Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **2477** Type: **Invited Speaker / Conférencier(ère) invité(e)**

Rare Isotope Production at ISAC/TRIUMF

Tuesday, 4 June 2019 15:45 (30 minutes)

The continuous 480 MeV proton beam from the TRIUMF H^- cyclotron offers a unique potential for the production of rare isotopes via spallation, fragmentation and fission reactions. It was first investigated with the TISOL (Test Isotope Separator On-Line) facility, a project of John d'Auria[1]. This ground-breaking work cleared the path for the present ISAC (Isotope Separation and ACceleration) and future ARIEL (Advanced Rare IsotopE Laboratory) facilities at TRIUMF[2].
Currently, the ISAC facility provides a wide range of isotopes[3] for basic research in the fields of nuclear astrophysics, nuclear structure and material science by irradiating targets containing a variety of refractory materials. Reaction products are extracted from the target via diffusion and effusion, ionized and transported through a network of electrostatic beamlines to the experiment. The isotope of interest determines the choice of target material and ion source.

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 applications[4].
While isotopes delivered to online experiments can have half-lives as short as a few milliseconds, radioactive samples collected for offline medical and radiochemistry studies at the ISAC Implantation Station typically have half-lives in the range of hours to days.

The focus has been so far on isotopes for targeted alpha therapy (TAT) from composite uranium carbide targets. Samples of ^{225}Ac, ^{224}Ra and $^{209/211}$At (generated from ^{213}Fr and ^{211}Fr beams) have been collected. In a new development, alternative isotopes for TAT and Auger Therapy are collected from high-power tantalum metal foil targets which provide high-intensity lanthanide beams[3]. In a first proof-of-principle test, a ^{165}Tm/Er sample was collected and characterized.

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3. Kunz P, ISAC Yield Database, 2018. URL: http://mis.triumf.ca/science/planning/yield/beam.
4. Hoehr, C. et al. Medical Isotope Production at TRIUMF –from Imaging to Treatment. Physics Procedia 90, 200–208 (2017).
5. Kunz P, et al. Composite uranium carbide targets at TRIUMF. J. Nuc. Mat. 2013;440(1–3):110–6.

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Session Classification: T4-3 Nuclear Astrophysics/Structure and Medical Isotopes in honour of Prof. John D'Auria PM-2 (DNP) | Astrophysique nucléaire / Structure et isotopes médicaux en hommage au prof. John D'Auria PM-2 (DPN)

Track Classification: Symposia Day - Nuclear Astrophysics and Medical Isotopes (in honour of Prof. John D'Auria)