IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Radiation Fields, Effects and Risks in Human Space Missions (5)

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A 235 MEV PROTON THERAPY MEDICAL CYCLOTRON FOR RADIATION RESEARCH RELEVANT TO HUMAN SPACE MISSIONS IN LEO ENVIRONMENT

Abstract

Outer space is flooded with ionizing radiations inflicting detrimental effects in the spacecraft electronics and radiation health hazard to astronauts undertaking space missions. The space radiation is composed of: (a) Galactic Cosmic Radiation (GCR)87% high-energy protons, 12% helium nuclei and an assortment (1%) of heavy charged (HZE) particles, (b) Trapped radiation field in the Van Allen belt (VAB) surrounding our earth made of energetic (1keV - 250MeV) protons and low energy (approx 10 MeV) electrons, (c) Solar flares or solar particle events (SPE) originated in solar corona made of 95% protons, 4% helium nuclei, ¡1% electron and ¡1% HZE particles. Low earth orbiting (LEO) spacecrafts (apogee: 200-1000km) are primarily exposed to trapped protons in the VAB while passing through the south Atlantic anomaly (SAA) zone located near the south-eastern coast of Brazil as well as sporadically occurring intense surge of solar flare (SPE) protons. The authors have developed a novel irradiation facility at a 235 MeV proton therapy Medical Cyclotron simulating the proton energy distribution of trapped protons in the VAB and SPE by modifying the existing treatment planning system (TPS) software used in routine proton therapy. The following major experimental projects are successfully carried out by the authors and reported in refereed journals: (a) Solar flare simulation and proton dosimetry using radiochromic films and TLD, (b) Efficacy shielding) testing of space suit components relevant to astronauts conducting extravehicular activities (EVA), (c) Microdosimeter for astronauts in space habitat and airline-pilots for radiation risk assessment, (d) LED based proton fluence monitor for LEO missions, (e) Radiation testing rig for microelectronic components for potential space applications. Important space science related applications of proton therapy medical cyclotrons in particular human space missions are highlighted in our report.