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Statistical Modelling of Electron- and Neutron-Induced Damage in DNA

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The study of the interaction of the radiation with the DNA is important due to its many implications in medical-physics (as e. g., the effects of the radio-therapy on the living cells) and radiation protection (as the determination of maximum dose allowed to be delivered for workers in radiation areas). We worked out a model for radiation damage in DNA which can be applied in these studies. In particular we can calculate the number of double strand breaks (DSB) in the DNA, which may cause the death of the living cell. We compare our results with recent data on electron- and neutron-induced DNA damage found in the literature, obtained with Atomic Force Microscopy as a function of the dose, are analyzed by means of a statistical model we had worked out. Model calculations were performed for the fraction of unbroken DNA, the number of breaks per DNA, the number of breaks per broken DNA, and compared with the corresponding experimental data. It was found that the statistical results describe the gross trend of the data for neutrons, while for electrons the agreement is excellent. Quite interesting, however, was the verification that statistical models are unable to predict multiple neutron-induced DNA breaks at near-zero doses pointing, thus, to the need of a cluster model.

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Microdistribution and localized dosimetry of ^{238}U in beagle bones

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The distribution of fission tracks from the bone surface and bone marrow- seeking radionuclide ^{238}U in the beagle femoral shaft, have been studied using a fission fragment technique. Transversal femoral cuts of beagles, which were fed from 3 to 18 months long periods with different concentrations of uranyl nitrate (240 and 1200 KBq/Kg of ^{238}U),were sandwiched between Makrofol E slides. The set was irradiated by neutron with a flux of 10^{13} n.cm^{-2}s^{-1} in the water cooled reactor of IPEN(SP). A typical result is shown in the figure.

The results show that accumulative doses are concentrated in the central bone marrow , which had been observed previously for alkaline earth metals as radium, strontium and calcium[1]. The main radiological implication suggested by our findings is that the radiation burden in marrow is substantial, with a dose rate of the order of 20 Gy/d.

Reference
[1] N.D. Priest, The distribution and behaviour of heavy metals in the skeleton and body: Studies with bone-seeking radionuclides. In Trace Metals and Fluoride in Bones and Teeth, pp83-139. CRC. Press, London, 1990.

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DETERMINAÇÃO DE FATORES DE RETROESPALHAMENTO UTILIZANDO RAIO-X DIAGNÓSTICO PARA PADRÕES IEC E ISO

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Quando se consideram as novas grandezas recomendadas pelos órgãos internacionais para atribuição de doses, verifica-se a necessidade de determinação dos fatores de retroespalhamento decorrentes da utilização de simuladores na determinação dessas grandezas. O presente trabalho apresenta a medida experimental destes fatores obtidos para qualidades de raio-X diagnóstico seguindo os padrões IEC (International Electrotechnical Commission) para feixes primários e atenuados por alumínio e ISO (International Standartization Organization) para espectros estreitos. As medidas de dose em profundidade foram feita utilizando-se dosímetros termoluminescentes do tipo LiF -100H e foram irradiados em um simulador de PMMA (polimetilmetacrilato) de dimensões 30 x 30 x 15 cm3 . Os valores obtidos pelos dois padrões foram comparados entre si e se apresentaram em perfeito acordo com dados teóricos obtidos na literatura existente sobre este assunto e gerados a partir de cálculos de Monte Carlo.

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Radiation Damage of CsI (Tl): Blocking of the Energy Transfer Processes From Vk Centers and Electrons to the Activator of Tl

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The interest in radiation resistance of scintillators for application in scintillator-based particle detectors has been renewed, due to the new generation of particle accelerators, SSC. LHC and RHIC. It is expected that some parts of new experimental setups will have to work in a severe radiation environment. Among the devices most strongly affected by high radiation environment are eletromagnetic (EM) calorimeter since they absorb the entire energy of the incoming particles. It is now realistic to expect that some components of EM-calorimeters will have to endure annual dose at least 1 Mrad or more. The CsI(Tl) detectors are extremely well suited for this purpose.

In this work CsI(Tl) crystals were irradiated with gamma rays at different doses, ranging from 0.01 to 500 kGy, using a ^{60}Co irradiator at 5.8 kGy/h. After the irradiation, the scintillation pulse height and decay curves were measured, systematically, under electrons and alpha particles excitations. As a complementary experiment, transmittance spectra were measured before and after each irradiation. Decreases in the transmittance and pulse height values were enhanced as the radiation dose increased. A decrease of $10-30\%$ in transmittance was observed for the crystals irradiated over 1 kGy compared with those of non-irradiated crystals. The decrease in scintillation pulse height is attributed to the blocking of the energy transfer processes of Vk centers and electrons by the traps and lattice disorders, which were produced in irradiated crystals. The effect of this blocking of the energy transfer processes is clearly observed as a difference in decay curves for the crystals before and after irradiation. It was also observed that the damage for irradiation is not permanent and it obeys a bi-exponential function.