MS 7: Accelerator Mass Spectrometry

Time: Thursday 14:30–16:30 Location: N 6

Invited Talk MS 7.1 Thu 14:30 N 6

Turning Atmospheric Radiocabon Variability into a Tool: High-Precision Tree-Ring Records for Solar Activity and Cross-Dating — •Lukas Wacker[1], Nicolas Brehm[1], Macus Christl[1], Hans-Arno Synal[1], Charlotte L. Pearson[2], Kurt Nicolussi[3], Thomas Pilcher[3], Alex Bayliss[4], and David Brown[5] — [1]Ion Beam Laboratory of Ion Beam Physics, Department of Physics, ETH Zurich, Switzerland — [2]Laboratory of Tree-Ring Research, University of Arizona, Tucson, USA — [3]Department of Geography, University of Innsbruck, Innsbruck, Austria — [4]Department of Anthropology and Archaeology, University of Bristol, Bristol, UK — [5]School of Natural and Built Environment, Queen's University, Belfast, UK

Atmospheric radiocarbon (^{14}C) concentrations over the last 10 000 years vary primarily due to changes in cosmogenic ^{14}C production driven by solar activity and Earth*s magnetic dipole moment. These variations complicate conventional radiocarbon dating, but also offer the opportunity to reconstruct past solar activity. Recent advances in state-of-the-art AMS systems developed at ETH Zürich now allow efficient production of highly precise, annually resolved ^{14}C time series from tree rings. In this contribution, we present what can be inferred about past solar activity from such annually resolved ^{14}C records. We further demonstrate that the fine structure in atmospheric ^{14}C is not only a bane for precise ^{14}C dating, but can become a powerful gain when exploited for dating other ^{14}C records and for precisely synchronizing paleoarchives containing cosmogenic radionuclides.

MS 7.2 Thu 15:00 N 6

Commissioning of the HAMSTER - the cutting edge accelerator mass spectrometry system at HZDR — •Stella Winkler[1], Shruti Dabke[1], Toralf Döring[1], Sebastian Fichter[1], Thilo Hauser[2], Dominik Koll[1], Allan O'Connor[2], Johannes Lachner[1], Georg Rugel[1], Mark Sundquist[2], Janis Wolf[1], René Ziegenrücker[1], Sebastian Zwickel[1], and Anton Wallner[1] — [1]Accelerator Mass Spectrometry & Isotope Research, Helmholtz-Zentrum Dresden- Rossendorf, 01328, Dresden — [2]National Electrostatic Corp. (NEC), Middleton, WI 53562, USA

The HAMSTER is currently the most advanced development in accelerator mass spectrometry (AMS) systems. It is based on a 'small' 1MV accelerator and designed to offer high performance for all AMS isotopes, be they established, in development or envisioned. The key AMS parts of the system were delivered and installed at HZDR from August to early October 2025. Since then, the phase of beam testing, trouble-shooting, and characterising performance is underway.

The HAMSTER features advanced capabilities for the heavy isotopes, to be measured at even the lowest levels currently known. Besides the instrumentation for radioisotopes, the equipped dynode electron multipliers offer new options for stable isotopes at trace element level.

Here we will present the physics background for AMS that drove the inception of this system, the installation and testing of this system, and first performance data for 'classic' AMS isotopes.

MS 7.3 Thu 15:15 N 6

First actinide performance tests at HAMSTER — •Dominik Koll, Shruti Dabke, Sebastian Fichter, Johannes Lachner, Georg Rugel, Stella Winkler, Sebastian Zwickel, and Anton Wallner — Accelerator Mass Spectrometry & Isotope Research, Helmholtz-Zentrum Dresden-Rossendorf, 01328, Dresden

The newly installed Helmholtz Accelerator Mass Spectrometer Tracing Environmental Radionuclides (HAMSTER) facility at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) has been designed for actinide AMS measurements with high detection efficiency and sensitivity. These capabilities are essential for advancing environmental and nuclear astrophysics research. Plutonium was selected as the initial actinide to be tested because the sister facility VEGA at ANSTO (Australia) demonstrated that plutonium detection efficiencies approaching 1% are feasible; thereby setting the benchmark for HAMSTER.

In this contribution, we present the approach adopted for actinide AMS at HAMSTER, describe the first steps undertaken with plutonium, and discuss the main technical challenges encountered during early operation. Furthermore, we report first measurement results illustrating the current performance of the facility. An outlook on planned developments as well as upcoming scientific applications of HAMSTER, with a particular emphasis on future searches for interstellar radionuclides, will be given.

MS 7.4 Thu 15:30 N 6

$^{14}CO_2$ Pine Tree Ring Measurement at CologneAMS — •Martina Gwozdz[1], Thorsten Westphal[2], Susanne Lindauer[3], Stefan Heinze[1], Markus Schiffer[2], and Dennis Mücher[1] — [1]University of Cologne, Institute for Nuclear Physics, Cologne, Germany — [2]University of Cologne, Department of Prehistoric Archaeology, Laboratory of Isotope Archaeology — [3]Curt-Engelhorn-Centre Archaeometry, Mannheim, Germany

An assemblage of pine trees was recovered in February 2021 in Paderborn, Schloss Neuhaus. Preliminary radiocarbon-dating of a pine cone places the age to the Late Paleolithic or Allerød Interstadial, approximately 11 400 - 10 700 BC. Attempts to correlate the ring-width series with established Late Glacial pine chronologies from Switzerland (Zürich, Winterthur), Central Poland (Koźmin), and the Netherlands (Leusden-Den Treek) have yielded no successful alignment so far. We measured the radiocarbon age of the tree rings at CologneAMS with CO_2 samples and at CEZA Mannheim with graphitization samples. The resulting calibrated age range of 11 400 - 10 800 cal BC confirms the Late Glacial context of the assemblage. These parallel measurements provided an opportunity for us to compare the performance of the CologneAMS small-sample CO_2 setup with the established graphitization procedure, while simultaneously expanding the dendrochronological archive for Late Glacial pine material.

MS 7.5 Thu 15:45 N 6

Constraints on the local fluence of interstellar ^{60}Fe on the Moon — •Sebastian Zwickel[1,2], Sebastian Fichter[1], Michael Hotchkis[3], Dominik Koll[1,4], Johannes Lachner[1], Marc Norman[4], Stefan Pavetich[4], Georg Rugel[1], Konstanze Stübner[1], Stephen Tims[4], and Anton Wallner[1,2,4] — [1]HZDR, Dresden, Germany — [2]TU Dresden, Germany — [3]ANSTO, Sydney, Australia — [4]ANU, Canberra, Australia

The lunar regolith is a promising archive for live interstellar radionuclides such as supernova-^{60}Fe and r-process ^{244}Pu. Due to the absence of geological activity, interstellar material can accumulate in the upper regolith over a few to up to several hundred Myr. This provides an integral record of nucleosynthesis in the solar neighbourhood, albeit with limited time resolution. Our measurements of the interstellar particle influx probe the astrophysical site of the r-process using ^{244}Pu and constrain the local lunar fluence of interstellar ^{60}Fe. Regolith mixing from continuous (micro-)meteoritic bombardment dilutes interstellar radionuclide inventories over depth and is taken into account.

This contribution presents new results on the local lunar fluence of interstellar ^{60}Fe obtained from surface soil samples. Lunar soils that are expected to contain the full ^{60}Fe inventory observed in previous lunar depth profiles and terrestrial archives were identified by relating cosmogenic ^{26}Al to interstellar ^{60}Fe. A lower limit of interstellar ^{60}Fe fluence was established from a sample with $\mathcal{O}$(Myr) surface exposure. Together with ^{60}Fe, we also present first data on the search for interstellar ^{244}Pu in lunar soil samples.

MS 7.6 Thu 16:00 N 6

Sample preparation of $CaSO_4$-containing sediments for exposure dating by ^{36}Cl — •Natasha Goaba Kalanke[1,2], Markus Schiffer[2,3], Stefan Heinze[2], Erik Strub[4], Gregory Campbell[1], Michael Staubwasser[5], Steven Binnie[5], and Dennis Muecher[2] — [1]Department of Physics and Astronomy, Botswana International University of Science and Technology — [2]Institute of Nuclear Physics, University of Cologne — [3]Laboratory of Isotope Archaeology, Department of Prehistoric Archaeology, University of Cologne — [4]Institute of Nuclear Chemistry, University of Cologne — [5]Institute of Geology and Mineralogy, University of Cologne

The application of cosmogenic ^{36}Cl exposure dating to gypsum ($CaSO_4 \cdot 2H_2O$) is limited by pervasive sulfur isobaric interference and complex chemical purification requirements. A novel chemical protocol that effectively isolates chlorine from a sulfate-rich gypsum matrix has been developed. It was tested through procedural chemical blanks and natural gypsum deposits from the Atacama Desert with isotope dilution (ID-AMS). Chemical blanks were processed by the new protocol and revealed, on average, a ^{36}Cl/^{35}Cl ratio of $(1.5 \pm 3.48) \times 10^{-14}$ with $^{35}Cl^{5+}$ currents ranging from 4-10 μA. The method will be used for exposure age determination of gypsum landforms including evaporite deposits, desert crusts and paleohydrological features, opening new avenues for Quaternary research in arid and sulfate-rich environments. First preliminary results of gypsum samples from the Atacama Desert will be reported and compared to their U-Th dating.

MS 7.7 Thu 16:15 N 6

Setting up Super-SIMS at HAMSTER — •Georg Rugel, Toralf Döring, Sebastian Fichter, Dominik Koll, Johannes Lachner, Axel D. Renno, Stella Winkler, René Ziegenrücker, and Anton Wallner — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The combination of Accelerator Mass Spectrometry (AMS) with the capabilities of a secondary-ion mass spectrometer (SIMS: IMS 7f-Auto from Cameca) is challenging. The idea is to use the micron-scale spatial resolution of the SIMS and the high selectivity through molecule suppression by the stripping process at an AMS system, a combination named Super-SIMS. The aim is to detect background-limited trace elements more sensitively than regular SIMS or other techniques. After first steps at the DREsden AMS-facility (DREAMS) at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) [1] the system moved to the new compact facility HAMSTER (Helmholtz Accelerator Mass Spectrometer Tracing Environmental Radionuclides) dedicated for AMS measurements and designed to incorporate Super-SIMS capabilities [2]. HAMSTER is based on a 1-MV tandem accelerator and has dedicated instruments for tuning low current ion-beams $<$ nA from the SIMS. In this presentation, I will highlight the current status after arrival of the HAMSTER system, achieved transmissions and future initiatives. [1] Rugel, G. et al.(2022)NIMB, 532, 52-57. [2] this conference.