UCRL-JC-125604 Rev. 1
PREPRINT

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This paper was prepared for submittal to the
Symposium of Northeastern Accelerator Personnel-31
Julich, Germany
October 12-15, 1997

September 1997

Lawrence Livermore National Laboratory

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The Center for Accelerator Mass Spectrometry (CAMS) at Lawrence Livermore National Laboratory (LLNL) is a multi-disciplinary research organization that conducts both technological and applications research. CAMS operates both an HVEC FN tandem and a NEC Model 5SDH-2 tandem accelerator. Using highly sensitive accelerator-based element and isotope detection methods, staff at CAMS collaborate with a broad scope of external and internal researchers to solve problems for LLNL, the University of California, the U.S. Department of Energy, and other academic, government, and industrial laboratories.

The HVEC FN tandem is used by the LLNL Accelerator Mass Spectrometry (AMS) group. AMS is a technique that uses isotope ratio mass spectrometry at MeV energies to quantify long lived radioisotopes. For AMS, the FN tandem is operated under a distributed computer control system that makes possible rapid and precise switching between experimental configurations on a daily basis. The accelerator and beam lines are unshielded with radiation protection provided by a computer supervised radiation monitoring system and proximity shielding. With AMS, we routinely measure the isotopes ^{3}H, ^{7}Be, ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{59}Ni, and ^{129}I at abundance's as low as 1 part in 10^{15}. Research programs are as diverse as archaeology, dosimetry of carcinogens and mutagens, oceanic and atmospheric chemistry, paleoclimatology, and detection of signatures of nuclear fuel reprocessing for non-proliferation purposes. During the past year our AMS group has run approximately 20,000 research samples. AMS Operations at LLNL during fiscal year 1997 are listed below.

AMS Operations at LLNL in Fiscal Year 1997

Isotope	Stable Ion Current	Research Background	Accuracy	Number of Samples
^{14}C Bio	100 μA $^{12}C^-$	$1x10^{-14}$	2%	6500
^{14}C Natural	150 μA $^{12}C^-$	45ka	0.5%	9000
^{3}H	10 μA $^{1}H^-$	$2x10^{-15}$	5%	400
^{10}Be	5 μA $^{9}BeO^-$	$1x10^{-14}$	3%	1800
^{26}Al	1 μA $^{27}Al^-$	$2x10^{-15}$	4%	800
^{36}Cl	20-40 μA $^{37}Cl^-$	$3x10^{-15}$	3%	700
^{41}Ca	500 nA $^{40}CaF_3^-$	$3x10^{-13}$	5%	350
^{129}I	25 μA $^{129}I^-$	$5x10^{-14}$	5%	250
				19800

The NEC Model 5SDH-2 tandem accelerator is used by the Ion Micro Analysis Group (IMAG), a joint collaboration between LLNL and Sandia National Laboratories/California in biological and materials science research.

The 1.7 MV accelerator and an Oxford Microbeams Quadrupole Triplet Lens System are used to create a 3 MeV micron scale focused ion beam which is rapidly scanned across research samples. Analysis techniques include Particle Induced X-ray Emission (PIXE) to determine elemental compositions, Scanning Transmission Ion Microtomography (STIM) to determine areal densities, Particle Induced γ-ray Emission (PIGE) to determine isotopic distributions, Elastic Recoil Detection Analysis (ERDA) to determine hydrogen profiles, and Rutherford Back Scattering (RBS). Control of the accelerator, beam transport components, and data acquisition system is through CAMAC using LabVIEW software. Control of the ion source is accomplished using Group 3 hardware. For radiation shielding against x-rays, approximately 20 mm of lead surrounds the accelerator while the direct extraction source is shielded with approximately 3 mm of steel. The rest of the transport system and beam line is unshielded. A unique feature of the system is the detection system consisting of four Ortec IGLET/IGLET-X™ detectors arranged in an array such that a detection solid angle of almost 1 steradian can be achieved. Each detector is capable of detecting approximately 1 keV to 30 keV x-rays with an energy resolution of approximately 160 eV.

Current plans at LLNL call for the construction of a new high-resolution high-mass AMS ion source and injection beam line. This injector will be used to develop AMS for long lived isotopes with masses between 79 and 244 AMU. The injector will utilize a Danfysik electrostatic analyzer (90° deflection angle, 750 mm bend radius, 100 mm plate separation, maximum beam rigidity of 75 kV), and an ion source/sample changer identical to our present setup. Because of space constraints, however, the present low-mass AMS injection beam line must be moved/rebuilt before the new high-mass injection beam line can be constructed. We are therefore currently in the process of building a new low-mass AMS ion source and injection beam line. Once this new source/beam line is completed in the next few months, we will begin construction of the high-mass AMS injector.

We are also constructing a new high-mass high-energy AMS detection beam line off the North 30˚ port of our switching magnet. This beam line will be used for AMS measurements of isotopes with masses greater than approximately 75 AMU. The beam line will consist of an off-axis faraday cup (for stable beam current measurements), a large magnetic quadrupole lens (4” bore, 5.6 kG pole field strength), a Danfysik Wien filter (1m length, 80 mm gap, 3 kG pole field strength, ± 60 kV maximum plate voltage) for velocity separation, and isotope specific detectors. For ^{129}I AMS measurements, time-of-flight detectors will be used to discriminate ^{129}I ions from ^{127}I ions. For other isotopes, a combination of multi- or single-anode gas ionization detectors and an Ortec IGLET x-ray detector will be used. The high-mass detection beam line is expected to be complete sometime before the first of the year.

This work was performed under the auspices of the Lawrence Livermore National Laboratory for the Department of Energy under contract W7405ENG-48.

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