Contribution ID: **101** Contribution code: **NIM-1** Type: **Oral Presentation**

The 90s –Exciting opportunities for AMS at the Heavy Ion Accelerator Facility

Friday, 25 October 2024 09:20 (20 minutes)

The mass region between 90 and 100 amu is home to several long-lived radionuclides that are interesting for various applications of AMS. Two examples are ^{93}Zr, and ^{99}Tc with half-lives of ˜1.6 Ma, and ˜211 ka respectively. Both isotopes are high-yield fission products and were produced and distributed in the environment by atmospheric nuclear weapons tests and nowadays are produced in large quantities in nuclear power plants. In addition to fission, ^{93}Zr is also created by neutron capture on stable ^{92}Zr due to usage of zirconium alloys for cladding of nuclear fuel rods. The neutron capture cross sections of ^{92}Zr for thermal energies (˜25 meV) as well as for stellar energies (tens of keV) are not well known. These cross sections are important for nuclear industry, nuclear waste management and for modelling the astrophysical slow neutron capture process, respectively. Technetium-99 can serve as an ocean current tracer and owing to its high mobility and long half-life, it is an important radionuclide for long-term dose-assessment and radiotoxicity.
The high achievable particle energies (>200 MeV) at the Heavy Ion Accelerator Facility (HIAF) and our dedicated 8-anode ionisation chamber are ideal to tackle the challenging separation of ^{93}Zr and ^{99}Tc from their respective isobars, ^{93}Nb and ^{99}Ru.
For 93Zr, detection limits of ^{93}Zr/^{92}Zr ˜10^{-12} were achieved, however currently no well-defined ^{93}Zr AMS reference material exists. In collaboration with the Institute Laue-Langevin and HZDR we produced well-defined amounts of ^{93}Zr via neutron-induced fission on ^{235}U in two uranium-oxide targets. Addition of known amounts of stable Zr carrier and extraction of the Zr resulted in primary reference samples with known ^{93}Zr/Zr ratios. Currently cross calibrations of secondary reference materials (neutron-irradiated ZrO_2) to these materials are being conducted at HIAF.
First AMS measurements of ^{99}Tc were performed in the early 2000s at HIAF [1,2] and in collaboration with the University of Vienna they are currently refined. In the absence of a stable Tc isotope, we follow the approach described in Koll et al [3]. The Tc is dispersed in a Nb_2O_5 matrix, extracted from the ion source as TcO^- and measured relative to stable ^{93}Nb. A precision of ˜10% and blank levels in the order of 10^7 ^{99}Tc atoms per sample were achieved, allowing for measurement of the ^{99}Tc content in various environmental samples. Recent investigations showed that using a degrader consisting of a stack of nine 1 µm thick silicon nitride foils in combination with our multi-anode ionisation chamber increases the Tc-Ru separation and improves the normalisation by a factor of two, arriving at the same blank levels. The degrader foil technique will be explored for other AMS isotopes in this mass region, where ^{90}Sr with two protons less than its isobar ^{90}Zr is a particularly interesting candidate.

[1] Fifield et al., Nucl. Instrum. Meth. B 168, 427 (2000). doi: 10.1016/S0168-583X(99)01094-0
[2] Wacker et al., Nucl. Instrum. Meth. B 223-224, 185 (2004). doi: 10.1016/j.nimb.2004.04.038
[3] Koll et al, Nucl. Instrum. Meth. B 438, 180 (2019). doi: 10.1016/j.nimb.2018.05.002

Student Submission

No

Primary authors: PAVETICH, Stefan (The Australian National University); ADLER, Stephanie (University of Vienna); DIETRICH, Carolin (University of the Bundeswehr Munich, Munich, Germany); FICHTER, Sebastian

(Helmholtz-Zentrum Dresden-Rossendorf); FIFIELD, L. Keith (Australian National University, Research School of Physics, Department of Nuclear Physics and Accelerator Applications, Canberra, Australia); FROEHLICH, Michaela (The Australian National University); GÜLCE, Fadime (University of Vienna, Faculty of Physics, Isotope Physics, Vienna, Austria); HAIN, Karin (University of Vienna –Faculty of Physics, Isotope Physics, Vienna, Austria); KOESTER, Uli (Institut Laue-Langevin, Grenoble, France); KOLL, Dominik (The Australian National University & TU Dresden & Helmholtz-Zentrum Dresden-Rossendorf); MARTSCHINI, Martin (University of Vienna - Faculty of Physics); ROTHERY, Christopher (The Australian National University, Canberra, Australia); SOLDNER, Torsten (Institut Laue-Langevin, Grenoble, France); TIMS, Steve G. (Australian National University, Research School of Physics, Department of Nuclear Physics and Accelerator Applications, Canberra, Australia); WALLNER, Anton (HZDR)

Presenter: PAVETICH, Stefan (The Australian National University)

Session Classification: New Isotopes Methodologies

Track Classification: New Isotopes Methodologies