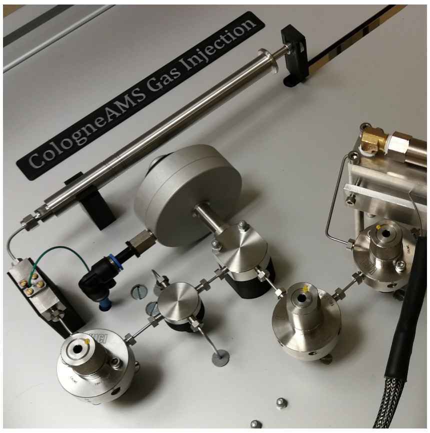
CologneAMS Newsletter



FORKA C14-AMS Project

Phase I of the FORKA C14-AMS Project is now completed with the development of an automated CO_2 gas injection system for accelerator mass spectrometry. In phase II different dilution series will be done with standard material, to show the measurement strategy of high ^{14}C concentrations. The prove of the setup will be performed in phase III by measurement of test graphite samples, irradiated with defined neutron flux and irradiation times at the TRIGA reactor Mainz. Finally real graphite-reactor samples will be measured from different German graphite moderated nuclear-reactors.

— Markus Schiffer

FORKA C14-AMS Project

The German federal ministry of research promotes the development, optimization and proving of application-oriented technologies and processes of nuclear decommissioning, as well as the maintenance of competence and training of junior scientific staff, within the FORKA funding concept. Two research groups of the University of Cologne, PD Dr. Erik Strub, institute of nuclear chemistry, and apl. Prof. Dr. Alfred Dewald, institute of nuclear physics, and the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) have successfully proposed a joined FORKA project about the characterization and quantification of ^{14}C content in reactor graphite with accelerator mass spectrometry; project name C14-AMS.

Currently no comprehensive disposal strategy exists for the worldwide 250,000 tons of neutron-irradiated reactor graphite[1]. The aim of the FORKA C14-AMS project is the development of an automated ^{14}C quantification system for reliable industrial use. The system is supposed to avoid background problems and complex sample preparation, normally induced by the standard Liquid Scintillation Counting (LSC) method, by the use of CO_2 gas injection to an accelerator mass spectrometer.

For the measurement an elemental analyzer (EA) is used to transform the graphite to CO_2. This gas, with high ^{14}C concentration, is then diluted with blank CO_2 gas in a mixing volume of the dedicated gas injection system and transfered to a gas ion source, where negative ions are produced. With the accelerator mass spectrometer the

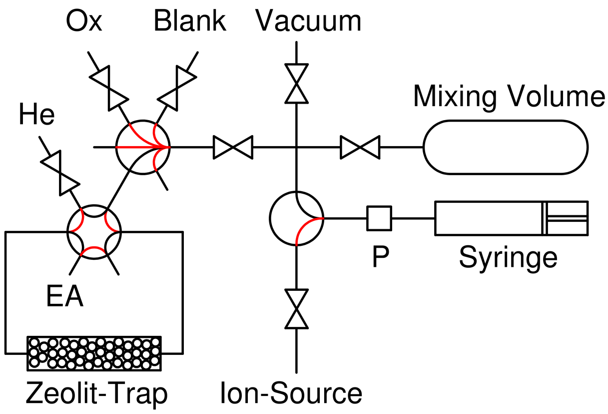


Figure 1: *Dedicated gas mixing and injection system for the measurement of ($^{14}C/^{12}C$) isotopic ratios from neutron-irradiated reactor graphite; designed by Alexander Stolz.*

(^{14}C/^{12}C) isotopic ratios are determined. The total activity is then calculated out of the system efficiency and total sample mass. In addition, the measurement of other beta-nuclides like ^{3}H and ^{36}Cl from the same gas-phase of the graphite will be developed.

The verification of the new measurement technology will be proofed by test graphite samples, irradiated with defined neutron flux and defined irradiation times at the TRIGA reactor Mainz, within a collaboration with K. Eberhardt, institute for nuclear chemistry, University of Mainz. by MARKUS SCHIFFER

Figure 2: The new 100 kV Tandem accelerator at the mass separator for optimization of negative ion sources.

The new 100 kV Tandem Accelerator

Since 2017 the institute of nuclear physics uses an mass separator for optimization of negative ion sources. It consists of an ion source high voltage deck, for the use of a Middleton-Type or a NEC MC-SNICS ion source, and a double focusing 90° analyzing magnet. The magnet is designed for high momentum resolution and high transmissions.

For the tests of the new gas injection system and the measurement of ^{3}H and ^{14}C a new 100 kV Tandem accelerator was designed by the use of an 1 m acceleration tube and a carbon foil stripper. The high voltage will be generated by a commercial power supply. The precision mechanics workshop of the institute developed a special single stripper foil unit with an easy to use foil changing tool. On the high energy side of the accelerator a magnetic quadrupol lens is used to focus the ion beam in front of the new installed high energy analyzing magnet. This magnet was formerly operated at the Cologne 0.6 MV single ended accelerator and the magnet field of 0.77 T is suitable to bend $^{3}H^{+}$ with 350 keV ion energy. The bending radius of the magnet is 190 mm and the iron gap is 25.4 mm [2]. With the vertical acceptance of the vacuum chamber (14 mm) a calculated transmission of approx. 80% can be reached. The vertical acceptance is limited because of the needed mechanical stability. The new vacuum chamber was designed for the use of offset Faraday cups at the waist at the focal plane in a standard ISO-160 double-cross. It is planned to use a silicon detector for the detection of the radionuclides downstream the analyzing magnet.

The whole setup will be controlled by programmable logic controller (PLC), Siemens S7 type. The LabVIEW based control software, used at the FN accelerator, is also suitable for this setup with minor changes for the different ion beam components.

Master student Timm-Florian Papst and bachelor student Yannik Jakobi have recently started their graduation theses at the new machine.

by Markus Schiffer

HIAS2019 Student Award

PhD student Susan Herb won the student award of the 7th Heavy Ion Accelerator Symposium on Fundamental and Applied Science for an outstanding student presentation. The symposium took place at the Australian National University in Canberra, Australia, from 9th to 13th September 2019.

Figure 3: *HIAS2019 Student Award for Susan Herb with the talk: "The status of the new AMS device for medium mass isotopes at the Cologne University."*

Susan Herb reported about the status of the new AMS device for medium mass isotopes at the Cologne University and showed the first (^{60}Fe/Fe) isotopic ratio measurements at the Cologne 10 MV FN-Tandem accelerator.

New CologneAMS Publications

S. Herb, M. Schiffer, R. Spanier, S. Heinze, A. Stolz, L. Bussmann, G. Hackenberg, D. Schumann, N. Kivel, and A. Dewald, *First AMS measurements of ^{60}Fe/Fe isotopic ratios at the Cologne 10MV tandem accelerator*, Nucl. Instr. Meth. B 461 (2019) 166-170.

References

[1] D. Vulpius, K. Baginski, B. Kraus, B. Thomauske, *Thermal treatment of neutron-irradiated nuclear graphite* Nuclear Engineering and Design 265 (2013) 294–309.

[2] Dieter Werdecker, *Umbau eines 0,6 MV-Teilchenbeschleunigers und Messungen am Strahl*, Diploma thesis, University of Cologne (1969)