Woods Hole
National Ocean Sciences AMS Facility

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The National Ocean Sciences Accelerator Mass Spectrometry (NOSAMS) Facility at the Woods Hole Oceanographic Institution provides radiocarbon analyses to the ocean science research community. Applications include dating of sedimentary deposits, studies of carbon-bearing materials in sediments and marine water column, studies of paleocirculation and ventilation and detailed studies of circulation and carbon cycling in the modern ocean. A gradual shift in sample origin has been experienced over the last five years. The World Ocean Circulation Experiment (WOCE) initially provided almost all of our samples, whereas nowadays, samples arrive from a diverse group of client submitters from all of the aforementioned applications.

In general, the trend has been towards smaller sample size. With our capacity to process very small samples of radiocarbon (between 20-100 ug C), we have experienced a growing numbers of these submissions, which currently comprise about 25% of our sample queue. The facility produces approximately 5,000 reportable results per year (in addition to a complement of primary and secondary standards and blanks).

Tandetron

Our AMS system was built by US-AMS Corporation, based on a 3MV Tandetron accelerator with two recombinator/ injector legs sharing a switching magnet. A US-AMS IS-60 sample ion source (GIX 846) is located on the first recombinator/injector leg and the second leg has been dismantled while future development is under consideration. The IS-60 ion source is our production workhorse as progress continues on the developing CFAMS system (see below).

The primary AMS has been improved this year with continued upgrades to the control system, including a new control PC, progress in converting to a distributed serial fiber optic control system (Group 3), and closed-loop control of analyzer magnet fields. We replaced our previous rack mount control PC running Windows 95 and LabVIEW 6 with a new machine with redundant power supplies, hardware RAID, and dual displays running Windows XP and LabVIEW 8.0.1. The upgrade to LV8 required new code to add functionality to the newest version of the Group3 drivers. Our parallel port shunt control for the low energy magnet power supplies would not run under Windows XP, so we changed to PID loop control in LabVIEW to set magnet fields, using Lakeshore Hall probes, and are able to maintain fields to within 0.1% of set values. The change from the original US-AMS analog fiber optic control system to a digital loop topology using the GMW system is nearing completion. We have now converted all of the source controls at ground and extraction potentials to Group 3, leaving only conversion of the sample actuation controls on the cathode deck and much of the vacuum system (with associated interlocks) to complete the installation.

The accelerator has been in continuous operation since the last SNEAP meeting. Review of the past year's log book reveal repeated issues with our deionized water cooling loop and associated pumps/parts and heat exchangers that required short periods of downtime to exchange parts or install spares. We observed an elevated dark current in the ion source, which seemed to be associated with cooling line degradation and increased hard deposits noted in the lines since the system was expanded (mid March) to incorporate the developing CFAMS system. After installing a second deionization unit (Barnstead B-pure Model #D4511) at the ion source cabinet, the dark current is lowered but not quite to previously observed levels. The primary deionization unit is located in an adjoining utility room at the water reservoir source. We continue to monitor and plot cathode current history for each wheel and use the data to evaluate filter performance and determine necessary filter change frequency.

Subsequent to our Group3 conversion, we started to observe control instability due to unavoidable discharging on the high voltage deck of the ion source, especially during warm-up. In particular, the Group3 board seemed to be vulnerable even with signal conditioning measures. We concluded that the Group3 fiber optically linked distributed control devices may not be as EMF robust as our "clunky", aged, custom designed fiber optically linked circuit boards that are being phased out. Several measures were taken to mitigate this problem, including: cleaning the source deck and insulators with ethanol; verifying all power supply connections and the wiring harness interface with the Group3 box; improving ventilation within the Group3 box by modifying side panel to accept a muffin fan; adding/improving shielding to all signal devices and power cables; and replacing suspect pins on power connectors. Short term results after repairs/maintenance are favorable, as the cathode deck is now stable with no evidence of discharge related failures.

Continuous Flow Accelerator Mass Spectrometry System

We are currently constructing a new AMS system that is primarily designed for the analysis of ^{14}C from a continuously flowing stream of sample gas. A layout of the new system is shown in Figure 1. The system is located in a new, 900 ft^2 addition to our present laboratory which we occupied in March of 2005. A key component of the new system will be a gas-accepting microwave-plasma ion source first built at Atomic Energy of Canada Limited, Chalk River, Ontario, Canada and further developed at NOSAMS. A description of the source was presented at the 2004 SNEAP conference at McMaster. The system will also have a NEC 134 sample MC-SNICS for 'traditional' AMS measurements. The accelerator is a National Electrostatics Corporation (NEC) model 1.5SDH-1 with a maximum terminal potential of 500 kV.

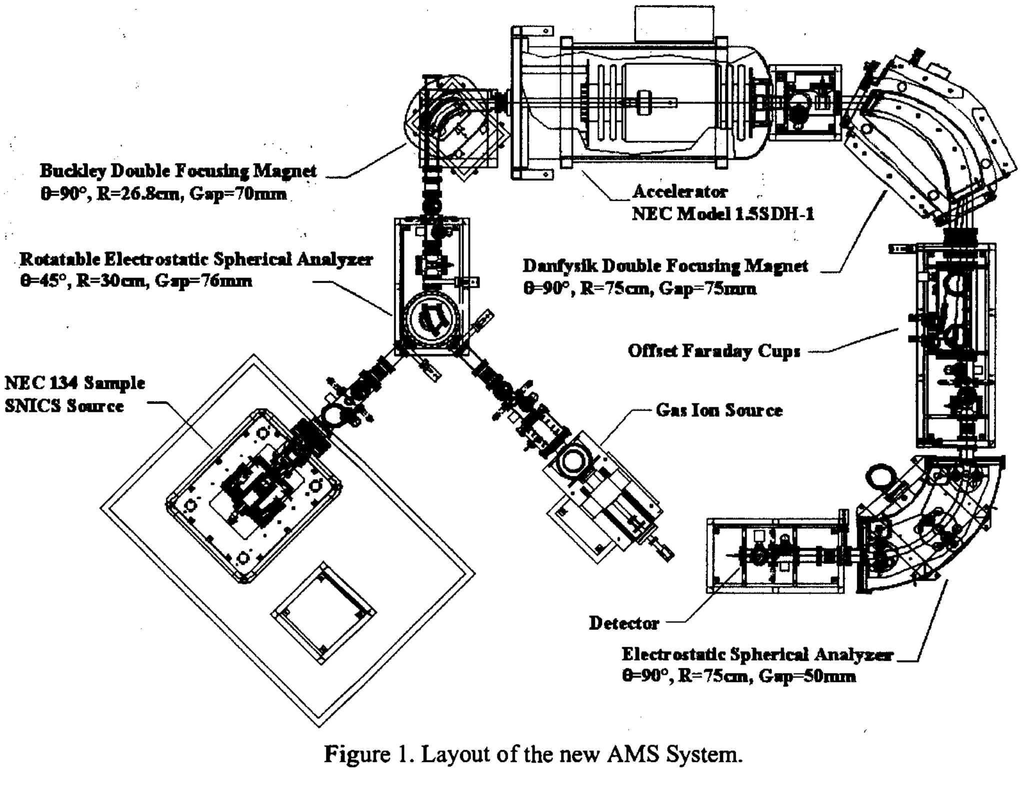

Figure 1. Layout of the new AMS System.

To date, we have installed the accelerator, NEC MC-SNICS, low-energy, and high-energy parts of the system. A new and improved gas ion source is being designed and will be constructed the first half of 2007. Control of the system is with National Instruments PXI hardware and LabVIEW software. To date, the National Instruments hardware has been fairly robust and worked well. Data Acquisition will be with a combination of Sparrow Corporation and National Instruments hardware and LabVIEW software. Vacuum pumping for the system is provided by 7 Varian turbopumps and 1 CryoTorr cryopump. In contrast to other past reports from SNEAP, we have had no problem with our two each Varian Turbo-V 551 Navigator pumps.

As the system has been installed, various components have undergone extensive testing. Over the past year we have had the following 'issues':

- About 80 hours after initial turn on, we had a small 'fire' (no flames, but copious amounts of smoke) in our large (260A, 75V) Danfysik power supply. The problem originated in a filter circuit consisting of two large capacitors and a small printed circuit board. Danfysik replaced the destroyed components, and the supply has since operated without incident. The larger issue was that the 'fire' set off the smoke alarms causing a substantial response (> 5 fire trucks) from the local fire department. The resulting paperwork and series of meetings was significantly more time consuming than the repair itself.
- We experienced failure on three National Instruments PXI-6528 digital I/O boards. The failure was traced to an over current situation on the inputs (an implementation error on our part). Current limiting resistors solved the problem.
- We had a failure of a 75 kV Glassman High Voltage power supply. As previously reported at SNEAP, the problem was with a bad batch of capacitors that found their way into the manufacturing process. Glassman repaired the supply for free and also replaced capacitors in two other supplies.
- The drive shaft on our 1.5SDH-1 accelerator has broken twice. This is the drive shaft from the motor at ground to the georator in the terminal. In both cases, the break occurred near the shaft coupling. Extensive measurements (of run-out, co-centricity, etc.) have been made, but the fundamental cause of the failures is not 100% known. The current working theory is that the shafts were improperly machined at NEC. This is still a work in progress.
- The room in which the new system is located has large swings in relative humidity. We have seen relative humidity readings as high as 85% on rainy days. Our physical plant has been unable to get a handle on the situation. When the humidity was high, we experienced external arcing to ground of the 75 kV feedthroughs on the high-energy electrostatic analyzer. For now, we have placed several layers of Teflon around the feedthrough. This has stopped the arcing. The longer-term solution, however, will be for our physical plant to install some type of humidity control.
- We experienced failure of the fiber optic bundle on our 1.5SDH-1. This bundle provides communication with the accelerator terminal. What we believe to be a column spark, broke several (but not all) of the fibers. The bundle was replaced.

Other than these failures, construction of the system has gone well with no huge surprises. We expect beam from the MC-SNICS source before the end of 2006.