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First Astatine-211 production at SPIRAL-2: contaminants cross-section measurements

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Targeted Alpha Therapy (TAT) offers a promising approach to treat cancer, particularly micrometastases, by utilizing the short range of alpha particles and their high linear energy transfer. Astatine-211, which belongs to the halogen family also shares chemical properties with Iodine, a radioisotope commonly used for imaging. This similarity enables the use of Iodine as an analogue for biodistribution and dosimetry studies while using ^{211}At for treatment. For these reasons, the production of ^{211}At and the characterization of the contaminants must be studied and optimized. In this study, we used an alpha beam at SPIRAL2, NFS to produce ^{211}At via the reaction $^{209}\text{Bi}(\alpha,2n)^{211}\text{At}$. The production cross-section of ^{211}At increases with increasing alpha energy up to 31 MeV. However, caution must be exercised as ^{210}At production also occurs via the $^{209}\text{Bi}(\alpha,3n)^{210}\text{At}$ reaction above 28.6 MeV. ^{210}At decays to ^{210}Po , an alpha-emitting radionuclide with a half-life of 138.3 days and high toxicity. We irradiated ^{209}Bi target at various alpha beam energies between 28 to 31 MeV to measure $^{210,211}\text{At}$ cross-sections and to determine the $^{210}\text{At}/^{211}\text{At}$ ratio. We employed gamma spectroscopy using germanium detectors to evaluate the contribution of $^{210,211}\text{At}$ through characteristics gamma rays. The incident particle flux was monitored using a Faraday cup. This flux measurement combined with the number of detected γ -rays allowed to determine the production cross-sections of $^{210,211}\text{At}$ as a function of energy and the results were in good agreement with the literature values. We have also used well-known cross-sections of alpha on Cu from literature to cross-check and improve the accuracy of our flux measurements. Astatine-211 is a promising radionuclide for TAT and needs careful monitoring of unwanted radionuclides. This study was the first step in the evaluation of cross-section to optimize the alpha energy. The next step will be ^{211}At production with a high power target for interdisciplinary studies. This study was financially supported by the REPARE ANR project (Projet-ANR-19-CE31-0013).

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