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Instrumental developments at the IBA-AMS dating facility at the University of Lecce

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Abstract

The accelerator mass spectrometry (AMS) radiocarbon dating facility at the University of Lecce, Italy is now fully operational and in the first year of operation more than 500 samples both organic and inorganic have been measured for applications in archaeology, history of art, geology and environmental sciences. The experimental capabilities of the facility have been recently significantly improved by the installation of an in vacuum and in air ion beam analysis (IBA) beam line. Investigations are routinely carried out in material science and cultural heritage diagnostics.

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1. Introduction

We report on the instrumental developments implemented at the accelerator mass spectrometry and ion beam analysis facility of the University of Lecce (CEDAD), Italy.

The facility is based on a 3 MV tandetron accelerator manufactured by High Voltage Engineering Europa equipped with an AMS radiocarbon dating beam line and a high energy switching magnet capable to deflect the high energy beam into nine experimental lines.

We report on the state of the AMS beam line describing the performance achieved by the system in terms of precision, accuracy and background and by the sample preparation laboratory in terms of sample handling capabilities.

Recently a new IBA beam line has been installed and is now fully operational. The potential of the beam line, originally devoted to in vacuum Rutherford backscattering spectrometry (RBS) analysis and equipped with a high precision

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goniometer for channeling studies, has been significantly enhanced by the installation of a new end stage for in air PIXE analysis. Experiments have already been carried out by irradiating metallic objects of archaeological relevance in air.

New projects, already in progress, will extend the facilities potential by the installation of a new beam line entirely dedicated to in air ion beam analysis and by a new nuclear microprobe. In particular the microprobe experimental chamber has been designed to perform integrated optical and nuclear spectroscopic investigations.

2. One year of operation of the AMS facility in Lecce

The possibility to carry out radiocarbon determinations with a precision of 0.2–0.3% with the Lecce sequential mass spectrometer has been already demonstrated [1,2]. The system exhibits a very stable functioning [3] and a machine background level as low as 71 ka [4].

The accuracy of the radiocarbon analyses is constantly monitored in the frame of a quality assurance protocol by measuring standard materials supplied by the International Atomic Energy Agency (IAEA) and National Institute of Standards and Technology (NIST) as well as samples already measured in other AMS and beta counting facilities worldwide [4].

The AMS facility also houses the sample processing laboratories equipped for the physical and chemical preparation of both organic and inorganic materials [5]. During the first year of operation the total sample handling capabilities of the sample preparation laboratories have been improved by duplicating the total number of combustion/graphitization cells such that about 500 radiocarbon samples have been prepared and measured. Fig. 1 schematically shows how these samples were divided on respect to the applications. It can be seen that most of the samples are for archaeological studies [6–8] although the activity in environmental sciences is constantly increasing [9].

Archaeology	**70 %**
Environmental Sciences	**23 %**
Geology	**4 %**
History of Art	**3 %**

Fig. 1. Summary of the different kind of radiocarbon samples measured in the first year of operation.

3. The IBA beam line

The IBA beam line is connected to the +45° port of the high energy switching magnet which is able to deflect in this beam line particles with a magnetic rigidity as high as 19.6 MeV amu.

The beam is focused on the target by two electrostatic quadrupoles: a doublet and a triplet placed at the exit of the accelerator and at the switching magnet entrance, respectively. A set of vertical and magnetic steering systems is used to correct, along the beam line, the beam position (Fig. 2). This set-up allows to focus the 2 MeV,

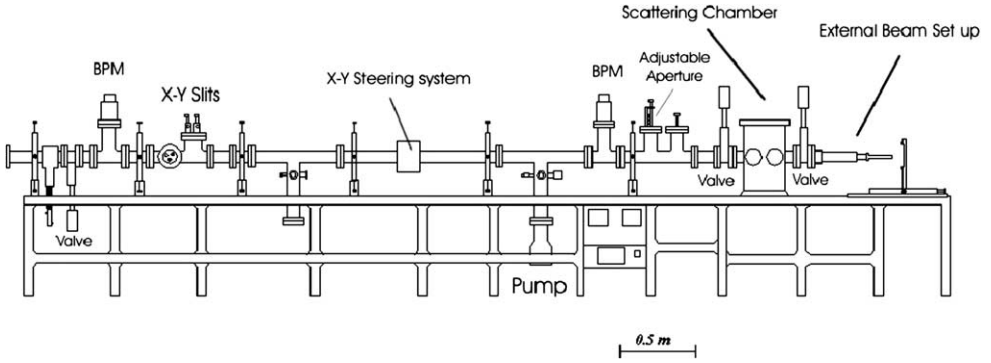

Fig. 2. Schematic view of the new in vaccum and in air beam line installed at CEDAD, University of Lecce.