A novel approach to medical radioisotope production using inverse kinematics: A successful production test of the theranostic radionuclide ^{67}Cu

G.A. Souliotis,[1] M.R.D. Rodrigues,[2,5] K. Wang,[2] V. Iacob,[2] N. Nica,[2] B. Roeder,[2] G. Tabacaru,[2] M. Yu,[3] P. Zanotti-Fregonara,[3] and A. Bonasera[2,4]

[1]*Laboratory of Physical Chemistry, Department of Chemistry, National and Kapodistrian University of Athens, Athens 15771, Greece*

[2]*Cyclotron Institute, Texas A & M University, College Station, Texas 77048, USA*

[3]*Houston Methodist Research Institute, Houston, Texas , 77030, USA*

[4]*Laboratori Nazionali del Sud, INFN, Catania 95123, Italy*

[5]Instituto *de F´ısica, Universidade de S˜ao Paulo, S˜ao Paulo 05508-090, Brazil*

A novel method for the production of important medical radioisotopes has been developed. The approach is based on performing the nuclear reaction in inverse kinematics, namely sending a heavy-ion beam of appropriate energy on a light target (e.g. H, d, He) and collecting the isotope of interest [1]. In this work, as a proof-of-concept, we studied the production of the theranostic radionuclide ^{67}Cu ($T_{1/2}$=62 h) via the reaction of a ^{70}Zn beam at 15 MeV/nucleon with a hydrogen gas target. The ^{67}Cu radionuclide, alongside other coproduced isotopes, was collected after the gas target on an Al catcher foil and their radioactivity was measured by offline γ-ray analysis. After 36 h from the end of the irradiation, apart from the product of interest ^{67}Cu, the main radioimpurity coming from the ^{70}Zn+p reaction was ^{69m}Zn ($T_{1/2}$=13.8 h) that can be reduced by further radio-cooling. Moreover, along with the radionuclide of interest produced in inverse kinematics, the production of additional radioisotopes is possible by making use of the forward-focused neutrons from the reaction and letting them interact with a secondary target. A preliminary successful test of this concept was realized in the present study. The main requirement to obtain activities appropriate for preclinical studies is the development of high-intensity heavy-ion primary beams.

[1] G.A. Souliotis *et al.*, Appl. Radiat. Isot. **149**, 89 (2019); https://doi.org/10.1016/j.apradiso.-2019.04.019