

A PROJECT OF TANDEM ACCELERATOR MASS SPECTROMETRY FACILITY AT PEKING UNIVERSITY

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INTRODUCTION

The measurement of ^{14}C and ^{10}Be abundance using tandem accelerator mass spectrometry (AMS) is now a well established technique^[1].

To study the cosmogenic nuclides, a project of the tandem AMS facility is being developed in Peking University, supported by NSFC. The research group of this project consists of members of following institutes and departments. They are Institute of Heavy Ion Physics, Department of Technical Physics, Department of Archaeology, Department of Geology in Peking University and Shanghai Institute of Nuclear Research. The AMS facility is based on a 1.7 MV Pelletron^[2] and a line consisting of ion source, low energy pre-analyzing and injection system, high energy analyzing and transport system, $\delta\text{E-E}$ detector and data acquisition system will be built. As the first step, a sensitivity of 10^{-14} and a precision of 2% are expected for ^{14}C , and 10^{-12} and 5-10 %, for ^{10}Be respectively.

DESCRIPTION OF THE AMS SYSTEM

The layout of the AMS facility is shown in Fig.1.

A modified HICONEX 834 sputter source is used for ^{14}C sample measurements. For the higher beam intensity with BeO^+ , a new ion source will be developed which should give high beam current, good stability, and small memory or cross contamination effects.

In order to limit the background, a double-focusing 90 degree magnet with radius of 400 mm is designed in the low energy injection system. Considering the requirement of flat-top beam transmission, the magnet gap is chosen to be 50 mm, the sputter tail reduction of 10^{-5} is expected. To avoid the beam loading effects of the Pelletron, and to determine isotopic ratios accurately, alternating

injection of ^{12}C , ^{13}C , and ^{14}C is used. The cycling frequency is 7 Hz, the injection duration are 1 ms, and 6 ms for ^{12}C and ^{13}C respectively. To avoid isotope fractionations, all the lenses and steers used in the injection system are only electrostatic rather than magnetic.

In order to filter out the fragments molecular, damping the tail of the intense peak, and reduce the background, after acceleration the high energy beam is analyzed by a magnet analyzer with mass resolution of 200, and Wien filter with resolution of 85 for Beryllium. To improve the measurement precision, the terminal voltage of the tandem is controlled within 300V. All the beam optics components are designed for getting a high transmission efficiency which should be higher than 90 %.

For particle identification, a $\delta\text{E-E}$ counter telescope is designed which consists of a grid chamber and a Au-Si barrier detector. The detector has an effective length of about 8 cm, a plate electrode of $10.6 \times 2.3 \text{ cm}^2$, a grid electrode made of CuBe wires of 0.02 mm with intervals of 1 mm, and the space between plate and grid is 5 mm. The incidence window is made of a $2\mu\text{m}$, $\Phi 4 \text{ mm}$ Mylar film. The operation gas is P-10 (90 % Ar + 10 % CH_4) with adjustable pressure between 0 and 250 Torr, and the stability of the gas pressure is about 1 Torr per hour. An energy resolution of 1-10 % for particles with $Z \leq 15$ is expected.

The data acquisition system is based on an IBM PC/XT computer with interfaces and softwares for display, analysis and manipulations. Multiple display modes are available such as two-dimension map mode and isometric mode. The channel number are 1024×256 or 512×256 . Two markers can be moved to choose the interesting area which can be expanded and contracted. The measurements are also controlled by the IBM microcomputer.

THE BEAM OPTICS DESIGN OF THE AMS SYSTEM

Some problems have been considered in the beam optics design of the AMS system. Such as flat-top transmission feature, the elimination of background, the space of the laboratory. The computer program OPTRYK^[3] is used in the beam optical calculations, and the emittance of the ion source is supposed to be $14 \pi \text{ mm mrad MeV}^{1/2}$, which is an upper limit for sputter source^[4].

Fig. 2 shows the results of the calculations. It contains the physical parameters, geometry parameters, the locations of the optical elements; the phase space parameters at every components; and the beam envelope of the whole system. Three envelopes in Fig 2 correspond to the ion source emittance of 7, 10, and $14 \pi \text{ mm mrad MeV}^{1/2}$, respectively.

PRELIMINARY APPLICATIONS

The first application under consideration of this AMS facility is radiocarbon dating of Malain Loess and Chinese Paleolithic and paleoanthropologic samples, as well as ^{10}Be abundance variation study for sediments

and suspended particles in the estuary of Yellow River outlet.

This project is planned to be accomplished by the end of 1990. Then we will move most parts of the beam line with necessary modifications to EN-18 tandem which was transferred from Oxford, in order to get higher sensitivity and to improve the precision. With that EN based AMS facility, the nuclides with higher Z such as ^{26}Al , ^{36}Cl could be detected.

We would like to thank Prof. K. W. Allen, Mr. H. R. McK Hyder, and Prof. A. E. Litherland for their suggestions and encouragement. Special thanks are due to Dr. R. E. M. Hedges for his valuable discussions, Suggestions and informations.

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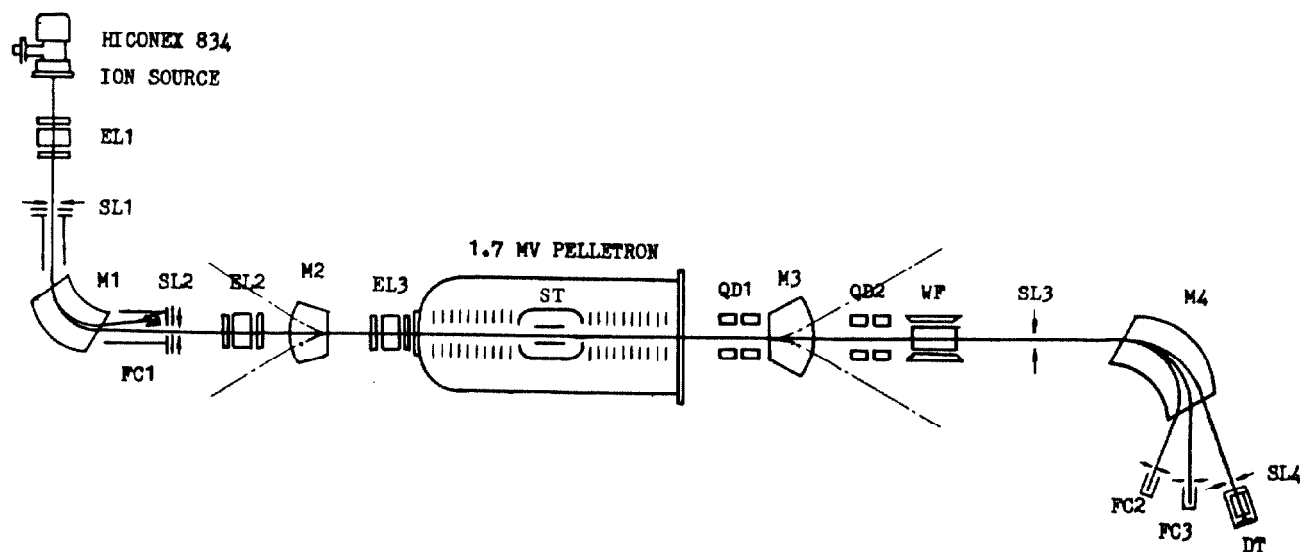


Fig. 1 Schematic layout of the AMS at Peking University. DT is detector, EL1-EL3 are einzel lenses, FC1-FC3 faraday cups, M1 injection magnet, M2-M3 switching magnets, M4 analysing magnet, QD1-QD2 quadrupole lenses, SL1-SL4 slits, ST stripper, WF Wien filter.

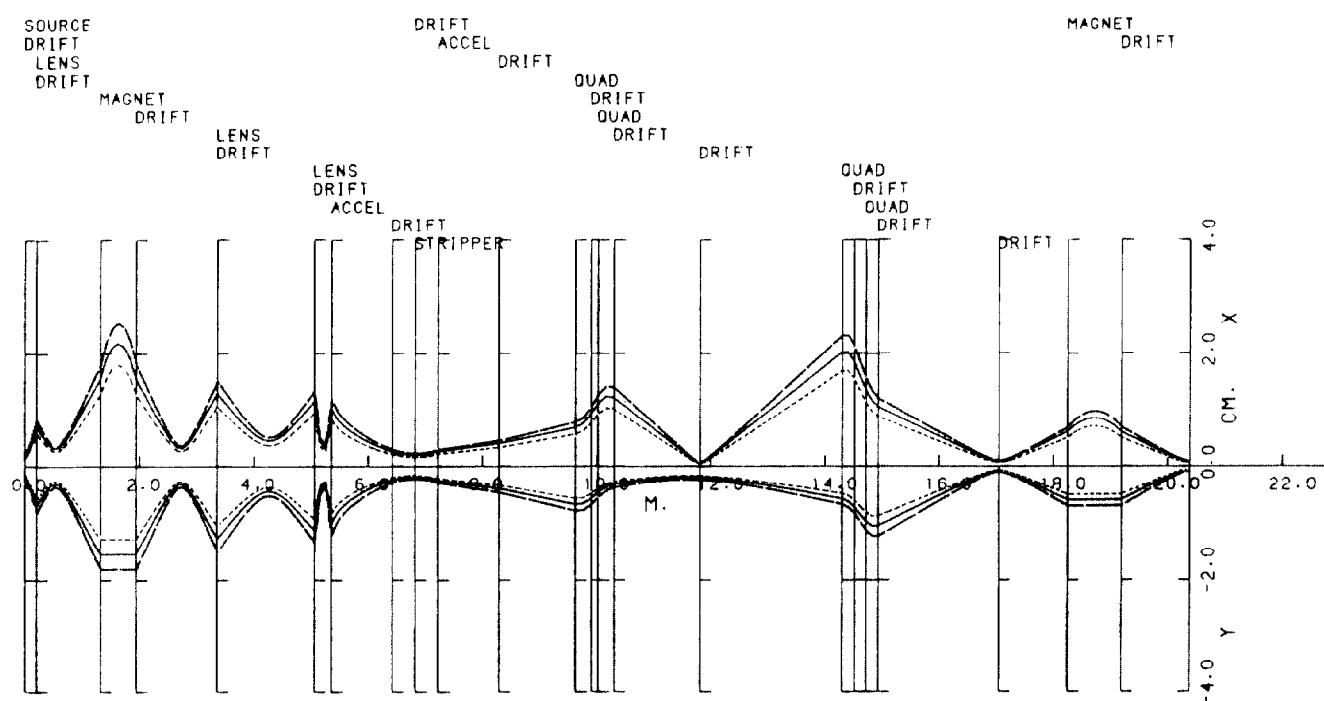


Fig. 2 The beam envelopes diagram of the AMS at Peking University.
The three envelopes correspond to the ion source emittance
of 7, 10, and 14 π .mm.mrad.MeV^{1/2}.