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Monte Carlo simulation and radiometric characterization of proton irradiated [^{18}O]H_2O for the treatment of the waste streams originated from [^{18}F]FDG synthesis process

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ABSTRACT

The aim of this work is quantifying the radionuclidic impurities of the irradiated [^{18}O]water originated by the [^{18}F]FDG synthesis process, and characterizing, from a radioprotection point of view, the waste streams produced. Two samples of 2.4 ml [^{18}O]H_2O, contained in two different target cells, have been irradiated with a proton current of 37 μA in a PETtrace cyclotron for about one hour each; after irradiation, without performing any chemical purification process but waiting only for the ^{18}F decay, they have been transferred in two vials and measured by HPGe gamma spectrometry and, subsequently, by Liquid Scintillation Counting. Previously, Monte Carlo calculations had been carried out in order to estimate the radionuclides generated within the target components ([^{18}O]H_2O, silver body and Havar® foil), with the aim to identify the nuclides expected to be found in the irradiated water.

Experimental results for the two samples, normalized to the same irradiation time, show practically the same value of tritium concentration (about 36 kBq/ml) while gamma emitters activity concentrations exhibit a greater spread. Considering that tritium derives from water activation while other pollutants are caused by activated cell materials released into water through erosion/corrosion mechanisms, such a spread is likely to be attributable to differences in the proton beam shape and position (production of different natural circulation patterns inside the target and different erosion mechanisms of the target cell walls).

Both tritium and the other radioactive pollutants exhibit absolute values of activity and activity concentrations below the exemption limits set down in EURATOM Council Directive 96/29.