Accelerator Mass Spectrometry at the Rossendorf 5 MV Tandem Accelerator

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Abstract

A short description of the Rossendorf AMS system is given and first experimental results are presented.

1. INTRODUCTION

The Rossendorf electrostatic accelerators (5 MV tandem accelerator and single ended 2 MV van de Graaff accelerator) are already used for ion beam analysis. The existing methods (RBS, PIXE, ERDA, NRA, nuclear microprobe and external beam) will be completed by introduction of AMS. During 1991 intensive investigations were focused on the detection of ^{14}C. After succesfull realization and applications of radiocarbon dating AMS may be extended to other isotopes (^{10}Be, ^{26}Al), too.

2. DESCRIPTION OF THE SYSTEM

The negative ions are generated in a Cs sputter source (Fig. 1) constructed in our laboratory [1].

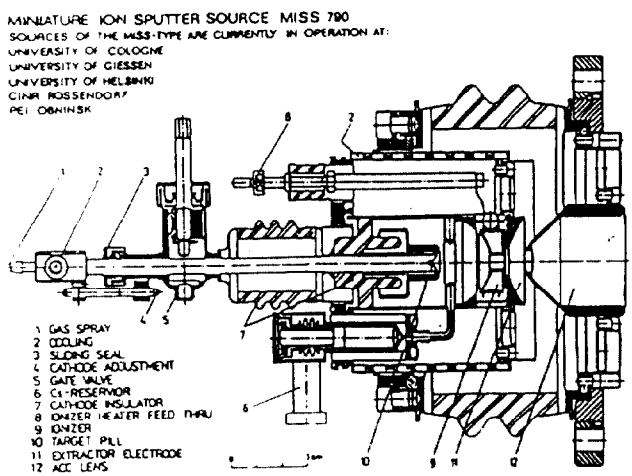

Figure 1. High intensity negative ion sputter source model MISS-790.

The mechanical conditions of the 2 x 90° inflection magnet complicate the realization of a fast switching system based on an insolated magnet chamber [2]. A slow switching mode with a period > 1 minute was used for the first experiments.

The Rossendorf tandem accelelerator is built in vertical arrangement [3]. The ions are accelerated by inclined field tubes (10° inclination) and stripped in a nitrogen gas stripper. Under optimized conditions a fraction of about 20 per cent of the injected beam was obtained for 16 MeV C^{3+}ions behind the analyzing magnet.

The main problem for AMS exists in stabilizing the terminal voltage during ^{14}C acceleration. After some improvements the accelerator voltage could be stabilized during a period of about 20 minutes using the generating voltmeter.

After acceleration and separation the ions are detected in a gas filled Bragg ionization chamber [4] (Fig. 2).

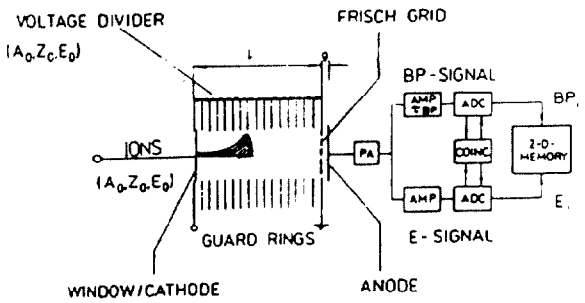

Figure 2. Schematic diagram of the gas filled ionization chamber. By BP and E the Bragg peak height and the energy are denoted, respectively.

The same chamber is also used for ERDA studies. First measurements have proved that a sufficient separation of energy (or respectively of mass) and atomic number of the incident particles is obtained (Fig. 3).

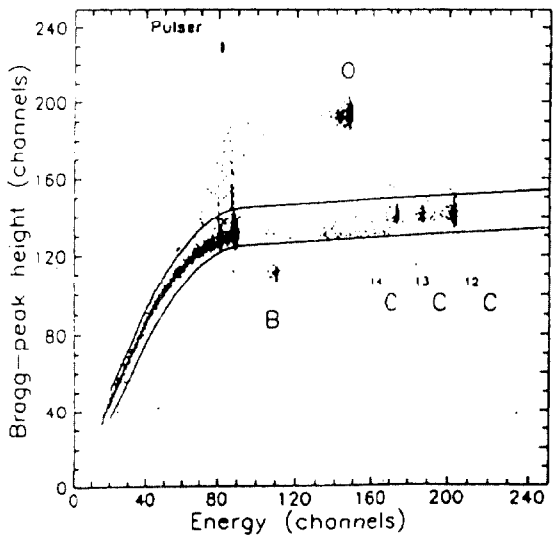

Figure 3. Mass spectrum of the first AMS measurement.

3. Experimental Results

After optimizing the whole system a counting rate of about 20 counts/s was obtained for a modern charcoal sample mixed with silver powder (Fig. 4).

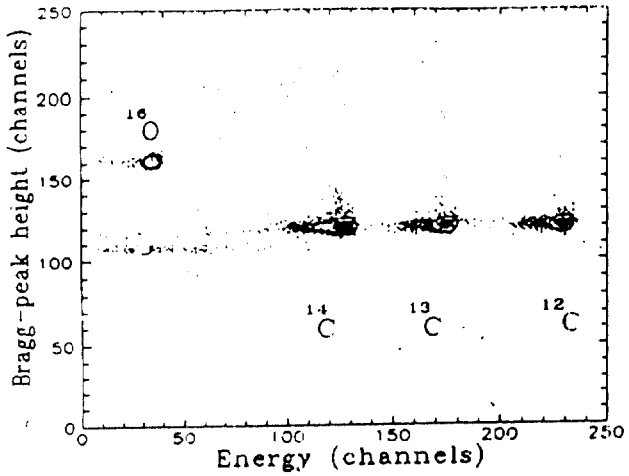

Figure 4. Mass spectrum around the $^{14}C^{3+}$ peak for a modern charcoal sample.

A background of 0.02 counts/s was determined using a graphit sample. Contrary to the results of other groups [3] no ^{14}N peak was visible. This peak appears only if the acceleration voltage is increased at fixed field of the analyzing magnet from 4.0 to 4.07 MV (Fig. 5). This value is the resonance voltage for injection of the low energy tail of $^{14}NH^{-}_{2}$. From this result follows that the ^{14}N background normally caused by the strippers and by the residual gas is completely suppressed by the inclined field of the acceleration tube.

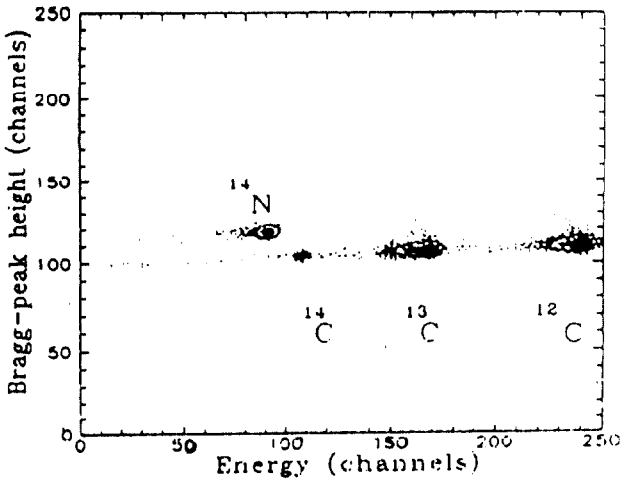

Figure 5. Position of the ^{14}N peak in the mass spectrum. C peaks were measured at 4.0 MV and N peak at 4.07 MV, respectively.

The AMS system was tested with samples from trees (poplar) of known, different age. The results agree with the variation of the ^{14}C concentration in the atmosphere caused by the atomic weapons tests [2] (Fig. 6).

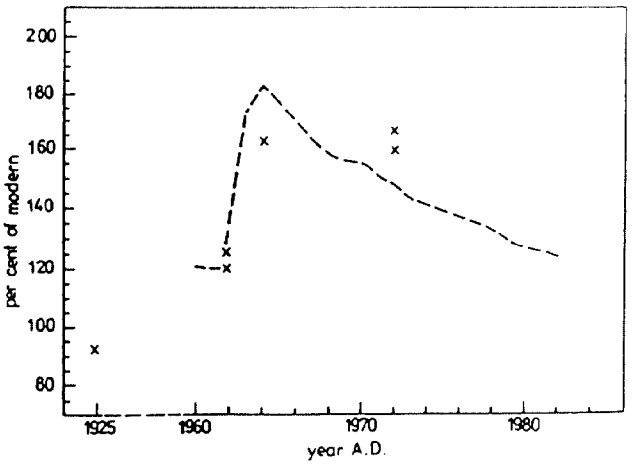

Figure 6. Measured ^{14}C concentration of different old samples from trees with respect to concentration of ^{14}C in modern samples. The dashed line shows the ^{14}C variation in the atmosphere caused by the atomic weapons tests.

4. Future Applications and Developments

At the Rossendorf tandem accelerator AMS will be used in cooperation with the Mining Academy Freiberg for investigations of ground waters resources, water influx in salt mines and enviroment protection. In combination with PIXE at the external beam AMS may also be used for investigation of art objects.

5. REFERENCES

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