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Cyclotron-based production of the theranostic radionuclides 67Cu and 47Sc

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The aim of this work is the analysis of 67Cu and 47Sc 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), in the framework of SPES project. The aim of the SPES project is focused both on the use of Radioactive Ion Beams (RIB) in nuclear physics experiments and applied research in the field of nuclear medicine, through the LARAMED project –acronym of LAboratory of RAdionuclides for MEDicine. Among the radionuclides of major interest for LARAMED project there are 67Cu and 47Sc, thanks to their great potential in theranostics. This innovative medical approach is based on the use of the same radiopharmaceutical labelled with isotopes emitting radiation useful for both diagnosis and therapy. The use of theranostic radionuclides or theranostic mixture of isotopes of the same chemical element (as 64Cu/67Cu or 44Sc/47Sc) allows the selection of patients with higher chance to respond to specific treatments and the application of individually customized dosimetry.
The interest on 67Cu and 47Sc production stands on their physical characteristics: they both emit β- particles of low-medium energy (mean Eβ- = 141 keV and Eβ- = 162.0 keV respectively) and γ-rays suitable for SPECT or SPECT/CT cameras (67Cu: Eγ = 184.58 keV, Iγ = 48.6%; 47Sc: Eγ = 159.381 keV, Iγ = 68.3%); moreover, their relatively long half-life (61.83 h and 3.3492 d) permit to follow the slow biodistribution of monoclonal antibodies and specific molecular vectors, such as peptides, allowing their use in radioimmunotherapy.
In this work the production of 67Cu and 47Sc for medical use is analysed, taking into account the yield of different nuclear reactions induced by proton beams. Relevant production cross sections have been measured in collaboration with the ARRONAX facility. In view of an optimized production, considerations on the co-production of contaminant radionuclides, especially the isotopic impurities that can not be chemically separated from the desired product, are also given.

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