LATVIA Project proposal to the MEDICIS collaboration meeting

Tb and Sc radionuclide separation and purification methods from solid targets and liquids for theranostic radiopharmaceutical development

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Introduction & background: (state of the art and goal/motivation for the project)

There is a new radiochemistry lab being set up at the University of Latvia, dedicated to radionuclide studies with a particular interest in medical radionuclides. While the first studies with Sc isotopes are ongoing, the aim of the lab is to build competence also in radiolanthanides and alpha decay medical radionuclide purification and labeling studies.

Terbium radioisotopes (^{149}Tb, ^{152}Tb and ^{155}Tb) are particularly promising for theranostics due to their dual capability in therapy and imaging. However, currently these radionuclides are not readily available in sufficient quantities due to their low production cross sections or enriched target material availability. Therefore, it is necessary to find and develop robust technology for the production, separation, and purification of terbium radionuclides to obtain high specific activity for radiopharmaceutical development. Furthermore, lately developments of electrochemical separation methods at UoL are being investigated to selectively purify radionuclide solutions.

Coupled with mass separation at CERN-MEDICIS there is an interest in target material characterization and developments for medical radionuclide production, as this is another UoL-ICP research field. A particular interest is in materials that could be irradiated with a cyclotron and subsequently used in a mass separator for radionuclide release.

A lot of developments were made during the MED-015 project for Sc production and separation towards RPH developments. The obtained methods now provide a way to supply the radionuclides to the radiochemistry lab at UoL, Riga, Latvia for further electrochemical and chemical separation studies. During the mass separation studies of Sc radionuclides, proposals for different vanadium and titanium containing target materials were proposed and would be investigated (e.g. VC, VB, TiC-nanoscale).

Project description : (detailed description of the project, translational, pre-clinical, imaging, treatment, new method)

The goal of this project is to:

1. Obtain bulk target material, suitable for ^{149}Tb, ^{152}Tb and ^{155}Tb radionuclide production and cyclotrons via light particle-induced nuclear reactions, such as protons, deuterons, neutrons and alpha particles, coupled with mass separation and/or chemical purification:

   1.1 Investigate composite target materials with resistance to sintering, good mechanical stability and high specific surface area.

   1.2 Material sample characterization prior and after the thermal treatment and preparation for irradiation and mass separation by the means of Scanning Electron Microscopy (SEM), Energy Dispersive X-ray analysis EDX, Brunauer, Emmett and Teller (BET) method, pycnometry, Fourier Transform Infra-Red (FT-IR) spectroscopy. Experiments on Tb release from the TaC matrix by doping target material with stable Tb compounds can be made to test the suitability of the proposed composite materials.

2. Perform mass separation of Tb radionuclides from irradiated Ta target materials:

   2.1 Produce Tb-149, Tb-152, and Tb-155 radionuclides with proton irradiation and perform mass separation and radionuclide collection at CERN-MEDICIS facility.

   2.2 Investigate the most appropriate release method from the target and ion source unit and corresponding ion sources.

3. Perform obtained Tb radionuclide separation and purification by conventional radiochemical methods and ion exchange resins, which includes developing a semi-automated radionuclide separation prototype system. Evaluate the separation efficiency, yield and radiochemical purity of obtained Tb radionuclide solution for method optimization.

4. Prepare, characterize and investigate target materials such as VC, VB, TiC (nanoscale) for the Sc production and mass separation with collected Sc sample post purification using the developed chemical separation methods.

5. Test the separation of Tb and Sc radionuclide from mass separation collection foils with electrochemical methods. Investigate non-aqueous electrolysis as means of the radionuclide separation from isobaric contaminants.

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