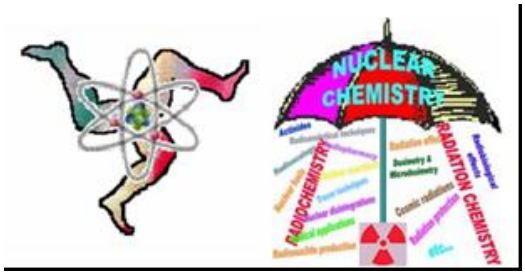

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Lu-177g produced with high specific activity by deuteron irradiation for metabolic radiotherapy

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Lu-177g is a low energy negatron emitter that, thanks to its favourable decay properties (t(1/2) = 6.734 d, negatron emission 100 %, E(β,max) = 489.3 keV, <Eβ> = 163 keV, Eγ = 208.4 keV), is one of the most promising radionuclide to be used in nuclear medicine, especially in metabolic radiotherapy of cancer of small dimensions. This RN is mainly produced in thermal nuclear reactor in two different ways: the first in carrier added (CA) form by (n,γ) reaction on enriched target of Lu-176 leading to a lower specific activity (AS), compared with the theoretical carrier free value AS(CF) = 4.05 GBq•μgˆ-1, the second in no carrier added (NCA) form by (n,γ) reaction on enriched target of Yb-176 followed by negatron decay leading, after selective separation of Lu from Yb, to a higher AS. This latter case shows no evidence of production of the long-lived impurity Lu-177m. An alternative method is to produce Lu-177 by the deuteron activation of natural or enriched in 176Yb targets. In this case, the routes of interest are the indirect reaction Yb-176(d,p)Yb-177 that decays by negatron emission to Lu-177g and the direct reaction Yb-176(d,n)Lu-177(g+m).

In order to optimize the Lu-177g production the thin target yields (ttys) of the nuclear reactions involved were measured as a function of the projectiles energy by the stacked-foil technique irradiating Yb targets of natural composition at the MC40 cyclotron of the JRC, Ispra, Italy, that can deliver deuterons with energies up to 19 MeV. The measurements, done at the radiochemistry laboratory of LASA by high resolution gamma spectrometry (HPGe detectors), were started few hours from the EOB (end of bombardment) and were carried on for many months, till more than one year, after the irradiation.

The excitation functions of all radionuclides produced were measured and compared with the data, if present, published in the unique previous literature publication. It was determined the decay curve of Yb-177 and the growth curve of the cumulative (direct and indirect) production of Lu-177g. The analysis of these curves conduct to the evidence that the predominant route for the production of Lu-177g is the indirect reaction Yb-176(d,p)Yb-177, that decays to Lu-177g. The direct reaction Yb-176(d,n)Lu-177(g+m) is observable only above 13 MeV and contributes for only 4% of the total in correspondence of 14.6 MeV. In the spectra acquired one year from the EOB the γ lines of Lu-177m are not presented. By detection limit method the activity of Lu-177m at the EOB is been evaluated, in the worst case, less than 0.07% of total activity of Lu-177.

The production of Lu-117g by deuteron irradiation of Yb targets will be competitive with neutron activation. The deuteron activation for 12 hours of a thick target of Yb-176 (100% enriched) with E(in) = 12.5 MeV, ΔE = 10.0 MeV, I = 100 μA can produce up to 10 GBq of cumulative Lu-177g.

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