AO-10-IBER-16 – Ground based radiation field simulation of the MATROSHKA experiment: Physical and Biological Experiments for Radiation Risk Assessment - PART II

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One goal of the AO-10-IBER-16 is the irradiation of the ground based model (phantom head) of the MATROSHKA phantom equipped with passive (Thermoluminescence (TLDs) detectors. At the same time the biological part of the experiment includes the survival reflected by radiation-dependent reduction of growth of stably and constitutively tdTomato expressing human embryonic kidney cells exposed outside and inside the phantom head.

Fig. 1. shows the dose distribution inside the phantom head after irradiation with 2Gy 1GeV/n Ti ions as a baseline for intercomparison with cell survival inside the phantom head.

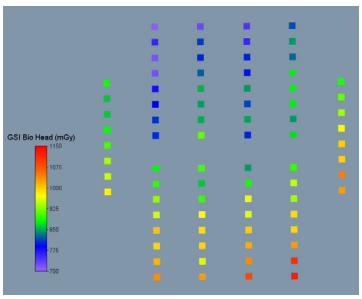

Figure 1: Dose distribution inside the phantom head measured with thermoluminescence detectors (2 Gy 1MeV/n Ti ions)

Stress-induced gene expression mediated by Nuclear Factor κB (NF-κB) was monitored by means of stably transfected HEK-pNF-κB-d2EGFP/Neo L2 cells. In these cells, d2EGFP expression is operated by four NF-κB binding sites (Hellweg et al., J. Biomol. Screen. 8, 511-521, 2003; Hellweg et al., Annals of the New York Academy of Sciences 1091, 191–204, 2006; Hellweg et al., Advances in Space Research 44, 907–916, 2009). NF-κB-dependent gene expression was monitored by flow cytometric detection of d2EGFP, a destabilized form of Enhanced Green Fluorescent Protein (EGFP).

Using these cell lines, it was recently shown that NF-κB activation depends on LET and reaches a maximum in the range of 80-300 keV/µm (Hellweg et al., International Journal of Radiation Biology, 87(9), 954–963, 2011; Hellweg et al. Radiation Research 175, 424-431, 2011). The highest biological effectiveness (RBE) in NF-κB activation was observed with argon ions (LET 172 keV/µm) with an RBE of ~9. The experiments at GSI with Ti ions (1GeV/n, LET 108 keV/µm) and Ni ions (1GeV/n, LET 175 keV/µm) complemented these results and give further inside into the dose-effect relationship and the kinetics of NF-κB dependent gene expression (**Fig. 2 A and B**). The RBE for NF-κB activation was 4.8 after Ti ions exposure, compared to 200 kV X-rays as reference radiation.

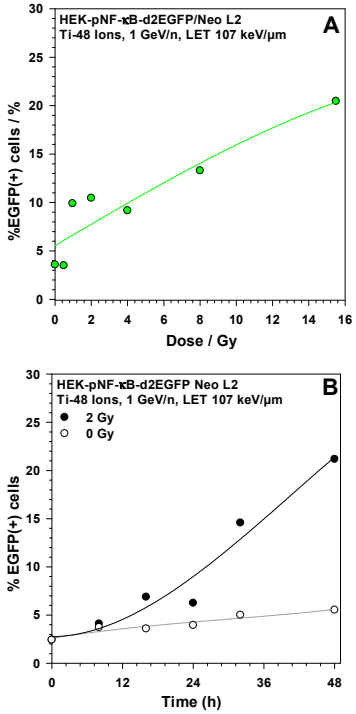

Figure 2: Induction of NF-κB dependent gene expression in HEK-pNF-κB-d2EGFP/Neo L2 cells after exposure to Ti ions. The expression of the reporter EGFP increases dose-dependently 18 h after exposure (**A**). The NF-κB activation continuously increases over two days after exposure to 2 Gy Ti ions (**B**).

Outlook

The data acquired during the beam times at GSI in 2011-2012 are being currently further evaluated. These investigations include also simulations of the physics experiment with GEANT4 Monte Carlo code. Publications on NF-κB dependent gene expression are currently under preparation.