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Cyclotron production of ^{67}Cu: A new measurement of the ^{68}Zn(p,2p)^{67}Cu, ^{68}Zn(p,2n)^{67}Ga and ^{68}Zn(p,3n)^{66}Ga nuclear cross sections

^{67}Cu is a promising isotope for theranostics, the innovative medical strategy that allows the selection of patients prior treatment and the optimisation of therapy throught a personal dosimetry. The γ-radiation of ^{67}Cu (E = 184.58 keV, I = 48.6%) is suitable for SPECT/CT imaging, while its β-emission (mean E$_-$ = 141 keV) and relatively long half-life (61.83 h) permits to follow the slow biodistribution of antibodies, making radioimmuno-therapy its primary application. Since the limiting factor of a widespread use of ^{67}Cu is its availability, the aim of this work is the analysis of ^{67}Cu production by using high-energy and high-intensity cyclotrons, as the one operating at Arronax facility (Nantes, France) and the one recently installed at Legnaro National Laboratories (INFN-LNL, Padova, Italy). The accurate measurement of the ^{68}Zn(p,2p)^{67}Cu cross section in the energy range 35-70 MeV is described in detail, including the realization of enriched ^{68}Zn thin target foils by electrodeposition on silver backing, the stacked-foils target assembly and the radiochemical process to separate Ga from Cu. Indeed, ^{67}Ga (half-life 3.26 d) is co-produced on ^{68}Zn targets via the (p,2n) reaction and presents the same γ-lines as ^{67}Cu, since they both decay into ^{67}Zn. The efficiency of the chemical procedure, is always monitored by using ^{61}Cu and ^{66}Ga radionuclides as tracer isotopes. Results from different irradiation runs show the repeatability of the method and the stability of chemical processing, that can be optimized for massive production with thicker targets. Experimental results on the production of ^{67}Cu, ^{67}Ga and ^{66}Ga are compared with literature data and, if available, with recommended cross sections proposed by the International Atomic Energy Agency (IAEA). Our experimental data are also compared with theoretical estimations obtained by using the TALYS code and different set of parameters (a dedicated talk is also proposed on this topic).

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