MS 7: Accelerator Mass Spectrometry III

Time: Thursday 11:00–13:00 Location: HS 3042

Invited Talk MS 7.1 Thu 11:00 HS 3042

High-precision mass measurements for nuclear structure and nuclear astrophysics — •Anu Kankainen — University of Jyväskylä, Department of Physics, Accelerator laboratory, P.O. Box 35(YFL), FI-40014 University of Jyväskylä, Finland

High-precision atomic mass measurements with a Penning trap provide a way to precisely determine nuclear binding energies even for short-lived radioactive nuclei. Nuclear binding energies serve as excellent testing points for nuclear models and understanding nuclear structure far from stability. Masses are also key inputs for nuclear astrophysics applications, such as for the rapid neutron capture process (r process) responsible for around half of the heavy-element abundances above iron. Penning-trap mass spectrometry can also be used to determine excitation energies of isomeric states.

We have measured more than 460 atomic masses, including over 70 isomeric states, with the JYFLTRAP double Penning trap mass spectrometer at the Ion Guide Isotope Separator On-Line (IGISOL) facility in the Accelerator Laboratory of the University of Jyväskylä, Finland. A large number of low-lying isomeric states have been recently measured with the phase-imaging ion cyclotron resonance technique. In many cases, the measurements have been supported by laser or post-trap decay spectroscopy to further identify the studied states. In my presentation, I will give an overview with selected highlights on our precision mass measurements for nuclear structure and astrophysics.

MS 7.2 Thu 11:30 HS 3042

AMS of I-129 at low energies - 10 years later — Christof Vockenhuber[1,2], •Núria Casacuberta Arola[1,2], and Marcus Christl[1] — [1]Laboratory of Ion Beam Physics, ETH Zurich, Zurich, Switzerland — [2]Department of Environmental Systems Science, ETH Zurich, Zurich, Switzerland

For the DPG 2014 conference in Berlin we had a contribution on AMS of I-129 at low-energy AMS systems. Focusing on the 500 kV Tandy at the Laboratory of Ion Beam Physics at ETH Zurich, we were discussing the advantages but also the challenges of measuring this long-lived radionuclide at low energies with a special focus on cross contamination and its correction.

Here we will provide a review of I-129 AMS at low energies, after the experience we gained in the last 10 years by measuring thousands of samples. Although most of the measurements were performed in the AMS Tandy system, since a few years the 300 kV multi-isotope systems MILEA is also in our portfolio. MILEA helped in expanding the measurement capabilities with a new type of ion source and an improved ion-optical setup. We will compare measurements performed at both Tandy and MILEA and discuss the performance with the focus on background, cross contamination and detection limit. Finally, we will also show a few examples of the application of I-129 as an anthropogenic ocean tracer from the past 10 years.

MS 7.3 Thu 11:45 HS 3042

First ^{129}I Measurements at CologneAMS — •Christian Schlaier[1], Stefan Heinze[1], Martina Gwozdz[1], Gereon Hackenberg[1], Marco Michel[2], Markus Schiffer[1], Erik Strub[2], and Dennis Mücher[1] — [1]Institut für Kernphysik, University zu Köln — [2]Institut für Kernchemie, Universität zu Köln

In the Atacama Desert, one of the driest places in the world, plants had to adapt to survive with the low humidity mainly caused by fog. This fog contains an increased proportion of the unstable rare ^{129}I due to nuclear bomb tests in the South Pacific. The AMS Iodine analysis of this plants can be used to gain information about environmental conditions and might help the colabborating bio- and geoscientists of the CRC1211 to understand the evolution of life in the hyper arid environement.

For this reason first Iodine measurements have been performed at the 6 MV AMS system of CologeneAMS. Standard samples covering the entire capabilities of the accelerator system were measured. In this contribution we will present the current status and the results of the Iodine measurements in Cologne.

MS 7.4 Thu 12:00 HS 3042

Analysis of ^{90}Sr in environmental samples with utmost sensitivity by Accelerator Mass Spectrometry — •Martin Martschini[1], Silke Merchel[1], Stephan Winkler[2], Maki Honda[3], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]HZDR, Accelerator Mass Spectrometry and Isotope Research, Germany — [3]Japan Atomic Energy Agency, Japan

The world-wide unique Ion-Laser InterAction Mass Spectrometry (ILIAMS) technique at the Vienna Environmental Research Accelerator AMS-facility provides unprecedented sensitivity for the radiologically relevant anthropogenic radioisotope ^{90}Sr ($T_{1/2}$ = 28.9 a). Highly-efficient suppression of the isobaric interference ^{90}Zr via ion-gas-reactions and laser photodetachment of ZrF_3^- inside a radiofrequency-quadrupole ion cooler enables a blank value of $^{90}Sr/Sr < 5\times10^{-16}$ at an overall Sr-detection efficiency of 4×10^{-4}. This corresponds to a detection limit of <0.016 mBq, i.e., 2×10^4 atoms or 3 ag of ^{90}Sr in a sample of mg of stable Sr, which is at least a factor 100 better than with any other technique including conventional AMS.

Recently, we have successfully applied this technique to determine the $^{90}Sr/Sr$ ratio in <1 g of contemporary coral aragonite and samples of 300-500 ml of South Atlantic seawater. Furthermore, the ^{90}Sr content in environmental archives like deer antlers, snail shells and ivory has been analyzed with sample sizes as low as 2 mg of ashed material. Measurement results on IAEA reference materials (bone and soil) are in good agreement with their expected values and demonstrate the robustness of the technique.

MS 7.5 Thu 12:15 HS 3042

Developments towards ion cooler assisted ^{90}Sr measurements at CologneAMS — •Oscar Marchhart[1,2,3], Markus Schiffer[3], Elisa Linnartz[3], Martin Martschini[1], Melisa Maslo[4], Gereon Hackenberg[3], Timm-Florian Pabst[3], Peter Steier[1], Erik Strub[4], Tibor Dunai[5], Dennis Mücher[3], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics - Isotope Physics, Vienna, Austria — [2]University of Vienna, Faculty of Physics & Vienna Doctoral School in Physics, Vienna, Austria — [3]University of Cologne, Institute for Nuclear Physics, Cologne, Germany — [4]University of Cologne, Division of Nuclear Chemistry, Cologne, Germany — [5]University of Cologne, Institute of Geology and Mineralogy, Cologne, Germany

The fission product ^{90}Sr ($T_{1/2}$ = 28.90 a) is a radiotoxic trace nuclide produced with high yield in the nuclear fuel cycle and weapons tests. State-of-the-art radiometric measurements are time-consuming and cumbersome, hence, accelerator mass spectrometry (AMS) has the potential to be a fast and highly sensitive alternative, especially for large quantities.

In a collaboration between the University of Vienna and University of Cologne, a new advanced ion cooler for ion beams with high emittance, e.g. SrF_3^-, was designed and built. Performance tests, including residence time measurements, have been conducted at a dedicated test bench in Vienna. Simultaneously, a simple and fast chemical preparation for Sr in soil samples for large amounts of samples is worked on. The performance tests and sample preparation will be presented.

MS 7.6 Thu 12:30 HS 3042

^{53}Mn burial dating at Cologne-AMS — •Gereon Hackenberg[1], Markus Schiffer[1], Steven Binnie[2], Alfred Dewald[1], Tibor Dunai[2], Stefan Heinze[1], Timm-Florian Pabst[1], and Dennis Mücher[1] — [1]Insitute for Nuclear Physics, University of Cologne — [2]Instiute for Geology and Mineralogy, University of Cologne

The CRC1211 Earth - Evolution at the Dry Limit investigates the formation and evolution of life and landscapes in severely water-limited environments, which constitute significant portions of the Earth. Age determination of sporadically deposited sediments in hyper-arid and arid regions poses challenges due to the absence of age-indicating fossils. In this presentation we discuss a novel approach using Accelerator Mass Spectrometry (AMS) to measure the cosmogenic $^{53}Mn/^3He$ concentration in iron-titanium oxides (hematite, magnetite, titanomagnetite, ilmenite). Notably, ^{53}Mn, with a half-life of T=3.74*Ma, offers extended exposure times compared to 26Al/10Be burial dating.

The utilization of AMS for 53Mn demands a Tandem accelerator with a high terminal voltage, exemplified by the 10MV FN-Tandem accelerator at the University of Cologne, coupled to a gas-filled magnet. Systematic optimization, including the development of a new Bragg

detector and enhanced stability of the accelerator voltage via active slit control, has resulted in stable conditions for ^{53}Mn burial dating, achieving a low blank level of $^{53}\mathrm{Mn}/^{55}\mathrm{Mn} < 10^{-13}$. Our presentation includes dating results from Namibian iron oxide surface samples and a discussion of their implications for advancing our understanding of the geological dynamics within the Namibian desert.

MS 7.7 Thu 12:45 HS 3042

Utilizing δ^{13}C from IRMS to improve the precision of AMS measurments — •Martina Gwozdz[1], Andrea Jaeschke[2], Stefan Heinze[1], Janet Rethemeyer[2], Dennis Mücher[1], and Markus Schiffer[1] — [1]University of Cologne, Institute for Nuclear Physics, Cologne, Germany — [2]University of Cologne, Institute for Geology and Mineralogy, Cologne, Germany

Within the CRC1211 project-Evolution at the Dry Limit, there is a need for precise dating analysis on soil samples from the Atacama Desert, which are characterized by low carbon contents. We employ an elemental analyser, an isotope ratio mass spectrometer and an existing gas interface in conjunction with the 6 MV AMS system of CologneAMS. This setup facilitates a fully automated, online analysis of $^{14}\mathrm{C}/^{12}\mathrm{C}$, while also delivering accurate δ^{13}C values. To address the compatibility of δ^{13}C values derived from AMS and IRMS measurements for fractionation correction, we simultneously determined δ^{13}C values from various standard materials using both AMS and IRMS. Our findings reveal that the mean δ^{13}C values from AMS and IRMS align within their respective error ranges. Consequently, we advocate for the utilization of the more precise δ^{13}C values from IRMS for an effective and refined AMS fractionation correction. Notably, our investigation did not unveil any correlation between the observed scattering of δ^{13}C AMS values and fluctuations in the $^{14}\mathrm{C}/^{12}\mathrm{C}$ AMS ratios. This insight sheds light on the origin of small fluctuations beyond statistical expectations in radiocarbon AMS dating applications.