MS 9: Accelerator Mass Spectrometry IV

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

Invited Talk MS 9.1 Fri 11:00 HS 3042

Influx of interstellar ^{60}Fe and ^{244}Pu onto Earth within the last 10 million years recorded in a ferromanganese crust — •Dominik Koll[1,2,3], Anton Wallner[2,3], Michael Hotchkis[4], Sebastian Fichter[2], L. Keith Fifield[1], Michaela Froehlich[1], Michi Hartnett[1], Johannes Lachner[2], Stefan Pavetich[1], Georg Rugel[2], Zuzana Slavkovska[1], and Steve Tims[1] — [1]The Australian National University, Canberra, Australia — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [3]TU Dresden, Dresden, Germany — [4]Australian Nuclear Science and Technology Organisation, Sydney, Australia

Within the last 25 years, copious evidence was presented for supernova-produced ^{60}Fe influxes onto Earth using accelerator mass spectrometry (AMS); pointing to a near-Earth supernova activity within the last few million years. The rare interstellar *r*-process radionuclide ^{244}Pu, however, was only recently discovered. The combination of both, supernova-produced ^{60}Fe and *r*-process ^{244}Pu, allows to shed light onto the nucleosynthesis site of heavy elements in the universe.

A well-characterized and ^{10}Be-dated ferromanganese crust from the Pacific Ocean was used to search for ^{60}Fe and ^{244}Pu abundances with unprecedented time-resolution and sensitivity. The acquired ^{60}Fe profile shows two pronounced peaks of ^{60}Fe influxes with updated timing. A *r*-process ^{244}Pu influx was discovered with a time-resolution of 1 Myr within the last 10 Myr due to the extraordinarily high total efficiency of Pu AMS of 1% achieved in this project.

MS 9.2 Fri 11:30 HS 3042

Environmental ^{99}Tc concentrations determined by AMS — •Karin Hain[1], Stephanie Adler[1], L. Keith Fifield[2], Fadime Gülce[1], Martin Martschini[1], Stefan Pavetich[2], Stephen G. Tims[2], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]Australian National University, Research School of Physics, Australia

In the last 4.5 years we have intensively studied possibilities of analyzing environmental concentrations of the anthropogenic radionuclide ^{99}Tc ($t_{1/2}$ =2.1·10^5 yr) with AMS. The applied techniques for isobar suppression comprised the gas-filled analyzing system (GAMS) at the TU Munich and an 8-anode ionization chamber at the Australian National University (ANU, Canberra), both using a tandem accelerator with a terminal voltage of up to 14 MV. Experiments using the 3 MV tandem at VERA investigated the application of Ion-Laser InterAction Mass Spectrometry (ILIAMS). While all three methods achieved a ^{99}Ru suppression that enabled detection of Tc from global fallout, i.e. a blank level below 5·10^6 at/sample, none of them could make use of the ^{97}Tc spike added for normalization to obtain absolute concentrations owing to its omnipresent isobar ^{97}Mo. At ANU, we have followed the example of TU Munich and used the $^{93}Nb^{12+}$ current for normalization, achieving a precision of 15% when extracting TcO^- and NbO^- from the ion source. This allowed the determination of the ^{99}Tc concentration in selected samples from different environmental reservoirs, including 1 g peat bog samples and 10 L water samples from the Pacific Ocean and European rivers.

MS 9.3 Fri 11:45 HS 3042

Isobar suppression and normalization methods for ultra-trace analysis of Tc-99 — •Stephanie Adler[1], Karin Hain[1], Martin Martschini[1], Stefan Pavetich[2], Steve G. Tims[2], L. Keith Fifield[2], Dominik Koll[2], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]Australian National University, Research School of Physics, Australia

Determination of absolute concentrations of the anthropogenic radionuclide ^{99}Tc ($t_{1/2}$=2.1 × 10^5 yr) in environmental samples by AMS requires suppression of the stable isobaric background of ^{99}Ru and a reliable normalization method. At the Vienna Environmental Research Accelerator (VERA), isobar suppression is addressed with Ion-Laser InterAction MS (ILIAMS). It was shown that RuF_5^- can be suppressed by a factor of up to 10^5 using a 532 nm-laser, making extraction of $^{99}TcF_5^-$ a viable option for ILIAMS. For normalization to NbF_5^- extracted from the same sample, the reproducibility of the method was significantly improved from 50% to 15% by optimization of ion source parameters. Without ILIAMS, the separation of ^{99}Ru from ^{99}Tc is currently only possible at the AMS facility at the Australian National University (ANU), using ion energies of up to 190 MeV. There, TcO^- extraction and normalization to the ^{93}Nb-current showed a reproducibility of 15%. ^{99}Ru and ^{99}Tc are separated in an 8-anode ionization chamber owing to minute differences in their energy loss characteristics, observable only at highest ion energies. This method yielded a Ru suppression factor of 8000, and recent investigations showed a potential improvement by using an additional SiN degrader foil stack.

MS 9.4 Fri 12:00 HS 3042

Towards the Redetermination of the Half-life of ^{32}Si - AMS Measurement — •Matthias Schlomberg, Christof Vockenhuber, and Hans-Arno Synal — Laboratory of Ion Beam Physics, ETH Zurich

^{32}Si is a cosmogenic, long-lived radionuclide with potentially interesting applications for dating the recent past. However, its half-life of about 150 years is still not known with sufficient precision despite several independent measurements over the past four decades. The SINCHRON collaboration with partners from PSI, CHUV, PTB and ETH aims at a comprehensive redetermination of the half-life of ^{32}Si.

The Laboratory of Ion Beam Physics (LIP) at ETH Zurich will perform the AMS measurements using the 6 MV-Tandem facility for the determination of the number of ^{32}Si atoms in the samples used for the activity measurement. This task is especially challenging since an absolute measurement must be performed without having any standard material available.

Therefore, we developed a dedicated method using a passive gas absorber in front of a gas ionization detector for separation of ^{32}Si from its isobar ^{32}S at 30 MeV and 40 MeV which is compared to the standard method of using a gas-filled magnet. In this talk, the measurement setup and first results are presented and discussed. Furthermore, an outlook is given for a possible improvement and application to natural samples.

MS 9.5 Fri 12:15 HS 3042

Towards the half-life of ^{135}Cs — •Alexander Wieser[1,2], Johannes Lachner[2], Serge Nagorny[3], Martin Martschini[1], Anton Wallner[2], and Robin Golser[1] — [1]University of Vienna - Faculty of Physics, Isotope Physics — [2]HZDR - Accelerator Mass Spectrometry and Isotope Research — [3]Queen's University Kingston - Engineering Physics and Astronomy

^{135}Cs is a long-lived radionuclide which is produced both naturally via spontaneous fission of ^{238}U and anthropogenically in neutron induced fission. The half-life of ^{135}Cs is of special interest for geological repositories for high-level nuclear waste. The dose from the repository is dominated by ^{135}Cs on a million year timescale, however the half-life is not very well known. Published values range from 0.7 Myr to 3.0 Myr. For determining the half-life we need both, an activity measurement and a mass-spectrometric determination of the number of ^{135}Cs atoms in a sample, however, both measurements are challenging. ^{135}Cs is a pure beta-emitter and has a low end-point energy of only 268 keV, making low-level beta-measurements difficult, mainly due to interferences from other short-lived cesium isotopes. For the mass spectrometric determination, Cs measurements suffer from isobaric interference from the highly abundant ^{135}Ba. We present in this talk first results of accelerator mass spectrometry measurements of ^{135}Cs in a Cs_2ZrCl_6-crystal which was previously analyzed at Laboratori Nazionali del Gran Sasso, where a ^{135}Cs activity in the 100 mBq/kg-range was determined [Belli et al. 2023, EPJ A].

MS 9.6 Fri 12:30 HS 3042

Characterizing Lunar Soil with Cosmogenic Radionuclides for the Search for Interstellar Radionuclides — •Sebastian Zwickel[1,2], Sebastian Fichter[1], Dominik Koll[1,2,3], Johannes Lachner[1], Marc Norman[3], Stefan Pavetich[3], Georg Rugel[1], Konstanze Stuebner[1], Steve Tims[3], Josua Vahle[1,2], Stephan Winkler[1], and Anton Wallner[1,2] — [1]Helmholtz-Zentrum Dreden-Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]Australian National University, Canberra, Australia

Despite being responsible for the nucleosynthesis of half of all heavier nuclides in the galaxy, the site of the r-process is still an open question in nuclear astrophysics. The detection of the pure r-process nuclide

^{244}Pu, live, in deep-sea ferromanganese crusts already demonstrated ongoing r-process events. A complementary archive for ^{244}Pu is lunar soil - lacking in time resolution, but offering a proposed exposure time to interstellar dust deposition ranging from a few up to hundreds of million years. In this project we aim for the detection of interstellar ^{244}Pu and ^{60}Fe in lunar soil. Important will be the proper characterization of lunar soil for exposure history and composition. Among various additional analytical methods, we measure cosmogenic ^{10}Be, ^{26}Al, ^{41}Ca and ^{53}Mn.

This talk presents first results of the cosmogenic radionuclides ^{10}Be, ^{26}Al and ^{53}Mn measured in a set of lunar samples and discusses their use in characterizing the exposure history of the samples.

MS 9.7 Fri 12:45 HS 3042

Chasing Stardust: Unveiling Radionuclide Signatures in Antarctic Ice — •Annabel Rolofs[1], Dominik Koll[1,2], Florian Adolphi[3], Maria Hörhold[3], Johannes Lachner[1], Stefan Pavetich[2], Georg Rugel[1], Steve Tims[2], Sebastian Zwickel[1], and Anton Wallner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [2]Australian National University (ANU), Canberra, Australia — [3]Alfred-Wegener-Institut, Bremerhaven, Germany

Radionuclides provide clues about the solar system's history and can elucidate the role of supernovae in its evolution. The production of ^{60}Fe in massive stars and its ejection in supernovae make this isotope an invaluable indicator to reconstruct cosmic history. Earlier studies showed an ^{60}Fe activity about 2 - 3 Myr ago, as well as an older influx 7 - 8 Myr ago, both attributed to interstellar dust containing traces of supernova-produced ^{60}Fe.

In this project, we analyse continuous-flow analysis (CFA) water from an Antarctic EDML ice core for its radionuclide concentrations to bridge a pivotal time gap in prior ^{60}Fe measurements. Antarctic ice offers a unique geological archive because the isolated location reduces terrestrial contamination to a minimum. The sample material spans a time period from 50,000 to 80,000 years ago. We will present results on the radionuclides ^{10}Be, ^{26}Al and ^{41}Ca that were measured at the DREAMS facility (HZDR), as well as ^{53}Mn and ^{60}Fe which were measured at HIAF (ANU).