Use of the convoluted Poisson-Neyman distribution

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Chromosome aberration data obtained for various types of mammalian cells including human lymphocytes after exposure to low and high LET clearly demonstrate the differences in the energy deposition pattern of both radiation qualities. In our paper the distribution of chromosome aberrations observed in human peripheral blood lymphocytes after exposure to 900 MeV/u Fe ions are analyzed and compared to the effects of 250 kV X-rays.

After low LET exposure the distribution of aberrations among cells at the first post-irradiation mitosis is characterized by a Poisson distribution, reflecting a simple random distribution of damages as expected according to the homogeneous pattern of energy distribution. On the contrary, after high LET exposure, the distribution of aberrations reflects the microscopic inhomogeneity of energy depositions. If particle hits to the cell nucleus can be viewed as independent events, each contributing with an average number of aberrations per hit, the overall distribution of aberrations can be represented by a compound Poisson (Neyman) statistics.

However, in the case of high energetic particles, the radial extension of the particle tracks cannot be neglected; due to overlap effects from different tracks the particle traversals cannot be treated as independent. In this case, the distribution of aberrations is characterized by a mixture of a Neyman distribution with a background of a Poisson-type distribution, representing the contributions from the center part of the tracks and the outer, overlapping part of the tracks, respectively.