# MS 9: Accelerator Mass Spectrometry and Applications II

Time: Thursday 14:30–17:00 Location: RW 2

MS 9.1 Thu 14:30 RW 2

**AMS measurements of $^{26}$Al at ETH Zurich** — •Christof Vockenhuber[1], Marcus Christl[1], Klaus-Ulrich Miltenberger[1], Arnold Müller[1], Kristina Hippe[1], and Naki Akçar[2] — [1]Laboratory of Ion Beam Physics, ETH Zurich, Switzerland — [2]Institute of Geological Sciences, University of Bern, Switzerland

At ETH Zurich $^{26}$Al has been measured for many decades at the 6 MV EN tandem accelerator. Compared to other cosmogenic rationuclides (e.g. $^{10}$Be), the number of samples was always smaller because of the limited precision that could be achieved. A key challenge is the low ionization efficiency of $^{26}Al^-$ (from an Al-oxide matrix) required to suppress the isobar $^{26}$Mg. Recent developments at low energies at the 500 kV TANDY promised significant improvements in overall efficiency due to higher transmission through the accelerator. Alternatively, the ionization efficiency can be increased by using $^{26}AlO^-$ from the ion source; however, then, high ion energies and the gas-filled magnet (GFM) are necessary to remove the majority of interfering $^{26}$Mg before the final detector. In this talk we will give a comparison of the measurement methods at ETH Zurich, present their performance under routine measurement conditions and finally discuss the advantages and limitations of each setup.

MS 9.2 Thu 14:45 RW 2

**Gas flow dynamics in an AMS stripper** — •Sascha Maxeiner, Hans-Arno Synal, Marcus Christl, Lukas Wacker, and Andreas Herrmann — Laboratory for Ion Beam Physics (LIP), ETH Zurich, Switzerland

The stripper of an AMS system is required to strip off electrons from the incident negative ion beam and it is responsible for the dissociation of molecules. In low energy AMS gas strippers are widely applied. Besides their desired effects (charge exchange and molecule destruction) gas strippers can have a big influence on measurement sensitivity and background. For example, the interaction of incident ions with residual stripper gas outside of the stripper tube, e.g. during acceleration, is known to cause interferences which limit the abundance sensitivity.

In this presentation processes are discussed which can lead to increased leakage of stripper gas into the AMS beam line. Methods are presented to model these processes and an experimental setup is described to measure the gas leakage out of the stripper tube. The results of both, experiments and simulations are used to optimize the separation of stripper target and vacuum by designing new stripper geometries. As an example, the application of the optimization procedure to the TANDY AMS facility is presented and the potential of the new tool for optimization of existing systems is discussed.

MS 9.3 Thu 15:00 RW 2

**Improvement of the Laser Ablation Interface for Direct $^{14}$C -AMS analysis of carbonates** — •Christiane Yeman[1], Caroline Welte[1], Bodo Hattendorf[2], Joachim Koch[2], Marcus Christl[1], Lukas Wacker[1], and Allen Andrews[3] — [1]Laboratory of Ion Beam Physics, ETH Zurich, 8093 Zurich, Switzerland — [2]Laboratory for Inorganic Chemistry, ETH Zurich, 8093 Zurich, Switzerland — [3]NOAA Fisheries, Pacific Islands Fisheries Science Center, HI 96818, USA

A novel method for direct and quasi continuous $^{14}$C analysis of carbonates was developed, where a laser ablation (LA) system is coupled to the gas ion source of the MICADAS (MIniCArbonDAtingSystem) accelerator mass spectrometer (AMS) at the Laboratory of Ion Beam Physics, ETH Zurich. By focusing a pulsed laser beam (ArF excimer laser 193 nm, 200 - 250 Hz) on the sample surface, $CO_2$ is produced, which is directly and continuously introduced into the gas ion source and analyzed for radiocarbon. With the new design of the ablation cell and the modified optical setup the energy on the sample is doubled leading to higher $CO_2$ production. Moreover, the spatial resolution has improved from 100$\mu$m down to 75$\mu$m.

LA-AMS can be used for the analysis of terrestrial and marine carbonate samples, such as stalagmites, corals, shells and otoliths. Here, we present the analysis of the otolith of a red snapper (Lutjanus campechanus) - only a few hundred micrometers thick - by LA-AMS. The $^{14}$C signature recorded for the lifespan of the fish shows pre-bomb and peak $^{14}$C, indicating the fish was more than 50 years old.

MS 9.4 Thu 15:15 RW 2

**$^{14}CO_2$ Radiocarbonmessungen am CologneAMS *** — •Alexander Stolz[1], Alfred Dewald[1], Stefan Heinze[1], Richard Altenkirch[1], Markus Schiffer[1], Claus Müller-Gatermann[1] und Tibor Dunai[2] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Geologie, Universität zu Köln

Die zweite HVE-SO110 Sputterquelle am CologneAMS-Beschleuniger der Universität zu Köln wurde mit einem Gasinjektionssystem der Ionplus AG ausgestattet, um $^{14}CO_2$ Radiocarbonmessungen durchzuführen. Nach anfänglichen Instabilitäten der Quelle und vergleichsweise geringen Ionisierungseffizienzen von maximal 2% wurden nun Betriebsparameter gefunden, die einen stabilen Routinebetrieb bei Effizienzen über 5% gewährleisten. Um eine maximale Ausleuchtung der Ti-Inserts zu erreichen wurde eine modifizierte Immersionslinse verbaut und der Cs-Strahl vermessen. Die Targetposition und -geometrie wurden der neuen Optik angepasst. Zusätzlich wurde eine neue Steuerungssoftware für das Gasinjektionssystem entwickelt, die eine automatisierte Regelung des Gasflusses und optimierte Routinen für den Transfer und die Mischung sehr kleiner Proben bis 2 $\mu$g C mit dem Trägergas He bereitstellt. Testmessungen und Resultate zur Untersuchung der Abhängigkeiten von Probengröße, Mischungsverhältnis, Position und Targetspannung, sowie zur Reproduzierbarkeit der gemessenen $^{14}C/^{12}C$-Verhältnisse werden vorgestellt.

* Das Projekt wurde teilweise aus Mitteln des Deutschen GeoForschungsZentrums GFZ, Helmholtz-Zentrum Potsdam finanziert.

MS 9.5 Thu 15:30 RW 2

**Current developments for AMS with medium mass isotopes in Garching** — •Peter Ludwig[1], Christoph Busser[1], Thomas Faestermann[1], Jose Manuel Gomez Guzman[1], Karin Hain[2], Dominik Koll[1], Gunther Korschinek[1], David Krieg[1], and Manuel Lebert[1] — [1]Physik Department, Technische Universität München — [2]Isotopenforschung und Kernphysik, Universität Wien

The AMS setup at the Maier-Leibnitz-Laboratory (MLL) in Garching features a 14 MV tandem accelerator and two dedicated beam lines for high-sensitivity measurements of isotopes in all mass ranges. Especially in the medium mass range ($70 < A < 120$), AMS sensitivity is often limited by isobaric and isotopic background with only small relative difference in Z and/or A. Recent developments at the MLL are aimed at improved sensitivity for isotopes such as 79Se, 93Zr, and 99Tc. Possible applications include the measurement of astrophysical cross-sections and environmental studies. In this talk, I will present the employed measurement techniques, specifically isobaric suppression via either a gas-filled magnet or passive absorber foils, and show the status of the current upgrade of the facility with a new silicon detector array.

MS 9.6 Thu 15:45 RW 2

**New and upgraded ionization chambers for AMS at HIAF** — •Martin Martschini, Keith Fifield, Michaela Froehlich, Stefan Pavetich, Stephen Tims, and Anton Wallner — Department of Nuclear Physics, The Australian National University, ACT 2601, Australia

Radionuclides measured by Accelerator Mass Spectrometry at the Heavy Ion Accelerator Facility (HIAF) of the Australian National University include $^{10}$Be, $^{26}$Al, $^{36}$Cl, $^{53}$Mn, $^{60}$Fe, $^{93}$Zr, $^{129}$I, $^{236}$U and Pu. The 14UD pelletron accelerator provides ample energy for isobar separation using a gas-filled-magnet setup with an ENGE-split-pole spectrograph.

In order to fully exploit the isotopic and isobaric separation capabilities, three new ionization chambers are currently being designed and constructed: Two new compact ionization chambers based on similar designs to those at ETH Zurich and at VERA (Vienna) allow for measurements of actinides and other radioisotopes without atomic isobaric interferences. While one is optimized for high energy resolution, the other serves as the final energy detector in a time-of-flight setup. The third ionization chamber is a new multi-anode device optimized for the detection of $^{53}$Mn after the gas-filled magnet. The design is based on simulations with Raytrace and SRIM. Last but not least, an existing ionization chamber used, e.g., for $^{93}$Zr-measurements is undergoing an upgrade of detector electronics. Details of these projects and first experimental results will be discussed.

MS 9.7 Thu 16:00 RW 2

**Erste Tests für $^{44}$Ti-AMS an DREAMS** — •Andreas Scharf[1], Daniel Bemmerer[1], Tamás Ditrói[2], Nasrin B. Khojasteh[1], Silke Merchel[1], Georg Rugel[1] und Kai Zuber[3] — [1]HZDR, Dresden, Germany — [2]University of Debrecen, Hungary — [3]TU Dresden, Germany

Das Radionuklid $^{44}$Ti ($T_{1/2}$ = 58,9 a) wird vor allem während Supernovaexplosionen gebildet und spielt eine wichtige Rolle für deren theoretische Modelle und die Nukleosynthese schwerer Elemente. In Supernovaüberresten kann $^{44}$Ti mittels $\gamma$-Astronomie nachgewiesen werden, allerdings befinden sich die Beobachtungen nicht im Einklang mit den theoretischen Modellen. Problematisch dabei ist, dass der Wirkungsquerschnitt der Reaktion $^{40}$Ca($\alpha$,$\gamma$)$^{44}$Ti bisher nur unzureichend bekannt ist [1]. Während bislang nur $^{44}$Ti-AMS-Messungen an großen Beschleunigern (ab 10 MV Terminalspannung) durchgeführt wurden [2], sollte es prinzipiell auch möglich sein, an 6-MV-Anlagen dieses Radionuklid zuverlässig zu messen. Wir präsentieren erste Tests an der AMS-Anlage DREAMS des HZDR, die zeigen, dass mithilfe einer Degrader-Folie eine zuverlässige Abtrennung des stabilen Isobars $^{44}$Ca und Messung des Radionuklids $^{44}$Ti auch bei Beschleunigungsspannungen von 6 MV möglich ist. Diese ersten Tests dienen dazu, die Machbarkeit von AMS-basierten Messungen des Wirkungsquerschnitts der Reaktion $^{40}$Ca($\alpha$,$\gamma$)$^{44}$Ti an DREAMS auszuloten. Das Projekt wurde unterstützt vom DAAD.

Ref.: [1] Schmidt et al., Phys. Rev. C 88, 025803 (2013) [2] Nassar et al., Phys. Rev. Let. 96, 041102 (2006)

MS 9.8 Thu 16:15 RW 2

**Mass spectrometry and the evolution of the western Namibian drainage systems** — •Andreas Gärtner[1], Ulf Linnemann[1], Silke Merchel[2], Samuel Niedermann[3], Axel Gerdes[4], Georg Rugel[2], Andreas Scharf[2], Loic Le Bras[2], Mandy Hofmann[1], and Johannes Zieger[1] — [1]SNSD, Geochronologie, Dresden, Germany — [2]HZDR, Dresden, Germany — [3]GFZ, Potsdam, Germany — [4]JWG-Universität Frankfurt, Institut für Geowissenschaften, Frankfurt, Germany

Our multi-method MS study (AMS, noble gas MS, LA-(MC)-ICP-MS) aims to constrain the evolution of the western Namibian drainages since the last ca. 40 Ma. Therefore, fluvial sediments of several rivers and their precursors were sampled. In order to obtain precise surface exposure ages of the various terrace levels, the routinely used cosmogenic nuclides $^{10}$Be, $^{21}$Ne, $^{26}$Al (quartz), and $^{36}$Cl (calcite) were applied either on surface samples or on depth-profiles consisting of 3 to 5 samples each. U-Pb small scale isochrone (SSI) ages of calcareous matrices were also used for terrace dating. Sedimentary provenances were revealed by detrital zircon ($ZrSiO_4$) geochronology using U-Th-Pb and Lu-Hf isotope systematics. They indicate varying detrital zircon patterns through time. Our approach facilitates the recognition of changes in the fluvial sediment provenance at certain points in time. Such combined studies have a huge potential for revealing the palaeohydrological history, and to estimate amplitudes and processing speeds of past events or changing sizes of catchment areas, which is of particular interest for modelling the palaeoclimate and palaeogeography.

MS 9.9 Thu 16:30 RW 2

**Tackling challenges in AMS sample preparation** — •Silke Merchel[1], Loic Le Bras[1], Sabrina Gurlit[1], Georg Rugel[1], Andreas Scharf[1], Thomas Opel[2], and Sebastian Wetterich[2] — [1]HZDR, Dresden, Germany — [2]AWI, Potsdam, Germany

Since 2009 the DREAMS (DREsden Accelerator Mass Spectrometry) facility offers users to do their own sample preparation for AMS targets. A large number of samples from interdisciplinary research topics such as astronomy, climate, cosmochemistry and geology could be transformed into BeO, $Al_2O_3$, AgCl and $CaF_2$ showing reasonable to excellent performance [Rugel et al., this DPG.]. However, besides our constant approach to become a little better every day, sometimes very new challenges can arise due to the low availability of the sample material, low radionuclide concentration or a possible contamination of the sample with disturbing elements and nuclides. Two examples:

Ice samples are always in our focus. As we were facing problems with $^{10}$Be contamination in "dirty" ground ice, we measured $^{36}$Cl and $^{nat}$Cl by isotope dilution in permafrost ice wedge samples as heavy as 1.6 kg. The chemical yield of AgCl was only 20-35% (and is a function of total $^{nat}$Cl), which might be improved by preconcentration steps.

For the determination of in-situ or atmospheric $^{26}$Al in marine and terrestrial sediments [e.g. Gärtner et al., this DPG.], we had sometimes unaccountable low chemical yields, which seems to be partially due to redissolving aluminium hydroxide in the last washings.

Thanks to A. Gärtner, P. Ludwig, D. Rodrigues and several students for providing/processing samples.

MS 9.10 Thu 16:45 RW 2

**Avoiding pitfalls: Better performance of AMS at DREAMS** — •Georg Rugel[1], DREAMS users[2], Nasrin B. Khojasteh[1], Silke Merchel[1], Andreas Scharf[1], and René Ziegenrücker[1] — [1]HZDR, Dresden, Germany — [2]all over the world

Since autumn 2011, the DREsden AMS-facility (DREAMS), is performing routine AMS at the 6 MV tandem accelerator of the ion beam centre (IBC) at the Helmholtz-Zentrum Dresden-Rossendorf [1,2]. In routine operation are measurements of $^{10}$Be, $^{26}$Al, $^{36}$Cl, $^{41}$Ca, and $^{129}$I for a wide range of applications. Most of the samples are prepared at our own chemistry labs – or in close cooperation with the users – to allow best performance for diverse tasks [3]. Our performance to measure these routine isotopes improved considerably over the last years [2]. This successful approach needs a careful selection of measurement parameters like a propper measurement order, a specific tuning using low-level (traceable) standards and individual setting of detector parameters for each beam time. One example for an additional improvement is the low-background value of $^{26}$Al/$^{27}$Al = $6 \times 10^{-16}$ reached in blanks from commercial carriers. For $^{41}$Ca measurements we get 30% more transmission, while having ten times less background from $^{41}$K. Further promising developments include the upgrade to non-routine AMS-nuclides like $^{44}$Ti [4] and to actinides [5].

Ref.: [1] S. Akhmadaliev et al., *NIMB* 294 (2013) 5. [2] G. Rugel et al., *NIMB* 370 (2016) 94. [3] S. Merchel, this conference. [4] A. Scharf, this conference. [5] Nasrin B. Khojasteh, this conference.