MS 9: Accelerator Mass Spectrometry and Applications II

Time: Thursday 14:30–16:15 Location: f128

Invited Talk MS 9.1 Thu 14:30 f128

Multi-actinide analysis with AMS for ultra-trace determination and small sample sizes: advantages and drawbacks — •Francesca Quinto[1], Markus Lagos[1], Markus Plaschke[1], Thorsten Schäfer[1], Peter Steier[2], Robin Golser[2], and Horst Geckeis[1] — [1]Institute for Nuclear Waste Disposal, Karlsruhe Institute of Technology, Germany — [2]VERA Laboratory, Faculty of Physics, University of Vienna, Austria

With the abundance sensitivities of AMS for U-236, Np-237 and Pu-239 relative to U-238 at levels lower than 1E-15, a simultaneous determination of several actinides without previous chemical separation from each other is possible. The actinides are extracted from the matrix elements via an iron hydroxide co-precipitation and the nuclides sequentially measured from the same sputter target. This simplified method allows for the use of non-isotopic tracers and consequently the determination of Np-237 and Am-243 for which isotopic tracers with the degree of purity required by ultra-trace mass-spectrometric analysis are not available. With detection limits of circa 1E+4 atoms in a sample, 1E+8 atoms are determined with circa 1 % relative uncertainty due to counting statistics. This allows for an unprecedented reduction of the sample size down to 100 ml of natural water. However, the use of non-isotopic tracers introduces a dominating uncertainty of up to 30 % related to the reproducibility of the results. The advantages and drawbacks of the novel method will be presented with the aid of recent results from the CFM Project at the Grimsel Test Site and from the investigation of global fallout in environmental samples.

MS 9.2 Thu 15:00 f128

Detection of Pu in Pacific Ocean water with AMS related to the Fukushima accident — •Karin Hain[1], Thomas Faestermann[1], Leticia Fimiani[1], Robin Golser[2], José Manuel Guzmán[1], Gunther Korschinek[1], Florian Kortmann[1], Christoph Lierse v. Gostomski[1], Peter Ludwig[1], Peter Steier[2], and Masatoshi Yamada[3] — [1]TUM, Germany — [2]Universität Wien, Austria — [3]Hirosaki University, Japan

The concentration of plutonium (Pu) and its isotopic ratios were determined by accelerator mass spectrometry (AMS) in Pacific Ocean water samples. The isotopic ratios ^{240}Pu/^{239}Pu and ^{241}Pu/^{239}Pu can be used to identify a possible release of Pu into the ocean by the Fukushima accident. ^{241}Pu from fallout of nuclear weapon testings has already significantly decayed. ^{241}Am, the daughter nuclide of ^{241}Pu, causes isobaric background on ^{241}Pu in mass-spectrometric measurements. Therefore, Am and Pu had to be separated chemically using extraction chromatography. The method was verified by analyzing certified reference material. 12 sea water samples, collected at different depths, were prepared at the Radiochemie München. The concentration of Pu was measured with AMS at the Maier-Leibnitz-Laboratory in Munich and the Vienna Environmental Research Laboratory (VERA). After a short motivation related to the Fukushima accident, the chemical separation method will be presented. Preliminary results of the distribution of Pu in ocean water will be discussed. This work was funded by the Studienstiftung des deutschen Volkes. We would like to acknowledge the valuable support of T. Shinonaga.

MS 9.3 Thu 15:15 f128

I-129 in Böden der nördlichen Ukraine und die retrospektive Dosimetrie der I-131-Exposition nach dem Reaktorunfall von Tschernobyl — •Abdelouahed Daraoui[1], Rolf Michel[1], Monika Gorny[1], Dieter Jakob[1], Rüdiger Sachse[1], Clemens Walther[1], Vassili Alfimov[2] und Hans-Arno Synal[2] — [1]Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannnover, Deutschland — [2]Labor für Ionenstrahlphysik, ETH Zürich, Schweiz

Nach dem Unfall von Tschernobyl stiegen in der Ukraine, Weißrussland und Russland die Fälle von Schilddrüsenkrebs bei Jugendlichen aufgrund der I-131 Strahlenexpositionen dramatisch an. Aufgrund von zu wenigen direkten Messungen der Schilddrüsenaktivitäten ist die Dosimetrie der I-131 Expositionen nicht befriedigend. Mit Hilfe des langlebiges I-129 kann retrospektiv der Fallout von I-131 nach dem Unfall von Tschernobyl bestimmt. Dafür wurden 300 Bodenproben aus 60 Siedlungen aus der nördlichen Ukraine aus Kontaminationszone II und III im Zeitraum zwischen 2004 und 2007 untersucht. Mit Hilfe von AMS für I-129 werden die Bodenproben analysiert. Die Ergebnisse zeigen, dass noch immer mehr als 90 % der I-129-Konentration in den oberen 40 cm der Bodenprofilen zu lokalisieren sind. Die I-129-Inventare sind mit den Cs-137-Inventare in den hoch kontaminierten Gebieten korreliert. Allerdings ist die Variabilität der I-129/Cs-137 Verhältnisse groß, sodass für die retrospektive Dosimetrie auf die I-129-Daten zurückzugreifen ist. Aus den I-129 Inventaren wurden über aggregierte Dosisfaktoren die I-131 Schilddrüsendosen berechnet. Die Ergebnisse werden mit direkten Messungen der Schilddrüsenaktivität verglichen.

MS 9.4 Thu 15:30 f128

Development of high-sensitivity AMS for ^{93}Zr — Boyana Deneva[1], Thomas Faestermann[1], Leticia Fimiani[1], José Manuel Gómez-Guzmán[1], Karin Hain[1], Gunther Korschinek[1], •Peter Ludwig[1], Victoria Sergeyeva[2], Nicolas Thiollay[2], and Olivier Vigneau[2] — [1]Physik Department TUM, Garching — [2]Centre CEA, Cadarache, France

The radioisotope ^{93}Zr ($T_{1/2}$ = 1.5 Ma) represents a very challenging background situation for AMS. Its two stable neighbouring isotopes ^{92}Zr and ^{94}Zr only differ in mass by ∼1%, making them difficult to separate. Additionally, the stable isobar ^{93}Nb with only one unit difference in proton number, needs to be suppressed in order to achieve high sensitivity. In recent studies at the Maier-Leibnitz-Laboratory in Garching, different experimental approaches have been explored: Firstly, by using stacked passive absorber (SiN) foils, exploiting the energy loss difference of ^{93}Zr and ^{93}Nb, in combination with a time-of-flight measurement and isotopic suppression of the neighbouring isotopes by a Wien-filter. And secondly, using the gas-filled magnet system GAMS providing isobaric suppression, in combination with an ionization chamber with a five-fold segmented anode. Both techniques have shown excellent preliminary results with sensitivities for the atom ratio of ^{93}Zr/Zr $\approx 2 \cdot 10^{-10}$. This opens the door towards applications in the fields of nuclear materials, fuel behaviour, and waste management, but also nuclear astrophysics, where ^{93}Zr represents a weak branching point in the s-process.

MS 9.5 Thu 15:45 f128

Accretion rate of IDPs onto the Earth by means of ^{53}Mn and ^{41}Ca AMS measurement in Antarctic snow — •Jose Manuel Gomez Guzman[1], Shawn Bishop[1], Thomas Faestermann[1], Jenny Feige[2], Leticia Fimiani[1], Karin Hain[1], Sepp Kipfstuhl[3], Gunther Korschinek[1], Peter Ludwig[1], Silke Merchel[4], Dario Rodrigues[5], Johannes Sterba[6], Jan Welch[6], and Rolf Weller[3] — [1]Technische Universität München, Fakultät für Physik, Garching (Germany) — [2]Zentrum für Astronomie und Astrophysik TU Berlin, Berlin (Germany) — [3]Helmholtz-Zentrum Alfred-Wegener-Institut. Bremerhaven (Germany) — [4]Helmholtz-Zentrum Dresden-Rossendorf (Germany) — [5]Laboratorio TANDAR, Comisión Nacional de Energía Atómica (Argentina) — [6]Atominstitut der Technische Universität Wien (Austria)

Interplanetary Dust Particles (IDPs) are small grains, a few hundred micrometers in size and mainly originated in the Asteroid Belt. During their flight to the Earth they are irradiated by GCR and SCR and ^{41}Ca ($T_{1/2} = 1.03 \times 10^5 yr$) and ^{53}Mn ($T_{1/2} = 3.68 \times 10^6 yr$) are formed. Since there are no significant terrestrial sources for those radionuclides they can be used as a key tracer to determine the accretion rate of IDPs onto the Earth. For this project, 550 kg of snow have been collected at the Antarctic German station Kohnen to be processed to extract ^{41}Ca and ^{53}Mn. Also the filter used will be processed to check the existence of IDPs surviving evaporation during their entry in the atmosphere. The AMS measurements will be made at the MLL in Garching, a facility with sensitivity down to 10^{-16} for ^{41}Ca and 10^{-14} for ^{53}Mn.

MS 9.6 Thu 16:00 f128

Dating with Atom Trap Trace Analysis of ^{39}Ar — •Sven Ebser[1], Zhongyi Feng[1], Lisa Ringena[1], Florian Ritterbusch[1,2], Arne Kersting[2], Stefan Beyersdorfer[2], Emeline Mathouchanh[2], Werner Aeschbach[2], and Markus K. Oberthaler[1] — [1]Kirchhoff-Institute for Physics, Heidelberg, Germany — [2]Institute of Environmental Physics, Heidelberg, Germany

Atom Trap Trace Analysis (ATTA) is an ultra-sensitive counting method for rare and long-lived isotopes. It is based on the high selectivity of resonant photon scattering during laser cooling and trapping in

order to distinguish the rare isotope from the abundant ones. We have focused on the rare argon isotope ^{39}Ar and developed an ATTA-setup. As an inert noble gas and with a half-life of 269 years it is the perfect tracer to fill the dating gap for ice and water samples between 50 and 1000 years before present, for which time period no other tracers exist. The experimental challenge lies in the low atmospheric abundance of ^{39}Ar ($^{39}\mathrm{Ar/Ar} = 8.23 \cdot 10^{-16}$) which requires a stable and reproducible performance of all components of the apparatus leading to a robust ^{39}Ar detection efficiency. Our first results from groundwater samples reveal the potential of this table top experiment to routinely measure small samples down to 10 mL STP of argon. Furthermore, we will present current developments such as more efficient cooling techniques and optical pumping to enhance the flux of metastable argon atoms with the aim to increase the count rate. Shorter measurement times and smaller sample sizes together with a reduction of statistical uncertainties will thus become possible.