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Status of the "new" AMS facility in Trondheim

Marie-Josée Nadeau [a,*], Einar Vaernes [a], Helene Løvstrand Svarva [a], Eiliv Larsen [a], Steinar Gulliksen [a], Matthias Klein [b], Dirk J.W. Mous [b]

[a] Department of Archaeometry, Norwegian University of Science and Technology, 7491 Trondheim, Norway
[b] High Voltage Engineering Europa B.V., P.O. Box 99, 3800 AB Amersfoort, The Netherlands

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ABSTRACT

The Radiocarbon Laboratory of the Norwegian University of Science and Technology (NTNU) in Trondheim has a long history, dating back to the 1950s. Its relatively new AMS facility is based on a 1 MV Tandetron from High Voltage Engineering Europa B.V. that is equipped with a hybrid solid/gas SO-110 ion source, a low energy spectrometer supporting sequential injection, a high energy analysis system consisting of a magnet and an electrostatic deflector, allowing insertion of an absorber foil for isobar suppression, and a two dimensional gas ionisation detector (E and ΔE). The system is at present capable of measuring ^{10}Be, ^{14}C, and ^{26}Al and can be easily modified to measure isotopes of higher masses.

Acceptance tests results for $^{10}Be^{1+}$, $^{14}C^{2+}$, $^{26}Al^{1+}$, and $^{26}Al^{3+}$ are presented. The laboratory measures only ^{14}C at present and the routine procedures are described.

The system has demonstrated a very low background (70,000 ^{14}C years BP or $2{\cdot}10^{-16}$ on Alfa Aesar 40795 graphite powder, −200 mesh, 99.9995%) for ^{14}C when charge state 2+ is measured and the interference of Li ions in the detector is minimal. Some ion optical peculiarities of the system are also discussed.

1. Introduction

The Radiocarbon Laboratory of the Norwegian University of Science and Technology in Trondheim has a long history, dating back to the 1950s. The first radiocarbon dates of the laboratory were published in 1957 [1,2]. Over the years, the laboratory reached a strong reputation and was a pioneer in tracing ^{14}C produced by atmospheric nuclear bomb tests through nature, notably the ocean [3–5]. Research on ocean reservoir ages was also carried out [6]. Dating performed by the laboratory was instrumental in resolving the last glaciations of Scandinavia into ice-free and ice covered periods [7], and to expand the fauna history into these periods [8]. Moreover, members of the laboratory participated in archaeological research, notably by dating the Norse settlement at l'Anse aux Meadows [8] but also many other sites in Norway and abroad [e.g. 9,10].

During the 1960s, the laboratory established an apparatus for the direct measurement of tritium as a tracer, furthering its involvement in atmospheric studies and hydrology [11].

Efforts towards the funding of an AMS system started in 1987 and the funds were granted in 2004. The AMS system was ordered in 2005 and delivered in 2006. Unfortunately, the installation of the system was delayed until January 2009 due to building constraints. The AMS system was accepted in May 2009.

The delays, caused by the allocation of a room for the AMS system and its renovation, brought forward untimely deadlines, mandatory retirements, and further delays in developing adequate AMS sample preparation. At time of writing, the sample preparation laboratory is being expanded from a few graphitization lines to a full scale preparation laboratory capable of preparing 150 ^{14}C graphite samples per week. In time, a preparation laboratory for ^{10}Be will also be established.

In the following, we describe the configuration of the AMS system, the result of the acceptance tests, the measurement procedure, machine background, and some aspects of the performance of the AMS system.

2. Description of the AMS system

As the AMS system was described elsewhere [12,13], we discuss the system only briefly and with an emphasis on specificities needed for a better understanding of the following sections. A schematic of the system can be found in Klein et al. [12] or in Chamizo et al. [14] as the differences between the systems are not significant at this level.

* Corresponding author.

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Table 1
Results of the acceptance tests for ^{14}C.

^{14}C	q = +2			Current corrected	
Reference Sample #	$^{13}C/^{12}C$	$^{14}C/^{12}C$	^{14}C (counts)	$^{13}C/^{12}C$	$^{14}C/^{12}C$
1 Oxalic Acid II	1.0440E−02	1.4122E−12	122,196	1.0439E−02	1.4119E−12
2 Oxalic Acid II	1.0449E−02	1.4201E−12	127,692	1.0430E−02	1.4150E−12
3 Oxalic Acid II	1.0411E−02	1.4128E−12	119,451	1.0416E−02	1.4142E−12
4 Oxalic Acid II	1.0412E−02	1.4114E−12	124,171	1.0427E−02	1.4155E−12
Mean	1.0428E−02	1.4141E-12		1.0428E−02	1.4141E−12
Average statistical error (‰)		2.85			2.85
Relative sd[1] (‰)	1.89	2.85		0.93	1.11
Background					
5 blank		1.8118E−15	481		1.8042E−15

[1] sd indicates standard deviation.

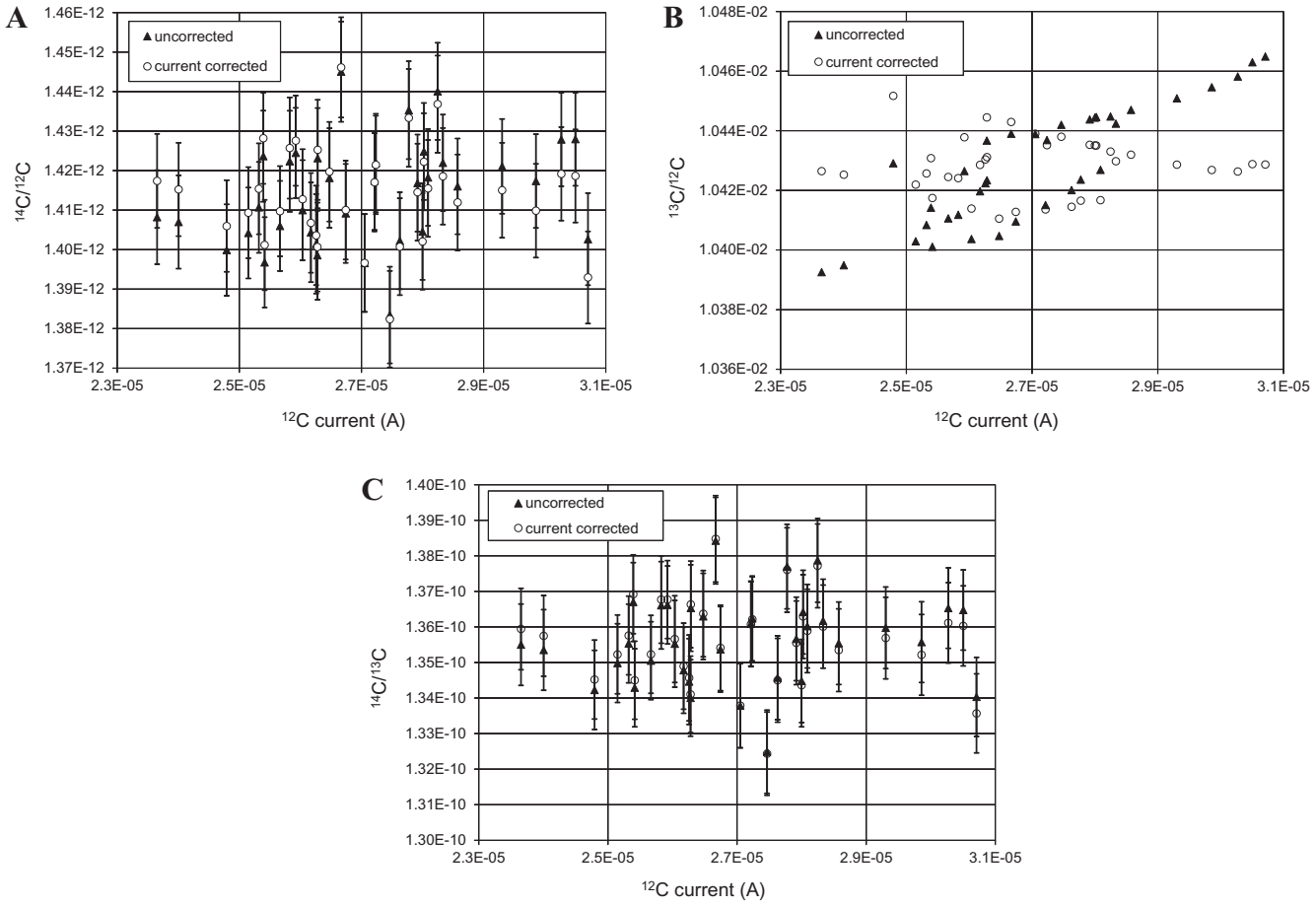

Fig. 1. Carbon isotope ratios vs. ^{12}C current of the interval measurements of the acceptance tests. (A) $^{14}C/^{12}C$, (B) $^{13}C/^{12}C$, (C) $^{14}C/^{12}C$. The filled triangles represent the raw ratios and the opened circles the current corrected ratios.

2.1. Ion source

The system is equipped with an SO 110 hybrid solid/gas Cs sputter ion source with a 50 target carousel. The ion source body is at ground potential. The target is moved from the carousel into the ion source by an insulating rod and set at −35 kV. An ionizer at −28 kV faces the target. The negative ions are extracted by Pierce geometry electrodes where the extraction cone is mounted on a movable table providing *x*, *y*, and *z* adjustments. The effect of these adjustments is discussed below.

2.2. Injection system

The ion source is followed by an Einzel lens and a 90° magnet. With a bending power of 9.8 MeV amu, the magnet is capable of analysing ions up to mass 260 amu at 35 keV ($^{244}Pu^{18}O$)., The magnet power supplies installed at present do not allow for the analysis of higher masses but this can be easily upgraded. Ions of different masses are injected in the accelerator sequentially by changing the voltage of the insulated magnet vacuum chamber (bouncing). The bouncing rate used for ^{14}C is 100 Hz. A beam