

Numerical response of Coaxial HPGe Detector for Skull and Knee measurement

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Abstract : Radiation workers of reprocessing plants have a potential for internal exposure due to actinides and fission products. Radionuclides like Americium, lead, Polonium and Europium are bone seekers and get accumulated in the skeletal part. As the major skeletal content is in the skull (13%) and knee (22%), measurements of old intake have to be carried out in the skull and knee. At the Indira Gandhi Centre for Atomic Research, a twin HPGe-based actinide monitor is used for the measurement of actinides present in bone. Efficiency estimation, which is one of the prerequisites for the quantification of radionuclides, requires anthropomorphic phantoms. Such phantoms are very limited. Hence, in this study, efficiency curves for a Twin HPGe-based actinide monitoring system are established theoretically using the FLUKA Monte Carlo method and ICRP adult male voxel phantom. In the case of skull measurement, the detector is placed over the forehead, and for knee measurement, one detector is placed over each knee. The efficiency values of radionuclides present in the knee and skull vary from $3.72E-04$ to $4.19E-04$ CPS/photon and $5.22E-04$ to $7.07E-04$ CPS/photon, respectively, for the energy range 17 to 3000keV. The efficiency curves for the measurement are established, and it is found that initially, the efficiency value increases up to 100 keV and then starts decreasing. It is found that the skull efficiency values are 4% to 63% higher than that of the knee, depending on the energy for all the energies except 17.74 keV. The reason is the closeness of the detector to the skull compared to the knee. But for 17.74 keV the efficiency of the knee is more than the skull due to the higher attenuation caused in the skull bones because of its greater thickness. The Minimum Detectable Activity (MDA) for ^{241}Am present in the skull and knee is 9 Bq. ^{239}Pu has a MDA of 950 Bq and 1270 Bq for knee and skull, respectively, for a counting time of 1800 sec. This paper discusses the simulation method and the results obtained in the study.

Keywords : FLUKA Monte Carlo Method, ICRP adult male voxel phantom, knee, Skull.

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