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Determination of neutron dose equivalent in organs from in-phantom measurements in proton therapy facilities.

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Poly-Allyl-Diglicol-Carbonate (PADC) track detectors, most commonly known by the name of one of its commercial brands (CR39), are the basis of the neutron dosimeter developed by the Radiation Physics Group at Universitat Autònoma de Barcelona (UAB). These dosimeters allow measuring the neutron component in general mixed radiation fields, including those encountered in proton radiotherapy. Essentially, the whole dosimeter is constituted by a layer of PADC and several layers of diverse materials acting as neutron converters, in which incident neutrons produce protons. These protons originate submiscroscopic damage (latent tracks) in the PADC, which can be afterwards enhanced through an electrochemical process that allows visualising and counting the tracks and, therefore, quantifying the neutron field. The physics and working principles of this dosimeter are explained elsewhere [1]. One great advantage of this dosimeter is that it is not sensitive to the photon component, so its use is of specific interest in photon-neutron mixed fields.
Our group participates in the task of characterizing the radiation field present in proton therapy installations in the frame of WG9 (Radiation dosimetry in Radiotherapy) of EURADOS (The European Radiation Dosimetry Group). One of the aims, is to determine the out-of-field dose equivalent due to neutrons at patient's radiological organs of interest. For this purpose, water slab and anthropomorphic phantoms are filled with several types of dosimeters, which need accurate and specific characterization. On one hand, dose equivalent in tissue is a quantity which is not measurable as such, and it must be evaluated from modelling the interaction of radiation with the tissue, via a calibration coefficient applied to a measured physical quantity, such as particle fluence. This calibration coefficient depends on the energy distribution of the neutron field to be measured. On the other hand, the track detector response is also highly energy-dependent, so that calibrations in a field having a given energy distribution cannot be used to determine dose equivalents in a radiation field with a different energy distribution.
In this work we will present the methodology that we use to evaluate neutron dose-equivalents in organs from measurements with our PADC-based dosimeters. Results of dose equivalent from irradiations performed in proton therapy facilities will also be presented.

References:

[1] Domingo C., et al. Estimation of the response function of a PADC based neutron dosimeter in terms of fluence and Hp(10). Radiation Measurements 50 (2013) 82-86.

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