Monte Carlo Modeling of the Wall Effect in Cylindrical Tissue-Equivalent Proportional Counters from Heavy Ions

I. Khvostunov

Medical Radiological Research Centre, Koroliov str. 4, 249036 Obninsk, Russian Federation

726727@mrrc.obninsk.ru

Heavy ions constitute a significant part of radiation in space, they are used for radiation therapy and laboratory experiments with accelerators. The useful instrument for measurement of radiation dose and investigation radiation quality factor for heavy ions is tissue equivalent proportional counter (TEPC). It was found previously [1,2] that response of spherical wall TEPC shows distortions at the wall/cavity interface due to enhanced entry of secondary electrons into the sensitive volume of counter. In this study it was theoretically investigated whether similar effect is expected in cylinder TEPC. The Monte Carlo code [1] originally designed for spherical TEPC was updated by extension with cylindrical shape of internal gas cavity. It was tested the following three geometries of irradiation: ion tracks are parallel-, perpendicular to cylindrical detector axis and μ-randomness superposition. The coordinates of track segments in the wall and gas cavity were calculated using stochastic track structure code PITS to score the energy deposition in the counter. The internal gas cavity with a 0.635 cm radius, 1.27 cm height contains tissue equivalent gas at 7.87 e-5 g/cm**3 density and wall plastic density - 1.0 g/cm**3. Liquid water cross sections were chosen as a target to approximate the plastic and gas. The stochastic tracks of 20-Ne ions with energy 46 MeV/nucleon and LET=167 keV/μm were used for modeling of TEPC response. The linear energy for three mentioned beam geometries was calculated and plotted against impact parameter which is the perpendicular distance from the center of counter to the ion track. In contract to spherical counter [1,2] for the cylindrical TEPC was found no clear occurrence of the peak at the interface between the wall and the gas for all three tested geometries. Nothing but in the case when ion beam is parallel to TEPC axis the weak effect as a small height peak succeeded resulted from grazing events. This findings lead to the conclusion that wall effect like [1] observed in spherical TEPC hardly is expected in experiments with cylindrical proportional counters.

References.

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