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Mass-separation of ^{43,44,47}Sc radionuclides from irradiated natural Ti targets at the CERN-MEDICIS facility

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Medical radionuclides as ^{43,44m,44g,47}Sc are very promising in "matched theranostic pair" radiopharmaceutical development for cancer treatment. Use of natural titanium as target material for production of ^{43,44m,44g,47}Sc radionuclides is favorable in terms of cost and the wide availability of target material, in contrast of using low abundant enriched Ca targets. We report here the recent studies, development, production and extraction of scandium radionuclides from irradiated thick natural titanium targets at MEDICIS at CERN.

In this work, natural titanium targets were irradiated at the MEDICIS target irradiation station with 1.4 GeV protons delivered by the CERN Proton Synchroton Booster (PSB). Although nuclear reaction cross-sections of ^{43,44m,44g,47}Sc for nat-Ti(p,x) confirm that enough production yield can be achieved to synthesize radiobioconjugates for imaging studies [1], the presence of contaminant isotopes such as long lived Sc-46 in radiopharmaceutical precursor is not acceptable. To overcome this obstacle, Sc radionuclide purification step, according to their mass using the Isotope Separator OnLine (ISOL) technique and the MEDICIS mass-separator was introduced. The separation of Sc and Ti as elemental radioactive beams is challenging due to their reactive nature, high boiling points and low vapour pressure. Therefore, formation of more volatile molecules, extraction and collection of desired radionuclides were introduced.

Low intensity radioactive Sc^+ and ScF^+ beams with W surface ion source have been reported at ISOLDE [2]. In this work, ScF_x^+ (x=1-2) and natTiF_y^+ (x=1-3) molecular beams in natural Ti target material and natural Ta target structure ambience have been obtained with a Versatile Arc Discharge Ion Source (VADIS). Also, optimal radionuclide extraction and separator operation parameters were yet to be determined.

We hereby report our results on the positive effect of volatile rare earth and refractory metal molecular beam formation for isotopically pure ^{44,47}Sc extraction and mass-separation. Although ISOL and mass-separation is mandatory, chemical separation step on the collected elements must be done to separatee from presence of isobars in the collection foil.

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