MS 4: Accelerator Mass Spectrometry and Applications

Time: Wednesday 10:30–12:15 Location: U A-Esch 2

MS 4.1 Wed 10:30 U A-Esch 2

Proof of suitability of ^{41}Ca as a reference isotope for the characterization of reactor concrete — •R. Spanier[1], S. Heinze[1], M. Schiffer[1], A. Stolz[1], G. Hackenberg[1], S. Herb[1], L. Bussmann[1], C. Müller-Gatermann[1], A. Dewald[1], R. Magreiter[2], E. Strub[2], M. Michel[2], K. Eberhardt[3], M. Dewald[4], and B. Dittmann[4] — [1]Institut für Kernphysik, Köln, Deutschland — [2]Abteilung Nuklearchemie, Köln, Deutschland — [3]Institut für Kernchemie, Mainz, Deutschland — [4]Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) GmbH

In the field of nuclear waste management reference isotopes are important for the radiological characterization of the radioactive material. Often ^{60}Co or ^{152}Eu are used for this purpose as they are relatively easy to measure by means of gamma ray spectroscopy. The disadvantages are the relatively short half-lives and in the case of reactor concrete these seed materials ^{59}Co or ^{151}Eu are contained only as trace elements and homogeneity of the seed material in a large amount of material is not guaranteed. Thus, these reference nuclides are not very well suited if longer storage and control is needed. Therefore, we investigated the suitability of ^{41}Ca as a reference isotope for reactor concrete e.g. originating from the bio-shield of a nuclear power station. We measured ^{41}Ca concentration of irradiated samples at the 6MV TANDETRON AMS set-up of the University of Cologne. The ^{41}Ca was chemically extracted as CaF to produce a sputter target for the AMS measurement . We will report on the results with respect to sensitivity and precision obtained so far.

MS 4.2 Wed 10:45 U A-Esch 2

AMS measurement of ^{14}C concentration in reactor concrete — •A. Stolz[1], S. Heinze[1], M. Schiffer[1], C. Müller-Gatermann[1], G. Hackenberg[1], S. Herb[1], L. Bussmann[1], R. Spanier[1], A. Dewald[1], R. Magreiter[2], E. Strub[2], M. Michel[2], K. Eberhardt[3], M. Dewald[4], and B. Dittmann[4] — [1]Institut für Kernphysik, Köln, Deutschland — [2]Abteilung Nuklearchemie, Köln, Deutschland — [3]Institut für Kernchemie, Mainz, Deutschland — [4]Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) GmbH

In the field of nuclear waste management ^{14}C plays an important role. So far ^{14}C is measured with the liquid scintillation technique (LS) for which chemical treatment of the sample material is needed. The detection limit for ^{14}C reached with the LS technique is limited to 1Bq/g when almost no background from other beta decaying isotopes is present. The AMS technique offers here a much higher sensitivity which becomes crucial in the future since the activity of the clearance levels for the release of material from regulatory control has been reduced from 1Bq/g to 0.1Bq/g. It appears that also the effort for a ^{14}C measurement is much reduced with AMS since no pre-treatment is needed. Especially in the case of reactor concrete origination e.g. from the bio-shield of a nuclear power plant the sample material can be directly burned in an Elemental Analyzer (EA) and the extracted CO_2 gas can be delivered to the AMS system. In this way automated measuring procedures became feasible with a high throughput and a cost reduction compared to the so far established measuring technique. We will report on first measurements and discuss the results .

MS 4.3 Wed 11:00 U A-Esch 2

Accelerator mass spectrometry of ^{93}Zr at the Australian National University — •Stefan Pavetich[1], L.Keith Fifield[1], Michaela B.Froehlich[1], Shlomi Halfon[2], Yanan Huang[1], Dominik Koll[1], Martin Martschini[3], Michael Paul[4], Asher Shor[2], Johannes H.Sterba[5], Moshe Tessler[4], Stephen G.Tims[1], Leonid Weissman[2], and Anton Wallner[1] — [1]Australian National University, Australia — [2]Soreq Nuclear Research Center, Israel — [3]University of Vienna, Austria — [4]Hebrew University, Israel — [5]Technische Universität Wien, Austria

Neutron capture cross sections at keV energies in the Zr mass region are important for nuclear astrophysics as this is the matching point for two components of the slow neutron capture process. Zirconium is used in cladding of nuclear fuel rods and is a high yield fission product, hence production rates of ^{93}Zr ($t_{1/2}$ ∼1.6 Ma), are important for nuclear technology and waste management. Despite their significance, neutron capture cross sections for production of ^{93}Zr are poorly known. The long half-life and decay characteristics, make decay counting of ^{93}Zr difficult. We have used accelerator mass spectrometry to measure ^{93}Zr produced by neutron activation of ^{92}Zr with thermal and keV neutrons, yielding independent values for the respective cross section. The main challenge here is the separation of ^{93}Zr from its stable isobar ^{93}Nb. The high particle energies available with the 14UD accelerator at ANU, combined with an 8-anode ionization chamber are ideal to tackle this challenge. The achieved detection limits of ^{93}Zr/Zr∼10^{-12} could lead to new applications of ^{93}Zr as environmental tracer.

MS 4.4 Wed 11:15 U A-Esch 2

Detection of Extraterrestrial ^{60}Fe in Antarctica with AMS — •Dominik Koll[1,2], Thomas Faestermann[1], Gunther Korschinek[1], Silke Merchel[3], Jan M. Welch[4], and Sepp Kipfstuhl[5] — [1]Technische Universität München, Germany — [2]The Australian National University, Australia — [3]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [4]TU Wien, Austria — [5]Alfred Wegener Institute, Germany

The long-lived radioactive isotope ^{60}Fe with a half-life of 2.6 Myr is mainly produced by stellar nucleosynthesis and ejected into space by core-collapse supernovae. Former investigations by Accelerator Mass Spectrometry (AMS) showed a supernova signal on Earth 1.7-3.2 Myr ago.

Considering an enrichment of the solar neighborhood in long-lived radionuclides by previous supernovae, deposition of ^{60}Fe on Earth could be currently ongoing. To investigate this case, 500 kg of Antarctic snow were analyzed by Accelerator Mass Spectrometry with the 14 MV tandem accelerator and the Gas-filled Analyzing Magnet System (GAMS) at the Maier-Leibnitz-Laboratorium in Garching, Germany.

Indeed, ^{60}Fe was discovered in Antarctic snow and by the measurement of ^{53}Mn, which is dominantly produced by cosmic ray interactions with solar system objects, the origin of these ^{60}Fe atoms could be deduced.

MS 4.5 Wed 11:30 U A-Esch 2

First tests of the new 135° gas-filled magnet at the Cologne 10 MV AMS-System — •Susan Herb, Richard Spanier, Markus Schiffer, Heinze Stefan, Claus Müller-Gatermann, Gereon Hackenberg, Lena Bussmann, Alexander Stolz, and Alfred Dewald — Institut für Kernphysik, Universität zu Köln

The AMS setup at the Cologne 10 MV Tandem Accelerator is dedicated to measure isotopic ratios of medium mass nuclei. After the first measurements of ^{53}Mn, measurements of ^{60}Fe and ^{63}Ni are possible with the new 135° gas-filled magnet. The isotope ^{60}Fe is of great importance for nuclear astrophysics and ^{63}Ni for nuclear waste management. Test measurements of the new gas-filled magnet were performed with stable Fe and Ni beams. In order to avoid high energy loss in the entrance window of the magnet, the mylar-foil was replaced by a Si_3N_4 window. In addition a new 5-anode gas-detector was positioned after the magnet. A large 2cmx2cm Si_3N_4 foil is used at the entrance and x-slits allow to reduce scattered particles. We will present the first results on the isotope separation and transmission of the system.

MS 4.6 Wed 11:45 U A-Esch 2

Super-SIMS at HZDR - first steps with halogens — •G. Rugel[1], A.D. Renno[1], S. Akhmadaliev[1], G. Belokonov[1], R. Böttger[1], J. von Borany[1], J. Gutzmer[1], P. Kaever[1], M. Meyer[1], P. Noga[2], C. J. Tiessen[1,3], J. Voigtländer[1], N. Wagner[1], M. Wiedenbeck[4], A. Winter[1], and R. Ziegenrücker[1] — [1]HZDR, Dresden — [2]STU MTF, Bratislava — [3]A.E. Lalonde AMS, Ottawa — [4]GFZ Potsdam

The integration of an ion source with very high spatial resolution with a tandem accelerator is a long-standing concept for improving analytical selectivity and sensitivity by orders of magnitude [1-3]. Translating this design concept to reality has its challenges [e.g. 4-6]. Supporting a strong focus on natural, metallic and mineral resources the Helmholtz Institute Freiberg for Resource Technology installed such a system at the Ion Beam Centre at HZDR. This so-called Super-SIMS is the combination of a CAMECA IMS 7f-auto with the 6 MV Dresden Accelerator Mass Spectrometry facility [7,8], which quantitatively eliminates isobaric molecular species. We will present measurements of the performance parameters of the instrument as well as first results of halogen

(F, Cl, Br, and I) determinations in galena and sphalerite. Ref.: [1] Purser et al. Surface and Interface Analysis 1(1), 1979, 12. [2] J. M. Anthony, D. J. Donahue, A. J. T. Jull, MRS Proceedings 69(1986)311-316. [3] S. Matteson, Mass Spectrom. Rev., 27(2008)470. [4] Ender et al. NIMB 123(1997)575. [5] Maden, PhD thesis, ETH Zurich 2003. [6] Fahey et al. Analytical Chemistry 88(14), 2016, 7145. [7] Akhmadaliev et al., NIMB 294 (2013) 5. [8] Rugel et al. NIMB 370 (2016) 94.

MS 4.7 Wed 12:00 U A-Esch 2

Nuclear Forensics on the 135Cs/137Cs ratio by ICP-QQQ-MS — •Dorian Zok, Rebecca Querfeld, Lena Grüger, and Georg Steinhauser — Leibniz Universität Hannover - Institute of Radioecology and Radiation Protection

The atmospheric fallout and the Chernobyl disaster have released a lot of radioactive material, which has contaminated Germany. The most famous element is the cesium with his directly produced radioactive fission isotope 137Cs (T1/2 = 30 a). Just with the 137Cs it is not possible to say something about the origin. The remedy is the ratio 135Cs/137Cs with the long-living isotope 135Cs (T1/2 = 2.3 Ma). Additionally, the formation of the daughter 135Cs from the mother 135Xe depends on the currently occurring neutron flux. The analyse is done by a Triple-Quadrupole-Mass spectrometer (ICP-QQQ-MS). This allows a further suppression of isobaric interference by the use of a reaction gas after a previous element-specific separation. In the case of cesium the nitrous oxide N2O reacts with the isobaric Barium (Ba) to barium oxide (BaO+). The radioecological questions of the wild boar paradox with the not decreasing amounts of radiocesium and the general analyse of environmental and food samples are in the focus of the research. Another point is the origin analyse of radioactive, amorphous glass beads out of the destroyed reactors in Fukushima, with should be achieved with a spatially resolved laser ablation unit coupled to the mass spectrometer.