

Identification of weak neutron field in operator rooms of medical linacs by means of gamma-ray spectroscopy

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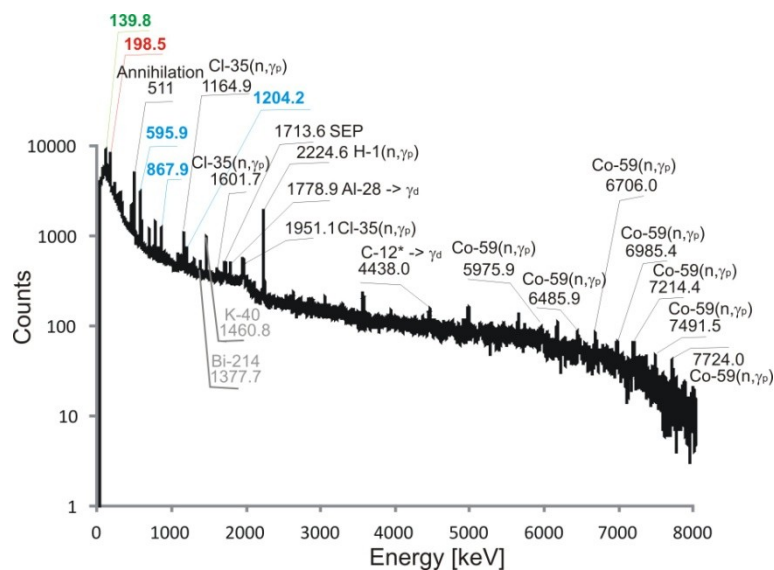
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High-energy therapeutic photon beams used in radiotherapy induce photonuclear reactions (γ, n) in components and accessories of medical accelerators. The produced neutrons cause secondary reactions in all objects in a treatment room as well as in walls, floor, ceiling and door. The neutrons can also get to operator rooms, passing through a door of a treatment room. As a result the weak neutron field can appear in an operator room when a high-energy therapeutic photon beam is on. The gamma-ray spectroscopy based on the neutron capture reactions in the germanium crystal in the HPGe detector turns to be very good method of identification of weak neutron field because of relatively low level of natural radiation background reduced by the thick concrete walls and floor surrounding a medical linac.

The list of nuclear reactions and energies of gamma-rays used for the identification of neutron field. γ_p – prompt gamma-rays from nuclear reactions occurring in the Ge crystal, γ_d – gamma-rays from decays of induced nuclear isomers of germanium.

Nuclear reaction	Gamma-ray energy [keV]
$^{70}\text{Ge}(n, \gamma_p) ^{71\text{m}}\text{Ge} \rightarrow ^{71}\text{Ge} + \gamma_d$	198.4
$^{73}\text{Ge}(n, \gamma_p) ^{74}\text{Ge}$	595.9, 867.9, 1204.2
$^{74}\text{Ge}(n, \gamma_p) ^{75\text{m}}\text{Ge} \rightarrow ^{75}\text{Ge} + \gamma_d$	139.8

The exemplary spectrum measured close to the treatment room door in the operator room of the Elekta medical accelerator in the CO in Opole is shown in Figure. The measurement was carried out when the 18 MV X-ray therapeutic beam was on. The peaks related to the neutron reactions in the Ge crystal in the detector HPGe are visible. It indicates that the neutrons are present in the measuring place.



The spectrum measured with HPGe detector in the operator room during emission of 18 MV beam from Elekta. The peaks related to neutron reactions occurring in the Ge crystal in the detector HPGe and some others are marked.

Keywords: gamma-ray spectroscopy, neutron reactions, germanium detector.

