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

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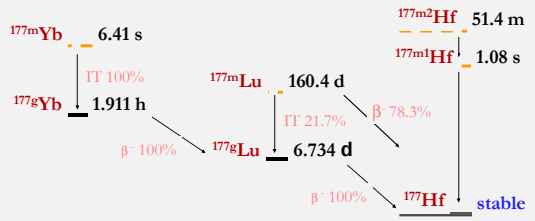
INTRODUCTION

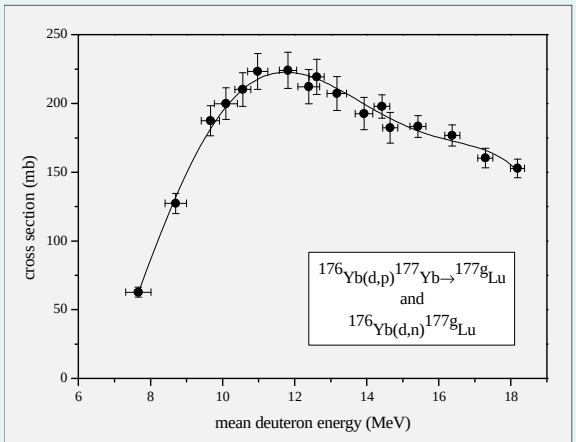
^{177g}Lu is a low energy β$^-$ emitter that thanks to its favorable decay properties ($T_{1/2}$ = 6.734 d, β$^-$ emission 100%, max $E_{β^-}$ = 489.3 keV, < $E_{β^-}$ > = 163 keV, $E_γ$ = 208.4 keV) is one of the most promising RNs for metabolic radiotherapy of cancer of small dimensions. The production of ^{177g}Lu is carried out mainly in nuclear reactors in by using either targets of Lu or Yb: in the first case $^{177(g+m)}$Lu is produced in *carrier-added* (CA) form by (n,γ) reaction on enriched ^{176}Lu leading to a low specific activity A_s compared to the theoretical *carrier-free* value A_s(CF) = 4.05 GBq μg^{-1}, while in the second case ^{177g}Lu is produced in *no-carrier-added* (NCA) form by (n,γ) reaction on enriched ^{176}Yb followed by β$^-$-decay leading, after separation of Lu from Yb, to a higher A_s than in previous case. This latter case shows also evidence of no production of the long-lived impurity ^{177m}Lu.

Simplified Decay Scheme of ^{177}Yb and ^{177}Lu

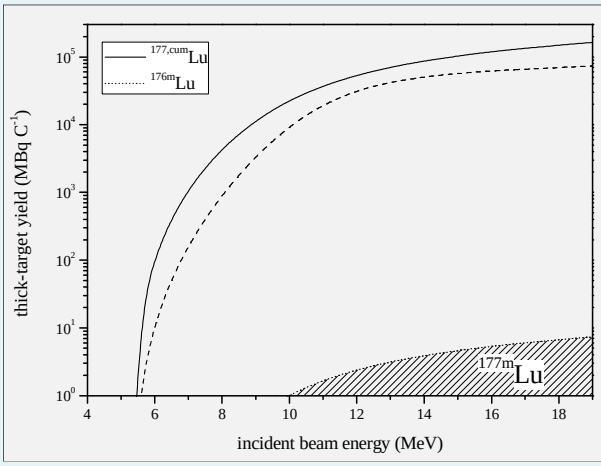


GOAL

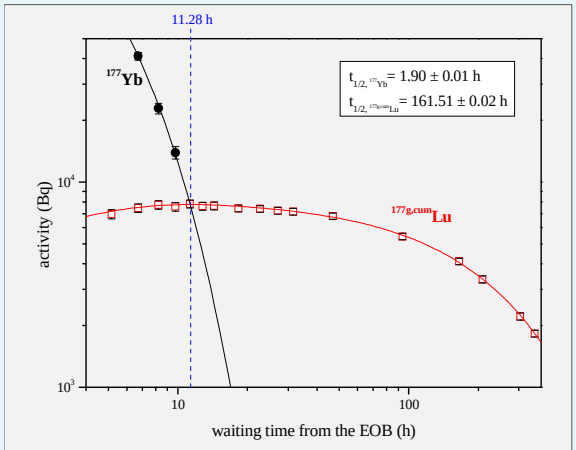
As an alternative method to the reactor production of ^{177g}Lu, the deuteron activation on thin and thick foils of natural Yb with a cyclotron was studied. The routes of interest are the indirect reaction ^{176}Yb(d,p)^{177}Yb → ^{177g}Lu via β$^-$ decay of ^{177}Yb and the direct reaction ^{176}Yb(d,n)$^{177(g+m)}$Lu.



Reaction cross-section for the (cumulative) production of ^{177g}Lu



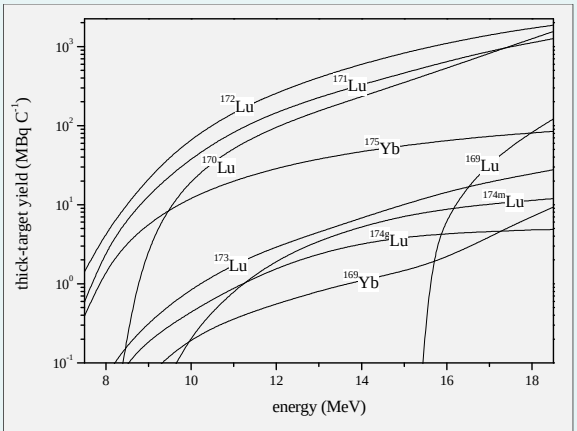
Calculated thick-target yields with total energy absorption for 100 % ^{176}Yb enriched target. ^{177m}Lu yield is lower than 0.0045 % of ^{177g}Lu yield, after an irradiation time of 2 h.



Decay curve of ^{177}Yb and the growing and decay curve of ^{177g,dir}Lu, obtained from the measurement of the Yb target irradiated at 14.65 MeV for two hours.

EXPERIMENTAL RESULTS

- The analysis of the growth curve of cumulative ^{177g}Lu leads to conclusion that the preferred route for the production of ^{177g}Lu is via the indirect reaction ^{176}Yb(d,p)^{177}Yb → ^{177g}Lu, with the direct reaction ^{176}Yb(d,n)$^{177(g+m)}$Lu being observable only above 11 MeV.
- No gamma lines of ^{177m}Lu were seen. From the detection limit it follows that the activity of ^{177m}Lu in less than 0.0045% of the ^{177}Lu activity at EOB.
- The deuteron activation for 12 hours of a thick target of ^{176}Yb (100% enriched) with E_{in} = 12.5 MeV, ΔE = 10.0 MeV, I = 100 μA can produce up to 10 GBq of cumulative ^{177g}Lu.



Calculated thick-target yields with total energy absorption for Yb target

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