

## MS 10: Accelerator Mass Spectrometry and Applications II

Time: Thursday 11:00–13:00

Location: f128

MS 10.1 Thu 11:00 f128

**14C Datierungen im Zusammenhang mit einer Sarkophagöffnung in der Johanniskirche von Mainz** — ●ALFRED DEWALD<sup>1</sup>, ALEXANDER STOLZ<sup>1</sup>, STEFAN HEINZE<sup>1</sup>, JANET RETHEMEYER<sup>1</sup>, DANIELA WAROCK<sup>2</sup>, SVETLANA JOHN<sup>2</sup>, ULRIKE PATT<sup>2</sup>, GUIDO FACCANI<sup>3</sup>, RÜDIGER GOGRAFE<sup>4</sup>, CAROLA BERSZIN<sup>5</sup>, ANJA BAYER<sup>6</sup> und JUTTA GÖPFRICH<sup>7</sup> — <sup>1</sup>Inst. für Kernphysik, UzK — <sup>2</sup>Inst. für Gologie und Mineralogie, UzK — <sup>3</sup>arch. fab. et sculp. medial., Basel — <sup>4</sup>IBD Marburg/Lahn — <sup>5</sup>Anthr. Dienstl. Konstanz — <sup>6</sup>Abegg-Stiftung, Riggisberg — <sup>7</sup>Deut. Ledermuseum, Offenbach

Bei Grabungen in der Kirche St. Johannis in Mainz zog ein Sarkophag die Aufmerksamkeit der Archäologen auf sich, da vermutet wurde, dass hier der Erzbischof Erkanbald von Mainz bestattet sein könnte, dessen Grabstätte nicht bekannt war. Im Sarkophag fand man die Überreste eines in liturgischer Kleidung beigesetzten Mannes. Da der Leichnam mit Ätzkalk bedeckt worden war, waren die Knochen des Skeletts für eine Datierung unbrauchbar. Reste der textilen Bekleidung und der Lederschuhe des Toten konnten jedoch mit der 14C Methode datiert werden. Diese Messungen wurden am CologneAMS durchgeführt. Zusammen mit den Textilanalysen und anderen archäologischen Befunden, konnte der Schluss gezogen werden, dass es sich bei dem Bestatteten tatsächlich um Erzbischof Erkanbald gehandelt hat. In diesem Beitrag werden wir Einzelheiten der durchgeführten Untersuchungen vorstellen. Darüber hinaus werden wir die Datierung der Proben aus dem Sarkophag mit Datierungen von Proben aus der Umgebung des Sarkophags vergleichen.

MS 10.2 Thu 11:15 f128

**Developments in the measurements of <sup>14</sup>CO<sub>2</sub> samples at CologneAMS** — ●ALEXANDER STOLZ<sup>1</sup>, ALFRED DEWALD<sup>1</sup>, STEFAN HEINZE<sup>1</sup>, MARKUS SCHIFFER<sup>1</sup>, SUSAN HERB<sup>1</sup>, CLAUD MÜLLER-GATERMANN<sup>1</sup>, GEREON HACKENBERG<sup>1</sup>, JANET RETHEMEYER<sup>2</sup>, and TIBOR DUNAI<sup>2</sup> — <sup>1</sup>Institut für Kernphysik, Universität zu Köln — <sup>2</sup>Institut für Geologie und Mineralogie, Universität zu Köln

In this contribution we report on the status of the actual <sup>14</sup>C<sub>2</sub> system at CologneAMS, which consists of a second HVE SO-110 B ion source, a gas injection system from Ionplus AG and a EuroVector EA3000 elemental analyzer (EA). Recently a new isoprime precisION IRMS and a second EA from elemental were installed for the study of fractionation effects of our AMS system. Additionally, a second gas system for CO<sub>2</sub> EA measurements was developed and built. The new development was aimed for the measurements of samples with high <sup>14</sup>C concentrations (> 1e-11) by diluting the sample CO<sub>2</sub> material with blank gas, in order to avoid contaminations of the equipment. We will report on the routine performance of gas measurements and discuss first results of test runs with the new system.

MS 10.3 Thu 11:30 f128

**On the behavior of <sup>14</sup>C in a radioactive waste repository** — ●SÖNKE SZIDAT<sup>1</sup>, GARY SALAZAR<sup>1</sup>, TYPHAINE L. M. GUILLEMOT<sup>2</sup>, BENJAMIN Z. CVETKOVIC<sup>2</sup>, DOMINIK KUNZ<sup>2</sup>, and ERICH WIELAND<sup>2</sup> — <sup>1</sup>University of Bern, Bern, Switzerland — <sup>2</sup>Paul Scherrer Institut (PSI), Villigen-PSI, Switzerland

Current strategies of the disposal of radioactive waste involve multi-barrier retaining in geological repositories in order to prevent the mobilization of long-lived radionuclides. <sup>14</sup>C has not been considered explicitly for a long time, as the risk emerging from its total activity, radiotoxicity and half-life is rather moderate compared to other components of the radioactive waste. However, the diversity of inorganic and organic carbon chemistry may challenge the effectiveness of state-of-the-art multi-barrier systems.

Most of the <sup>14</sup>C in low- and intermediate-level (L/ILW) radioactive waste from Switzerland originates from <sup>14</sup>C-containing irradiated steel. During anoxic corrosion of the steel, <sup>14</sup>C will be released in the near field of a cement-based L/ILW repository. In this work, we simulate these conditions in a corrosion experiment using irradiated steel from a nuclear power plant and trace <sup>14</sup>C-containing products with compound-specific radiocarbon analysis (CSRA). Dissolved carboxylic acids such as formic and acetic acid are separated with ion chromatography, whereas alkanes such as methane are isolated using gas chromatography. We report on the development of the analytical setup and the outcome of the first three years of the corrosion experi-

ment.

MS 10.4 Thu 11:45 f128

**Measurements of volatile radioactive isotopes in reactor graphite** — ●TIMM-FLORIAN PABST, GEREON HACKENBERG, STEFAN HEINZE, SUSAN HERB, YANNIK JAKOBI, CLAUD MÜLLER-GATERMANN, MARKUS SCHIFFER, ALEXANDER STOLZ, and ALFRED DEWALD — Institute for Nuclear Physics, University of Cologne, Germany

In order to determine the tritium concentration in reactor graphite samples, we expanded our ion source test bench. We added a 100 kV accelerator stage along with a 90° analyzing magnet and a silicon detector, with the aim to suppress the molecular background for tritium measurements.

Activated graphite from graphite moderated reactors contains volatile radioactive isotopes like <sup>14</sup>C, <sup>36</sup>Cl, or <sup>3</sup>H. For a final disposal of reactor graphite a quantitative characterization is needed.

We are aiming for a system which allows fully automated measurements of <sup>14</sup>C, <sup>36</sup>Cl and <sup>3</sup>H with a high sample throughput by using AMS techniques with gaseous samples. This will allow for an optimal handling of the nuclear waste, which has to be stored in disposal sites like e.g. Zeche Konrad.

In this contribution we will present the layout of our system as well as preliminary results of first test runs.

MS 10.5 Thu 12:00 f128

**The status of the AMS device for medium mass isotopes at the Cologne University** — ●SUSAN HERB, STEFAN HEINZE, MARKUS SCHIFFER, GEREON HACKENBERG, CLAUD MÜLLER-GATERMANN, ALEXANDER STOLZ, and ALFRED DEWALD — Institute of Nuclear Physics, University of Cologne, Cologne, Germany

In order to improve the features of the new mass spectrometer at the Cologne 10 MV FN accelerator we started a detailed investigation of the actual beam optics by installing beam profile monitors at four locations along the beamline. The beam path inside the gas-filled 135° bending magnet is inspected by use of multiple array of solar cells which were mounted at different angles of the magnet and moved along the focal plane. In addition it is intended to measure the flight time through the magnet by a MCP start detector in front and a Silicon detector after the magnet.

In this contribution we will report on the actual performance of the system and the results of the beam profile measurements.

MS 10.6 Thu 12:15 f128

**Ion Laser Interaction Mass Spectrometry - status and prospects** — ●MARTIN MARTSCHINI<sup>1</sup>, JOHANNES LACHNER<sup>1,2</sup>, KARIN HAIN<sup>1</sup>, OSCAR MARCHHART<sup>1</sup>, JOHANNA PITTERS<sup>1</sup>, ALFRED PRILLER<sup>1</sup>, PETER STEIER<sup>1</sup>, ALEXANDER WIESER<sup>1</sup>, and ROBIN GOLSER<sup>1</sup> — <sup>1</sup>University of Vienna, Faculty of Physics - Isotope Physics, Austria — <sup>2</sup>HZDR Dresden, Germany

The Ion Laser InterAction Mass Spectrometry (ILIAMS) technique at the Vienna Environmental Research Accelerator (VERA) tackles the problem of elemental selectivity in AMS. It achieves near-complete suppression of isobar contaminants via selective laser photodetachment of decelerated anion beams in a gas-filled radio frequency quadrupole cooler. The technique exploits differences in electron affinities (EA) within elemental or molecular isobaric systems neutralizing anions with EAs smaller than the photon energy. Collisional detachment or chemical reactions with the buffer gas can further enhance anion separation.

In AMS of <sup>36</sup>Cl and <sup>26</sup>Al, ILIAMS reliably provides isobar suppression of more than 10 orders of magnitude. Furthermore it already enables measurements of <sup>90</sup>Sr, <sup>135,137</sup>Cs and <sup>182</sup>Hf with unprecedented sensitivity at VERA and allows to study anion chemistry at eV energies. Current research focusses on extending this technique to <sup>41</sup>Ca, <sup>53</sup>Mn, <sup>59</sup>Ni, <sup>99</sup>Tc and <sup>107</sup>Pd. Exotic species such as double-negatively charged carbon clusters complete the cooler 'guestbook'. This contribution will give an overview over these achievements and prospects of the ILIAMS-technique for the near future.

MS 10.7 Thu 12:30 f128

**Developments towards the detection of <sup>135</sup>Cs and <sup>137</sup>Cs by AMS** — ●ALEXANDER WIESER<sup>1</sup>, JOHANNES LACHNER<sup>1,2</sup>, MARTIN MARTSCHINI<sup>1</sup>, PETER STEIER<sup>1</sup>, ALFRED PRILLER<sup>1</sup>, MAKI HONDA<sup>1</sup>,

OSCAR MARCHHART<sup>1</sup>, and ROBIN GOLSER<sup>1</sup> — <sup>1</sup>University of Vienna, Faculty of Physics - Isotope Physics, Austria — <sup>2</sup>HZDR, Dresden

The isotopic ratio  $^{135}\text{Cs}/^{137}\text{Cs}$  can be used to assign sources of anthropogenic cesium, as a geochemical tracer, or for modifying dispersion models. Due to its long half-life,  $^{135}\text{Cs}$  is hard to detect via decay counting.

Mass Spectrometry has to deal with isobaric interferences of the stable  $^{135}\text{Ba}$  and  $^{137}\text{Ba}$  for Cs detection. The new method of Ion Laser InterAction Mass Spectrometry (ILIAMS) at the Vienna Environmental Research Accelerator (VERA) overcomes this problem by exploiting differences in the electron affinities of  $\text{CsF}_2^-$  and  $\text{BaF}_2^-$  molecules.

A  $^{133}\text{CsF}_2^-$  current on the order of 100 nA from a mixed  $\text{Cs}_2\text{SO}_4$  and  $\text{PbF}_2$  - matrix is extracted from the ion source. The sample material is mobilized by heating the ionizer only, so no external sputtering material is needed. First results show reproducible detection of  $^{135}\text{Cs}$  and  $^{137}\text{Cs}$  in in-house reference materials. With 1 mg stable Cs carrier, we reach a blank level of  $^{137}\text{Cs}/^{133}\text{Cs} = 6 \cdot 10^{-12}$ , which corresponds to  $\approx 30$  mBq. We aim to further improve this value by at least two orders of magnitude for measuring environmental samples.

MS 10.8 Thu 12:45 f128

**AMS of  $^{90}\text{Sr}$  at the sub-fg-level using laser photodetachment at VERA** — ●OSCAR MARCHHART<sup>1</sup>, MARTIN MARTSCHINI<sup>1</sup>,

MAKI HONDA<sup>1</sup>, DAG HANSTORP<sup>2</sup>, JOHANNES LACHNER<sup>1,3</sup>, HAIMEI LIANG<sup>2</sup>, ALFRED PRILLER<sup>1</sup>, PETER STEIER<sup>1</sup>, ALEXANDER WIESER<sup>1</sup>, and ROBIN GOLSER<sup>1</sup> — <sup>1</sup>University of Vienna, Faculty of Physics-Isotope Physics, Austria — <sup>2</sup>University of Gothenburg, Department of Physics, Sweden — <sup>3</sup>HZDR, Dresden

The fission product  $^{90}\text{Sr}$  ( $T_{1/2} = 28.9$  a) is of interest in environmental sciences for its radiotoxicity as well as a potential tracer. Limits of detection (LoD) of mass spectrometric methods such as ICP-MS, RIMS or conventional AMS are close to the radiometric limit of 3 mBq.

The main problem in AMS of  $^{90}\text{Sr}$  is the strong interference of the stable isobar  $^{90}\text{Zr}$ . This problem can be overcome with the new Ion Laser InterAction Mass Spectrometry (ILIAMS) setup at the Vienna Environmental Research Accelerator (VERA). It provides near complete suppression of elemental or molecular isobars via selective laser photodetachment inside a gas-filled radiofrequency quadrupole (RFQ). With 10 W of laser power from a 532 nm cw-laser and a He + O<sub>2</sub> mixture as buffer gas, ILIAMS achieves a suppression factor for  $^{90}\text{Zr}$  of  $10^7$ . Extracting  $\text{SrF}_3^-$  out of the ion source and elemental separation inside an ionization chamber gives an additional Zr suppression of  $10^5$ . Measurements with dilution series of reference materials were successfully conducted. The overall Sr detection efficiency is 0.4% and the blank level  $^{90}\text{Sr}/\text{Sr} = (4.5 \pm 3.2) \times 10^{-15}$ . This corresponds to a more than tenfold improved LoD of 0.1 mBq.