MS 10: Accelerator Mass Spectrometry II

Time: Friday 11:00–12:30 Location: HS 2 Chemie

Invited Talk MS 10.1 Fri 11:00 HS 2 Chemie

Rare-RI Ring facility: tool of precision mass spectrometry of short-lived nuclei — •Takayuki Yamaguchi — Saitama University, Saitama 338-8570, Japan

Today challenge is to precisely measure atomic masses of short-lived exotic nuclei, which contribute to the understanding of nuclear structure evolution, various interactions and symmetries, and astrophysical observations. The Rare-RI Ring (R3) facility is a unique storage ring facility coupled with the cyclotron complex through the high-energy fragment separator BigRIPS at the RIKEN RI beam factory [1]. Ions of interest are in-flight selected and are individually injected in the storage ring where the precision isochronous condition is realized. The event-by-event data processing is performed with information from auxiliary detectors at the BigRIPS. Thus obtained revolution times of stored ions provide the mass-to-charge ratios. Since successful developments of the related devices, several commissioning and physics runs have been conducted; a highlight is the masses in the vicinity of the r-process nucleosynthesis [2]. In this talk, I will overview the BigRIPS-R3 facility and physics programs and will discuss possible extensions and collaborations in the future.

References

[1] D. Nagae et al., Phys. Rev. C 110, 014310 (2024).

[2] H.F. Li et al., Phys. Rev. Lett. 128, 152701 (2022).

MS 10.2 Fri 11:30 HS 2 Chemie

Upgraded LE side of the 6 MV Tandem Accelerator — •Christof Vockenhuber, Matthias Schlomberg, Thorben Wulff, Urs Ramsberger, Lukas Wacker, and Marcus Christl — Laboratory of Ion Beam Physics, ETH Zürich, Switzerland

At ETH, six AMS facilities are in operation, spanning terminal voltages from as low as 50 kV up to 6 MV. In the past decades, the focus of the instrumental development at the laboratory had been on the small, compact AMS system with the aim of making AMS measurements easier, more affordable and more precise. Yet, a few radionuclides still need larger accelerators for sufficient isobar separation, such as Cl-36 or Si-32. Some of the developments at the small AMS systems can be beneficial for the larger machines. Based on these experience we have rebuilt the LE side of the 60-year-old 6 MV EN Tandem accelerator over the past two years. A key part is the MICADAS-type ion source with some refinements for the need of the radionuclides measured at this accelerator. Especially the target design and the target position system were improved. The upgraded system will be presented and the performance, in particular the ion source output and cross talk, for the key-radionuclide Cl-36 discussed.

MS 10.3 Fri 11:45 HS 2 Chemie

Detecting Environmental ^{231}Pa Using Accelerator Mass Spectrometry — •Janis Wolf[1], Marcus Christl[2], Sebastian Fichter[1], Habacuc Perez Tribouillier[2], Stella Winkler[1], and Anton Wallner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]ETH Zürich, Laboratory of Ion Beam Physics (LIP), Zürich, Switzerland

While many actinides (e.g., ^{236}U, ^{239}Pu, ^{241}Am) are routinely measured in environmental samples using accelerator mass spectrometry (AMS), the naturally occurring radionuclide ^{231}Pa ($t_{1/2} = 3.28 \cdot 10^4 a$) is not among them, even though it has been shown that its AMS detection limit is in the lower femtogram range[1]. Challenges in the measurement of ^{231}Pa include the complicated sample preparation and the lack of a long-lived isotope that one could use for normalization.

We developed chemical sample preparation procedures for environmental water and sediment samples, proven successful by our first beam time using MILEA at ETH Zürich. We could achieve a great abundance sensitivity on the mass 231, with no significant background contriburion of ^{232}Th. We also investigated complications caused by the short-lived ^{233}Pa ($t_{1/2}$ = 26.98 days), used for normalization. The ingrowth of ^{233}U in our samples causes a lower ^{231}Pa/^{233}X ratio to be measured, as UO^- has up to 10 times higher negative ion formation efficiency than PaO^- in the ion source. This needs to be accounted for by measurement of standards.

[1] M. Christl et al., Nucl. Instrum. Methods Phys. Res., B 262 (2007) 379

MS 10.4 Fri 12:00 HS 2 Chemie

ILIAMS assisted AMS measurements of long-lived radionuclides produced in fusion environment — •Carlos Vivo-Vilches[1], Esad Hrnjic[1], Martin Martschini[1], Lee W. Packer[2], Silke Merchel[1], Johannes H. Sterba[3], Karin Hain[1], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Vienna, Austria — [2]UKAEA, Culham Campus, Abingdon, United Kingdom — [3]Center for Labelling and Isotope Production, TRIGA Center Atominstitut, TU Wien, Austria

To reliably assess the radionuclide inventories of future nuclear fusion reactors, foils of different materials were irradiated with deuterium-tritium neutrons in the Joint European Torus (JET) reactor, followed by γ-measurements of short-lived radionuclides. The activities of long-lived radionuclides are too low for radiometric techniques. At the Vienna Environmental Research Accelerator (VERA), the potential of AMS for the detection of ^{91}Nb ($T_{1/2}$ = 680 a), ^{94}Nb ($T_{1/2}$ = 20300 a) and ^{93}Mo ($T_{1/2}$ = 4839 a) is investigated. These three radionuclides are produced in Mo-containing materials, e.g. stainless steel SS316. Their measurement requires the use of VERA's Ion-Laser InterAction Mass Spectrometry (ILIAMS) setup for laser photodetachment to suppress their respective stable isobars: ^{91}Zr, ^{94}Zr and ^{94}Mo, and ^{93}Nb. For ^{91,94}Nb, NbO_3^- is selected for ILIAMS. Suppression of $^{91,94}ZrO_3^-$ is observed just by collisions with the He buffer gas. This suppression is enhanced by photons from a 355 nm laser, which also suppress $^{94}MoO_3^-$ by a factor 3900. For ^{93}Mo, MoO_2^- is selected, while isobaric $^{93}NbO_2^-$ is suppressed a factor $>10^6$ by our new 637 nm laser.

MS 10.5 Fri 12:15 HS 2 Chemie

Developments towards detection of ^{26}Al at ALIS — •Ferhat Altun, Markus Schiffer, Stefan Heinze, Timm-Florian Pabst, Gereon Weingarten, and Dennis Muecher — Institute for Nuclear Physics, University of Cologne, Germany

To expand the list of measurable isotopes for AMS, the Anion Laser Isobar Separator (ALIS) was installed at CologneAMS. The system uses element-selective photo-detachment for the suppression of the high abundant isobars. The process of laser isobar interaction requires the superposition of a high intense laser with the anion beam. For the decoupling of the laser and the anion beam, an electrostatic deflector with a hole in the outer electrode is used. Holes in electrodes of electrostatic devices lead to unwanted field inhomogeneities. Therefore, we developed an additional correction electrode for electrostatic deflectors, that is able to correct the inhomogeneity and hence ensures a precise energy filtering. In this talk, the electric field measurements of the electrostatic deflector will be presented including our newly developed measurement technique. The main focus of the ALIS setup is the measurement of environmental (^{90}Sr, ^{135}Cs), and cosmogenic isotopes (^{26}Al, ^{41}Ca). For the benchmark test of the new setup, we measured the efficiency and level of detection of an isotope that is routinely measured at CologneAMS, which can be improved for the users of the facility. Therefore, we aim to measure ^{26}Al with ALIS by use of the prolific molecular injection (AlO^-) where the suppression of ^{26}MgO is required. The measured ionization efficiencies of the ion beams will be discussed during the talk.