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Phase II, Compact AMS System for Biological Tracer Detection Final Report CRADA No. TSV-1533-96

T. A. Brown, R. W. Hamm

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Disclaimer

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Phase II, Compact AMS System for Biological Tracer Detection

Project Accomplishments Summary
CRADA No. TSV-1533-96

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A. Parties

The project is a relationship between the Lawrence Livermore National Laboratory (LLNL) and AccSys Technology, Inc.

University of California
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, CA 94550
Dr. Thomas A. Brown
CAMS
Tel: (925) 423-8507
Fax: (925) 423-7884

AccSys Technology, Inc.
1177 A Quarry Lane
Pleasanton, CA 94566
Dr. Robert W. Hamm
Tel: (925) 462-6949
Fax: (925) 462-6993

B. Background

Over the past two decades, Accelerator Mass Spectrometer (AMS) has developed into a mature scientific tool for the detection of extremely low concentrations of long-lived radionuclides.

AMS is a type of mass spectrometry in which two mass spectrometers are separated by an accelerator that provides an energy gain from keV energies to MeV energies. This energy gain allows the use of nuclear detection methods for counting and identifying individual ions. When compared to decay counting methods, AMS has increased the sensitivity for detection of several long-lived radionuclides by three to six orders of magnitude.

The AMS technique is most highly developed for the following long-lived radionuclides: ^{3}H, ^{7}Be, ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{59}Ni, and ^{129}I. The unparalleled sensitivity of AMS has allowed major developments in many areas of geoscience, space science, and archeology.

Recently, the Center for Accelerator Mass Spectrometry (CAMS) at LLNL pioneered the use of ^{14}C AMS in the biological sciences. CAMS researchers have used ^{14}C AMS for research in metabolite analyses, nutrition research, pharmacology dermal transport studies, and in comparative medicine studies.

While much of the initial bio-science use of the AMS technique at LLNL centered around the use of ^{14}C, LLNL also worked on developing a ^{3}H AMS capability to measure ^{3}H activity of mg-sized biological samples. Development of bio-medical ^{3}H AMS was important because was the most widely used radioisotope in bio-medical research.

Initial ^{3}H AMS efforts at LLNL used CAMS's large AMS facility and concentrated on sample preparation methodologies and pioneering 'proof-of-principle' experiments. These beginning efforts demonstrated that when compared to conventional decay counting methods, ^{3}H AMS promises a 100 to 1,000 fold improvement in detection sensitivity for assaying mg-sized biological samples for ^{3}H content. While further development and application of the biomedical ^{3}H AMS technique would most likely continue at LLNL, it had become clear that wide-spread use of the ^{3}H AMS technique demanded the development of smaller and simpler AMS instrumentation.

There were few institutions in the world that could afford to build and maintain a facility as large as the LLNL AMS facility. It was important that instrumentation designed specifically for biomedical AMS be developed which would fall within the financial, resource, and space limitations of a typical university or regional research center. With an improved sensitivity of 100 to 1,000 over current capabilities, development of a small and simple ^{3}H AMS system would represent a technological leap for analyzing biological samples for ^{3}H activity and would have an immediate impact on many fields of biological research.

To that end, LLNL collaborated with AccSys Technology, Inc. of Pleasanton, CA, in a Phase I SBIR design study to establish the technical feasibility and operational design of a compact bio-medical ^{3}H AMS system. The proposed system (covered under LLNL/U.S. Patent Number 5,189,302) was based on a LLNL customized ion source and an AccSys Radio Frequency Quadrupole (RFQ) linac (covered under U.S. Patent Number 5,315,120).

In the Phase I period LLNL/CAMS personnel collaborated with AccSys Technology in a number of specific tasks to demonstrate system feasibility and to provide a sound basis for the Phase II prototype system engineering design. The results of the Phase I study established that it would be possible to design and build a compact bio-medical ^{3}H AMS prototype for less than $750K and within the budget constraints of a Phase II SBIR grant.

C. Description

With the successful completion of the Phase I SBIR design study, AccSys Technology submitted a Phase II SBIR proposal

The objective of this collaboration between LLNL and AccSys Technology, Inc. of Pleasanton, California was to build and demonstrate a low cost, compact tritium (^{3}H) Accelerator Mass Spectrometer (AMS) system matched to the requirements of bio-medical research. This collaborative work was funded by a National Institutes of Health (NIH), Phase II, Small Business Innovation Research Program (SBIR) grant to AccSys Technology (NIH Grant Number: 2 R44 CA 69960-02).

The new prototype system combined radio frequency quadruple linear accelerator technology developed at AccSys Technology with the ion injector and mass spectrometer technology developed at LLNL. The new system was constructed at AccSys Technology and then moved to LLNL. At LLNL, measurements were made to show the system had the sensitivity and stability necessary for accurate bio-medical ^{3}H measurements

At the conclusion of this project, the title of the prototype compact AMS system for biological tracer detection rested with NIH. AccSys intended to apply to NIH to have the prototype machine permanently transferred or placed on permanent loan to a user.

D. Expected Economic Impact

Under the funding provided by NIH (Phase II, Small Business Innovation Research Program (SBIR) grant to AccSys Technology (NIH Grant Number: 2 R44 CA 69960-02)) the collaboration between LLNL and AccSys Technology, Inc. of Pleasanton, California has built and demonstrated the operation of a low cost, compact tritium (^{3}H) Accelerator Mass Spectrometer (AMS) system. The ^{3}H measurements undertaken at LLNL have demonstrated that the system has the sensitivity necessary for accurate bio-medical ^{3}H measurements.

The development of this prototype low cost, compact tritium (^{3}H) Accelerator Mass Spectrometer (AMS) system provides the foundation for the further development of such RFQ-based ^{3}H AMS systems which will complete the technological leap bringing the factor of 100 to 1,000 increased sensitivity available through AMS techniques to the analysis of biological samples for ^{3}H activity at typical universities or regional research centers.

E. Benefits to DOE

The prototype low cost, compact tritium (^{3}H) Accelerator Mass Spectrometer (AMS) system that has been developed under this project has provided valuable insights into the numerous complex issues involved in developing a new accelerator system aimed at routine use in bio-medical research. The current prototype ^{3}H AMS system will be utilized in bio-medical research at LLNL and it is hoped that it will provide an elegant tool which will expand the repertoire of isotopic tracer methodologies that are available to LLNL researchers in the bio-medical sciences.

F. Industry Area

Medical

G. Project Status

This project is completed.

H. LLNL Point of Contact for Project Information

University of California
Lawrence Livermore National Laboratory
7000 East Avenue
Livermore, CA 94550
Dr. Thomas A. Brown
CAMS
Tel: (925) 423-8507
Fax: (925) 423-7884

I. Company Size and Point(s) of Contact

AccSys Technology, Inc. is a privately held company with annual sales of less than $10 million. The company employs fewer than 50 people.

AccSys Technology, Inc.
1177 A Quarry Lane
Pleasanton, CA 94566
Dr. Robert W. Hamm
CEO/President
Tel: (925) 462-6949
Fax: (925) 462-6993

J. Project Examples

There are no project examples.

K. Subject Inventions

This small value contractual mechanism did not anticipate any generation of Intellectual Property (IP) including subject inventions. The LLNL contributors and the company participants both indicate that no new intellectual property was generated.

Documents/Reference List

Reports

M.L. Roberts, R.W. Hamm, K.H. Dingley, M.L. Chiarappa and A.H. Love, "A Compact Tritium AMS System," Proceedings of the 8th International Conference on Accelerator Mass Spectrometry; Vienna, Austria, September 6-10, 1999.

R.W. Hamm, M.L. Roberts, K.H. Dingley, M.L. Chiarappa-Zucca and A.H. Love, "A Compact Tritium Analysis System," Proceedings of the Seventh International Symposium on Synthesis and Applications of Isotopically Labeled Compounds; John Wiley A. Sons, ISBN 0-471-49501-8, 451 (2001).

AccSys Technology, Inc. final Phase II SBIR report of 11/30/99 to the National Institutes of Health for the "Compact AMS System for Biological Tracer Detection," developed under NIH Grant No. 2R44 CA69960-02 during the period from 9/30/97 through 8/31/99.

Patent/Copyright Activity

None

Subject Inventions

None

Generated Information

None

Background Intellectual Property

No BIP was licensed.

L. Release of Information

I certify that all information contained in this report is accurate and releasable to the best of my knowledge.

Karena McKinley, Director — Date 6/5/01
Industrial Partnerships and Commercialization

Release of Information

I have reviewed the attached Project Accomplishment Summary prepared by Lawrence Livermore National Laboratory and agree that the information about our CRADA may be released for external distribution.

Dr. Robert W. Hamm, CEO/President — Date 5/29/01
AccSys Technology, Inc.