New insights into cytogenetics from simultaneous painting of all pairs of chromosomes

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Multicolor *in situ* hybridization (m-FISH) and Spectral Karyotyping (SKY) are molecular cytogenetic techniques that permit the simultaneous visualization of all human (or mouse) chromosomes in different colours (chromosome painting), facilitating a detailed karyotype analysis. Both methods use a combinatorial labelling scheme with spectrally distinguishable fluorochromes, but employ different methods for their detection and discrimination. In SKY, image acquisition is based on a combination of epifluorescence microscopy, charge-coupled device (CCD) imaging, and Fourier spectroscopy. In M-FISH, separate images are captured for each of the five fluorochromes using narrow bandpass microscope filters. These images are then combined by dedicated software. In both techniques, unique pseudo-colours are assigned to the chromosomes based on their specific fluorochrome spectrum.

Chromosome painting is mainly used for the screening of the whole genome for chromosomal aberrations related to human diseases such as cancer or inherited diseases. It can be applied for theoretical cytogenetic and radiobiological questions as well. In the present talk new insights into the induction of aberrations by high + low LET radiation, analysed by m-FISH will be discussed.

M-FISH analysis of irradiated cells revealed a high complexity of induced aberration. The difference between densely and sparsely irradiation can be read from cytogenetic fingerprints: such as incidence of insertions or the ratio of complex to simple aberrations, although these parameters seem to be dose dependent.

In conventional cytogenetic studies only complete mitoses with 46-chromosomes are analysed, assuming that the loss or gain of chromosomes result from technical problems, suggested by International Agency of Atomic Energy (2001). However m-FISH technique shows a non-random loss of chromosome X in healthy female donors and aberrations also arise from missegregation of chromosomes.

Finally the involvement of chromosomes in the formation of radiation induced aberrations will be discussed. According to the theoretical consideration chromosomes should be involved in aberration proportionally to their DNA content, but experimental results are controversial (Anderson 2005, Barquinero 1998, Knehr 1996, Sommer 2005). Data obtained for human lymphocytes exposed *in vitro* to low and high LET irradiation will be presented.