

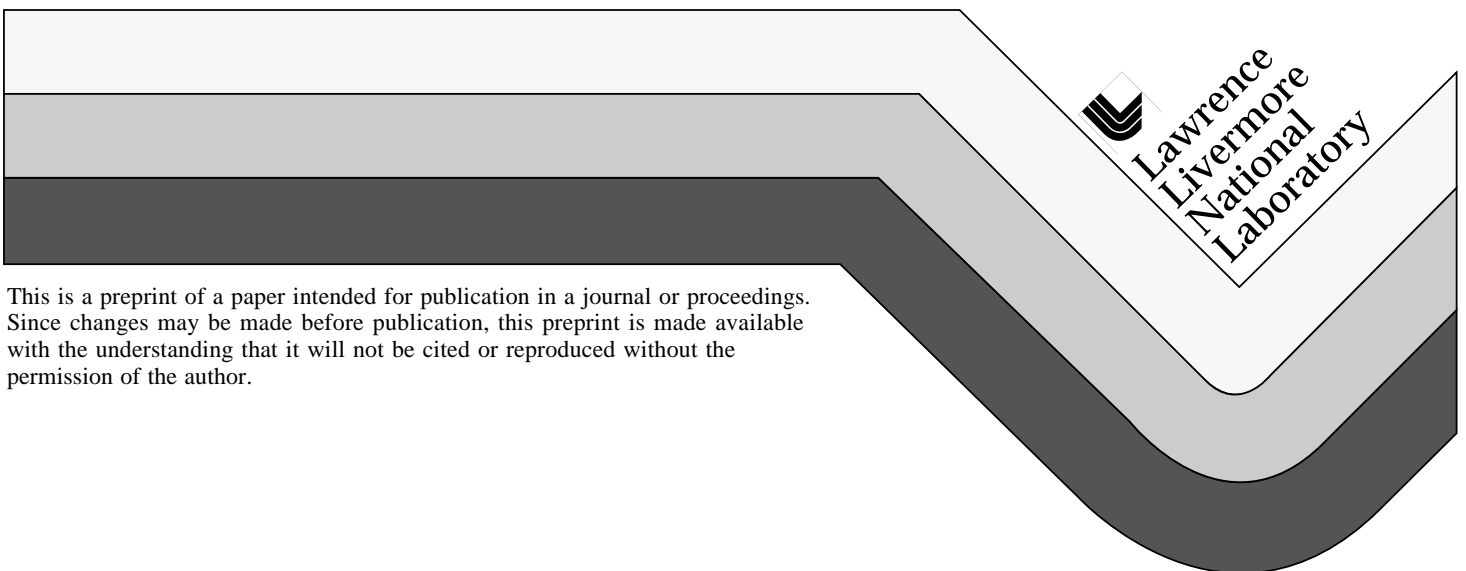
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## The Center for Accelerator Mass Spectrometry Lawrence Livermore National Laboratory

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The Center for Accelerator Mass Spectrometry (CAMS) at Lawrence Livermore National Laboratory (LLNL) operates an HVEC FN tandem accelerator for use in both basic research and technology development. The accelerator is operated under a distributed computer control system that has sophisticated auto-scaling, beam flat-topping, archiving, and recall capabilities. This system makes possible rapid and precise switching between experimental configurations on a daily basis. The accelerator and beamlines are unshielded with radiation protection provided by a computer supervised radiation monitoring system and proximity shielding as necessary on an experiment-by-experiment basis. This approach allows rapid reconfiguration of beamlines to meet special measurement needs.

The primary user of the tandem is the Accelerator Mass Spectrometry (AMS) group. Using the spectrometer, the AMS group can routinely measure the isotopes  $^3\text{H}$ ,  $^7\text{Be}$ ,  $^{10}\text{Be}$ ,  $^{14}\text{C}$ ,  $^{26}\text{Al}$ ,  $^{36}\text{Cl}$ ,  $^{41}\text{Ca}$ , and  $^{129}\text{I}$  at abundance's as low as 1 part in  $10^{15}$ . During the past year our AMS group has run approximately 17,000 research samples serving LLNL, other DOE, University of California, federal, and external academic, institute and corporate investigators. Research programs are as diverse as archaeology, art history, dosimetry of carcinogens and mutagens, oceanic and atmospheric chemistry, paleoclimatology, forensic reconstruction of Hiroshima, Nagasaki and Chernobyl dosimetry, and detection of signatures of nuclear fuel reprocessing for non-proliferation purposes. AMS Operations at LLNL during fiscal year 1996 are listed below.

### AMS Operations at LLNL in Fiscal Year 1996

<u>Isotope</u>	<u>Stable Ion Current</u>	<u>Research Background</u>	<u>Accuracy</u>	<u>Number of Samples*</u>
$^{14}\text{C}$ BioSci	100 $\mu\text{A}$ $^{12}\text{C}^-$	$1 \times 10^{-14}$	2%	5650
$^{14}\text{C}$ Natural	120 $\mu\text{A}$ $^{12}\text{C}^-$	45ka	0.7%	6850
$^3\text{H}$	15 $\mu\text{A}$ $^1\text{H}^-$	$2 \times 10^{-15}$	5%	250
$^{10}\text{Be}$	4 $\mu\text{A}$ $^9\text{BeO}^-$	$1 \times 10^{-14}$	3%	1600
$^{26}\text{Al}$	1 $\mu\text{A}$ $^{27}\text{Al}^-$	$2 \times 10^{-15}$	4%	800
$^{36}\text{Cl}$	20-40 $\mu\text{A}$ $^{37}\text{Cl}^-$	$3 \times 10^{-15}$	3%	750
$^{41}\text{Ca}$	500 nA $^{40}\text{CaF}_3^-$	$3 \times 10^{-13}$	5%	250
$^{129}\text{I}$	25 $\mu\text{A}$ $^{129}\text{I}^-$	$5 \times 10^{-14}$	5%	<u>450</u>
				16610

\*Includes secondary standards and process blanks

Another user of the LLNL accelerator is the Ion Micro Analysis Group (IMAG). The IMAG group utilizes a wide range of ion beam analysis techniques with sub-micron spatial resolution for biological and materials science research. Analysis techniques include Particle Induced X-ray Emission (PIXE), Particle Induced  $\gamma$ -ray Emission (PIGE), Scanning Transmission Ion Microtomography (STIM), Rutherford Back Scattering (RBS), and Elastic Recoil Detection Analysis (ERDA). Active research programs include the use of PIXE for elemental analyses of sperm cells and environmental air filters.

In the past year at LLNL, we have installed and tested a new thermal emission ion

source, installed a new AMS detector/detector housing, and replaced the turbo pump on our AMS sputter ion source with a cryopump. The thermal emission ion source was installed as part of a joint Pacific Northwest National Laboratory/LLNL project that proposed to combine the high sample-efficiency of a thermal emission ion source with the high isotopic ratio sensitivity of AMS. With the combination of thermal emission ion source and AMS, we had hoped to demonstrate that isotopic ratios of  $^{129}\text{I}/^{127}\text{I}$  as low as  $10^{-11}$  could be measured from samples as small as a few  $\mu\text{g}$ . The ion source for the project was a commercial, 20 sample, thermal emission ion source purchased from VG Isotech. Unfortunately, project results were disappointing. Using the thermal emission ion source, we were never able to obtain more than 1 or 2 nA of  $^{127}\text{I}$  current and with such small currents, it was almost impossible to 'tune' or set machine parameters using our standard Faraday cups and beam profile monitors. In the end, we were never able to obtain  $^{129}\text{I}/^{127}\text{I}$  ratios using the thermal emission ion source in conjunction with our AMS spectrometer and the project was canceled.

A new AMS detector/detector housing was recently installed. While the heart of this new detector housing is a fairly standard five anode gas ionization detector, other parts of the detector housing are unique in that they were specifically designed for ease of use and maintainability. For instance, pumped volume of the detector housing was minimized to decrease pump down time and access to the entrance window of the gas ionization detector is through a quick-entry port so that we can change detector windows in a matter of minutes. Other dedicated ports were provided for solid-state, time-of-flight, and X-ray detectors.

During the past year we also installed a CTI-Cryogenics On-Board 8 Cryopump on our AMS sputter ion source. This cryopump replaced a turbomolecular pump used previously. While the new cryo-system was installed primarily to eliminate turbomolecular pump oil back-streaming and contaminating small  $^{14}\text{C}$  samples, the cryo-pump has had several other advantages. For example, the base pressure in the ion source has been reduced from  $1 \times 10^{-6}$  Torr to about  $3 \times 10^{-7}$  Torr, pump down time after a sample wheel change has been cut nearly in half, and because of the excellent water vapor pumping capability of a cryo-pump, the contribution of  $^{12}\text{CH}$  beam to mass 13 beam (as measured on our low energy Faraday cup) has been reduced approximately 50%. It also appears that the cryo-system has substantially reduced  $^{36}\text{S}$  backgrounds in  $^{36}\text{Cl}$  AMS measurements. The cryo-system is fully interlocked and to date we have had no major vacuum accidents nor have we experienced any problems with cesium vapor.

Currently, we are building a new high-resolution high-mass AMS injector. This injector will be used to develop AMS for those long lived isotopes with masses between 79 and 244. The injector will utilize a Danfysik electrostatic analyzer (Model 263,  $90^\circ$  deflection angle, 750 mm bend radius, 100 mm plate separation, mean beam rigidity of 75 kV), and an ion source/sample changer identical to our present setup. This new injector should be operational sometime in mid 1997.

Another development in our laboratory is the installation of a new stand-alone microprobe system. This system will utilize a 1.7 MV National Electrostatic Corporation Model 5SDH accelerator and an Oxford Microbeams Quadrupole Triplet Lens System to create a 3 MeV focused ion beam. This ion beam will be rapidly scanned across various collection media (such as filter papers) and we will use PIXE to non-destructively determine alloy composition, trace impurities, and elemental ratios of particulates. Control of the stand-alone microprobe system will be accomplished using LabVIEW and CAMAC.

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