Contribution ID: **22** Type: **not specified**

^{155}Tb from natural targets: reaction modeling of ^{nat}Tb(p,5n) and ^{nat}Gd(α,x)

Friday 16 June 2023 10:40 (20 minutes)

Terbium has gained the attention of the community since it is the only element in the periodic table with four isotopes (^{149}Tb, ^{152}Tb, ^{155}Tb and ^{161}Tb) that can be used for many clinical applications [1]. In particular, the isotope ^{155}Tb, with the emission of Auger-electron and γ rays, suitable respectively for therapy and for SPECT imaging, is a promising key player in the field of radiopharmaceutical production.
Different nuclear reactions can be evaluated for direct or indirect production of ^{155}Tb by varying projectiles and targets with different enrichments. In particular, in this work we investigate and compare two ^{155}Tb generators by considering protons on ^{nat}Tb and alpha particles on ^{nat}Gd. Both routes, can be studied using intermediate energy cyclotrons for the production of ^{155}Dy, the precursor of ^{155}Tb. The production is followed by two radiochemical separations: initially to isolate dysprosium nuclides from the target, and finally terbium nuclides from their dysprosium parents. The timings of the two separations are crucial to optimize yields and purity of the sample and different scenarios have been considered.
The two production routes are analyzed with the nuclear reaction code TALYS [2], in which different theoretical models are available. The code allows to use state-of-art implementations of the optical potential, of the level density and of the preequilibrium processes: by varying the parameters of the models it is possible to improve the agreement between the calculated cross sections and the available experimental data using techniques similar to those presented in Refs. [3][4].
After a reliable description of the cross sections is obtained, realistic theoretical simulations for the production of ^{155}Tb are performed by varying the irradiation conditions and the times of the radiochemical separations, as suggested in Refs. [5][6]. Yields and purities of ^{155}Tb are calculated and optimal solutions are compared for the two reactions, showing that the use of ^{nat}Tb, as a target, is preferable in view of possible preclinical/clinical applications.

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Author: COLOMBI, Alessandro (University of Pavia and INFN - Pavia)

Co-authors: FONTANA, Andrea (INFN - Pavia); CARANTE, Mario Pietro (University of Pavia and INFN - Pavia)

Presenter: COLOMBI, Alessandro (University of Pavia and INFN - Pavia)

Session Classification: Medical radioisotopes

Track Classification: Medical radioisotopes