SPACE LIFE SCIENCES SYMPOSIUM (A1)
Radiation Fields, Effects and Risks in Human Space Missions (4)

Author: Dr. Christine Hellweg
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, christine.hellweg@dlr.de

Dr. Thomas Berger
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, thomas.berger@dlr.de
Mr. Arif Ali Chishti
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, arif.chishti@dlr.de
Mrs. Christine Körner
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, christine.koerner@dlr.de
Dr. Chiara La Tessa
GSI Helmholtz Centre for Heavy Ion Research, Germany, c.latessa@gsi.de
Mr. Sebastian Feles
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, sebastian.feles@dlr.de
Mrs. Claudia Schmitz
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, claudia.schmitz@dlr.de
Dr. Patrick Lau
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, patrick.lau@dlr.de
Dr. Christa Baumstark-Khan
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, christa.baumstark-khan@dlr.de
Dr. Günther Reitz
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, guenther.reitz@dlr.de

GROWTH CAPACITY OF HUMAN CELLS AFTER EXPOSURE TO HEAVY IONS IN A PHANTOM HEAD

Abstract

Radiation measurements using anthropomorphic phantoms provide more reliable data for space radiation exposure risk estimates. There are currently no published data available on depth distribution of biological effects of space relevant energetic heavy ion beams in a human phantom. Therefore, a bioassay using the red fluorescent protein tdTomato was established to complement the physical detector systems used in the head of a human phantom with intrinsically biologically weighted measures of cellular responses to simulated compounds of the radiation field in a space habitat. The plasmid ptdTomato-N1 in which tdTomato is controlled by a constitutively active strong viral promoter (CMV) was stably transfected into human embryonic kidney cells (HEK-ptdTomato-N1). Measurement of this reporter protein in a fluorescence microplate reader allowed rapid quantification of cell number and proliferation. X-ray doses above 4 Gy resulted in significant reduction of cellular proliferation as monitored by constitutive tdTomato expression. The growth curves of HEK-ptdTomato-N1 cells after Fe and Ni ion exposure revealed a strong dose-dependent reduction in cellular proliferation. HEK-ptdTomato-N1 cells were irradiated during growth in the phantom head with iron or nickel ions (1 GeV/nucleon, linear energy transfer - LET - 150 and 175 keV/m) or with X-rays (200 kV). Therefore, the cells were seeded in strip well plates that were closed with lids during irradiation in the phantom head. Closing the culture vessels during irradiation did not affect the radiosensitivity of HEK-ptdTomato-N1 cells. The relative biological effectiveness (RBE) of iron and nickel ions in growth reduction with 200 kV X-rays as reference radiation is

17.5 and 5.8, respectively, based on the dose resulting in growth reduction to 37 %. The relative growth of HEK-ptdTomato-N1 cells 100 h after exposure to nickel and iron ions in one slice of the Phantom head showed that survival of cells is highest in the back of the head and lowest in the forehead region, with the beam entering from the nose. Cellular responses to radiation as invading in the phantom head might contribute to the risk assessment of astronauts' space radiation exposure.

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