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Development of 211At production via continuous extraction of 211Rn

Critically needed radionuclides for cancer therapy include the alpha-emitter 211At [1] and therapeutically useful Auger-electron emitters. The ATLAS (Argonne Tandem Linac Accelerator System) superconducting linac at Argonne National Laboratory is suitable for production of these radionuclides. Our work is initially focusing on demonstrating production capabilities for 211At (7.2 h half-life) using the 209Bi(7Li,5n)211Rn reaction. Cross sections for these reactions peak at 600 mbarn [2,3] making production of 10's of mCi per batch feasible using only a very small percentage of the accelerator beam time. Presently, in the U.S. 211At is primarily produced at 3 university facilities using the 209Bi(α,2n)211At reaction at in-house cyclotrons. Hence, clinical use of 211At nation-wide is limited due to its short half-life. By using the lithium induced reaction, the 211At daughter is extracted from the parent 211Rn, which has a half-life of 14 h, significantly extending the time-frame for effective distribution and use of this important radionuclide. ATLAS is an appropriate and flexible accelerator for production of medical isotopes because it can provide beams of any ion including protons, helium, lithium, and heavier ions with energies adjustable over a wide range. An upgrade of the accelerator to produce more intense lithium beams and the construction of improved neutron shielding is in progress. Following the completion of this work, currents of lithium beams of 1-10 particle microamps will be available to support the development of a 211Rn/211At generator. These combined upgrades will enable yields of ~100 mCi of 211Rn per batch. As part of this development, an option for the continuous collection of 211Rn from a bismuth oxide target followed by separation of the 211At daughter product is being investigated. Porous bismuth oxide targets have been developed by Innosense, LLC under a DOE Small Business Grant. [4] In two test runs to date, 211Rn released from the targets was collected in charcoal traps. In the first run a metallic bismuth target was used and in the second the recently developed bismuth oxide target was used. In both runs only a low fraction of the 211Rn was released and collected on line. The first case was limited by the melting point of the metal target, and the second was limited by the target being heated only to 60 oC. The release and capture were quantified by off-line gamma counting of the long lived 207Bi daughter remaining in the production target and in the charcoal. In upcoming test runs target heating up to 600 oC will be implemented to increase release and collection efficiency.

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Email Address

Nolen@ANL.gov

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Primary author: Dr NOLEN, Jerry (Argonne National Laboratory)

Co-authors: Dr MUSTAPHA, Brahim (Argonne National Laboratory); Prof. CHEN, Chin-Tu (University of Chicago); Dr ROTSCH, David (Argonne National Laboratory); Dr SONG, Jeongseog (Argonne National Laboratory); Mr GREENE, John (Argonne National Laboratory); Prof. WASHIYAMA, Kohshin (Fukushima Medical

University); Dr BROWN, M. Alex (Argonne National Laboratory); Dr GOTT, Matthew (Argonne National Laboratory); Mr GAMPA, Ravi (Argonne National Laboratory); Mr WINTER, Raymond (Innosense, LLC); Dr DE KRUIJFF, Robin (Argonne National Laboratory); Dr ZHU, Shaofei (Argonne National Laboratory); Dr SAMPATHKUMARAN, Uma (Innosense, LLC)

Presenter: Dr NOLEN, Jerry (Argonne National Laboratory)