CologneAMS Newsletter

Neutron dose determination by ^{41}Ca

The characterisation of radionuclides, produced by irradiation in nuclear reactor environments, is of great importance for dismantling and decomissioning purposes. Accelerator mass spectrometry, the state of the art technique for age dating, shows excellent possibilities for precise measurement of lowest activity levels for the field of nuclear waste management. First results for the measurement of ^{41}Ca in neutron irradiated concrete samples are highly promising. Preliminary results of AMS for nuclear waste management becomes the headline of Nuclear Engineering International magazine.

— Richard Spanier

Neutron dose determination by ^{41}Ca

In the field of nuclear waste management, reference isotopes are important for the radiological characterization of the radioactive material. Often ^{60}Co or ^{152}Eu are used for this purpose as they are relatively easy to measure by means of gamma ray spectroscopy. One disadvantage in case of ^{60}Co is the relatively short half-live of 5.3a. Thus, it is not very well suited if longer storage and control is needed. In addition, in the case of reactor concrete the seed materials ^{59}Co or ^{151}Eu are contained only as trace elements and homogeneity of the seed material in a large amount of material might not be guaranteed. Therefore, we investigated the suitability of ^{41}Ca as a reference isotope for reactor concrete e.g. originating from the bioshield of a nuclear power station. We measured ^{41}Ca concentration at the 6MV Tandetron AMS set-up, "CologneAMS", of the University of Cologne. The AMS system and the results are comparable to [1]. Several samples of concrete material were irradiated with thermal as well as epithermal neutrons with different doses at the Mainz TRIGA reactor. The irradiated samples were then measured by gamma spectroscopy and the ^{41}Ca was chemically extracted as CaF_2 to produce a sputter target for the AMS measurement. First results for the measurement of ^{41}Ca in neutron irradiated concrete samples are highly promising, see figure 1. The preliminary results of AMS measurements for nuclear waste management becomes the headline of Nuclear Engineering International magazine (figure 2).

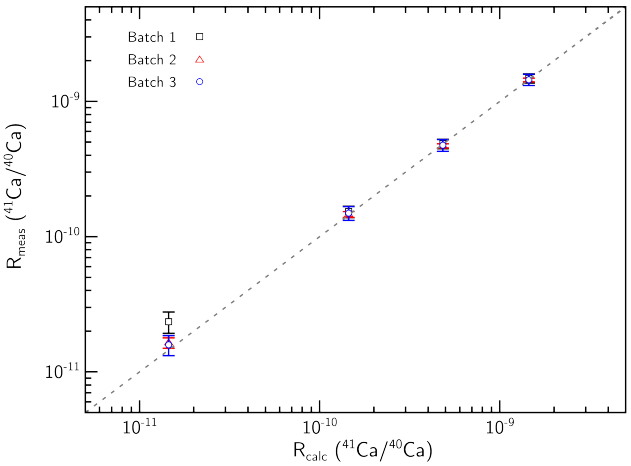

Figure 1: *Measurement of ^{41}Ca in irradiated concrete, for the determination of the dynamic feasibility over a wide range of activity [2]. Results show excellent linearity over more than four orders of magnitude lower than the acceptance level of activity.*

Supported by Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) under contract No.: 3617R01364-UA3413 Samples were partly supplied by KTE (Kerntechnische Entsorgung Karlsruhe)

by Richard Spanier

Figure 2: *Preliminary results of AMS for nuclear waste management becomes the headline of Nuclear Engineering International magazine.*

FN Automation Growth

With the establishing of the new AMS Injector at the FN accelerator we started Phase I of automation of the ion optical components by the use of programmable logic controller (PLC), Siemens S7 type. A LabVIEW™ based control software was developed in the course of the PhD thesis of Claus Feuerstein [3]. PhD student Susan Herb continues the work at the control software since September 2017 and she has successfully included the FAST ComTec MPA-3 data aquisition, in cooperation with Dr. Stefan Heinze. Therefore computer controlled scans of ion optical components can be done with respect of detector region of interest (ROI) counts with radionuclides, see figure 3.

In Phase II, the high energy mass spectrometer, located downstream the first 90° analyzing magnet, was integrated fully to the control software by PLCs.

In January 2019 we started Phase III of automation of the existing ion optical components from the 20° low energy magnet to the 90° high energy analyzing magnet by recommissioning the existing S7-400 PLC of the control room. This PLC provides 48 × 13 bit analog output, 48 × 13 bit analog input, 128 digital output, 128 digital input channels and is controlled via Ethernet. The output and input channels of the PLC can be increased by more than a factor of 10, if needed.

The main goal of Phase III is the computer control of the FN accelerator itself. The regulation of the charging system will still be done by the VARIAN slit feedback system and the PLC will control the nominal voltage, the corona distance and the Pelletron charging current.

by MARKUS SCHIFFER

Figure 3: *The automation of the FN accelerator is in rising progress. The controll desk for AMS measurements gives high potential of monitoring and scope of action.*

New CologneAMS Publications

R. Altenkirch, C. Feuerstein, M. Schiffer, G. Hackenberg, C. Müller-Gatermann, A. Dewald, *Operating the 120° Dipol-Magnet at the CologneAMS in a gas-filled mode*, Nucl. Instr. and Meth. B, 438 (2019) 184-188.

A. Stolz, A. Dewald, S. Heinze, R. Altenkirch, G. Hackenberg, S. Herb, C. Müller-Gatermann, M. Schiffer, G. Zitzer, T. Dunai, J. Rethemeyer, A. Wotte, *Improvements in the measurement of small $^{14}CO_2$ samples at CologneAMS*, Nucl. Instr. and Meth. B 439 (2019) 70-75.

Upcoming Events

- CRC 1211 “Earth evolution at the dry limit” Workshop, April 5th to 6th 2019, Vienna, Austria.
- General Assembly 2019 of the European Geosciences Union (EGU), April 7th to 12th 2019, Austria Center Vienna (ACV) in Vienna, Austria.
- 13th European Conference on Accelerators in Applied Research and Technology (ECAART13), May 5th to 10th 2019, Split, Croatia.

References

[1] S. Merchel, G. Rugel, S. Akhmadaliev, B. Gleisberg, and D. Hampe, *Determination of ^{41}Ca with LSC and AMS: method development, modifications and applications* (2012) Journal of Radioanalytical and Nuclear Chemistry 296 : 617-624

[2] R. Spanier, *A 135° Gas-Filled Magnet at the Cologne 10 MV AMS FN-Tandem Accelerator Setup and the use of ^{41}Ca as a Reference Nuclide for Nuclear Waste Management*, Dissertation, University of Cologne, submitted.

[3] C. Feuerstein, *Improvement of measurement capabilities at the Cologne Accelerator Mass Spectrometer*, Dissertation, University of Cologne, 2016.