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Design, fabrication and characterization of CLYC-based neutron dosimeters for proton therapy

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Proton therapy uses protons with energies ranging from a few MeV to over 250 MeV to treat cancer. The interactions of these protons with tissues or materials generate secondary neutrons that pose a risk of irradiation. The dosimetry of these neutrons must be measured accurately, and it must be monitored to minimize the risk of apparition of secondary cancers in patients, and also to protect the exposed workers.

Two CLYC-based neutron dosimeters have been designed and fabricated at CIEMAT, with the aim of assessing their application to neutron dosimetry. Cs_2LiYCl_6:Ce (CLYC) detectors are inorganic scintillators with excellent gamma-neutron discrimination properties. The detector takes advantage of the high enrichment of ^{6}Li for the detection of thermal neutrons, via the ^{6}Li(n,α) reaction. It is also sensitive to fast neutrons, when used in combination with polyethylene moderators and via nuclear reactions like the ^{35}Cl(n,p). The two devices were characterized at CIEMAT's Neutron Standards Laboratory (LPN), showing a good agreement with the expected behavior predicted by Monte Carlo simulations. In addition, one of the dosimeters was used at the Quirón Proton Therapy Center during irradiations with protons. In both cases, a commercial WENDI-II extended range dosimeter, based on a ^{3}He counter, was used as a reference.

CLYC detectors have similar efficiencies than equivalent sized ^{3}He-based detectors and a significantly faster time response, which makes them good candidates for neutron dosimetry in proton therapy FLASH treatments.

Abstract

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