IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (6)

Author: Dr. Bhaskar Mukherjee
The University of Sydney, Australia, bhamukh@gmail.com

Dr. Clemens Woda
Helmholtz-Muenchen, Germany, clemens.woda@helmholtz-muenchen.de
Dr. Vladimir Mares
Helmholtz-Muenchen, Germany, mares@helmholtz-muenchen.de

A REAL-TIME PROTON DOSIMETER BASED ON TISSUE EQUIVALENT GAFCHROMIC® EBT-3 FILM FOR ASTROBIOLOGY RESEARCH IN LEO ENVIRONMENT

Abstract

This paper highlights the principle of a novel real-time proton dosimeter for astrobiology experiments during low earth orbit (LEO) missions. Unlike semiconductor detectors based on Silicon-Chips this proton dosimeter is made of tissue equivalent thin (0.270 mm) Gafchromic® EBT3 (GafEBT-3) radiochromic film thereby mimicking mammalian cell-layers. Small (15mm x 15mm) sections of GafEBT-3 film were irradiated with 180 MeV protons to 0.29, 0.58, 1.17, 1.75, 2.39, 3.50 and 4.67 Gy from a 235 MeV Medical Cyclotron. A novel compact dosimeter reading device consisting of a red LED (lambda = 665 nm) and a light-to-frequency converter (LFC) chip interfaced to a micro-controller was used for film evaluation. The transmitted light intensity ratio (Icontrol/Iirradiated) of the control and irradiated films was fitted with a 2nd order polynomial function (y = ax2 + bx + c) of proton dose. The calibration function was parameterized for realistic AP9 trapped proton model attenuated by 1mm and 5mm thick Aluminum shields. The calibration function and parameterization factors were embedded in the micro-controller program. The maximum detectable proton doses were evaluated to be 29.4 Gy (1mm Al shield) and 9.36 Gy (5mm Al shield). The average LET in biological tissue were calculated to be 2.8 keV/μm (1mm-Al shield) and 0.95 keV/μm (5mm-Al shield). A piece of un-irradiated GafEBT-3 film from the same lot was secured in the 2nd dosimeter reading device for installation inside the spacecraft (i.e. Cube-Sat) of interest. This real-time proton dosimeter could also be used to forecast space weather caused by sporadic solar particle events (SPE).