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Medical Isotope Collection from ISAC Targets

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The Isotope Separation and Acceleration (ISAC) facility¹ at TRIUMF provides a wide range of radioactive isotope beams (RIB) by irradiating ISOL-type (Isotope Separation OnLine) targets with a 480 MeV proton beam from the TRIUMF H- cyclotron. The majority of the available beamtime is used for basic research in the fields of nuclear astrophysics, nuclear structure and material science. A more recent application is the generation of pure exotic isotope samples from proton-irradiated targets for pre-clinical medical research towards therapeutic and diagnostic applications².

The focus has been so far on the production of isotopes for targeted alpha therapy (TAT) from composite uranium carbide targets³. Samples of ²²⁵Ac, ²²⁴Ra and ^{209/211}At (generated from ²¹³Fr and ²¹¹Fr beams) have been collected. Another source for TAT and Auger Therapy isotopes are high-power tantalum metal foil targets. They produce high-intensity lanthanide beams⁴. In a first proof-of-principle test, a ¹⁶⁵Tm/Er sample was collected and characterized.

The RIB collection takes place at the ISAC Implantation Station (IIS) where a compact vessel, in which mass-separated RIB are implanted on a target disc at energies between 20-55 keV, is attached to the beamline. It features ion beam positioning and current monitoring capabilities and allows for sealed transport of the accumulated activity under vacuum.

A chemical etching procedure was developed to retrieve >95% of activity from the implantation target. Taking advantage of the fact that the RIB implantation energy is lower than the typical alpha decay recoil energy, the production of very pure samples of alpha decay products such as 213Bi and 212Pb was investigated as an alternative to common ion exchange separations.

To accommodate the demand of an increased number or uranium carbide targets for the new ARIEL facility¹ which features two additional target stations and a symbiotic medical isotope target, the carbothermal reduction process to fabricate composite uranium carbide targets3 was modified. A simplified, faster process that combines reduction to UC2 and sintering of composite ceramic target discs in one step was developed⁷.

The performance of ISAC targets is frequently assessed with yield measurements⁵ and Geant4 simulations⁶, using the latest hadronic cascade models. The combination of measurement data and simulation results is used to extrapolate yield rates and to determine release properties.

This presentation provides an overview of medical isotope collection from ISAC targets, associated target materials and yields. It concludes with a brief outlook towards future developments related to the ARIEL facility.

References

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