ID de Contribution: **37** Type: **Oral Presentation**

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

jeudi 28 septembre 2023 18:45 (20 minutes)

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 and also widely used to treat thyroid cancer. 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}Bi(α,2n)^{211}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}Bi(α,3n)^{210}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 is highly toxic, if released in tissues.

We irradiated ^{209}Bi target at various alpha beam energies between 28 to 31 MeV to measure ^{210,211}At cross-sections and to determine the ^{210}At/^{211}At ratio. We employed gamma-ray spectroscopy using germanium detectors to evaluate the respective contribution of ^{210,211}At. The incident particle flux was monitored using an instrumented Faraday cup. This flux measurement combined with the number of detected γ-rays allowed to determine the production cross-sections of ^{210,211}At as a function of energy and the results are 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 represents the first step in evaluating the cross-section to optimize the alpha beam energy and maximize ^{211}At production while maintaining an acceptable level of ^{210}At contamination. 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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Classification de Session: Applications and Interdisciplinary physics

Classification de thématique: Applications