85387T08-II

Small Business
Xemed, LLC
16 Strafford Avenue
Durham, NH 03824
Dr. William Hersman, PhD, Principal Investigator
hersman@unh.edu
Dr. William Hersman PhD, Business Official
hersman@unh.edu
603-868-1888

DOE Grant No. DE-FG02-08ER86369
Amount: $750,000

Research Institution
University of New Hampshire

Pulsed Focusing Recirculating Linacs for Muon Acceleration

The DOE supports facilities that use neutron scattering as a tool for the characterization of materials. In these systems, polarized ^{3}He cells can serve as neutron spin filters for the preparation of intense beams of polarized neutrons and as spin analyzers for determining polarization of scattered neutrons. However, existing ^{3}He polarization systems, which use lasers to illuminate cells *in situ*, suffer from a number of limitations: (1) the neutron beam has an immediate depolarizing effect, (2) a long-term aging effect leads to milky buildup on the cell walls, and (3) analyzers of unusual geometries are difficult to illuminate. Although e*x situ* polarization – i.e., separated operation of the polarizer with polarized gas delivery to the cells – has been exploited successfully, this approach requires a large volume for polarization and specialized compression equipment, at high cost. This project will adapt an existing ^{3}He polarization technology, developed for medical diagnostic imaging, for use as an *ex situ* system for neutron spin filters and analyzers. Phase I investigated the high polarization capabilities of the system by implementing a flowing-oil thermal stabilization system, reconfiguring a multi-kilowatt laser for, fabricating three aluminosilicate cells, and testing them for long lifetime and low X-factor. In Phase II, a non-ferrous compressor will be utilized to circulate the ^{3}He through a low pressure loop, thereby demonstrating its capabilities in a spin filter or analyzer application.

Commercial Applications and other Benefits as described by the awardee: Polarized ^{3}He should have synergistic applications not only as a neutron spin filter for producing polarized neutron beams and as a neutron spin analyzer to measure magnetic properties of thin films, but also as an electron beam target and as a contrast agent for measuring regional pulmonary function in diagnostic magnetic resonance imaging (MRI).

86026S08-II

Virtual Instrumentation Experiment Optimization for High-Throughput Scientific Analysis—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Mark L. Green, Principal Investigator; mlgreen@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85000
Amount: $749,360

Neutron scientists using large-scale neutron facilities, such as the Spallation Neutron Source (SNS) located at Oak Ridge National Laboratory, want to be prepared when they arrive at the facility, but virtual experiment capabilities are not sufficient for proper planning. This project will extend the Orbiter Virtual File System, developed in collaboration with the SNS, to provide virtual instrumentation-experiment optimization capabilities to neutron scientists. The technology not only will allow the neutron scientist to perform extensive pre-experiment virtual simulations but also will provide a high Quality of Service, yielding more efficient use of the facility. In Phase I, the Orbiter Virtual File System Service Oriented Architecture was implemented, providing a wealth of neutron facility information, experiment data file access and search capabilities, and authentication and authorization management. In Phase II, a robust and reliable service infrastructure will be developed to increase the effective system performance.

Commercial Applications and other Benefits as described by the awardee: The successful implementation of the proposed infrastructure and prototype should directly benefit U.S. and international neutron facilities. Improved simulations of neutron experiments using virtual instrumentation-experiment optimization should contribute to multiple applications in energy research, electronics, material science, manufacturing, and medical research.

86099S08-II

High Performance Neutron Detector—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Dr. Jaroslaw Glodo, PhD, Principal Investigator; jglodo@rmdinc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER84999
Amount: $749,996

Neutrons are invaluable to the characterization of materials in the physical, chemical, and biological sciences. To realize the full potential of present and future neutron facilities, improvements are needed for neutron detectors with respect to detection efficiency, high counting rate capability, high spatial resolution, time resolution (for pulsed source applications and energy estimation), cost per unit area, and adaptability to unique geometries. This project will develop new neutron detectors based on crystal layers of a new scintillating material. Phase I demonstrated the feasibility of producing a new thermal neutron scintillator in the form of crystal layers. The detection of thermal neutrons was demonstrated, and good light yield, timing resolution, and spatial resolution were obtained. Phase II will be aimed at optimizing the material manufacturing processes and detector design, in order to achieve high detection efficiency, high light, and high spatial resolution. Multiple detectors will be built and evaluated in house and at the National Institute for Standards and Technology (NIST).

Commercial Applications and other Benefits as described by the awardee: The proposed technology should be very useful for neutron detection. Although primarily targeted at neutron facilities, the technology also should find use in the growing number of portable neutron generators used in medical and industrial non-destructive imaging, homeland security, and other neutron detection applications.

86232T08-II

Small Business
Cryogenic Applications F, Inc.
450 Bacon Springs Lane
Clinton, TN 37716-5311
Dr. Christopher A. Foster, Principal Investigator
Foster_c_a@bellsouth.net
Dr. Christopher A. Foster, Business Official
Foster_c_a@bellsouth.net
865-435-5433

DOE Grant No. DE-FG02-08ER86344
Amount: $749,150

Research Institution
Indiana University Cyclotron Facility

Development and Neutronic Validation of Pelletized Cold and Very Cold Moderators for Pulsed Neutron Sources

Existing and planned neutron facilities, such as the Spallation Neutron Source, generate bursts of cold neutrons for materials research. The efficiency of the beam line components, which convert the fast neutrons to a cold neutron beam, determines the usefulness of the facility. Although existing solid methane moderators have a high efficiency, they cannot be scaled to work on high power facilities. This project will validate the neutron performance of a cold moderator that uses solid methane pellets and would be capable of operating on a high power pulsed neutron source. In Phase I, sample moderators filled with polyethylene pellets, similar to the solid methane pellets, were prepared and studied. Packing densities of over 60% were achieved. In addition, the Phase II apparatus was designed and a preliminary safety analysis was made. In Phase II, the solid methane pelletizer will be completed. Neutron scattering and transmission experiments will be performed with cryogenic moderators filled with solid methane pellets, in order to determine the effects of packing densities and non-uniformities on the neutron beam.

Commercial Applications and other Benefits as described by the awardee: Compared to a conventional hydrogen moderator, a methane pellet moderator would double the output of cold neutrons. The improved performance would advance the materials research capabilities of the neutron facilities.

86461S08-II

High Rate Large Area Enriched Boron Neutron Detector for SNS—Proportional Technologies, Inc., 8022 El Rio Street, Houston, TX 77054-4184; 713-747-7324
Dr. Jeffrey L. Lacy, Principal Investigator; jlacy@proportionaltech.com
Dr. Jeffrey L. Lacy, Business Official; jlacy@proportionaltech.com
DOE Grant No. DE-FG02-08ER84997
Amount: $745,221

With the recent announcement of plans to ramp up the operation of the Spallation Neutron Source (SNS) facility to 1 megawatt, the available thermal neutron flux will be pushed at least an order of magnitude above that achievable at any other neutron science facility. This markedly increased flux imposes extreme requirements on imaging detectors at many of the target stations, which cannot be met without fundamental detector improvements. This project will develop a detector technology based on the detection of reaction products in the gas of a thin straw detector. By using a dense-packed array of such straws, which can be more than 1 meter in length, efficient high resolution imaging can be achieved with a quantum leap in integral and differential counting rate. In previous work, a complete 1 m^2 neutron straw imaging system, utilizing natural boron-carbide straw coating, was developed. In Phase I, this development was extended by investing in expensive 10B4C sputtering targets and constructing a 1 meter detector module that demonstrated a five-fold increase in stopping power. In Phase II, a 22 module 1 m^2 single layer detector will be fabricated. Because the outsourced sputtering targets represent more than 80% of the total cost, an in-house reel-to-reel coating system for production of large quantities of the requisite coated foil also will be developed.

Commercial Applications and other Benefits as described by the awardee: The economical reel-to-reel production technique should enable the production of m^2 imaging detectors at a very small fraction of the cost of currently envisaged detectors based on ^{3}He. Because the availability of ^{3}He on earth is extremely limited, its utilization in the thousands of detectors currently contemplated is very unrealistic. In contrast, the 10B isotope is extremely plentiful and cheap, and therefore the innovative manufacturing capability should meet a very significant need in neutron detection.

85512T08-II

Small Business
Anasys Instruments Corp
25 W. Anapamu
Suite B
Santa Barbara, CA 93101-5151
Dr. Markus Raschke, Principal Investigator
raschke@chem.washington.edu
Dr. Roshan Shetty, Business Official
roshan@anasysinstruments.com
805-455-5482

Research Institution
Univ. of Washington

DOE Grant No. DE-FG02-08ER86338
Amount: $750,000

Scanning Probe Microscopy (SPM) is a strategically vital tool for nanotechnology research, constituting a $250 million/yr industry essential to such multi-billion-dollar downstream industries as materials and pharmaceuticals. However, the single biggest drawback to SPM is its inability to obtain any chemical information on its samples. This drawback impacts DOE researchers in the Genome-to-Life and bioremediation programs, academic researchers in the field of organic solar cells, and corporate researchers in chemicals and pharmaceuticals. This project will develop a novel detection scheme that, together with two other proprietary ideas, promises to solve the major problems that have prevented s-SNOM (scattering Scanning near-Field Optical Microscopy) technology from becoming a commercially feasible solution. The feasibility of this approach was demonstrated in Phase I. In Phase II, a prototype s-SNOM system will be built, in order to demonstrate sub-30 nm IR spectroscopy and imaging.

Commercial Applications and other Benefits as described by the awardee: In addition to providing materials science researchers using SPM with critical chemical information on their samples, the technology should enable SPMs to penetrate new markets in life sciences and disease screening, where lack of chemical information is a major bottleneck.

85610S08-II

Nanoscale Imaging of Solid-State Energy Conversion Processes at the Solid-Liquid Interface Using Real Time Transmission Electron Microscopy—Hummingbird Scientific, LLC, 8300 28th Court NE, Unit 200, Lacey, WA 98516; 360-252-2737
Mr. David Vetter, Principal Investigator; david_vetter@hummingbirdscientific.com
Mr. Norman J. Salmon, Business Official; norman@hummingbirdscientific.com
DOE Grant No. DE-FG02-08ER84992
Amount: $750,000

Researchers are currently hindered from observing dynamic liquid-liquid and liquid-solid interactions in transmission electron microscopes (TEMs) and scanning transmission electron microscopes (STEMs). Yet, solid-state materials and fluids interact in many important ways. For example, solid-state nanoparticles are formed via solution-based synthesis, and biological cells exist live only in a fluid environment. This project will develop a method for imaging these events at nanometer scale resolutions in continuously flowing fluids using STEM. Phase I designed and constructed an experimental apparatus that allows both solid state and biological materials to be enclosed within microfluidic cells and imaged within the confined space of the STEM objective lens. This apparatus was tested with a range of materials and liquids. In Phase II, additional functions – electrical biasing, heating/cooling, and controlled multi-fluid introduction – will be incorporated to produce a new commercial grade product.

Commercial Applications and other Benefits as described by the awardee: The real-time nanoscale interrogation of liquid-liquid and solid-liquid interactions should greatly improve the understanding of phenomena important to energy systems, including (1) electrochemical reactions that occur in batteries, fuel cells, and other energy generation systems, and (2) biologic systems that have significant application to bio-fuel formation.

85732S08-II

Parallel Data Collection Wavelength Dispersive X-Ray Spectrometer for Use on Scanning Electron Microscopes—Parallax Research, Inc., P.O. Box 12212, Tallahassee, FL 32317; 850-580-5481
Dr. David OHara, Principal Investigator; prlax@mindspring.com
Dr. David OHara, Business Official; prlax@mindspring.com
DOE Grant No. DE-FG02-08ER84995
Amount: $557,366

This project will develop a new type of Wavelength Dispersive Spectrometer (WDS) for use on Scanning Electron Microscopes. Instead of the slow serial scan used in a conventional WDS, the new system will collect and display data in a parallel fashion, thereby enabling the user to make very fast decisions about his/her samples. The device will be a variation on the Von Hamos style x-ray spectrometer that uses (1) diffractors with a small radius of curvature and (2) new long charge couple detectors (CCDs) arranged to simultaneously collect data from a very wide spectral range. In Phase I, the parallel data collection technique was demonstrated on a proof-of-concept system over a very narrow (300 eV) spectral interval. Tests were conducted to demonstrate a higher resolution at this energy than for any commercially available spectrometer. A design for a Phase II spectrometer was determined and software was written to allow a user to limit noise levels. Phase II will involve the construction of a spectrometer that provides parallel data collection over the energy range from 2100 eV to 10,000 eV. This system will be extensively tested on an SEM and on a small spot x-ray fluorescence (XRF) system. The system also will be tested for its ability to produce spectral images of spots as large as 1 mm with 0.05 mm resolution.

Commercial Applications and other Benefits as described by the awardee: The new system could be combined with an existing spectrometer to produce an expanded system that covers the entire energy range from 100 eV to 10,0000 eV for use on SEMs. In addition, the system could be used on stand-alone XRF systems for the analysis of small features, such as grains of rock, electronic circuits, and fibers.

86105S08-II

Advanced Scintillation Detector for Synchrotron Facilities—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Dr. Vivek Nagarkar, PhD, Principal Investigator; vnagarkar@rmdinc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER85019
Amount: $749,999

Recent developments in synchrotron radiation sources have enabled the growth of powerful techniques, such as time-resolved X-ray diffraction studies for understanding dynamic biological phenomena and the Multi-wavelength Anomalous Dispersion (MAD) method for recovering phase information in X-ray crystallography. To make the most effective use of synchrotron sources, however, new efficient, high-throughput detectors are needed. Although novel detectors based on new charge coupled devices (CCDs) have been developed, the performance of these devices is limited by current X-ray-to-light converters, which have low light conversion efficiency and low X-ray absorption. This project will develop a novel semiconductor scintillator that promises (1) a three-fold increase in emitted light at the wavelength range suitable for most CCDs, (2) high X-ray absorption due to high density as well as high effective atomic number, (3) a fast decay with no afterglow, and (4) a radiation resistance that is orders of magnitude higher than current scintillators. Phase I involved the fabrication of very bright, high-resolution scintillators and the creation of films with a wide variety of thicknesses useful for a range of synchrotron studies in medicine and science. Phase II will focus on technology optimization in the areas of precursor materials development, fabrication of larger-area scintillators, establishment of post-deposition protocols to further improve scintillation yields, and the fabrication and evaluation of a prototype X-ray detector.

Commercial Applications and other Benefits as described by the awardee: Applications for a scintillator with very bright emission, high spatial resolution, high X-ray absorption efficiency, and rapid decay time with no afterglow should range from macromolecular crystallography to medical imaging, and from nondestructive testing to polymer research.

86229S08-II

A Magneto-Hydrodynamic System for Generating High-Pressure Impluses in Spallation Targets—Creare Incorporated, 16 Great Hollow Road, P.O. Box 71, Hanover, NH 03755-0071; 603-640-2487
Dr Richard W. Kaszeta, PhD, Principal Investigator; rwk@creare.com
Dr James J. Barry, Business Official; contractsmgr@creare.com
DOE Grant No. DE-FG02-08ER85008
Amount: $749,385

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) produces neutrons for neutron scattering studies that allow researchers to study key materials properties. These neutrons are produced by the interaction of a very short (1 μsec), highly intense (1 MW at 60 Hz) pulse of protons within a flowing bath of mercury, in a process that deposits a large amount of thermal energy in the mercury. Because mercury has a high coefficient of thermal expansion, a high-amplitude (~38 MPa) short-duration (1 μsec) pressure pulse is created, which causes erosion damage to the mercury target assembly, impacting SNS target lifetime and operating costs. What is needed is a way to generate representative pressure pulses outside the SNS facility, in order to evaluate proposed erosion mitigation strategies. This project will develop a facility, based on magneto-hydrodynamic (MHD) pulse generation, capable of producing pressure pulses of similar magnitude and rise time to those experienced in the SNS. In Phase I, a pilot-scale facility, capable of producing such pressure pulses and rise times, was developed. The pressure pulses created in liquid mercury exceeded 1.4 MPa, with rise times under 5 μs and a repetition rate greater than 0.4 Hz. Phase II will design, fabricate, and characterize a 2nd-generation, full-scale current pulse generator that will accurately simulate the SNS target environment.

Commercial Applications and other Benefits as described by the awardee: In addition to providing immediate assistance to the SNS for the mitigation technology of erosion damage, the technology developed on this project should impact any system in which high-pressure, short-duration, and high pulse frequency impulses are present, including industrial applications involving water hammer and other flows that include cavitation.

86155S08-II

Mid IR Ultrafast Laser System for High Field Physics—Q-Peak, Incorporated, 135 South Road, Bedford, MA 01730-2307; 978-689-0003
Dr. Evgueni Slobodtchikov, Principal Investigator; Slobodtchikov@QPEAK.com
Dr. B. David Green, Business Official; green@psicorp.com
DOE Grant No. DE-FG02-08ER85016
Amount: $749,824

The Department of Energy seeks the development of advanced, ultrafast x-ray sources based on high-harmonic generation. Improvements in the technology will come from the use of driving lasers operating at wavelengths longer than those used in the incumbent Ti:sapphire-based systems. These current laser systems suffer from complexity due to the use of multiple nonlinear stages to achieve the desired wavelength, and they have issues with power scaling. This project will develop a novel, mid-infrared 100-femtosecond-pulse, high-pulse-energy hybrid laser system utilizing fiber and solid-state lasers. Phase I demonstrated the operation of a fiber laser-pumped femtosecond mid-IR solid-state laser. This laser was shown to be suitable as a seed source for a high-power mid-IR amplified femtosecond laser system. Phase II will develop a fiber laser-pumped femtosecond oscillator-regenerative amplifier laser system, with milliJoules output at kHz repetition rate.

Commercial Applications and other Benefits as described by the awardee: The proposed laser system should find use as a new tool for fundamental high-field-physics studies. It also should serve as a laser driver for a variety of applications, such as environmental analysis, remote-sensing, spectroscopy, and medicine.

85671S08-II

Development of a Superconducting RF 1.5 GHz Landau Cavity for Synchrotron Light Sources—Niowave, Inc., 1012 N. Walnut Street, Lansing, MI 48906; 517-230-7417
Dr. Terry Grimm, Principal Investigator; grimm@niowaveinc.com
Dr. Jerry Hollister, Business Official; hollister@niowaveinc.com
DOE Grant No. DE-FG02-08ER85014
Amount: $750,000.

Superconducting radio frequency (SRF) cavities are used to accelerate electron beams worldwide. Brookhaven National Laboratory (BNL) has proposed to build the NSLSII, a third generation light source, and has identified SRF cavities as the technology of choice. The final machine configuration will require four single-cell 500 MHz SRF cavities fed by four 300 kW klystrons to compensate beam loss. In addition, two passive two-cell 1.5 GHz Landau (3rd harmonic) SRF cavities are required to lengthen the bunch, thereby increasing beam lifetime to greater than 3 hours. This project will develop a 1500 MHz SRF Landau cavity. Whereas previously designed cavities used niobium sputtered onto high purity copper, this cavity will utilize bulk niobium to enable the stringent specifications and requirements for the NSLSII ring to be satisfied. Phase I demonstrated technical feasibility by completing the preliminary cavity and cryomodule design. Phase II will finalize the cryomodule design and prototype critical aspects of the system: SRF cavities, power coupler, HOM spectrum, and frequency tuners.

Commercial Applications and other Benefits as described by the awardee: The development and demonstration of this new type of superconducting radio frequency Landau cavity should open up many new applications for both scientific and industrial accelerators.

85904S08-II

High Power Fundamental Power Coupler for Next Generation Light Sources—Advanced Energy Systems, Inc, 27 Industrial Blvd, Unit E, Medford, NY 11763-2286; 631-345-6264
Mr. Thomas J. Schultheiss, Principal Investigator; tom_schulthesis@mail.aesys.net
Mr. Tim Myers, Business Official; tim_myers@mail.aesys.net
DOE Grant No. DE-FG02-08ER85002
Amount: $749,816

Future third generation light sources, such as the NSLS-II synchrotron light source proposed for Brookhaven National Laboratory (BNL), push the operating current and subsequent beam power to levels beyond the capabilities of single CESR-B/KEKB cavities. The proposed light source requires 500mA and 1000kW of radiated beam power that must be provided through the power couplers/windows. The development of a power coupler that can provide greater than 500kW to the cavities would reduce the installed RF impedance by a factor of two and significantly increase the beam lifetime. This project will develop a fundamental power coupler that can transmit greater than 500kW of power, with innovative cooling through the center conductor of a coax type coupler. A separate effort proposes to develop the cavity for this source; thus, if both grants are awarded, the power coupler will be integrated with the cavity. Phase I identified a general coupler configuration and layout with a KEKB-like cavity. An analysis showed that the RF requirements were met. Phase II will develop the final design of the coupler, with input from BNL. *Commercial Applications and other Benefits as described by the awardee:* The power coupler should find application in third and fourth generation light sources, high power Free Electron Lasers, and other high current accelerators requiring high power couplers to power SRF cavities.

85906S08-II

Improved Superconducting Accelerator System for Next Generation Light Sources—
Advanced Energy Systems, Inc, 27 Industrial Blvd, Unit E, Medford, NY 11763-2286;
631-345-6264
Mr. John Rathke, Principal Investigator; john_rathke@mail.aesys.net
Mr. Timothy Myers, Business Official; tim_myers@mail.aesys.net
DOE Grant No. DE-FG02-08ER85003
Amount: $747,867

Modern synchrotron light sources have come to rely upon superconducting radio frequency (SRF) acceleration to achieve high luminosity. To date, the workhorse in this area has been the SRF system developed by Cornell in the mid-1990's for the CESR-B machine. However, as the quest for higher performance continues, this system is being stretched beyond its design limits. Required increases in input power, increases in detrimental higher order mode (HOM) power, and new requirements for pressure-vessel-code compliance demand an advanced design for these systems. This project will adapt new developments in HOM absorbers to the development of an advanced SRF cryomodule system that provides higher luminosity. Phase I developed conceptual designs for the cavity and cryomodule by implementing more-structurally-robust helium vessels and providing for a high power coaxial power coupler. In addition, a concept for a next-generation HOM absorber, with broader frequency response and higher power capability, was developed. Phase II will involve the fabrication of the cavity and cryomodule.

Commercial Applications and other Benefits as described by the awardee: An advanced SRF system should enable the operation of higher performance synchrotron light sources with fewer SRF cavities, benefiting both in beam lifetime and luminosity, and reducing capital costs.

85395T08-II

Small Business
Resonon, Inc.
619 N. Church Avenue, Suite 3
Bozeman, MT 59715-3087
Dr. Rand Swanson, Principal Investigator
swanson@resonon.com
Dr. Michael Kehoe, Business Official
kehoe@resonon.com
406-586-3356

Research Institution
Montana State University (MSU

DOE Grant No. DE-FG02-08ER86359
Amount: $750,000

Geologic carbon sequestration has been identified as a potential means of reducing the amount of carbon-dioxide emitted into our atmosphere, thereby reducing one of the major contributors to global warming and climate change. A major difficulty with carbon-dioxide sequestration involves the monitoring of sequestration sites and pipelines for leakage. This leakage may come from zones on the order of 1 meter in size and be spread over areas on the order of hundreds of square kilometers. Consequently, a cost-effective, high-resolution, large-area monitoring technology for carbon-dioxide leakage is required. This project will develop a carbon-dioxide leakage monitoring technology that utilizes hyperspectral imaging to identify the natural change in reflectance of vegetation as it responds to carbon-dioxide leakage. Because plants cover a large fraction of potential leakage sites, they provide a massive natural array of sensors for carbon-dioxide leakage. During Phase I, an underground slotted pipeline was used to simulate carbon-dioxide leaks at the minimum levels needed for geologic carbon sequestration. Airborne hyperspectral images were used to identify plant stress due to their exposure to the simulated carbon-dioxide leakage. Phase II will include scientific experiments to better understand the capabilities and limitations of the technology, development of ancillary sensors and software, and rigorous testing on airborne platforms.

Commercial Applications and other Benefits as described by the awardee: In addition to monitoring carbon sequestration sites and pipelines, the proposed technology should find applications in agriculture, pipeline monitoring for other gases such as methane, and environmental monitoring, including point-source pollution, algal blooms in oceans, and beetle-kill in forests.

85820S08-II

Large Area Leak Sensor for Sequestered Carbon Dioxide—Vista Photonics, Inc., 67 Condesa Road, Santa Fe, NM 87508-8136; 505 466-3830
Dr. Jeffrey S. Pilgrim, Principal Investigator; jpilgrim@vistaphotonics.com
Dr. Jeffrey S. Pilgrim, Business Official; jpilgrim@vistaphotonics.com
DOE Grant No. DE-FG02-08ER85220
Amount: $750,000

The sustainable development and use of coal fired power plants will require carbon dioxide capture and sequestration (CCS) in the future. Without CCS, the emitted carbon dioxide could lead to irreversible climate change. Because it is critical to ensure that sequestered carbon dioxide remain trapped, high-performance sensors are required to detect any leaks at their earliest stages. This project will develop prototype wide-area carbon dioxide leak detectors. In this approach, a simple, rugged, long-path optical spectrometer will provide the required measurement precision for CO_2 leak detection in the presence of the atmospheric background. By combining multiple lines-of-sight with a central transceiver, wide-area leak detection can be achieved. In Phase I, a breadboard laser diode long-path optical spectrometer was constructed for testing and proof-of-principle. Measurement precision for atmospheric carbon dioxide was determined over several line-of-sight path lengths in the field, and requirements for calibration and stable measurement were determined. A stack of control electronics was reduced to the size of a shoe box. In Phase II, fully-integrated sensor prototypes will be constructed for wide-area CO_2 leak detection, standard operating protocols for the sensors will be established, and the prototypes will be refined through beta-testing in several field applications.

Commercial Applications and other Benefits as described by the awardee: The proposed technology should provide high-performance in an inexpensive, field-compatible, package. The approach would offer a compelling blend of price, performance, and physical advantages in a variety of gas detection applications. Examples include atmospheric monitoring, environmental regulatory compliance, process gas analysis, and biomedical breath diagnostics.

86288S08-II

Advanced Coal Research - Sealing Systems for High Temperature SOFC—Materials and Systems Research, Inc., 5395 West 700 South, Salt Lake City, UT 84104; 801-530-4987
Dr. Niladri Dasgupta, Principal Investigator; ndasgupta@msrihome.com
Mr. Anthony D. Decheek, Business Official; adecheek@msrihome.com
DOE Grant No. DE-FG02-08ER85202
Amount: $750,000

In planar Solid Oxide Fuel Cells (SOFC), separation of the anode and cathode side gases are achieved by hermetic seals. These seals may be rigid, compressive, or compliant. However, the design of improved sealing materials must address two major challenges: (1) mechanical stability of the seals in the face of thermal cycling, and (2) chemical stability with respect to the metallic interconnect. This project will add a nanosize oxide to a prevalent glass composition, along with a novel non-reactive protective coating on the sealing area of the interconnect. In Phase I, the proposed nanosize-oxide-enhanced glass was characterized for its crystalline-phase development and thermal expansion. A novel protective coating was applied on the interconnect by a spray technique. In leak tests and stack tests, the new materials performed better than conventional state-of-the-art materials and showed promise for improved long term performance. In Phase II, the base glass composition will be fine-tuned, a superior protective coating technique will be perfected, and the material will be characterized, both by itself and in the stack environment.

Commercial Applications and other Benefits as described by the awardee: The technology should lead to the development of viable sealing solutions for planar SOFC modules, which are preferred for their higher current density. An effective sealing solution should provide an impetus to clean and efficient energy generation.

86169S08-II

Novel Sorbents for Removal of Mercury, Arsenic, Sulfur and Halides from Coal-Derived Synthesis Gas—TDA Research, Inc., 12345 W. 52nd Avenue, Wheat Ridge, CO 80033-1916; 303-940-2300
Dr. Gokhan Alptekin, PhD, Principal Investigator; galptekin@tda.com
Mr. John D. Wright, Business Official; jdwright@tda.com
DOE Grant No. DE-FG02-08ER85211
Amount: $750,000

Although the Fischer-Tropsch (FT) process for the production of liquid fuels from coal, natural gas, and biomass is run on a commercial scale in both South Africa and Malaysia, several challenges remain, in particular, the need to supply a clean, essentially-contaminant-free synthesis gas feed stream. This project will develop a low-cost, high-capacity sorbent that can remove trace contaminants – including sulfur, halides, arsenic, and mercury – from coal-derived synthesis gas. The sorbent will reduce the concentration of all these contaminants to ppbv levels, providing optimum protection for the FT synthesis catalysts used to convert coal derived synthesis gas into liquid fuels. Unlike the commercially available trace metal adsorbents or sulfur polishing sorbents, the proposed sorbent will operate at the exit temperature of the warm gas clean-up step (500^{o}F). Phase I developed a highly active sorbent that can reduce the concentration of sulfur, halides, nitrogen compounds and trace metals (such as arsenic and mercury) to ultra low levels. In a preliminary cost analysis, the economic viability of the process was demonstrated. Phase II will continue to improve the performance of the sorbent, and its production will be scaled-up using commercial manufacturing techniques. The concept will be demonstrated at a larger scale using actual coal-derived synthesis gas, and a detailed system analysis and engineering assessment will be conducted.

Commercial Applications and other Benefits as described by the awardee: A viable alternative to crude oil is needed to moderate the effect of oil price hikes and provide an interim bridge until some other fuel source can commercially supplant petroleum-based fuels. Coal is the most promising resource with over 250 billion tons of known domestic reserves. FT synthesis is the most economically viable method of converting coal into transportation fuels. The proposed gas clean-up technology should become an enabling technology for coal-to-liquids production.

85791S08-II

Advanced Nb-based Intermetallics for Nuclear Applications—Transition45 Technologies, Inc., 1963 North Main Street, Orange, CA 92865-4101; 714-283-2118
Dr. Edward Chen, Principal Investigator; transition45@sbcglobal.net
Dr. Edward Chen, Business Official; transition45@sbcglobal.net
DOE Grant No. DE-FG02-08ER85050
Amount: $750,000

Niobium-based intermetallic composites can lead to revolutionary nuclear and fossil energy turbine and propulsion performance. In addition to superior high-temperature performance, niobium-based intermetallics could offer significant cost savings over conventional refractory alloys. This project will expand research and developmental efforts on this innovative class of refractory metal intermetallic composites, providing alternatives to the refractory, ceramic, and composite materials that are presently used or being considered for high temperature applications in Generation IV nuclear energy systems. In Phase I, a preliminary analysis of the microstructure- properties of these alloys was conducted, which will serve as a baseline for nuclear reactor-specific requirements. Phase II will explore alloy compositions that are most suitable for irradiated reactor environments. Both non-irradiated and irradiated materials will be tested to demonstrate the potential of these alloys for nuclear systems.

Commercial Applications and other Benefits as described by the awardee: The use of these alloys in nuclear reactors and industrial gas turbines should provide an opportunity to increase energy efficiency through higher reactor/turbine operating temperatures. This in turn will help to reduce dependence on fossil fuel in power generation, allowing for continued economic growth worldwide without the associated environmental damage.

86494S08-II

Impermeable SiC Composites—Physical Sciences Inc., 20 New England Business Center, Andover, MA 01810; 978-689-0003
Dr. John W. Steinbeck, Principal Investigator; steinbeck@psicorp.com
Dr. B. David Green, Business Official; green@psicorp.com
DOE Grant No. DE-FG02-08ER85051
Amount: $749,970

Next generation nuclear plants will operate with helium as the working fluid and operate most efficiently at temperatures approaching 1000°C. Steel alloys used in reactor construction lose their strength at temperatures above 850°C, and SiC/SiC composite systems generally have helium permeability that is too large for duct components. This project will develop a carbon-fiber-reinforced silicon carbide matrix composite system that retains its strength above 1000°C and has helium permeability less than $10^{-9}m^2/s$. Nanophase materials used in the matrix will minimize porosity without sacrificing strength or high temperature performance. In Phase I, the permeation of gas through a silicon-carbide-based ceramic composite was reduced by more than two orders of magnitude by adding a combination of oxides to the composite matrix. The oxides reacted during processing with the composite matrix to fill pores and gaps, thereby reducing the ability of both air and helium to flow through the matrix. It was shown that the permeability can be reduced to $10^{-9}m^2/s$, comparable to the best silicon carbide composite materials available. In Phase II, the processing of the matrix additives will be improved to further reduce gas permeability through the carbon-fiber-reinforced silicon carbide composites. In addition, it will be shown that complex assemblies can be fabricated using these materials, with the strength and gas permeability of joints comparable to the composite system.

Commercial Applications and other Benefits as described by the awardee: The successful development of a family of impermeable high-temperature, oxidation-resistant refractory composites would enable the full-scale commercial development of next generation nuclear plants. These high efficiency systems would produce both electricity and hydrogen to enable the U.S. to reduce its dependence on fossil fuels while minimally impacting the environment. The development of high temperature composite systems that are impermeable to gas flow also should facilitate the incorporation of high temperature ceramic composites into next generation gas turbines.

85278S08-II

Membranes for Solid State Lithium Batteries—NEI Corporation, 400 Apgar Drive, Suite E, Somerset, NJ 08873; 732-868-3141
Dr. Runqing Ou, Principal Investigator; rou@neicorporation.com
Dr. Ganesh Skandan, Business Official; gskandan@neicorporation.com
DOE Grant No. DE-FG02-08ER85100
Amount: $749,960

The use of a solid polymer electrolyte instead of the conventional liquid or gel electrolyte can drastically improve the safety aspects of Li-ion batteries. However, existing solid electrolytes based on poly(ethylene oxide) (PEO) do not meet the functional performance requirements. At low temperatures, the conductivity is poor due to the presence of crystalline PEO segments, which restrict lithium ion mobility. This restriction limits the useful operating temperature of Li-ion polymer batteries to between 70^{o}C and 100^{o}C, which excludes the use of solid polymer based batteries in room temperature commercial applications. This project will investigate the use of a novel nanocomposite organic/inorganic hybrid material as a potential solid polymer electrolyte system that can exhibit high Li-ion conductivity at room temperature and below, along with good mechanical properties. The presence of inorganic moieties in the material will inhibit the crystallization of PEO chains, leading to increased low temperature ionic conductivity and an increased lithium transference number. Phase I involved the synthesis of a composite material in which the PEO component remained amorphous, resulting in an order-of-magnitude higher Li-ion conductivity at room temperature and below, and almost twice the lithium transference number compared to conventional PEO/Li-salt membranes. In Phase II, the structure of the new material will be optimized, electrolyte membranes will be produced via an economical processing method, and both Li-metal and Li-ion cells will be fabricated and tested.

Commercial Applications and other Benefits as described by the awardee: Although rechargeable lithium-ion batteries are ubiquitous in the commercial marketplace, existing Li-ion batteries contain flammable liquid electrolytes, which compromises safety. The proposed solid polymer electrolyte should enable the development of safer lithium batteries, particularly those that can be used in large format batteries for electric and hybrid electric vehicles, telecommunications, and electric utility applications.

85461S08-II

Novel Solid State Electrolyte Development—Excellatron Solid State, LLC, 263 Decatur Street, Atlanta, GA 30312-1705; 404-584-2475
Dr. Davorin Babic, Principal Investigator; dbabic@excellatron.com
Mr. Anthony Pace, Business Official; pace@excellatron.com
DOE Grant No. DE-FG02-08ER85093
Amount: $749,914

Further development of rechargeable lithium batteries requires dramatic improvement of the ionically conducting electrolyte used in the batteries. Most of the limitations of current lithium-ion batteries are due to restrictions imposed by the general use of organic electrolytes, either liquid or polymer, that limit energy density, long term cycle life, and the rate of charge/discharge capability of these batteries. These limitations must be removed before lithium batteries can be viable as a high energy storage medium, such as required for electric vehicle applications. This project will develop a novel inorganic solid state electrolyte prepared by a sol gel technique that solves the problems due to the organic electrolytes, while being cost effective and offering manufacturing scalability. The novel electrolyte will have high lithium-ion conductivity, negligible conductivity of other ions and electrons, and stability with metallic lithium and other critical battery materials for applied voltages above 5V. Phase I developed a novel electrolyte with all of the above characteristics. The novel inorganic electrolyte was prepared by a sol gel technique, suggesting that manufacturing can be achieved at acceptable cost levels. Phase II will fabricate and characterize an all-solid-state lithium battery with the novel inorganic solid electrolyte.

Commercial Applications and other Benefits as described by the awardee: The ever-present gadgets of modern life remain constrained by the availability of power to quench the thirst of power hungry electronics. In addition, the development of batteries with long cycle life and high energy and power densities is of prime importance to the development of successful electric vehicles. The lithium battery technology developed in this project should address these needs.

85839S08-II

High Performance Hydroxyl Conductive Membrane For Advanced Rechargeable Alcaline Batteries—Enogetek Inc., 2055 Albany Post Road, Suite AT-6, Croton-on-Hudson, NY 10520-1156; 914-290-4747
Dr. Lin-Feng Li, Principal Investigator; crotonlfli@netzero.com
Dr. Lin-Feng Li, Business Official; crotonlfli@netzero.com
DOE Grant No. DE-FG02-08ER85092
Amount: $749,980

Increasingly, strict environmental regulations, surging energy demand and oil prices, and the proliferation of the internet and electronic devices have given rise to a growing market demand for efficient, clean, and renewable energy sources, such as solar and wind energy. However, the electricity generated from these renewable sources suffers from the drawback of fluctuation. To solve this problem, a low cost, reliable, long life, and efficient electrical energy storage (EES) system is sought to ensure 24/7 reliability for commercial and residential grid applications. One option is to use alkaline-based rechargeable batteries, such as NiMH, provided that issues of performance, safety, and cost effectiveness can be addressed. This project will investigate replacing the aqueous KOH electrolyte with a solid polymer electrolyte. Phase I developed a novel hydroxyl conductive membrane with the following characteristics: (1) high ionic conductivity; (2) good thermal, chemical, and electrochemical stability; (3) scalable for large quantity manufacturing; (4) good compatibility with other cell components; and (5) low cost. Bipolar cell stacks were fabricated with this membrane, and excellent electrochemical performance was obtained. In Phase II, the hydroxyl conductive membrane will be incorporated into a unique bipolar NiMH battery.

Commercial Applications and other Benefits as described by the awardee: The membrane not only should find use as the energy storage system for load leveling of electricity generated from renewable sources, but also could be used in NiMH batteries that already have been commercialized in hybrid electric vehicles (HEV). In the future, it also could be used as the energy storage device in plug-in HEVs.

85607S08-II

Study of the Use of Quantum Well Thermoelectrics for Truck Air Conditioning—Hi-Z Technology, 7606 Miramar Road, Suite 7400, San Diego, CA 92126-4210; 858-695-6660
Mr. John C. Bass, Principal Investigator; j.c.bass@hi-z.com
Mr. Norbert B. Elsner, Business Official; n.elsner@hi-z.com
DOE Grant No. DE-FG02-08ER85066
Amount: $750,000

The systems currently used to cool truck cabs include a vapor compression system attached to the engine. This system uses a refrigerant fluid (R134A) that is potentially harmful to the environment. In fact, this fluid has been outlawed in Europe and likely will be outlawed in the United States soon. In addition, the compression system is a high maintenance item, is noisy, vibrates, and is a significant power drain on the vehicle. This project will develop a new type of thermoelectric, called quantum wells, a solid state means of cooling that does not use dangerous gases and can achieve cooling efficiencies that are equal to or better than vapor compression systems. In Phase I, a working model was used to demonstrate that quantum-well thermoelectrics could be used to cool the interior of a truck, without any hazardous gases such as R134A. The coefficient of performance was shown to be comparable to currently used vapor compression cycles, without the attendant high maintenance and noise. Phase II will design, fabricate, and test a complete prototype system.

Commercial Applications and other Benefits as described by the awardee: Applications for the new cooling system include trucks and automobiles. Savings in fuel consumption, elimination of refrigerant leakage, reduction in noise and vibration, and reduction in overall maintenance costs would be among the chief benefits. There exists a vast potential market of over a billion dollars.

85780S08-II

Heat Activated Metal Hydride Refrigeration Cycle—TIAX, LLC, 15 Acorn Park, Cambridge, MA 02140-2301; 617-498-5655
Mr. JohnDetlef Dieckmann, PhD, Principal Investigator; dieckmann.j@tiaxllc.com
Ms. Renee Wong, Business Official; wong.renee@tiaxllc.com
DOE Grant No. DE-FG02-08ER85078
Amount: $749,882

Roughly two-thirds of the fuel used in electric power plants to generate electricity is wasted in the form of dissipated heat. An opportunity exists to maximize the use of this heat for heating and cooling needs by generating power and using the waste heat on-site, the concept behind combined heating and power (CHP) systems. Because there is a greater coincidence of cooling and electricity needs compared to heat and electricity needs, efficient cooling and refrigeration equipment, which utilizes the waste heat to create cooling, is essential to maximize waste heat utilization. This project will develop refrigeration cycles based on use of metal hydride slurry technology. Although metal hydrides have been under development for another application (for storage and transport of hydrogen in future hydrogen vehicle applications), recent work has shown that these materials would be viable for use in absorption refrigeration cycles. Phase I involved analysis and initial feasibility studies for metal hydride slurry refrigeration cycles. A prototype metal hydride slurry chiller will be developed in Phase II.

Commercial Applications and other Benefits as described by the awardee: Metal hydride slurry chillers and refrigeration systems would be expected to improve the energy savings and economic attractiveness of CHP systems, helping to increase the adoption of such systems, particularly in large commercial buildings and industry. Waste heat streams in industrial applications such as food processing also should provide a setting for the proposed technology. Benefits would include reductions in energy use, relief of electricity grid stress during times of peak load, and reduction of emissions.

85656S08-II

Enhancing the Heat Exchanger Performance Through the use of Durable Superhydrophobic Surface Treatment—NEI Corporation, 400 Apgar Drive, Suite E, Somerset, NJ 08873; 732-868-3141
Dr. Jiong Liu, Principal Investigator; jliu@neicorporation.com
Dr. Ganesh Skandan, Business Official; gskandan@neicorporation.com
DOE Grant No. DE-FG02-08ER85071
Amount: $749,904

The formation of a condensate film on the surface of a heat exchanger tube reduces the heat transfer coefficient of vapor-to-liquid heat exchangers. This reduction occurs because the thermal conductivity of the condensate liquid is only a fraction of that of the metallic heat exchanging tube material, thereby lowering the overall thermal conductivity. This situation can be overcome if the vapor condensation occurred in the form of droplets, instead of a continuous film. However, to date, it has remained a challenge to promote "dropwise" condensation in practical heat exchangers. This project will develop surface treatment techniques that can lead to superhydrophobicity, resulting in durable dropwise condensation on heat exchanger tubes. In Phase I, two surface treatment techniques were demonstrated, and both led to superhydrophobic surfaces and a dramatic enhancement of the heat transfer rate due to the formation of dropwise condensation. Further, these surfaces maintained dropwise condensation in a high temperature steam environment and exhibited superior durability compared to traditional hydrophobic coatings. Phase II will (1) optimize the superhydrophobic surface treatments; (2) develop variations of the surface treatments for organic systems used in geothermal and solar thermal applications; (3) conduct performance testing of superhydrophobic surface treatments in a test heat exchanger under simulated use conditions; and (4) develop a predictive model for dropwise condensation heat transfer in a multi-tube practical heat exchanger.

Commercial Applications and other Benefits as described by the awardee: The development of a durable superhydrophobic surface treatment for heat exchangers should lead to lower electricity costs due to improved heat transfer efficiency and reduced power generation. Superhydrophobic surfaces also should find applications in water-repellant textiles, anti-fouling and anti-corrosion coatings, fluidic drag reduction, oil-water separation, and biomaterials.

85366S08-II

Enhanced WOLEDs Outcoupling Using Low Index Grids—Universal Display Corporation, 375 Phillips Blvd., Ewing, NJ 08618; 609-671-0980
Dr. Peter Levermore, Principal Investigator; plevermore@universaldisplay.com
Mrs. Janice Mahon, Business Official; jkmahon@universaldisplay.com
DOE Grant No. DE-FG02-08ER85082
Amount: $750,000

Lighting consumes approximately 22% of the total electricity generated in the U.S. To reduce this energy use, new high-efficiency solid-state light sources, such as Organic Light Emitting Diodes (OLEDs), are needed. An OLED is potentially an inexpensive diffuse source that would complete directly with, and offer a "green" alternative to, conventional light sources. However, improvements in the overall efficiency of these devices are required before they can become commercially viable products and attain expected goals for cost ($3 per 1000 lumens) and performance (150 im/W). This project will utilize novel outcoupling enhancement features in OLED architectures to enable highly-efficient solid-state lighting sources to replace short-lifetime incandescent sources. Phase I demonstrated that the integration of a low index grid into the OLED device enhanced light outcoupling. Using non-optimized materials, a 15% increase in device light output was achieved. During Phase II, the low index grid will be optimized to obtain a 40% outcoupling enhancement.

Commercial Applications and other Benefits as described by the awardee: Today, OLED technology is the leading emerging technology for flat panel displays (FEDs), with recent product introductions in cell phones and TV's. Many of the features desired for FPDs are also making OLED technology of great interest to the solid-state lighting community. Because OLEDs are bright and thin, with desirable color rendering indices and excellent power efficiency at low voltages, they are expected to provide significant energy savings for general lighting.

85628S08-II

Improved Heterogeneous Catalyst for the Production of Biodiesel—Lynntech, Inc., 7610 Eastmark Drive, College Station, TX 77840; 979-693-0017
Dr. Anthony Giletto, Principal Investigator; tony.giletto@lynntech.com
Dr. G. Duncan Hitchens, Business Official; proposals@lynntech.com
DOE Grant No. DE-FG02-08ER85118
Amount: $750,000

The conversion of renewable oils to biodiesel, primarily through the methanolysis of triglycerides, represents an attractive option as a renewable source of energy. In this approach, an immobilized lipase is used as a heterogeneous biocatalyst to transform renewable oils into biodiesel. However, immobilized lipases catalyze the transesterification reaction slowly. Also, they are poisoned by high methanol concentrations, which preclude their industrial implementation. This project will modify a promising commercially-available immobilized lipase to improve the rate of methanol transesterification and to improve the stability of the catalyst in the presence of high concentrations of methanol. In Phase I, a commercially available immobilized lipase was modified with different substituents, and it was demonstrated the modified materials catalyzed the transesterification reaction faster than unmodified catalyst. In addition, the modified catalyst was used multiple times without a decrease in performance. In Phase II, (1) the performance of the catalyst will be further improved; (2) its activity will be characterized to define the operational envelope of the material; (3) its performance will be determined as a function of re-use cycle; and (4) a preliminary design for industrially-sized batch and continuous transesterification processes will be developed.

Commercial Applications and other Benefits as described by the awardee: The ability to cheaply and efficiently convert plant oils to biodiesel would provide the country with a renewable source of diesel fuel. The technology would reduce the country's dependence on foreign oil and would result in a net decrease in carbon dioxide emissions.

86053S08-II

Acetic Acid Manufacture by the Selective Photocatalytic Oxidation of Ethylene—KSE, Inc.,
665 Amherst Road, Sunderland, MA 01375-9420; 413-549-5506
Dr. James R. Kittrell, Principal Investigator; kseinc@aol.com
Dr. James R. Kittrell, Business Official; kseinc@aol.com
DOE Grant No. DE-FG02-08ER85117
Amount: $750,000

Acetic acid is a large volume, global commodity chemical used as a basic building block in manufacturing polymers, anhydrides, and esters. Current acetic acid manufacturing technologies are based on carbon monoxide, which is produced by inherently inefficient techniques, wasting scarce hydrocarbon resources, consuming excessive energy, and generating substantial greenhouse gases. Alternative acetic acid production technologies based on direct oxidation of ethane or ethylene exist, but these technologies suffer from poor oxidation selectivity, poor energy efficiency, and wasted hydrocarbon resources. This project will utilize a photocatalytic technology for the selective oxidation of ethane to acetic acid. In this approach, photocatalytic oxidation uses UV light to produce acetic acid at ambient temperatures and pressure, with exceptionally high selectivity to acetic acid. Phase I developed novel photocatalyst compositions, which produced acetic acid from ethane in very high yield, reduced energy consumption by one-half, reduced waste of hydrocarbon resources, and reduced generation of the greenhouse gas carbon dioxide. Phase II will entail optimizing the performance of the novel photocatalysts for acetic acid selectivity, and maximizing overall energy efficiency and manufacturing cost savings. To facilitate early commercialization, the technology will be demonstrated in a prototype unit.

Commercial Applications and other Benefits as described by the awardee: Selective photocatalytic oxidation should find immediate application in the commercial production of acetic acid, improving U.S. competitiveness in global markets. The novel technology should achieve energy savings of over 10 trillion BTU per year, potential annual manufacturing cost savings approaching $500 million, and a payout time of less than 2 years when replacing current technology in an existing acetic acid plant.

86175S08-II

Novel Catalytic Ammoxidation Process—TDA Research, Inc., 12345 W. 52nd Avenue, Wheat Ridge, CO 80033-1916; 303-940-2300
Dr. Steven Gebhard, Principal Investigator; gebhard@tda.com
Mr. John D. Wright, Business Official; jdwright@tda.com
DOE Grant No. DE-FG02-08ER85133
Amount: $750,000

Acrylonitrile is an important chemical intermediate used to produce acrylic fibers, synthetic rubber, and other polymers. Current catalysts for the production of acrylonitrile operate at high temperatures, making the processes energy intensive, and generate large quantities of unwanted byproducts, including carbon dioxide and hydrogen cyanide (HCN). This project will investigate several new catalyst formulations for propylene ammoxidation to produce acrylonitrile. These catalysts would be expected be active at significantly lower temperatures than for existing industrial catalysts. Phase I prepared and characterized a variety of new catalyst compositions for achieving better selectivity and activity for the ammoxidation of propylene. Tests conducted in an automated flow reactor demonstrated that the new catalyst formulations gave high selectivity to acrylonitrile at temperatures lower than for catalysts in current use. Limited lifetime testing showed that these catalysts would remain active for long periods. Phase II will further optimize and test several of these new catalysts to determine the combination of catalyst formulation and operating conditions that provide the best selectivity to acrylonitrile at the lowest possible temperature. Based on the results of these tests, extended lifetime testing (> 1000 hours) will be conducted with the best ammoxidation catalyst, and the results will be used to predict catalyst lifetime and replacement costs.

Commercial Applications and other Benefits as described by the awardee: The new propylene ammoxidation catalyst would be designed for use as a drop-in replacement for current commercial catalysts. As such, no new process or reaction equipment would need to be developed. By operating at lower temperatures with greater selectivity to acrylonitrile, the new catalyst should enable better product selectivity, increased energy savings, and decreased amounts of HCN and especially CO_2, which represents wasted carbon.

86281S08-II

An Innovative Triple Function Cathode for MEMS Fuel Cells—Materials & Electrochemical Research (MER) Corporation, 7960 S. Kolb Road, Tucson, AZ 85756; 520-574-1980
Dr. Raouf O. Loutfy, Principal Investigator; mercorp@mercorp.com
Dr. Raouf O. Loutfy, Business Official; mercorp@mercorp.com
DOE Grant No. DE-FG02-08ER85120
Amount: $750,000

State-of-the-art fuel cells yield low power densities of 0.04 W/gram for small cells and 0.07 W/gram for large cells. This low power density results from poor catalytic performance of the conventional fuel cell catalytic electrode. This project will develop a novel, high performance, triple function fuel cell electrode, which will function as a catalytic promoter for reduction or oxidation reactions, as a current collector, and as a channel for gas flow. Phase I demonstrated that the performance of the catalytic electrode can be significantly increased by using a high-surface-area carbon-nanotube substrate, which retards catalyst particle agglomeration and increases substrate conductivity. Phase II will focus on further increasing the surface area and conductivity of this new substrate by adjusting the processing conditions and by achieving a deeper understanding of the mechanism of this surprising improvement. In addition, the cost-effectiveness and commercial viability of the developed materials will be evaluated for their use in methanol fuel cells.

Commercial Applications and other Benefits as described by the awardee: The new electrodes should enhance the performance, and power density of miniature fuel cells. The compact structure should make the electrochemical system more practical for use in transportation vehicles as well as in consumer electronics. Other applications of this strong, conductive, high-surface-area carbon substrate material include its use as a support for catalyst systems in the petroleum industries, for the direct activation of alkanes, in ammonia synthesis, and as a selective absorbent.

85550B08-II

Small Business
Compact Membrane Systems, Inc.
335 Water Street
Newport, DE 19804-2410
Dr. Stuart Nemser, Principal Investigator
snemser@compactmembrane.com
Dr. Stuart Nemser, Business Official
snemser@compactmembrane.com
302-999-7996

Research Institution
Georgia Technology Research Center

DOE Grant No. DE-FG02-08ER86343
Amount: $750,000

Membrane reactors have the potential to improve reactivity and productivity of various chemical syntheses, including enzymatic water sensitive reactions. To be of value, these reactors must exhibit higher use temperature, improved chemical resistance, and better mass transfer. In this project, novel membrane modules with improved mass transfer will be fabricated, and technology will be developed to enhance membrane reactivity. In Phase I, key elements of a universal membrane reactor for reactive separation were demonstrated and reactive synthesis was enhanced by controlling water activity. Improvements in chemical resistance also were demonstrated. Lastly, the membranes were shown to be low cost and to be able to remove multiple small molecules that create industrial side reactions. Phase II will optimize the Phase I product, build prototypes, and demonstrate performance in the laboratory and in scaled-up systems.

Commercial Applications and other Benefits as described by the awardee: The technology should impact a broad spectrum of chemical reactions that can be enhanced by membrane reactors. Direct applications would include the production of over 5 billion pounds/yr of product, leading to a savings of over 50 trillion BTU/yr. These applications include the enhancement of fuel grade ethanol and pipeline ethanol.

85330S08-II

Structured Catalyst for Biodiesel Production—United Environment & Energy LLC, 111 Ridge Road, Horseheads, NY 14845-1507; 607-796-0830
Ms. Peng Zhang, Principal Investigator; p-zhang@unitedee.com
Dr. Ben Wen, Business Official; b-wen@unitedee.com
DOE Grant No. DE-FG02-08ER85081
Amount: $749,931

Currently, most biodiesel is produced commercially by a homogeneous-catalyst-based transesterification process, wherein soybean oil is reacted with methanol in the presence of sodium methoxide. After transesterification, the homogeneous alkaline catalyst remains mixed with the biodiesel and the byproduct glycerol. The purification of the biodiesel and glycerol, by removing the homogeneous alkaline catalyst, is an energy and labor-intensive operation that produces a waste stream. Productivity is restricted by the need to use a batch reactor and the need for a long reaction time. In addition, the glycerol byproduct has low quality. This project will develop a novel structured heterogeneous-catalyst technology for high-efficiency, high-throughput, and low-cost biodiesel production in a continuous-flow fixed-bed reactor. The unique design of the structured catalyst will improve the catalyst utilization efficiency and overall activity, and will protect the catalyst from deactivation. In Phase I, the structured catalyst was successfully prepared with the required physical properties and catalytic performance. The operating conditions for the fixed-bed reactor were determined, and an economic analysis was conducted. Phase II will move the technology from laboratory scale to pilot scale, and demonstrate commercial viability.

Commercial Applications and other Benefits as described by the awardee: The use of the structured-catalyst fixed-bed technology in biodiesel production should significantly simplify product separation and purification, increase biodiesel productivity, reduce plant size, remove the need for a constant feed of catalyst, improve glycerol quality, eliminate the waste stream, and reduce capital and processing costs. In turn, the substitution of petroleum diesel with domestically produced alternative fuel would be expedited, leading to reductions in energy consumption, environmental impact, and U.S. dependence on foreign oil imports.

85795S08-II

Xylose Utilization for Ethanol Production Enabled by a Parallel Microfiber Reactor with Immobilized Xylose Isomerase—Trillium FiberFuels, Inc., 33898 SE Eastgate Circle, Corvallis, OR 97333-2248; 541-990-0337
Mr. Chris Beatty, Principal Investigator; chris@trilliumfiberfuels.com
Mr. Chris Beatty, Business Official; chris@trilliumfiberfuels.com
DOE Grant No. DE-FG02-08ER85080
Amount: $749,888

Concerns over the escalating use of petroleum-based liquid fuels include climate change, trade imbalances, global security issues, and environmental harm resulting from petroleum extraction and processing. Although ethanol is the leading replacement for petroleum-based gasoline, the current corn-based source of ethanol is hindered by serious social and environmental issues. The production of cellulosic ethanol from lignocellulosic feedstocks – including straws, corn stalks, and woody biomass – represents a key, underutilized resource in our energy portfolio. In particular, the effective utilization of xylose would make a much higher fraction of the biomass viable as source materials for cellulosic ethanol. Therefore, this project will develop a next-generation system for increased xylose utilization in the ethanol-production process. In this approach, an industrial enzyme, xylose isomerase, is used to convert xylose to xylulose. Then, familiar brewing yeasts could metabolize the xylulose to ethanol. In Phase I, the feasibility of utilizing xylose by having a separate reactor convert it to xylulose was demonstrated. Phase II will design, build, and characterize a 200-liter-scale xylose isomerization and fermentation system, and the operating conditions needed to achieve high productivity of the isomerase enzyme will be determined. A pilot system (4000 liters) will be built in year 2 of the project.

Commercial Applications and other Benefits as described by the awardee: Commercial application of the isomerization technology would expand the economic viability of cellulosic ethanol and increase the sustainability of the US liquid fuel supply. Success with this technology would contribute to meeting the ambitious national targets for the use of alternative fuels in the next decade.

86054S08-II

Reduction in Distillation Usage in the Manufacture of Biomass Ethanol by Reactive Water Separation—KSE, Inc., 665 Amherst Road, Sunderland, MA 01375-9420; 413-549-5506
Dr. James R. Kittrell, Principal Investigator; kseinc@aol.com
Dr. James R. Kittrell, Business Official; kseinc@aol.com
DOE Grant No. DE-FG02-08ER85068
Amount: $750,000

Biomass-derived ethanol is now an integral part of the overall transportation fuel system in the U.S. To be useful as fuel grade ethanol, large amounts of water must be evaporated from dilute fermentation alcohol, a process that is energy-intensive, costly, and an impediment to the transition to a biofuels economy. By 2012, the total distillation energy required for water evaporation from dilute fermentation ethanol will approach 270 trillion BTU/yr. This project will demonstrate the technical feasibility of a novel reactive technology to reduce or substantially eliminate the reliance on distillation for water removal from biomass-derived ethanol. In this approach, a novel reagent will be added to the crude ethanol to convert the water into a highly volatile product, which is readily removed from the ethanol with a substantially reduced energy input. The reagent is then regenerated off-line by reversing the reaction and producing water, which is removed by simple decanting and phase separation. Phase I demonstrated that fuel-grade ethanol meeting commercial specifications could be produced by reactive dehydration. Phase II will entail optimizing the performance of the reactive dehydration catalysts for maximum energy savings. To facilitate early commercialization, the technology will be demonstrated through operation in a prototype unit.

Commercial Applications and other Benefits as described by the awardee: The reactive dehydration system should find immediate application to the production of fuel-grade ethanol from biomass materials, saving at least 35 trillion BTU's in 2015 and resulting in annual cost savings of $700 million. Reactive dehydration also should be applicable to the production of many other industrial chemicals that require water removal, leading to opportunities for a major reduction in the energy requirements for dehydration in the production of chemicals and fuels for the U.S. economy.

85076S08-II

Development of High Temperature Melt Integrity Seperators for Lithium-Ion Cells—
MaxPower, Inc., 141 Christopher Lane, Harleysville, PA 19438; 215-256-4575
Dr. Benjamin Meyer, Principal Investigator; ben.meyer@maxpowerinc.com
Dr. David L. Chua, Business Official; maxpowerdc@aol.com
DOE Grant No. DE-FG02-08ER85070
Amount: $722,692

During charge and discharge at high rates and in high abuse situations, a battery can become quite hot, as the heat generated from internal chemical reactions can exceed the battery's capability to dissipate the heat. When internal temperatures become excessive, separator breakdown can result, even after separator shutdown, as the internal cell temperature continues to climb. Eventually the separator begins to melt and shrink. Upon shrinking, the electrodes can short circuit, leading to a thermal and/or electrochemical runaway, which possibly could result in explosion and fire. To develop high-melt-integrity (>200°C) separators, this project will pursue two approaches based upon traditional solution-based electro-spinning and melt-electro-spinning processes. During Phase I, a polyimide-based electrospun separator with melt integrity up to 400°C was produced via solution-based electro-spinning. This separator performed extremely well during performance testing in a lithium-ion cell. Phase II will include further development of the melt-based electro-spinning technology, incorporation of shutdown features for both melt and solution based technologies, and demonstration of manufacturing scalability of the electrospun separator.

Commercial Applications and other Benefits as described by the awardee: Separators with higher melt temperatures (>200°C) would significantly improve a lithium-ion cell's resilience to the onset of a thermal runaway situation. This would greatly increase the safety of lithium batteries, which are used in a wide range of applications such as electric and hybrid electric vehicles, aerospace, medical, and military markets.

86077S08-II

Development of Separators for Lithium-Ion Cells with High Temperature Melt Integrity--
Policell Technolpgies, Inc., 160 Liberty Street, Building #4, Metuchen, NJ 08840;
732-516-1288
Dr. Luying Sun, Principal Investigator; Lysun@policell.com
Dr. Luying Sun, Business Official; Lysun@policell.com
DOE Grant No. DE-FG02-08ER85076
Amount: $749,805

Lithium-ion batteries have been the preferred power source for many small format applications such as cellular phones and notebook computers. However, its safety problems related to thermal runaways are delaying the introduction of lithium-ion batteries into large format systems such as hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs). One of the concerns is the possibility of an internal short-circuit caused by the shrinkage of the separator at high temperatures. This project will develop thermally stable separators – i.e., separators that retain their integrity at temperatures of 200 degrees C or higher – for making safe lithium-ion batteries. Phase I demonstrated the feasibility of developing such separators, which showed no shrinkage after heat treatment at temperatures up to 205^{o}C. Lithium-ion cells were then made with the use of these thermally stable separators and evaluated in terms of electric performance. Phase II will (1) refine the recipes and formulations for making these separators; (2) characterize the separators in terms of thermal stability, durability in electrolytes, mechanical properties, porosity, pore size, wettability; (3) evaluate the electric performance of cells built using the separator; and (4) prepare the separator membranes in quantities sufficient to make 100 vehicle-size cells, using an automated production machine.

Commercial Applications and other Benefits as described by the awardee: The thermally stable separators should result in safe lithium-ion batteries, enabling such batteries to be used in large format systems such as HEVs, PHEVs, electric vehicles (EVs), and standby power stations. Because of the improved safety and reliability, the battery also could be used for such applications as mobile power sources for space or space-related devices for NASA, the U.S. military, and other federal government agencies.

86338S08-II

High Voltage Electrolyte for Lithium-Ion Cells—TIAX, LLC, 15 Acorn Park, Cambridge, MA 02140-2301; 617-498-5655
Dr. David Ofer, Principal Investigator; ofer.david@tiaxllc.com
Ms. Renee Wong, Business Official; wong.renee@tiaxllc.com
DOE Grant No. DE-FG02-08ER85079
Amount: $749,808

For plug-in hybrid electric vehicles (PHEVs) to become commercially viable, the energy content of their batteries must be increased and battery cost must be decreased. This project will develop an electrolyte that will allow lithium-ion cells for PHEV and HEV batteries to operate at higher voltage. At higher voltage, the batteries would be able to deliver higher power and energy. In Phase I, the feasibility of the high voltage electrolyte was demonstrated by improved cycling of high voltage lithium-ion cells and by increased oxidative and thermal stability. In Phase II, the electrolyte formulation(s) will be optimized, and selected combinations of cathode material and novel electrolyte formulation will be tested for pulse power capability. An electrolyte and cathode chemistry will be selected for assembly in graphitic carbon anode lithium-ion cells, which will be tested for performance and stability, and compared to control cells built with standard electrolyte.

Commercial Applications and other Benefits as described by the awardee: Improved lithium-ion batteries would have the potential to extend the electric-vehicle range of PHEVs and HEVs while also reducing battery mass and size. These improvements would increase both the environmental benefits and the consumer appeal of these vehicles.

85658S08-II

Self-Healing Polymeric Coatings: Beyond Scratch-Healing—NEI Corporation, 400 Apgar Drive, Suite E, Somerset, NJ 08873; 732- 868-3141
Dr. Runqing Ou, Principal Investigator; rou@neicorporation.com
Dr. Ganesh Skandan, Business Official; gskandan@neicorporation.com
DOE Grant No. DE-FG02-08ER85101
Amount: $749,931

Most polymeric coatings are susceptible to impairments induced by environmental degradation and mechanical damage, which eventually lead to loss of function or even macroscopic failure of the coating. With conventional coating technologies, repair of a coating is tedious and expensive. The use of self-healing coatings – i.e., coatings that possess an intrinsic ability to heal damage – can prolong the operational life of coatings and reduce the frequency of full coating replacement. This project will develop a generic platform technology that can repair not only minor surface scratches but also deep cracks, via a simultaneous crack closing and sealing process. The approach involves the use of a polymer composite coating that has a unique morphology at an ultrafine scale. In Phase I, a new self-healing polyurethane-based coating formulation, and a method of producing the same, was developed. The self-healing of surface scratches, as well as deep and narrow razor blade cracks, was demonstrated. In addition, the coating's high gloss was maintained after the self-healing of the crack or scratch occurred. Phase II will optimize the self-healing polyurethane nanocomposite system and implement the platform technology in various polymer matrices for different commercial applications. Additionally, environmentally-friendly solutions, including a zero VOC coating solution, will be developed.

Commercial Applications and other Benefits as described by the awardee: The paint and coating industry represents a mature $50+ billion market worldwide. The proposed self-healing nanocomposite coating technology should have immense potential in OEM/product coating applications, in maintenance paints, and in marine and other special purpose coating applications. Reduction in the frequency of the repainting job not only would be cost-effective, but also would help the environment by reducing the consumption of raw materials and the emission of VOCs.

85668S08-II

Nano-Engineered Anodes for Lithium-ion Batteries—nGimat Co., 5315 Peachtree Industrial Blvd., Atlanta, GA 30341; 678-287-2451
Dr. Ganesh Venugopal, Principal Investigator; gvenugopal@ngimat.com
David Smith, Business Official; dsmith@ngimat.com
DOE Grant No. DE-FG02-08ER85102
Amount: $749,999

Renewable energy and energy storage both play a very important part in the emerging energy landscape, especially when used in concert. An example of an often-cited "ideal situation" is one where renewable energy sources, such as solar or wind, generate electricity that can then either be stored in electric vehicle batteries for transportation or in battery energy storage systems for off-grid energy and power management. Hence, high-power and extended life batteries are going to be a major piece of the energy equation going forward. This project addresses the enhancement of a key component of high-performance lithium-ion batteries, which are emerging as the future of battery energy storage. This enhanced component, a nano-engineered lithium titanate (nGLTO) will be made in a low-cost single-step process. Phase I established a single-step process for making high-capacity lithium titanate in "pilot-scale" volumes exceeding 1kg per day. The non-optimized prototype cells were shown to be able to cycle for up to 200 cycles. In Phase II, the particle morphology of the lithium titanate will be fine tuned to optimize performance and enable production of over 10kg/day.

Commercial Applications and other Benefits as described by the awardee: The lithium titanate should enable the use of high-power and extended-life lithium-ion batteries for hybrid electric vehicles and stationary battery energy storage systems. Future marketing opportunities for lithium titanate include automotive, space, military, and stationary energy storage applications.

85538S08-II

Identification, Production and Characterization of Novel Lignase Proteins from Termites for Deplymerization of Lignocellulose Pretreatment/Biochemical—Chesapeake PERL, Inc., 8510A Corridor Road, Savage, MD 20763; 301-317-9300
Dr. George W. Buchman, Principal Investigator; gbuchman@c-perl.com
Mr. Robert Balcerzak, Business Official; bbalcerzak@c-perl.com
DOE Grant No. DE-FG02-08ER85063
Amount: $744,195

Cost effective enzymatic lignin degradation could play a key role in enabling commercially viable processes for producing fuel ethanol from woody feedstocks, such as corn stover, switchgrass, hybrid poplar, willow, loblolly pine, and eucalyptus. This project focuses on the identification, production, and eventual commercialization of one important class of these enzymes, lignases, which catalyze the degradation of lignin in woody substrates. The biological source of these enzymes is the expressed genomes of termites and their symbionts. Therefore, the approach also involves the identification and commercialization of the cellulases and hemicellulases that typically cooperate with lignases during termite digestion. In Phase I, a subset of *R. flavipes* termite lignase, hemicellulase, and cellulase enzymes were cloned, produced and partially characterized. In Phase II, (1) additional termite lignases, cellulases, and hemicellulases will be identified, produced, and tested, in order to improve the ability to use these alternative woody feedstocks; and (2) optimized enzyme mixtures will be developed for subsequent commercialization.

Commercial Applications and other Benefits as described by the awardee: The technology should contribute to important Presidential directives to produce greater quantities of ethanol biofuel, at greater efficiency, in order to reduce U.S. dependence on foreign oil.

85765S08-II

Feasibility of Commercialization of a Pre-Pretreatment Process for Enhanced Biomass Saccharification—Suganit Systems Inc, 10903 Hunt Club Road, Reston, VA 20190-3912; 703-736-0634
Mrs. Guneet Kumar, PhD, Principal Investigator; kumarg@suganit.com
Mr. Praveen Paripati, Business Official; praveen@suganit.com
DOE Grant No. DE-FG02-08ER85225
Amount: $750,000

In an economy based on renewable resources, plant biomass can provide a sustainable feedstock for future "biorefineries," partially replacing conventional petrochemical refineries. Toward this objective, this project addresses the deconstruction of lignocellulosic biomass to generate sugars and lignin, which form the precursors for producing biofuels and value added chemicals. Specifically, the approach involves the development of a novel pretreatment method that is efficient and yet facile with regards to the severity of the operating parameters. In Phase I, the viability of this pretreatment method was demonstrated, and the unique features that distinguish this method from several leading pretreatment methods were identified. Phase II will focus on the scale up and techno-economic optimization of this promising pretreatment method, with special emphasis on the development of techniques that facilitate the recovery of the biomass components.

Commercial Applications and other Benefits as described by the awardee: Successful scale up of the technology should enable the cost-competitive production of sugars and lignin from biomass, which in turn could tremendously increase the commercialization prospects of cellulosic ethanol, as well as other biofuels and products.

86352S08-II

Increased Seed Oil by Metabolic Regulation—Plant Sensory Systems, LLC., 6204 Blackburn Lane, Baltimore, MD 21212; 443-543-5580
Dr. Frank Turano, Principal Investigator; fturano@plant-ss.com
Dr. Kathleen Turano, Business Official; kturano@plant-ss.com
DOE Grant No. DE-FG02-08ER85075
Amount: $741,412

The biodiesel industry is growing rapidly in the U.S. and is expected to continue growing. However, even if all oilseeds produced in the U.S. were used for biodiesel, the supply would still fall short of the nation's need. Moreover, as the biodiesel market increases, food prices are expected to increase due to the efflux of seeds into the expanded biofuel market. Thus, an increase in seed oil content is needed to increase crop productivity per acre, in order to better meet the biodiesel demand. This project will employ a molecular approach to enhance seed oil content by inserting a novel gene in oilseed plants to direct the carbon flow into oil biosynthesis. In Phase I, the technology was tested in the plant model system, *Arabidopsis*. It was demonstrated that the seed oil content was 7 to 36% higher in the transgenic lines compared to the normal (or wildtype) line. Moreover, yield and seed viability were unaffected in the transgenic lines. In Phase II, the gene construct will be moved into a crop plant, canola, to demonstrate commercialization potential. Analyses will be performed to determine the quantity and quality of the seed oil content in the transgenic canola compared to that found in wildtype canola. Yield and seed viability also will be determined.

Commercial Applications and other Benefits as described by the awardee: Once demonstrated in a crop plant, the technology would be marketed to agribusinesses in the form of licensing agreements. Oilseeds with higher oil content would increase oilseed crop productivity per acre and help establish a thriving biodiesel market. Increased oilseed production would stimulate local and regional economies by increasing farming profit and creating new jobs.

86161S08-II

High Resolution Millimeter Wave Radar-Radiometer System for Volume Imaging of Clouds—ProSensing, Inc., 107 Sunderland Road, Amherst, MA 01002-1098; 413-549-4402
Dr. James S Mead, Principal Investigator; mead@prosensing.com
Dr. Ivan PopStefanija, Business Official; popstefanija@prosensing.com
DOE Grant No. DE-FG02-08ER85174
Amount: $750,000

The role of clouds in regulating fluxes of incoming solar radiation and upwelling infrared radiation is a poorly understood factor affecting global climate. In this project, a high-range-resolution (1m) scanning radar/radiometer system will be designed specifically to test cloud model predictions. The proposed radar will operate in the atmospheric transmission window centered at 35 GHz, which will provide high sensitivity and fine spatial resolution in a compact design. In addition, by adding a parallel radiometer channel at each frequency, the system will be able to estimate cloud liquid water content and correct the radar signal for attenuation. During Phase I, (1) the hardware needed to implement a parallel 35 GHz radiometer channel was developed and used to test the beam efficiency of a high performance 35 GHz Cassegrain antenna; (2) the mechanical design of a liquid cooled radar enclosure, suitable for all-weather operation, was completed; and (3) the feasibility of making high resolution millimeter-wave Doppler spectrum measurements in precipitation was demonstrated using a low power radar. Phase II will build a high power 35 GHz scanning cloud radar/radiometer with programmable range resolution as fine as 1.0 meter. The radar will employ the high performance Cassegrain antenna tested during Phase I, and the entire system will be mounted on a heavy duty elevation-over-azimuth pedestal.

Commercial Applications and other Benefits as described by the awardee: Commercial sales of this system are anticipated for future ground-based and airborne atmospheric research radars applied to the study of cloud microphysics and fine-scale atmospheric turbulence, and for cloud model verification.

85932S08-II

Characterization of Particulate Organic via Combined Thermal Desorption Aerosol Gas Chromatography and Aerosol Mass Spectrometry (TAG-AMS)—Aerodyne Research, Inc., 45 Manning Road, Billerica, MA 01821-3976; 978-932-0215
Dr. Leah Williams, Principal Investigator; williams@aerodyne.com
Mr. George N. Wittreich, Business Official; gnw@aerodyne.com
DOE Grant No. DE-FG02-08ER85160
Amount: $749,869

Although aerosol particles have important impacts on visibility, acid deposition, climate, and human health, large uncertainties remain in quantifying their chemical composition and atmospheric transformations. Particularly lacking are real-time, quantitative instruments for the identification, speciation, and source apportionment of organic-containing aerosols. An innovative thermal desorption, time-of-flight aerosol mass spectrometer has been developed to fill a critical need for size-resolved, quantitative chemical composition data on aerosol particles. In this project, this instrument will be integrated with a technology that provides chemical identification of individual organic constituents in aerosol particles, using retention time on a gas chromatography column. Phase I demonstrated that the aerosol collection/desorption/gas-chromatography technology can be integrated into the aerosol mass spectrometer, and the performance of the combined instrument was evaluated with ambient aerosol particles. During Phase II, (1) new hardware for the interface between the two instruments will be designed and constructed; (2) the footprint of the combined instrument will be minimized; (3) software will be developed for computer control of the combined instrument, for rapid data acquisition, and for comprehensive data analysis; and (4) the combined instrument will be evaluated in the laboratory and deployed in a field campaign.

Commercial Applications and other Benefits as described by the awardee: The primary market for this instrument will be atmospheric research groups at universities and national laboratories. In addition, the combined instrument has the potential to provide aerosol measurement capabilities for a variety of monitoring applications beyond the field of atmospheric research – e.g., industrial and energy production processes that produce aerosol-laden exhaust, including semiconductor manufacturing, gas turbines, fluidized bed combustors, diesel combustors, and conventional furnaces.

85934B08-II

Small Business
Aerosol Dynamics, Inc.
935 Grayson Street
Berkeley, CA 94710-2640
Dr. Susanne V. Hering, Principal Investigator
Susanne@aerosol.us
Dr. Susanne V. Hering, Business Official
Susanne@aerosol.us
510-649-9360

Research Institution
University of California

DOE Grant No. DE-FG02-08ER86335
Amount: $750,000

Semi-volatile organic compounds are a significant but poorly characterized fraction of atmosphere aerosols. Knowledge at the molecular level of the abundance and vapor-particle phase partitioning of these compounds is needed to understand the relative roles of biogenic and anthropogenic emissions to the global burden of particulate organic matter, to elucidate atmospheric oxidation pathways, and to assess their impact on global climate. This project will develop and validate an *in situ* method for the time-resolved quantification, at the molecular level, of the semi-volatile organic constituents in ambient air and their partitioning between vapor and particle phases. Phase I demonstrated a capability to (1) separately collect semi-volatile organic compounds in ambient air from particle and vapor phases, (2) thermally desorb and focus these semi-volatile organics onto a gas chromatograph (GC) column, and (3) analyze vapor and particle organic components by GC-molecular spectroscopy. In Phase II, the technology will be developed into a field-proven system for measurement at the molecular level of the concentration and phase-partitioning of the semi-volatile organic compounds in ambient air. Specific tasks include optimizing the vapor-particle collection and thermal desorption system, developing a methodology for in-field system calibration, and demonstrating the fully-integrated automated instrument in the field.

Commercial Applications and other Benefits as described by the awardee: The technology should advance our capability for real-time organic aerosol characterization. The technology should be attractive to multiple research groups and to regulatory agencies responsible for monitoring air toxics.

86326S08-II

Overexpression and Rapid Purification of Membrane and Secretory Proteins in Tetrahymena—Tetragenetics, Inc., 95 Brown Road, Ithaca, NY 14850; 607-257-1199
Dr. Ashot Papoyan, Principal Investigator; apapoyan@tetragenetics.com
Mr. John Peter Reilly, Business Official; jreilly@tetragenetics.com
DOE Grant No. DE-FG02-08ER85214
Amount: $750,000

Genetically engineered proteins are now being used in a wide range of critically important applications, including bioremediation, alternative energy production, and the treatment and prevention of human and animal disease. However, current manufacturing platforms are limited to a small number of cell-based systems that rely on bacteria, fungi, and insect and mammalian tissue culture cells. While adequate for the production of soluble proteins, these platforms often fall short of the large-scale manufacturing processes that are needed to produce the membrane and secretory proteins that are now under scrutiny by the energy and pharmaceutical industries. This project will develop a novel platform technology – based on a common pond-water ciliate, *Tetrahymena thermophila* – that is ideally suited to the rapid, low-cost production of such difficult-to-express proteins. Phase I demonstrated the utility of this approach for overproduction and rapid purification of a flu vaccine antigen, which served as a model membrane/secretory protein. Phase II will apply this technology to the production of enzymes being developed for biofuel manufacture. In addition, *Tetrahymena*'s vast membrane system will be exploited to overproduce a G-protein-coupled receptor; then, it will be demonstrated that the receptor can be labeled with stable isotopes for structure-based studies with NMR.

Commercial Applications and other Benefits as described by the awardee: The new platform technology should have direct application to vaccine development, therapeutic protein manufacture, rational drug design, and industrial processes, including alternative energy production. The technology would be made available to government, industry, and academia through contract protein expression services and user-friendly kits

86480S08-II

Microbioreactor Technology for Obligate Anaerobes—Pharyx, Inc., 49 Hemenway St #3, Boston, MA 02115; 617-792-0524
Dr. Harry Lee, Principal Investigator; harrylee@pharyx.com
Dr. Harry Lee, Business Official; harrylee@pharyx.com
DOE Grant No. DE-FG02-08ER85207
Amount: $750,000

The 2005 DOE Research Roadmap for biofuels concluded that "efficient conversion of biomass to liquid fuels will require new and innovative approaches for controlling cultivation and simultaneously monitoring cell physiological states and metabolic processes under a range of conditions." In support of this requirement, this project will customize a bench-top bioreactor system that will allow high-throughput cultivation of obligate anaerobes under a range of controlled conditions. In this approach, integrated, on-line sensors will enable detailed monitoring of culture conditions (including pH and trace oxygen), and of cell concentration and activity, without the risk of introducing oxygen. Phase I developed and tested five generations of bioreactor devices to overcome problems inherent in anaerobic culture. Three different obligate anaerobies – Clostridum, Bifido, and Ruminococcus – were grown in parallel bioreactor devices, and the development of a sixth-generation device was begun to further improve performance. Phase II will develop prototype systems for beta testing with industrial partners.

Commercial Applications and other Benefits as described by the awardee: The micorbioreactor technology should be useful for culturing and screening anaerobes and extremophiles from diverse sources with regard to beneficial properties (e.g., the production of industrially or medically relevant compounds and enzymes). The technology also should enable the screening of libraries of mutagenized/modified anaerobes to identify those that produce enzymes with improved activities. Furthermore, because of its parallel format, the microbioreactors should enable rapid optimization of culture conditions for the purposes of commercially manufacturing anaerobe-derived enzymes and chemicals.

85929S08-II

Dual Laser Isotopic Flux Monitor for Carbon Dioxide and Water Vapor—Aerodyne Research, Inc., 45 Manning Road, Billerica, MA 01821-3976; 978-932-0215
Dr. John Barry McManus, Principal Investigator; mcmanus@aerodyne.com
Mr. George N. Wittreich, Business Official; gnw@aerodyne.com
DOE Grant No. DE-FG02-08ER84962
Amount: $749,858

The increase of carbon dioxide (CO_2) in the Earth's atmosphere is the most important driver of global warming. In order to predict future carbon dioxide concentrations under various mitigation strategies, a much better quantitative understanding of the sources and sinks of atmospheric carbon dioxide is required. Studying the ratios of the stable isotopes of CO_2 has long been recognized as a tool for identifying sources and sinks of atmospheric CO_2. Because of the coupling of the water and carbon dioxide cycles, measurements of isotopic water vapor also are required to quantify the carbon cycle. This project will develop an advanced laser-based instrument for the simultaneous real-time measurement of isotopologues of CO_2 and H_2O. This instrument will be suitable for field-measurement of isotopic fluxes by eddy covariance, allowing the determination of wide area emission and deposition of CO_2, and allowing the partition between plant photosynthesis and respiration fluxes. In Phase I, a CW-QC laser was used to demonstrate outstanding precision (0.03‰) for the measurement of the target CO_2 isotopologues with a cryogen free system. In Phase II, a second CW-QC laser will be obtained for the measurement of H_2O isotopologues ($H_2{}^{16}O$, $H_2{}^{18}O$, $HD^{16}O$). The combined prototype instrument and its calibration system will be designed, constructed, and tested.

Commercial Applications and other Benefits as described by the awardee: The primary market for this instrument will be atmospheric, ecological, and environmental research groups at universities and national laboratories. The instrument has the potential to benefit human health and well being by improving our understanding of the sources and sinks of atmospheric CO_2.

85816S08-II

Price-Protected High-Precision Carbon Dioxide Analyzer—Vista Photonics, Inc., 67 Condesa Road, Santa Fe, NM 87508-8136; 505-466-3830
Dr. Jeffrey S. Pilgrim, Principal Investigator; davewalsh@vista-clara.com
Dr. Jeffrey S. Pilgrim, Business Official; davewalsh@vista-clara.com
DOE Grant No. DE-FG02-08ER84973
Amount: $750,000

Understanding global warming requires continuous field measurements of carbon dioxide concentrations. High precision measurements (one part in 3000 or better) are required; yet, these high performance instruments must meet stringent cost objectives. A simple, rugged, photoacoustic spectrometer can provide the required measurement precision at the required volume price point. This project will develop a laser-diode-based spectrometer that can determine ambient carbon dioxide concentration to better than one part in 3000 in less than one minute, while meeting a retail price of $5,000 under volume manufacturing. In Phase I, a bench-top laser diode (LD) photoacoustic spectrometer (PAS) was constructed for proof-of-principle testing. The excellent performance characteristics of the LDPAS sensor – including sensitivity, selectivity, and long term behavior – were experimentally confirmed. In Phase II, (1) fully integrated LDPAS sensor prototypes will be constructed for carbon dioxide field analysis; (2) standard operating protocols for the sensors will be established; and (3) the prototypes will be refined through beta testing in several field applications.

Commercial Applications and other Benefits as described by the awardee: In addition to measurements of atmospheric carbon dioxide, the technology should enable general-purpose trace gas detection in a variety of applications, including biomedical breath diagnostics, process gas analysis, and environmental regulatory compliance.

86061S08-II

A Closed-Path Methane and Water Vapor Gas Analyzer—LI-COR Biosciences, 4421 Superior Street, Lincoln, NE 68504-1395; 402-467-3576
Dr. Liukang Xu, Principal Investigator; liukang.xu@licor.com
Dr. Dayle K. McDermitt, Business Official; dayle.mcdermitt@licor.com
DOE Grant No. DE-FG02-08ER84968
Amount: $750,000

A closed-path methane and water vapor gas analyzer – which is robust, portable, has low power consumption consistent with solar powered applications, uses room-temperature lasers, and is suitable for long-term and remote field measurements – is not commercially available. Yet, such an analyzer is required to support the widespread deployment needed to achieve a better understanding of the global methane budget and to quantify exchanges between the atmosphere and terrestrial biosphere. Building on an open-path methane analyzer developed previously, this project will develop a tunable diode laser-based closed-path CH_4 and H_2O gas analyzer. The new closed-path instrument will use newly-developed laser technology: vertical cavity surface emitting lasers (VCSEL) and wavelength modulation spectroscopy (WMS). Compared to cavity ring-down spectroscopy (CRDS), VCSEL and WMS will provide better spectral performance (especially at ambient pressure), lower power consumption, high sensitivity, and less susceptibility to mirror contamination. Phase I demonstrated the feasibility of developing a closed-path CH_4 and H_2O gas analyzer with VCSEL and WMS. The resolution of this analyzer was better than 2 ppb $CH4 \cdot (Hz)^{-1/2}$, which exceeded the required specification for methane flux measurement. Phase II will (1) develop a closed-path CH_4 and H_2O gas analyzer prototype, using a VCSEL, a dense-pattern multi-pass optical cell, and WMS; and (2) develop the instrument-embedded and application software.

Commercial Applications and other Benefits as described by the awardee: Available methane analysis methods, such as gas chromatography and mass spectroscopy, are not suitable for long-term continuous field measurement, and laser-based CRDS requires main power, ultraclean optics, and isolation from the environment. The proposed analyzer could be used for net ecosystem methane exchange measurement. It also could be used for year-round measurements of atmospheric methane concentration, with minimum maintenance and with power from solar panels and batteries.

86457S08-II

The Ratiometric NDIR Analyzer for Robotic Platforms—Atmospheric Observing Systems, Inc., 1930 Central Avenue, Suite A, Boulder, CO 80301-2895; 303-817-6854
Dr. James R. Smith, Principal Investigator; jim@aosinc.net
Dr. James R. Smith, Business Official; jim@aosinc.net
DOE Grant No. DE-FG02-08ER84965
Amount: $750,000

Almost all of America's energy needs are supplied by the combustion of fossil fuels, and a great amount of anthropogenic CO_2 is a byproduct of this process. The DOE has expressed a need for the development of CO_2 instrumentation that can be deployed on small balloons and other robotic platforms and can achieve 1 ppm accuracy for a temporal resolution less than 30 seconds. This project will design and build a new CO_2 Nondispersive Infrared (NDIR) technology that is appropriate for a great many robotic platforms. In Phase I, four prototypes of the new NDIR technology were built and the best of them was selected for more than 50 tests in the laboratory. This prototype was then configured into a balloon payload that was tested in an environmental chamber within substantial ranges of ambient pressure (830 to 180 mBar) and temperature (+25 to -20 C). Phase II will build additional production payloads for testing on a tower and on balloons. The tower payloads will be tested for all four seasons, with the objective of providing an inexpensive tower analyzer system that can be operated autonomously at height for long duration. The balloon payloads will be tested in an unmanned airborne vehicle to validate performance through the atmospheric boundary layer.

Commercial Applications and other Benefits as described by the awardee: The new NDIR technology could support the deployment of a great number of robotic platforms, thereby introducing a substantial resource into the developing field of Observational Climate Change. A distributed sensor network consisting of towers and balloons may produce a new data product, CO_2 Weather, which would be intended to inform on the environmental impact of our day-to-day lives.

85814S08-II

Surface NMR Instrumentation and Analysis Methods for Characterizing Vadose Zone Hydrology—Vista Clara Inc., 2615 W Casino Road, Suite 4-JK, Everett, WA 98204; 425-290-3626
Dr. David Oliver Walsh, Principal Investigator; davewalsh@vista-clara.com
Dr. David Oliver Walsh, Business Official; davewalsh@vista-clara.com
DOE Grant No. DE-FG02-08ER84979
Amount: $750,000

The Department of Energy is responsible for the investigation and remediation of large-scale subsurface contamination at several existing and former DOE facilities. An understanding the hydrogeology of the vadose zone is crucial to understanding the transport and fate of underground contaminants. This project will develop practical field-based measurement and analysis techniques for determining vadose zone transport properties from multi-coil surface NMR measurements. Phase I demonstrated the theoretical and practical basis for using surface NMR geophysics to detect and characterize vadose zone water, and to translate the NMR signal properties of vadose zone water into hydraulic properties and/or transport models at the site scale. Phase II will entail the full-scale development of vadose-zone surface NMR instrumentation and analysis methods, coupled with extensive laboratory and field testing at DOE facilities, in order to demonstrate proof-of-principle.

Commercial Applications and other Benefits as described by the awardee: The surface NMR instrumentation and analysis techniques should enable high-resolution, non-invasive measurements of gravitational, capillary, and clay-bound water content in the unsaturated zone. In turn, these measurement capabilities would enable the more accurate prediction of contaminant transport and aquifer recharge processes. Vadose zone properties are especially important to assessing the feasibility and efficacy of aquifer storage and recovery projects.

86064S08-II

Field-Deployable Water Isotope Analyzer for Stream Sampling—Los Gatos Research, 67 East Evelyn Avenue, Suite 3, Mountain View, CA 94041; 650-965-7772
Dr. Manish Gupta, Principal Investigator; m.gupta@lgrinc.com
Dr. Douglas Baer, Business Official; d.baer@lgrinc.com
DOE Grant No. DE-FG02-08ER84976
Amount: $741,098

The DOE is responsible for the remediation of 1.7 trillion gallons of contaminated ground water and 40 million cubic meters of contaminated soil generated from weapons production activities at 7000 discrete sites. In order to maintain site stewardship, the DOE requires improved instrumentation to study subsurface transport, develop models, and improve remediation strategies. In particular, measurements of water isotope ratios are critical to understanding the migration and flow of contaminated groundwater. Currently, these measurements require taking discrete samples to mass spectrometry laboratories, a process that is expensive and labor intensive. This project will develop a field-deployable water isotope analyzer that can provide rapid (< 20 minutes) quantification of δD and $\delta^{18}O$ to better than ±1.0 ‰ and ±0.3 ‰, sufficient for isotope hydrology studies. Phase I fabricated and deployed an analyzer that measured δD and $\delta^{18}O$ to better than 0.6 ‰ and 0.2 ‰ in < 16 minutes. A sampling system was developed to draw water from different sources and direct them into the instrument for quantification. The prototype system was deployed in a forest for 4 weeks and yielded the first-ever high-frequency quantification of isotope data over a long time period. Phase II will develop three analyzers for continuous measurements of $^{2}H/^{1}H$ and $^{18}O/^{16}O$ water isotope ratios in the field.

Commercial Applications and other Benefits as described by the awardee: The analyzers would be used to validate subsurface transport models and provide continuous monitoring of water flow pathways. In addition to the DOE application to the remediation of contaminated facilities, the proposed sensor could be marketed for environmental research and medical diagnostics. The instrument also could be adapted to target the hydrology market.

85041T08-II

Small Business
Burge Environmental, Inc.
6100 South Maple Avenue
Suite 114
Tempe, AZ 85283-2872
Dr. Scott R. Burge, Principal Investigator
burge@burgenv.com
Dr. Scott R. Burge, Business Official
burge@burgenv.com
480-968-5141

DOE Grant No. DE-FG02-08ER86341
Amount: $744,640

Research Institution
Battelle PNWD

The long-term monitoring of groundwater contamination plumes, needed to determine the fate of contaminants in the environment, is expensive and labor intensive. Current baseline methods have resulted in monitoring programs that collect less data than is required to fully understand the fate and transport mechanisms of the contaminants. This project will develop an automated field-deployable monitoring system using a colorimetric sensor, which will be used to monitor uranium concentrations. The system will be capable of being deployed and operated in the field for several months, measuring uranium concentrations below the regulatory limits. The system will provide more frequent data with less reporting delay and at a lower cost than baseline methods. In Phase I, a prototype analytical system was developed and tested. The system successfully detected uranium below the regulatory limit and appeared to have the necessary attributes for deployment in the field. In Phase II, two systems will be field-deployed to demonstrate near-real-time monitoring at several areas of the DOE Handford Site in the State of Washington.

Commercial Applications and other Benefits as described by the awardee: The system should have application at DOE sites with radiological contaminants. The system should decrease monitoring costs, enhance the understanding of the fate of radiologicals in the environment, and ultimately decrease the cost of groundwater remediation activities.

85215S08-II

Development of Automated Software Program for the Analysis of Alzheimer's Disease Beta-Amyloid Scans—Molecular NeuroImaging, L.L.C., 60 Temple Street, Suite 8A, New Haven, CT 06510; 203-401-4351
Dr. George Zubal, Principal Investigator; gzubal@indd.org
Mr. Jack Mariotti, Business Official; jmariotti@indd.org
DOE Grant No. DE-FG02-08ER85170
Amount: $750,000

Clinical trials are now underway for the commercialization of radiopharmaceuticals that target beta amyloid, a compound that requires quantification for the diagnosis of Alzheimer's Disease (AD). This project will develop an automated software processing package that will objectively yield quantitative regional uptake values for evaluating the efficacy of these radiopharmaceuticals for measuring the beta amyloid load. This study is designed to reflect the way in which the scan and automated analysis package will be used in a real world clinical setting, and will provide information in a format most useful to physicians referring AD patients for scans. In Phase I, a fully-automated Objective and Generalized Tracer Evaluation (OGRE) package was developed and carried through preclinical validation. Phase II will apply the OGRE analysis package (1) to an ongoing radio-tracer evaluation program, in order to determine the degree to which the technique reduces the variance associated with imaging; and (2) to a prospective clinical study, in order to assess the utility of the technique as an aid in the diagnosis and monitoring of Alzheimer's patients.

Commercial Applications and other Benefits as described by the awardee: It is anticipated that OGRE would co-evolve with the new beta amyloid radiopharmaceuticals and would emerge as a clinically-accepted software analysis package for the diagnosis of Alzheimer's disease.

86102S08-II

Novel Approach for Depth-of-Interaction Encoding in PET—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Mr. Kanai Shah, Principal Investigator; KShah@RMDInc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER85158
Amount: $749,995

Depth-of-interaction (DOI) encoding is an important requirement in clinical as well as small-animal positron emission tomography (PET). At present, almost none of the commercial PET scanners have DOI encoding capability, and, as a result, these scanners show parallax error, which degrades their spatial resolution for events that are distant from the central axis in the radial direction. This project will investigate a new detector design that promises to provide high resolution DOI encoding in a continuous manner, with single-ended detector readout. Phase I demonstrated the feasibility of obtaining high resolution, continuous DOI encoding with the new detector configuration with single ended scintillator readout. Phase II will be aimed at optimizing the detector design to achieve high DOI resolution, along with good energy and timing resolution. Multiple modules that incorporate the proposed design will be built and evaluated.

Commercial Applications and other Benefits as described by the awardee: The proposed detector technology should be very promising for small animal and clinical PET applications. It also should be applicable to gamma-ray imaging systems for astronomy, non-destructive studies, and nuclear non-proliferation, which also require depth-of-interaction information.

86107S08-II

High Resolution Scintillators for SPECT—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Dr. Gerald Entine, Principal Investigator; GEntine@RMDInc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER85176
Amount: $749,993

Single photon emission computed tomography (SPECT) is a powerful, noninvasive medical imaging modality that mathematically reconstructs the three dimensional distribution of a radionuclide throughout the body of a human patient or research animal. At present, the performance of available SPECT systems is limited by available detector technology. This project will investigate new gamma-ray detectors that have the potential to provide excellent energy resolution, a very important requirement in SPECT. During Phase I, small detectors of the proposed configuration were designed and built, and their performance was characterized. Energy resolution measurements confirmed the promise of the proposed technology and overall feasibility was demonstrated. Phase II will involve optimization of the proposed technology, scale-up, detailed characterization of performance, and construction and evaluation of SPECT modules.

Commercial Applications and other Benefits as described by the awardee: The proposed detector technology should be very promising for clinical SPECT applications. It also should be applicable to gamma-ray imaging systems for astronomy, nondestructive studies, and nuclear non-proliferation.

86113S08-II

Advanced Detectors for PET—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Dr. Purushottam Dokhale, Principal Investigator; PDokhale@RMDInc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER85177
Amount: $749,994

Positron Emission Tomography (PET) is a functional imaging technique with the potential to quantify the rates of biological processes *in vivo.* PET imaging can provide diagnosis for symptoms of diseases such as Alzheimer's disease, head trauma, cancer, and stroke. However, the performance of existing PET systems is limited by the properties of the detectors available at present. This project will investigate a new solid state photodetector that appears to be very promising, due to its high gain, fast response, and low noise. In Phase I, the proposed photodetector was built and then coupled to scintillation crystals. The performance of these detector modules was evaluated, and energy, timing, and depth-of-interaction (DOI) resolution studies were conducted. Phase II will be aimed at the optimization of the proposed detector design to achieve high DOI resolution, along with good energy and timing resolution. Multiple modules with the proposed design will be built and evaluated

Commercial Applications and other Benefits as described by the awardee: Over and above the use in nuclear medicine, the new detectors should be applicable to nuclear and high energy physics, space research, homeland security, and nuclear non-proliferation.

85894S08-II

Wind Resource Assessment Lidar—Physical Optics Corporation, 20600 Gramercy Place, Building 100, Torrance, CA 90501-1821; 310-320-3088
Mr. Ponniah Sivanesan, Principal Investigator; pspproposals@poc.com
Mr. Gordon Drew, Business Official; gedrew@poc.com
DOE Grant No. DE-FG02-08ER85147
Amount: $750,000

New low-cost remote sensing systems are needed to evaluate potential sites for wind turbines. The use of traditional meteorological towers with cup anemometers is becoming increasingly costly: as the size of the wind turbines continues to increase, the corresponding wind measurements must be obtained at greater and greater heights. This project will develop a new autonomous Wind Resource Assessment Lidar (WIRAL), based on a self-mixing interferometric and on a direct-detection Raman dual-wavelength lidar system. The new lidar system will measure wind and temperature at heights between 10 m and 200 m from ground level. The system will be solar powered, low cost, compact, transportable, and autonomous, and will have high temporal and spatial resolution. In Phase I, a proof-of-concept laboratory prototype was designed and built using commercial off-the-shelf components, and key system parameters for wind assessment were experimentally and theoretically investigated. Wind speed measurement accuracy of better than ±2% was demonstrated. Phase II will focus on (1) enhancing the range of operation by boosting the optical power of the emitter laser; (2) introducing electronically-controlled laser scanning and focusing components; (3) building custom optical assemblies to improve light collection efficiency ; and (4) developing a commercially viable WIRAL prototype.

Commercial Applications and other Benefits as described by the awardee: The wind resource assessment system would be used to effectively and accurately measure wind conditions and assess potential wind farm sites, thereby speeding the installation of wind turbines for efficient and durable wind energy production at a fraction of the cost of any existing technological platform.

85513S08-II

SMarT Tower Systems for Small Wind Turbines (Simple Modular Technology)—
AnemErgonics, LLC, 7015 Nile Court, Arvada, CO 80007-7049; 303-940-7530
Dr. Paul Migliore, Principal Investigator; paulmigliore@msn.com
Dr. Paul Migliore, Business Official; paulmigliore@msn.com
DOE Grant No. DE-FG02-08ER85231
Amount: $750,000

The cost of electricity for small wind turbines is too high, and the installation process is too cumbersome, to achieve the widespread deployment goals of industry stakeholders. Guyed towers, which are traditionally the least expensive to erect, represent one approach to cost savings, but these systems have a larger footprint, require more maintenance, and are less visually appealing than the monopole towers preferred by many customers. Therefore, this project will develop technology to address the construction of the logistically cumbersome and cost inefficient monopole tower systems (foundations plus towers). For the foundation, dramatic simplification is achieved by inexpensively shipping all required foundation materials (except concrete) directly to the installer. The tower, which will be composed of a hybrid metal-fiberglass, will weigh about half as much as steel towers, will be inexpensive to ship, and will be much less costly than traditional monopole alternatives. In Phase I, 402 foundations were installed in 36 states and 9 off-shore locations. Both the towers and foundations were evaluated and approved by tower engineering professionals. Phase II will involve conducting field tests, developing improved components, optimizing the designs, and testing the system at the National Renewable Energy Laboratory.

Commercial Applications and other Benefits as described by the awardee: The proposed tower system should be suitable for use on all small wind turbines employing free-standing towers. With this system, a typical turbine on an 18.3 m (60 ft) tower would have an installed cost saving of approximately 30%. The technology would thus be a tool for promoting the expansion of wind turbines in the U.S.

86396S08-II

Advanced Coatings to Improve the Efficiency, Color Rendering and Life of High Intensity Discharge Lamps—Acree Technologies Incorporated, 1900 Olivia Road, Unit D, Concord, CA 94520; 925-798-5770
Dr. Mike McFarland, Principal Investigator; mcfarland@acreetech.com
Dr. Mike McFarland, Business Official; mcfarland@acreetech.com
DOE Grant No. DE-FG02-08ER85137
Amount: $748,903

High Intensity Discharge (HID) lamps are used extensively for large area lighting – such as for parking lots, streets, and warehouses – and are increasingly being used for general lighting in stores and homes. Improving the efficiency of HID lamps would result in significant energy savings. This project will develop an inexpensive, robust coating that is applied to the outside of an HID lamp and reflects IR and UV photons back into the lamp, thereby heating the plasma and generating a greater output of lumens for a given electrical energy input. Moreover, this increase in efficiency will be achieved with a single-layer coating as opposed to the multilayer coatings that are expensive to apply and are not economically viable. In Phase I, coatings were applied to off-the-shelf HID lamps, and photometric and thermal properties of the lamps were measured. The results showed that the efficacy of coated HID lamps was up to 22% higher than that of uncoated lamps, with better color rendering. Lifetime testing resulted in no degradation of the coating or bulb for hundreds of hours of operation. Phase II will involve a two-pronged approach: development of (1) a plug-replaceable coated HID lamp that can be used in existing lamp installations, with efficacy improvements of 10% to 15%; and (2) an optimized coated lamp/ballast system for new construction, with efficacy improvements of 20% to 25%.

Commercial Applications and other Benefits as described by the awardee: The single-layer coating developed in this project could be applied for pennies per bulb, and the deposition process will be compatible with large scale production. Because HID lighting accounts for about 200 TWh per year in the U.S., a 20% increase in the efficacy of HID lamps would result in a savings of 40 TWh per year, based on present HID use.

86485S08-II

Advanced Phosphor Technologies for Energy Efficient Lighting And Energy Harvesting—
PhosphorTech Corporation, 351 Thornton Road, Suite 130, Lithia Springs, GA 30122;
404-664-5008
Dr. Christopher J. Summers, Principal Investigator; chris@phosphortech.com
Mr. Hisham Menkara, Business Official; hisham@phosphortech.com
DOE Grant No. DE-FG02-08ER85146
Amount: $749,988

Although fluorescent and incandescent lighting consumes >50% of the lighting energy budget, they are relatively inefficient, losing ~37% and 85%, respectively, of their energy to the IR. Thus, phosphors that could efficiently up-convert IR radiation to visible light would have a significant impact on lamp efficiency and design. This project will develop technology to increase the efficiency of upconversion phosphors by more than an order of magnitude: from ~ 5% to 60% or higher. Phase I demonstrated, both experimentally and theoretically, that an upconverting nanophosphor could improve up-conversion efficiency by a factor of 4 (experiment) or by a factor greater than 10 (theory) compared to conventional particles. In these nanostructures, both the sensitizer and activator doping were confined to two-dimensioal layers, thus dramatically enhancing upconversion efficiency while simultaneously reducing sensitizer-defect interactions. In Phase II, these nanostructured materials will be encapsulated to achieve enhanced performance that is close to the maximum theoretical efficiency. Unwanted radiative losses will be inhibited by incorporating these structures into Bragg resonator or photonic crystal structures. Finally, a low-cost, high-volume, automated manufacturing process will be developed.

Commercial Applications and other Benefits as described by the awardee: The nanophosphors should have applicability to all existing lamp products, including incandescent, tungsten-halogen, and all types of fluorescents lamps. Potentially the technology could result in an annual national energy saving (commercial plus residential) of 0.979 quads, which translates into a reduction of 15.99 million metric tonnes of carbon. Additionally, the technology could significantly enhance the performance of solar cells by folding more of the solar spectrum into the operational range of the power cell.

86358S08-II

Selective Emitter Based Energy Efficient Incandescent Lamp Technology—Surmet Corporation, 31 B Street, Burlington, MA 01803; 781-345-5721
Mr. Uday Kashalikar, Principal Investigator; UKashalikar@Surmet.com
Dr. Santosh K. Jha, Business Official; SJha@Surmet.com
DOE Grant No. DE-FG02-08ER85151
Amount: $750,000

Artificial lighting consumes about 20 percent of U.S. energy production and has rather low efficiencies: from 7 percent for incandescent lamps to about 30 percent for the most efficient, but high cost, discharge and compact fluorescent lamps. This project will develop an economical incandescent lamp, based on an innovative selective emitter technology, with a high energy efficiency. Phase I analytically demonstrated feasibility of the selective-emitter-based energy efficient incandescent lamp, demonstrated the fabrication process for the key emitter element, and proved that the emitter could performe for several hours without filament burn-out. Phase II will optimize the designs, materials, and processes used in Phase I, demonstrate the technical goals (efficiency, life, cost) of the lamp through fabrication and testing, and demonstrate repeatability in performance and life. Phase II lamps are targeted to have twice the efficiency of current incandescent lamps, 2000 hr life, and a cost comparable to standard incandescent lamps.

Commercial Applications and other Benefits as described by the awardee: This technology should be applicable to many types of incandescent lamps for energy efficiency and conservation. Similar applications exist in industrial applications such as paper drying and photovoltaic systems (for energy generation). An economical incandescent lamp with a high energy efficiency would have a annual market exceeding $1 billion per year. After successful development and implementation, such efficient lamps would produce energy savings of 3-5 percent.

85559S08-II

Improved High-Temperature ESP Motor Lead Extension Cables for Reliable Geothermal Power Production—Composite Technology Development, Inc., 2600 Campus Drive, Suite D, Lafayette, CO 8002-3359; 303-664-0394
Dr. Matthew Hooker, Principal Investigator; matt.hooker@ctd-materials.com
Ms. Lori Pike, Business Official; lori.bass@ctd-materials.com
DOE Grant No. DE-FG02-08ER85138
Amount: $749,950

Geothermal energy has the potential to provide a significant source of clean, renewable energy for the United States. However, for geothermal energy to be economically viable, advanced technologies are needed to enable the transport of geothermal fluids to the surface from depths on the order of 3 to 10 km. One of the essential components is a motor-lead extension that is capable of delivering high-voltage electricity to electric submersible pumps (ESP) operating in geothermal wells at temperatures ranging from 200 to 300˚C. This project will demonstrate the performance of cable extensions based on novel inorganic electrical insulations that are capable of long-term, high-voltage, high-temperature operation. Phase I involved the production and testing of insulated wires produced with high-temperature, inorganic insulations. The wire insulation used in this work possessed an electrical resistivity eight times higher than currently-used polymer insulations at 250˚C, while also possessing the necessary mechanical strain tolerance needed for spooling and downhole deployment operations. In Phase II, the electrical insulation and cable design will be optimized. The high-temperature electrical and mechanical properties will be evaluated to ensure that the products of this work will meet the needs of future geothermal applications.

Commercial Applications and other Benefits as described by the awardee: The technology should be directly applicable to commercial geothermal energy production. Related commercial applications include the use of the cable in motor windings, downhole heaters for oil recovery, and micro-hole drilling operations. In addition, high temperature ESP's are also used in SAGD (Steam Assisted Gravity Drainage) for the production of heavy oil, and in deepwater offshore HTHP (high temperature high pressure) wells for the production of conventional oil and gas.

85653S08-II

Diamond-Hardfaced Nanocomposites for Extended Service Lives of Pump Berings in Geothermal Wells—Diamond Materials Inc., 120 Centennial Avenue, Piscataway, NJ 08854; 732-885-0805
Dr. Oleg A. Voronov, Principal Investigator; oavoronov@aol.com
Dr. Oleg A. Voronov, Business Official; oavoronov@aol.com
DOE Grant No. DE-FG02-08ER85139
Amount: $749,744

Renewable energy sources include electrical generators driven by steam from geothermal wells. To exploit this resource, submersible pumps with extended service lives are required to improve the economics of today's geothermal systems. A major problem is corrosive wear experienced by the pump bearings, when the lubricating brine becomes contaminated with fine sand particles. Typically, the bearings are hardfaced with WC/Co-Cr, which can resist degradation only when no sand is present. Thus, the bearings fall far short of the desired 5-10 years lifetimes. This project will develop diamond-hardfaced carbide-metal nanocomposites, in which a compositionally-graded layer of diamond nanoparticles is bonded to a nanostructured carbide-metal substrate. The graded coating/substrate interface resists coating spallation over the long term, even when the original geothermal brine becomes contaminated with entrained sand particles. Phase I fabricated a diamond-hardfaced WC/Co-Cr nanocomposite, in which a functionally-graded layer of diamond nanoparticles was bonded to a nanostructured WC/Co-Cr substrate. In Phase II, extensive materials characterization and mechanical properties studies will be performed.

Commercial Applications and other Benefits as described by the awardee: The nanocomposite structure would exhibit mechanical properties advantages that include higher hardness and compressive strength, as well as improved fracture toughness. Beyond the application to geothermal wells, other potential commercial applications for diamond-hardfaced nanocomposites include machine tools, drill bits, and wear parts.

85655S08-II

High Performance Fluoroelastomer Nanocomposite Seals For Geothermal Submersible Pumps—NEI Corporation, 400 Apgar Drive, Suite E, Somerset, NJ 08873; 732-868-3141
Mr. Daniel Eberly, Principal Investigator; deberly@neicorporation.com
Dr. Ganesh Skandan, Business Official; gskandan@neicorporation.com
DOE Grant No. DE-FG02-08ER85145
Amount: $749,963

The Electrical Submersible Pumps (ESPs) used in geothermal energy production are subjected to harsh downhole environments that include hot brine (e.g. calcium chloride), corrosive hydrogen sulfide/carbon dioxide, silica, and entrained sand, all at temperatures in the range of 300 to 450 °F. The fluoroelastomeric materials used as seals in these applications degrade in a relatively short period of time in these environments, which can lead to equipment failure. Attempts to improve the modulus and hardness have been accompanied by a reduction in elongation. This project will develop novel functionalized nanoscale additives that are designed to beneficially alter the stress-strain behavior of fluoroelastomers. Phase I synthesized surface functionalized nanoparticles and fabricated fluoroelastomer sheets and O-rings containing these nanoscale additives. An 82% improvement in modulus and a 7 point increase in Shore A hardness was observed, without decreasing the elongation at break. Phase II will (1) optimize the structure/size of the nanoscale additives; (2) determine structure/property correlation and interfacial mechanisms of the nanoscale additive and the fluoroelastomer; and (3) perform an objective comparison of the nanocomposite fluoroelastomers with that of commercially-used state of the art fluoroelastomer materials. Those nanoscale additives that show dramatic improvement will be utilized in fabricating prototype seals and supplied to potential customers for evaluation.

Commercial Applications and other Benefits as described by the awardee: The development of novel nanoscale additives for sealing applications offers a potentially new set of performance characteristics for fluoroelastomers. In addition to oil, gas, and geothermal operations, processes in pharmaceuticals, medical devices, and microelectronics could benefit from seals that offer better barrier and mechanical performance than currently available materials.

86247S08-II

Aqueous Phase Base-Facilitated-Reforming (BFR) of Renewable Fuels—Directed Technologies, Inc., 3601 Wilson Blvd., Suite 650, Arlington, VA 22201; 703-778-7115
Mr. Brian David James, Principal Investigator; brian_james@directedtechnologies.com
Ms. Julie Perez, Business Official; julie_perez@directedtechnologies.com
DOE Grant No. DE-FG02-08ER85111
Amount: $749,951

The primary industrial method for hydrogen production, Steam Methane Reforming (SMR) of natural gas (NG), has a number of shortcomings: (1) the natural gas feedstock is not renewable; (2) carbon emissions require costly mitigation systems to be compliant with EPA regulations; (3) reformation results in a dilute hydrogen gas stream that require extensive purification to obtain pure hydrogen; and (4) elevated processing temperatures, input energy requirements, and process inefficiencies induce high capital and operating costs. This project will develop an aqueous-phase base-facilitated reforming (BFR) and feedstock selection process that addresses these shortcomings. In Phase I, hydrogen yield from BFR was experimentally determined for different feedstocks (paper, wood, grass, food) in batch reactors and found to be between 50 % and 90% of theoretical. Phase II will involve the design and demonstration of an aqueous BFR reactor that can continuously produce 10 kg of hydrogen per day.

Commercial Applications and other Benefits as described by the awardee: The BFR technology would offer the following advantages: conversion of renewable fuels, liquid phase reformation, low temperature operation, elimination of water gas shift, and pure hydrogen gas creation. The hydrogen produced would have immediate use in existing industrial processes. In the longer term, the hydrogen produced from BFR should become a significant fuel source for transportation and the generation of electricity.

85116S08-II

Anode Concepts for SO2 Crossover Reduction in the HyS Electrolyzer—Giner Electrochemical Systems, LLC, 89 Rumford Avenue, Newton, MA 02466-1311; 781-529-0504
Mr. Simon G. Stone, Principal Investigator; sstone@ginerinc.com
Dr. Anthony J. Vaccaro, Business Official; avaccaro@ginerinc.com
DOE Grant No. DE-FG02-08ER85113
Amount: $749,485

Energy security and global warming are looming issues for the future of our nation's vitality, productivity, and environmental health. The notion of a hydrogen-fueled future is positive on many levels, including air quality and efficiency, but its realization depends critically on the identification of a carbon-free, or at least renewable, energy source. Thermochemical cycles, such as the Hybrid Sulfur (HyS) process, have the potential of providing hydrogen from nuclear energy at high efficiency and with minimal environmental impact. This project will develop an innovative electrolyzer design for the HyS proton-exchange membrane (PEM) to correct the SO_2 crossover problem inherent in current state-of-the-art HyS electrolyzers. In Phase I, anode technologies were developed to minimize SO_2 crossover, which was reduced by 70% (exceeding the 50% reduction target) while maintaining high electro-chemical performance. Phase II will (1) refine the novel anode technology and develop PEM improvements; (2) conduct an analysis and modeling of the sulfur generation chemistry of the cathode; and (3) design, fabricate, and demonstrate a scaled-up (1.6 lbs H_2/day) HyS electrolyzer stack incorporating the Phase I anode.

Commercial Applications and other Benefits as described by the awardee: The technology should enable the use of thinner PEMs in future HyS electrolyzers and extend operating lifetimes due to reduced sulfur layer buildup, which should significantly increase the total efficiency and operating costs of the HyS thermochemical cycle.

85132S08-II

Power Generation from an Integrated Biofuel Reformer and Solid Oxide Fuel Cell—
InnovaTek, Inc., 350 Hills Street, Suite 104, Richland, WA 99354-5511; 509-375-1093
Dr. Qimin Ming, PhD, Principal Investigator; ming@tekkie.com
Ms. Patricia M. Irving, Business Official; irving@tekkie.com
DOE Grant No. DE-FG02-08ER85115
Amount: $750,000

Alternative energy sources must be sought to meet the energy demand of our growing economy and to improve energy security while reducing environmental impacts. The conversion of bio-oil from non-food-based biomass to hydrogen for fuel cells would allow significant increases in the use of renewable feedstocks for energy production. This project will develop a non-food-biomass-based power plant with a solid oxide fuel cell for distributed power generation in the range from 3 to 30 kW. The bio-oil that will be used in the proposed process will be made from agricultural and forestry residuals, such as wood sawdust, through the fast pyrolysis process. In Phase I, a conceptual system design was developed to demonstrate that an integrated reformer and solid oxide fuel cell system is a commercially viable approach for producing electricity from biomass. During Phase II a scaled-up prototype system, which uses sawdust-derived pyrolysis oil as the test fuel, will be designed, fabricated, and tested. Micro-channel components will be used to obtain a highly efficient reforming system that will help achieve an overall system efficiency of 40%.

Commercial Applications and other Benefits as described by the awardee: The integrated power system should provide an opportunity to reduce the burden on the current electrical distribution system through greater availability of localized power generation from renewable sources. The use of bio-derived fuels in distributed generation applications would reduce the growth in the demand for natural gas and would enhance grid stability. By replacing petroleum-based fuels with renewable non-toxic biofuels, our nation can reduce its reliance on foreign sources of energy and reduce the environmental impacts of petroleum-based products.

85979S08-II

Faradayic ElectroEtching of Stainless Steel Bipolar Plates—Faraday Technology, Inc., 315 Huls Drive, Clayton, OH 45315; 937-836-7749
Ms. Heather McCrabb, Principal Investigator; heathermccrabb@faradaytechnology.com
Dr. E. Jennings Taylor, Business Official; jenningstaylor@faradaytechnology.com
DOE Grant No. DE-FG02-08ER85112
Amount: $750,000

Commercialization of polymer-electrolyte-membrane fuel cells requires low-cost components, materials, and manufacturing processes. However, current bipolar plate manufacturing methods are slow, expensive, and are inappropriate for some advanced flow-field designs. This project will develop an innovative electro-etching process that will enable through-mask etching of stainless steel bipolar plates at high volume and low cost. This technique will enable advanced flow channel designs, not easily attainable using current manufacturing technologies. In Phase I, an advanced electrochemical cell, which facilitates uniform flow across the entire surface of the test plates, was designed and modified to electro-etch a 2" x 2" serpentine flow field into 4" x 4" 304 and 440C stainless steel substrates. A preliminary economic analysis demonstrated that the innovative electro-etching process can meet the high volume cost target of ~$1.50 per bipolar plate. Phase II will (1) validate the development, optimization, and manufacturing of the electro-etching process for both gas and coolant flow field channels; (2) select appropriate tests to characterize the functionality, durability, and performance of the metal bipolar plates for single and short-stack fuel cells; and (3) conduct a more comprehensive economic assessment of the electro-etching process as it relates to bipolar plate manufacturing.

Commercial Applications and other Benefits as described by the awardee: An electrochemical etching processes for passive materials such as stainless steels, titanium, and nickel-based alloys should have wide applications in a variety of industries, including aerospace, medical, and automotive. With respect to the manufacturing of fuel cells, the proposed process for bipolar plates should facilitate the viability of polymer-electrolyte-membrane fuel cells as a power source, reducing pollution and increasing manufacturing job opportunities in the U.S.

85635S08-II

Non-thermal Plasma Cracking of Residual Distillate and Vacuum Gas Oil—Lynntech, Inc.,
7610 Eastmark Drive, College Station, TX 77840; 979-693-0017
Dr. Roger van Boeyen, Principal Investigator; roger.vanboeyen@lynntech.com
Dr. G. Duncan Hitchens, Business Official; proposals@lynntech.com
DOE Grant No. DE-FG02-08ER85119
Amount: $750,000

With the decreasing supply of light sweet crude oil, the importance of heavy crude oil is increasing. Correspondingly, the need for economical, viable processing methods to increase the value of heavy crude has increased. Current processing methods crack distillate byproducts, such as residual distillates and vacuum gas oil, into lighter components including gasoline and diesel. However, the cost and complexity of these cracking methods has limited these techniques to large-scale refinery operations. This project will develop a low cost, versatile cracking technology – a simple, highly efficient, non-thermal plasma reactor – that is able to process and crack heavy hydrocarbon materials in a rapid, continuous, and non-labor intensive manner, without large, complex, and energy intensive processing equipment. Phase I demonstrated the feasibility of the non-thermal plasma reactor by converting 75-80% of the heavy hydrocarbon content in vacuum gas oil (VGO) to gasoline and diesel fractions. Tolerance to sulfur and heavy metals over an extended period of time was demonstrated. In Phase II, (1) the reactor design will be optimized to improve cost, yield, and energy efficiency; (2) a preliminary design for a pre-pilot scale reactor, to be integrated with a small-scale refinery operation, will be developed; and (3) a scaled-up version (2 kW system) of the non-thermal plasma cracker system will be created.

Commercial Applications and other Benefits as described by the awardee: The simple, low cost cracking technology could be implemented in the approximately 190 small refinery operations in the US, which are critical to meeting the Nation’s liquid fuel supply.

86189S08-II

Hydrogen Production for Refineries—TDA Research, Inc., 12345 W. 52nd Avenue, Wheat Ridge, CO 80033-1916; 303-940-2300
Dr. Girish Srinivas, Principal Investigator; gsrinivas@tda.com
Mr. John D. Wright, Business Official; jdwright@tda.com
DOE Grant No. DE-FG02-08ER85135
Amount: $750,000

Refineries in the U.S. are processing increasingly heavy sour crudes that contain metals, sulfur, and high molecular weight aromatic hydrocarbons. Many sour crudes originate in the Western Hemisphere, including heavy crudes from Venezuela, southern California, and the enormous quantities of oil sands in Canada. Processing and upgrading these heavy feedstocks requires considerable quantities of hydrogen. Unfortunately, revamping or installing new hydrogen capacity with conventional technologies such as methane steam reforming or petroleum coke gasification is expensive. This project will develop a new technology that will allow hydrogen to be produced in refineries at a cost that is considerably lower than hydrogen produced from conventional technologies, and also less expensive than purchasing hydrogen from a third party. In this approach, "bottom of the barrel" materials will be converted into hydrogen, facilitating the production of more distillate fuels from each barrel of oil, especially from the less expensive heavy crudes that are available in great quantity.

Commercial Applications and other Benefits as described by the awardee: As refineries process increasingly heavier crudes, more and more hydrogen is needed to remove metals, sulfur, and nitrogen, as well as to upgrade highly aromatic feedstocks such as residuum. New technologies that have lower capital and feedstock costs for generating hydrogen should be of interest to the refining industry. This is even more the case with smaller refineries (~50,000 bbl/day) that cannot afford expensive methane steam reforming or petcoke gasifiers.

86286S08-II

Development of a Thermally and Electrically Self-Sustaining Hydrogen Generation System Directly Using Petcoke—Materials & Systems Research, Inc., 5395 West 700 South, Salt Lake City, UT 84104; 801-530-4987
Dr. Greg Tao, Principal Investigator; gtao@msrihome.com
Mr. Anthony D. Decheek, Business Official; adecheek@msrihome.com
DOE Grant No. DE-FG02-08ER85121
Amount: $750,000

Hydrogen has been widely used by petroleum refineries in upgrading processes necessary to facilitate the hydrotreating/catalytic hydrocracking of heavy hydrocarbon molecules and the reduction of sulfur content. However, the building of the infrastructure needed to transport hydrogen from central production facilities to small refineries is cost prohibitive. This project will develop an advanced, thermally and electrically self-sustaining, electrochemical hydrogen generation system for small petroleum refineries applications. In Phase I, electrode materials were identified and deposited using different approaches, an electrochemical device was successfully developed and fabricated, and proof-of-concept tests were performed. Both hydrogen production and power generation, directly using petcoke, was demonstrated. Phase II will focus on improvements and scaling of the hydrogen production technology. Over 500 hours of long-term tests will be performed to investigate possible degradation mechanisms, and the hydrogen production process will be demonstrated at bench-top scale.

Commercial Applications and other Benefits as described by the awardee: The technology should enable refineries to convert a locally available inexpensive feedstock, petroleum coke, into hydrogen at a cost much lower than the cost of purchasing hydrogen from a central production facility. Other benefits would include (1) no need for fuel clean-up or secondary purification of the hydrogen product; (2) versatile operations for hydrogen/power generation; (3) a sequestration-ready CO_2 production; and (4) a marketable by-product.

86233S08-II

Material Utilization and Waste Reduction through Kerf Recycling—Crystal Systems, Inc., 27 Congress Street, Salem, MA 01970; 978 745 0088
Dr. David Brian Joyce, Principal Investigator; dbjoyce@crystalsystems.com
Ms. Leila Panzner, Business Official; leila@crystalsystems.com
DOE Grant No. DE-FG02-08ER85087
Amount: $745,586

A major loss of the expensive silicon used in the production of photovoltaic (PV) solar cells occurs at the wafering stage, where as much as 50% of this valuable material ends up as a disposal problem rather than being recycled. The waste results from the use of a loose abrasive used with the multi-wire slurry saws currently used to cut the silicon wafers; this abrasive contaminates the swarf silicon and eliminates the possibility of recycling this silicon. This project will develop technology for recycling the swarf silicon via a fixed diamond abrasive process called Fixed Abrasive Slicing Technology (FAST). In Phase I, silicon was wafered on a FAST machine and the recovered swarf was analyzed. The swarf was simulated in composition, phase, and particle size, and then processed in a silicon furnace to produce solar grade feedstock. In Phase II, the processing technology will be scaled-up to demonstrate a clear path to the commercialization of the fixed diamond abrasive slicing of silicon wafers.

Commercial Applications and other Benefits as described by the awardee: Converting to a recyclable slicing technology would eliminate one of the largest waste streams in PV and reduce the costs and environmental impacts of PV by 50% or more. The technology should lead to a $30 million business, which could grow by over a factor of 100 as the industry converted to fixed abrasive wafering.

85517S08-II

Non-Contact, Printable Metallic Inks for Silicon Solar Cells—Applied Nanotech, Inc., 3006 Longhorn Blvd., #107, Austin, TX 78758-7518; 512-339-5020
Dr. James Novak, Principal Investigator; jnovak@appliednanotech.net
Dr. Richard Fink, Business Official; dfink@appliednanotech.net
DOE Grant No. DE-FG02-08ER85085
Amount: $749,997

Electrical contacts represent a critical element of photovoltaic technology and are problematic for silicon solar cell production. Current processes that use silver and nickel/copper top contacts are not cost effective: silver is too expensive and the use of a nickel diffusion barrier adds cost and complexity to the assembly process. Alternative metals such as aluminum and copper have thus far been unsuccessful because of their inherent chemistries. This project will develop metallic-nanoparticle-based conductive inks that can be applied through non-contact print techniques. Phase I demonstrated that a new aluminum ink that could be deposited and cured in ambient conditions. This ink provided a cured resistivity 2.3 times that of bulk aluminum. The aluminum ink provided Ohmic contacts and an enhanced BSF (back surface field) layer on silicon. Phase II will optimize the aluminum inks, refine the deposition process, and generate high efficiency solar cell prototypes.

Commercial Applications and other Benefits as described by the awardee: The technology should provide an accurate, robust, reliable, and cost-effective method for increasing electrical energy efficiency in silicon solar cell production and usage. The technology would simplify the manufacturing process for solar cells and lower costs, thereby accelerating the commercialization of photovoltaic technology.

85651S08-II

Multifunctional UV Curable Sol-Gel Organic Hybrid Nanocomposite Encapsulation System—Luminit, LLC, 1850 205 Street, Torrance, CA 90501-1821; 310-320-1066
Mr. Kevin Yu, Principal Investigator; kyu@luminitco.com
Ms. Linh Whitaker, Business Official; lwhitaker@luminitco.com
DOE Grant No. DE-FG02-08ER85097
Amount: $750,000

Innovative approaches are being sought to develop cost-effective and improved encapsulation materials to protect photovoltaic cells/modules from water and oxygen, without the cost, weight, and complexity of current solutions. This project will develop a new multifunctional, UV-curable, SOl-gel-orgaNIC (SONIC) hybrid nanocomposite encapsulation system, which will have an excellent water/oxygen barrier and provide improved antireflection, superhydrophobic, ultra-violet (UV), and atomic oxygen (AO) resistant properties. In this approach, an encapsulant will be applied by direct deposition. The encapsulating process will be automated as a continuously-operating process for both rigid and flexible photovoltaic cells/modules, reducing overall cost by 50 percent. In Phase I, experimental demonstrations proved the feasibility of the SONIC concept by reacting the sol-gel glass with a polymer hybrid matrix. In Phase II, the SONIC process will be optimized, and the formulation will be scaled up for roll-to-roll mass production

Commercial Applications and other Benefits as described by the awardee: The proposed technology should enable low-cost, easily manufactured, and mass-producible water/oxygen protective barriers for both rigid and flexible photovoltaic cells/modules. The overall cost of manufacturing photovoltaic cells/modules would be reduced by 50 percent, compared to the double-glass vacuum laminating system currently used. Potentially, this development could increase the uses of solar cells, particularly for flexible thin-film solar cells that can be adapted to non-planar surfaces.

85480S08-II

Lightweight Metal Foams with Tailorable Structure and Properties— Materials and Electrochemical Research (MER) Corporation, 7960 South Kolb Road, Tucson, AZ 85706-9237; 520-574-1980
Dr. Raouf Loutfy, Principal Investigator; mercorp@mercorp.com
Dr. Raouf Loutfy, Business Official; mercorp@mercorp.com
DOE Grant No. DE-FG02-08ER85201
Amount: $750,000

Metal foams and foam-filled structures are under consideration as light weight energy-absorbing and structural components for automotive applications (HEVs and PHEVs). This project will establish a cost-effective manufacturing process for enhancing the properties of these metal foams by increasing the uniformity and controlling the size of pores. In Phase I, two approaches, both based on using filler to provide uniform interstitial spaces for the metal, were investigated. In one approach (PCM technology) the filler was removable; in the other approach (SARB technology) the filler was composed of non-removable highly-resilient beads, which contribute to increased energy absorption. The process parameters were investigated and foam materials were produced and tested. Exceptional compressive strength, modulus, and energy absorption were obtained, and cost estimates for both processes were established. The PCM technology resulted in lighter weight foam with relatively good properties, but at potentially higher costs. The SARB process produced foams with exceptional properties at a very competitive cost but at a slightly higher weight. In Phase II, both processes will be scaled-up, and foams and structures will be fabricated for testing and validation of performance and cost.

Commercial Applications and other Benefits as described by the awardee: The new materials should provide opportunities for efficient, high yield production of lightweight energy absorbing vehicle components, which would enable weight savings, cost savings, and enhanced safety. The metal foams could be used as side members, boundaries of the floor of the passenger compartment, and in the region of the sills and pillars. Open-cell foams also could be utilized for sound insulation panels, highly efficient filters, heat exchangers, catalyst carriers, high temperature insulation, and transpiration cooled systems.

85652S08-II

Nanotechnology-Based Self-Healing Coating System to Enable Extensive Use of Magnesium Alloys in Automotives—NEI Corporation, 400 Apgar Drive, Suite E, Somerset, NJ 08873; 732-868-3141
Mr. Shekhar Bafna, Principal Investigator; sbafna@neicorporation.com
Dr. Ganesh Skandan, Business Official; gskandan@neicorporation.com
DOE Grant No. DE-FG02-08ER85204
Amount: $749,937

The use of lightweight metals such as magnesium can increase the fuel efficiency of automobiles. However, large scale use of magnesium is prevented due to its high propensity to corrode. In particular, galvanic corrosion is a severe problem when magnesium is used in the exterior sub-assemblies of automobiles. Hence, there is an unmet need for advanced protective coatings to protect magnesium from general and galvanic corrosion. Current non-chromate pretreatments and powder coats are not effective because defects form in the coating and expose the bare metal. This project will develop a self-healing waterborne pretreatment and a self-healing powder coat that will provide damage-responsive corrosion protection to magnesium. In Phase I, the pretreatment and powder coats, which contained a dispersion of corrosion inhibitor particles, were synthesized and deposited on AZ91D substrates. Accelerated corrosion and electrochemical tests demonstrated (1) the beneficial attributes of the nanoscale additive in the pretreatment, and (2) the ability of inhibitor particles in the powder coat to form a passivating film. Phase II will optimize the pretreatment and powder coat chemistries, determine the mechanism of corrosion inhibition by the particles dispersed in the coatings, and perform galvanic and general corrosion tests on magnesium test coupons in laboratory and field environments.

Commercial Applications and other Benefits as described by the awardee: The self-healing coatings should significantly increase the use of magnesium-based components in automobiles. Magnesium-based components in the chassis and powertrain could reduce the weight of a car by up to 10 %, thereby increasing its fuel efficiency. In addition, the aerospace industry uses magnesium in gear box and engine casings; corrosion protection of these components could be further enhanced by the self-healing coating system.

85248S08-II

High Temperature, High Energy Density Film Capacitors—Nanohmics, Inc., 6201 E. Oltorf Street #400, Austin, TX 78741; 512-389-9990
Dr. Keith Jamison, Principal Investigator; kjamison@nanohmics.com
Dr. Keith Jamison, Business Official; kjamison@nanohmics.com
DOE Grant No. DE-FG02-08ER85203
Amount: $749,844

Production of long life, light weight, high-volumetric-energy-density, high-voltage bus capacitors, which are stable at temperatures over 250C, would enable the electrical system of an electric vehicle to operate at a higher temperature, thereby readying these systems for next-generation SiC-based components. The key to producing these capacitors is through improvements in the capacitor dielectric. Properties such as dielectric strength, temperature stability, and dielectric constant need to be improved over tradition materials. This project will investigate the use of flexible amorphous hafnium dioxide films as a dielectric. Amorphous oxides can have a dielectric constant >25 and breakdown strength in excess of 400 V/micron, and, due to their flexibility, they can be rolled into various compact shapes. These properties make them ideal for improving the temperature stability, durability, and weight of the high voltage bus capacitors found in electric vehicles. In Phase I, amorphous HfO_2 dielectric films were deposited on glass and polyimide substrates and tested to demonstrate that HfO2 is an ideal dielectric for the fabrication of high capacitance wound capacitors.

Commercial Applications and other Benefits as described by the awardee: Development of an improved dielectric material for capacitors would allow development of a new generation of compact, high-voltage, temperature-stable capacitors that would have many applications, both in commercial and military markets. In particular, these capacitors should find use as bus capacitors in electric vehicles. Temperature tolerant capacitors also could be used in conjunction with wide bandgap materials for the next generation of high temperature electronics.

85867S08-II

Biomass Blending Densification System (BBADS)—Altex Technologies Corporation, 244 Sobrante Way, Sunnyvale, CA 94086; 408-328-8302
Dr. John T. Kelly, PhD, Principal Investigator; john@altextech.com
Dr. John T. Kelly, Business Official; john@altextech.com
DOE Grant No. DE-FG02-08ER85187
Amount: $749,855

Conventional biomass densification and energy enhancement equipment is too costly for use in upgrading feedstocks for biofuels plants. Therefore, this project will develop an innovative biomass blending and densification system (BBADS) to densify biomass and upgrade the energy value. In Phase I, the biomass densification system was designed, and the performance of the system was estimated. In Phase II, a pilot-scale densifier will be built and tested, first in the laboratory and ultimately in the field. Lastly, the technical and economic feasibility of the concept will be evaluated for biofuels production.

Commercial Applications and other Benefits as described by the awardee: The innovative BBADS could be used to densify biomass residues at widely dispersed production sites. The application of this technology could result in cost savings of over $1.3 billion/year, and also would offset fossil fuel use.

85488S08-II

Algal Biodiesel via Innovative Harvesting and Aquaculture Systems—Renewable Algal Energy, LLC, 225 Rosehaven Court, Kingsport, TN 37663-3427; 423-863-5291
Mr. Robert Clayton L., Principal Investigator; 76135.3645@compuserve.com
Dr. Steven N. Falling, Business Official; stevefalling@gmail.com
DOE Grant No. DE-FG02-08ER85224
Amount: $750,000

The United States needs to reduce its dependence on foreign oil by developing a renewable source of biodiesel fuel that is competitive with petroleum diesel but does not compete for scarce resources such as fresh water, arable land, and existing food crops. Algae are uniquely qualified for this challenge because of their high productivity of oil and biomass. Furthermore, algal biodiesel can be produced from aquaculture systems which absorb carbon dioxide from the air or from industrial flue gases, resulting in a net zero carbon cycle. This project will demonstrate the scale-up of improved, low-cost methods for growing and harvesting algae for biofuel production. In Phase I, a modestly-sized algal aquaculture was used to demonstrate that the harvesting methods were both economical and scaleable. Phase II will demonstrate continuous, year-round, operation of an open pond algal aquaculture system, integrated with semi-continuous harvesting, for the production of an algal concentrate suitable for lipid extraction and biodiesel production.

Commercial Applications and other Benefits as described by the awardee: A competitive, large scale process for algae biodiesel fuel could replace that portion of the nation's fuel supply which comes from foreign oil sources. The proprietary processes and designs resulting from this project could be licensed to a number of companies that would use it for the worldwide production of biodiesel fuel. The technology also could be used for the capture of carbon dioxide.

86394S08-II

A Novel Low Cost, High Efficiency, Algal Biomass Harvest and Dewatering Technology for Biodiesel Production—ACENT Laboratories LLC, 3 Scott Lane, Manorville, NY 11949;
757-218-5561
Dr. Randall Voland, Principal Investigator; randy.voland@acentlabs.com
Dr. Randall Voland, Business Official; randy.voland@acentlabs.com
DOE Grant No. DE-FG02-08ER85185
Amount: $745,126

Governments and industry have recently placed significant emphasis on finding affordable renewable fuels to supplement and/or replace fossil fuel use. Biodiesel produced from microalgae has been identified as a highly attractive option for affordable renewable fuel. This project will develop a low cost, high-efficiency algal biomass harvest and dewatering process. In Phase I, a small scale system was built and tested in partnership with the Virginia Coastal Energy Research Consortium. Experimental observations led to design improvements and a system demonstration of the derived algae concentration and dewatering system (ACDS). Results were highly favorable, with economic projections suggesting a fourfold reduction in cost compared to current technology. Further optimization of the ACDS will take place in Phase II, in which a larger-scale system will be built and tested based on the lessons-learned in Phase I. Refinement of the key performance parameters will be carried out, and the integration of the ACDS into algal biodiesel production will be investigated.

Commercial Applications and other Benefits as described by the awardee: Large-scale biodiesel fuel production from algae should reduce the economic uncertainty tied to energy costs, increase national security due to less dependence on imported oil, and reduce environmental threats from global warming.

85011T08-II

Small Business
Arkansas Power Electronics International, Inc.
535 W. Research Blvd. Suite 209
Fayetteville, AR 72701
Dr. Roberto Marcelo Schupbach, Principal Investigator
mschupb@apei.net
Mrs. Sharmila D. Mounce, Business Official
smounce@apei.net
479-443-5759

Research Institution
U of AK

DOE Grant No. DE-FG02-08ER86340
Amount: $749,998

SiC-Based Solid-State Fault Current Control System for Vulnerability Reduction of Power Distribution Networks

Presently, power interruption and quality issues cause economic losses to the nation that are conservatively estimated to be over $100 billion/year. Therefore, this project will develop high-voltage, high-performance Solid-State Fault Current Controller (SSFCC) technology utilizing silicon carbide (SiC) super gate turn-off thyristors (SGTOs). Due to improved technical advantages, the proposed SSFCC technology will minimize fault-related power quality issues (i.e., voltage sags, oscillations, harmonics, etc.), improve network reliability (i.e., minimization of affected area), and allow for power re-routing in the event of a long-term or permanent fault. In Phase I, a low-power, low voltage SiC-based SSFCC prototype was developed. Phase II will demonstrate the benefits of using the SiC-based SSFCC device technology by (1) extensively testing a single-phase 4160V-class SiC-based SSFCC hardware prototype available to this program, and (2) determining cost benefits associated with the unprecedented level of protection that this new SSFCC technology provides.

Commercial Applications and other Benefits as described by the awardee: As electric loads become more sophisticated and less resistant to disturbances, future distribution systems will have greater requirements for increased reliability and reduced risk vulnerability. As such, SSFCCs should become an integral part of the so-called smart grid. Additional benefits include minimization of affected areas, improved service quality, longer time between scheduled maintenance, and longer service life of distribution components (such as transformers, cables, etc.).

85576S08-II

Simulating the Smart Electric Power Grid of the 21st Century—Electrocon International Inc., 405 Little Lake Drive, Suite C, Ann Arbor, MI 48103; 734-761-8612
Dr. Ashok Gopalakrishnan, Principal Investigator; ashok@electrocon.com
Dr. Ashok Gopalakrishnan, Business Official; ashok@electrocon.com
DOE Grant No. DE-FG02-08ER85193
Amount: $729,901

To ensure the reliable operation of the electric grid when subject to disturbances, tools are needed for the design and analysis of wide-area control and protection algorithms. This project will develop a new platform that that will enable power system engineers to study the impact of protective relay switching on the overall dynamic behavior of the system. This new tool combines the much-used electromechanical transient stability function with a detailed protection system simulation. It will enable the study of different contingencies and scenarios, some of which may lead to cascading outages. For those that do, the engineers will be able to tune the relay settings to confine their effect to a small area. Phase I established a link between a commercial protective relay simulation program and a transient stability analysis program. Via this link, the effect of protective relay operation on the dynamic behavior of the electric grid was simulated. It was shown that, by modifying relay settings or introducing additional protection components, system behavior could be altered. Phase II will consolidate this link and integrate the two simulation programs to operate fast and efficiently as one simulation tool. A user interface for this new simulation will be developed to enable engineers to design and analyze smart grid applications.

Commercial Applications and other Benefits as described by the awardee: The analysis and simulation capability should be of great value to the industry in evaluating and improving the reliability of the electric grid.

86312S08-II

Flexible Cryostat for Superconductors—Technology Applications, Incorporated, 5700 Flatiron Parkway, Suite #5701A, Boulder, CO 80301-5718; 303 443-2262
Mr. Rolf Gerald Baumgartner, Principal Investigator; rbaumga@techapps.com
Mr. Gregory Paul Fickbohm, Business Official; gfickbohm@techapps.com
DOE Grant No. DE-FG02-08ER85212
Amount: $749,995

Existing cryostats for high temperature superconducting (HTS) electrical cable, which use stainless steel corrugated cylinders, have a number of reliability issues: (1) loss of vacuum integrity during or just after manufacture (micro-cracks develop in the corrugated metallic tubes due to hydrogen embrittlement), (2) damage to the cryostat during installation, and (3) degradation in service (due to voltage gradients between inner and outer tubes from lightning strikes). This project will demonstrate the use of a new flexible plastic material for the outer cable cylinder, instead of corrugated stainless steel. Phase I investigated and tested candidate plastic materials to determine mechanical properties, effective bonding methods, and manufacturing processes for cryostat assembly. Vacuum system performance testing was performed to establish design requirements for vacuum-jacketed pipe fabricated with plastic materials. In year 1 of Phase II, additional material and component-level testing will be performed, and a subscale prototype cryostat will be fabricated and evaluated. The second year will involve the fabrication and delivery of a full-scale prototype cryostat for performance testing.

Commercial Applications and other Benefits as described by the awardee: Reliability issues associated with existing cryostats drive excessive life-cycle costs that must be reduced to realize the potential economic benefits of adopting superconducting power cables. The technology developed in this project has the potential to improve cryostat reliability and reduce life-cycle costs.

85318S08-II

Innovative Surfaces for Controlled Flow of Molten Lithium—Ultramet, 12173 Montague Street, Pacoima, CA 91331; 818-899-0236
Dr. Arthur J. Fortini, Principal Investigator; art.fortinit@ultramet.com
Mr. Craig N. Ward, Business Official; craig.ward@ultramet.com
DOE Grant No. DE-FG02-08ER85217
Amount: $750,000

The economic, environmental, and strategic benefits associated with the development of fusion energy are numerous, but they cannot be realized until new technology is developed to allow operation under high heat flux conditions. Bathing the wall of a fusion reactor plasma-facing component in a liquid metal is a viable approach for accommodating high heat fluxes and for removing hydrogen isotopes. This project will develop an enabling technology for the controlled flow of molten lithium. In this approach, microtextured tungsten and rhenium coatings, consisting of hundreds of thousands of dendrites per square millimeter, will act as a high-efficiency wick to stabilize liquid metal flow, despite the existence of strong magnetohydrodynamic forces. Phase I demonstrated the ability of the textured tungsten and rhenium coatings to wick molten lithium. The wetted coatings retained the molten metal in the face of strong jxB forces. In Phase II, additional wetting experiments, using a variety of techniques, will be conducted. Specimens will be characterized, fabricated, and ultimately tested in the Lithium Tokamak eXperiment (LTX) reactor at the Princeton Plasma Physics Laboratory (PPPL).

Commercial Applications and other Benefits as described by the awardee: The new coatings can be applied to smooth surfaces and to the interior of porous bodies, such as refractory metal foams, for improved retention of the molten metal. Once demonstrated in the LTX reactor, the proposed technology should be applied in the near term to larger fusion reactors such as NSTX and ITER. As additional fusion reactors are brought on line, the textured coating technology will be incorporated into them as well.

86366S08-II

Electrochemical Microalloying of Tungsten for Plasma Facing Component Applications—
Plasma Processes, Inc., 4914 Moores Mill Road, Huntsville, AL 35811; 256-851-7653
Mr. John Scott O'Dell, Principal Investigator; scottodell@plasmapros.com
Ms. Angela Dawn Hattaway, Business Official; ahattaway@plasmapros.com
DOE Grant No. DE-FG02-08ER85209
Amount: $750,000

Tungsten's inherent chemical inertness and high melting temperature make it an ideal heat sink and armor material for fusion applications. However, tungsten's intrinsic low temperature brittleness makes it difficult to fabricate using conventional processing techniques. Recently, advanced electrochemical forming techniques based on microalloying and grain refinement have been developed that enable the near-net-shape fabrication of tungsten components. Based on these results, this project will develop near-net-shape, electrochemical processing techniques for the fabrication of fine-grain tungsten alloys for use in fusion devices. By proper selection of the alloying elements and processing parameters, it may be possible to tailor a tungsten alloy that resists grain growth, has improved strength and ductility, possesses good thermal conductivity, and is resistant to transmutation. During Phase I, the ability of electrochemical processing parameters to control the microstructure of deposits was evaluated, along with the ability to produce tungsten alloys. Preliminary microstructural analysis and testing verified that structural and properties improvements are possible using these techniques. During Phase II, the process will be optimized with respect to the electrochemical processing parameters and the amount of alloying additions. The optimized process will then be used to produce an advanced tungsten alloy heat sink, which will be high-heat-flux tested and compared to pure tungsten heat sinks.

Commercial Applications and other Benefits as described by the awardee: The near-net-shape forming of tungsten alloys with improved ductility and mechanical properties has tremendous commercial potential. Aside from nuclear fusion applications, electrochemical microalloyed tungsten should be applicable to non-eroding nozzles in rocket engines, crucibles for crystal growth, heat pipes, welding electrodes, x-ray targets, warhead penetrators, radiation/temperature shielding applications, and other high temperature furnace components.

85678S08-II

An In-Situ Calibration System for the MSW Diagnostic on ITER—Nova Photonics, Inc.,
One Oak Place, Princeton, NJ 08540; 609-258-5631
Dr. Fred M. Levinton, Principal Investigator; flevinton@novaphotonics.com
Dr. Fred M. Levinton, Business Official; flevinton@novaphotonics.com
DOE Grant No. DE-FG02-08ER85205
Amount: $749,993

The standard technique for measuring internal magnetic fields in fusion plasma experiments, the motional Stark effect diagnostic, relies on the analysis of visible light emitted from hydrogen beams in the plasma. However, in a fusion-relevant device with a large neutron flux, a labyrinth of mirrors is required to transmit the light through an effective radiation shield. Any plasma-facing mirror would suffer erosion and deposition from plasma exposure, with adverse effects on the transmitted light. These effects not only could be significant but also could vary during the experiment, destroying the ability of the diagnostic to determine the magnetic field. This project will develop a comprehensive *in situ* calibration system for the motional Stark effect diagnostic in a burning plasma. In Phase I, calculations were performed, proof-of-principle laboratory tests were conducted, and innovative designs were developed for the necessary hardware. In Phase II, the hardware will be built and qualified in a plasma environment, and the calibration technique will be performed during plasma exposure of a mirror.

Commercial Applications and other Benefits as described by the awardee: This technology would provide substantial benefits to future magnetic fusion plasma experiments, including ITER, which will require accurate diagnostics of the internal magnetic field.

86493S08-II

Frequency Doubler for CO2 Laser ITER Diagnostics—Physical Sciences Inc., 20 New England Business Center, Andover, MA 01810; 978-689-0003
Dr. David B. Fenner, Principal Investigator; fenner@psicorp.com
Dr. B. David Green, Business Official; green@psicorp.com
DOE Grant No. DE-FG02-08ER85208
Amount: $749,935

In order to meet the objectives of the U.S. contribution toward diagnostics on the ITER fusion reactor, which is being built by an international team, the CO_2 laser frequency doubler must achieve a significantly higher conversion efficiency, in order to enable very low noise operation of the sensing interferometer. This project will develop nonlinear optical (NLO) orientation-patterned gallium arsenide (OP-GaAs) crystals for high-efficiency doubling of CO_2 lasers. Phase I successfully fabricated OP-GaAs crystals of very high transparency in the long-wave IR and demonstrated the potential for scale-up to larger sizes with higher efficiencies for CO_2 laser second harmonic generation (SHG). The concept was demonstrated by converting a 1 W CO_2 laser beam from $\lambda \sim 10.6$ μm to the second harmonic at $\lambda \sim 5.3$ μm. Phase II will scale-up NLO OP-GaAs crystals and demonstrate SHG conversion efficiency (η) for a 50 W laser. The objective is to attain $\eta > 2\%$, which would be a one-hundred-fold improvement over existing frequency doublers. Then, an optical interferometer instrument system will be designed and constructed, including the OP-GaAs, and the instrument will be tested in a DIII-D fusion reactor.

Commercial Applications and other Benefits as described by the awardee: NLO OP-GaAs components should find use in markets for frequency-converter optical devices, including those with second harmonic generation, optical parametric generation, and similar functionality. NLO OP-GaAs for laser conversion also should see market demand within optical systems for DOD applications and for DOE applications such as diagnostic tools for plasma fusion reactors.

85072S08-II

Power Supply for Ion Cyclotron Resonance Heating—Diversified Technologies, Inc., 35 Wiggins Avenue, Bedford, MA 01730; 781-275-9444
Mr. John Kinross-Wright, Principal Investigator; kinross@divtecs.com
Mr. Michael Kempkes, Business Official; kempkes@divtecs.com
DOE Grant No. DE-FG02-08ER85190
Amount: $749,311

The latest generation of fusion experiments has stretched Ion Cyclotron Resonance Heating (ICRH) transmitters to their limits, in terms of reliably delivering multi-megawatts of RF power, because the transmitter design is based on 1970s vintage technology. An opportunity exists for advancing this transmitter technology by using an integrated solid-state opening switch. This project will design the complete ICRF transmitter and will work with researchers from Alcator-C Mod to identify, build, and install subsystem upgrades into the existing FMIT RF transmitter. The key upgrade is a pair of high voltage, solid-state opening switches to replace the outmoded ignitron crowbar technology. Phase I demonstrated that the installation of high voltage opening switches can significantly improve transmitter performance and reliability, and completed a preliminary electrical and mechanical design. In Phase II, a high voltage opening switch package for one transmitter will be built and installed. This effort includes integrating the control circuitry for the switches into the existing transmitter controls.

Commercial Applications and other Benefits as described by the awardee: In addition to the cost and performance benefits for future ICRH systems such as ITER, the controls and subsystems also should improve the reliability, efficiency, and performance of existing long pulse and CW transmitters. Applications include commercial broadcast transmitters, high energy accelerators, high power radar transmitters, and industrial RF applications in drying, curing, and related processes.

85990S08-II

A Toolset for Kalman Filter Resistive-Wall-Mode Feedback Modeling Including Plasma Rotation—FAR-TECH, Inc., 3550 General Atomics Court, Building 15, Suite 155, San Diego, CA 92121; 858-455-6655
Dr. Jin-Soo Kim, Principal Investigator; kim@far-tech.com
Dr. Jin-Soo Kim, Business Official; kim@far-tech.com
DOE Grant No. DE-FG02-08ER85195
Amount: $750,000

The Resistive Wall Mode (RWM) is a major instability that limits performance in current and projected future advanced tokamaks. Although the RWM is an instability that is directly related to plasma rotation, all feedback controls to date have been developed assuming no plasma rotation. Thus, more accurate RWM feedback modeling that includes plasma rotation would lead to an enhanced capability for active feedback control. This project will develop and validate an easy-to-use Kalman filter RWM feedback control model that includes plasma rotation. A rotation-compatible model-based RWM feedback controller not only would provide accurate RWM mode identification in a noisy situation but also would incorporate torque-based rotation control for RWM feedback. In Phase I, the rotation-compatible RWM model was completed. Model predictions were in good agreement with experimental data. In Phase II, the rotation-compatible model will be enhanced to include non-axisymmetric field effects, as well as an externally driven torque source or sink.

Commercial Applications and other Benefits as described by the awardee: The rotation--compatible RWM model should lead to the development model-based controllers that are essential for the success of advanced tokamak operation. The flexible and desktop nature of the modeling tool should facilitate the quick modeling of many different geometries and feedback methods. Its enhanced productivity would make the tool attractive to scientists interested in studying RWM active control on any toroidal devices.

85993S08-II

Hyper-Velocity High-Density C60-Fullerene Plasma Jet for Disruption Mitigation—

FAR-TECH, Inc., 3550 General Atomics Court, Building 15, Suite 155, San Diego, CA 92121; 858-455-6655
Dr. Ioan N. Bogatu, Principal Investigator; nbogatu@far-tech.com
Dr. Jin-Soo Kim, Business Official; kim@far-tech.com
DOE Grant No. DE-FG02-08ER85196
Amount: $750,000

Hypervelocity and high density plasma jets have important applications in magnetic fusion research, with applications in disruption mitigation, fueling, and driving plasma rotation. In particular, a reliable disruption-mitigation technique with real-time capability is a critical need for future fusion reactors such as the International Thermal Nuclear Experimental Reactor (ITER). This project will develop a tool for the investigation, design, and optimization of high-velocity high-density plasma jets that are accelerated in a plasma gun for plasma disruption mitigation. Phase I analyzed numerous aspects of the physics problems associated with C60-fullerene plasma jet mass production in a pulsed composite source. These aspects included acceleration in a plasma gun, transport, and penetration in magnetized plasmas. A firm basis for a practical tool for disruption mitigation on tokamak plasmas, including ITER, was thus established. Phase II will involve the design, fabrication, and testing of a prototype pulsed power injector and plasma accelerator for disruption mitigation. The plasma jet will be characterized by testbed measurements and the device will be prepared for a future proof-of-principle experiment on DIIID.

Commercial Applications and other Benefits as described by the awardee: Plasma jets have many applications with respect to fusion plasmas: mitigation of plasma disruptions, core fueling for burning plasma, liner-compressed magnetized target fusion, and driving plasma rotation for improved stability. The tool developed for disruption mitigation also should find application in space science and technology, in defense, and in commercial sectors where application of plasma jets is pursued.

86255S08-II

MiniRailguns for Fusion and HEDP—HyperV Technologies Corporation, 13935 Willard Road, Chantilly, VA 20151; 703-378-4882
Dr. Franklin Douglas Witherspoon, Principal Investigator; witherspoon@hyperv.com
Dr. Franklin Douglas Witherspoon, Business Official; witherspoon@hyperv.com
DOE Grant No. DE-FG02-08ER85114
Amount: $750,000

Magneto-inertial fusion and high-energy-density plasmas represent a promising approach to the generation of fusion energy. In this area of fusion research, the ability to compress a magnetized target plasma, without the need to replace a solid driver, is crucial to further development. Mini-railgun plasma accelerators with low operating costs and high repetition rates are a possible approach to meeting this requirement. Therefore, this project will develop mini-railgun plasma accelerators that can produce high density plasma jets at high velocity. In Phase I, a series of prototype accelerators were designed, fabricated, and tested. When four mini-railguns were used in a symmetric plane geometry, the resulting convergence density was a factor of 20 larger than the density of a single jet. Small railguns (1 cm bore) achieved nearly 200 micrograms of plasma at 80 km/s with high energy density. In Phase II, the mini-railgun accelerators will be further developed, pushing their performance to above 1000 micrograms of plasma at greater than 50 km/s, while maintaining the high density. A fully three-dimensional jet merging and implosion test will be performed at modest energy using 20-26 mini-railguns. These tests will be used to validate hardware and techniques for a much larger planned experiment.

Commercial Applications and other Benefits as described by the awardee: Mini-railgun plasma accelerators will be useful for commercial fusion power, refueling magnetically confined plasmas, high specific impulse thrusters for space propulsion, laboratory simulation of astrophysical jets, fast pulsed power switching, materials processing, and high-energy-density plasma research.

85390S08-II

High-Speed, Multi-Channel Detector Readout Electronics for Fast Radiation Detectors—
XIA, LLC, 31057 Genstar Road, Hayward, CA 94544; 510-401-5760
Dr. Wolfgang Hennig, Principal Investigator; whennig@xia.com
Dr. William Warburton, Business Official; bill@xia.com
DOE Grant No. DE-FG02-08ER84981
Amount: $690,672

Studies of exotic nuclei, performed at DOE accelerator facilities, use a variety of radiation detectors to measure the properties of these nuclei. Some of these accelerators are being upgraded to reach higher energies and generate better yields of highly unstable nuclei with shorter lifetimes. At the same time, detectors are being improved to generate faster signals that can provide higher count rates and better position, time, and/or energy resolution. To match these improvements, high-speed digital detector readout electronics will be needed. This project will involve the redesign of digital readout electronics, developed previously for radiation detectors, to achieve digitization of a detector signal up to 500 MHz and 12 bit precision, while still providing full spectrometer functions. In Phase I, field programmable gate arrays were evaluated for the feasibility of fast data capture; an existing electronics module was updated with a 500MHz, 12 bit analog-to-digital converter; and firmware for fast waveform capture was developed. The preliminary evaluation demonstrated that capture and on-board processing of fast waveforms at 500 MHz is feasible. In Phase II, the test hardware will be upgraded to a commercial prototype, a faster readout will be added, and throughput will be increased with a fast-floating-point digital signal processor.

Commercial Applications and other Benefits as described by the awardee: When applied to the studies of exotic nuclei, the proposed instrument will help in the attempt to answer important questions related to the fundamental physics beyond the Standard Model of Weak Interactions. In other scientific applications, the instrument could improve the quality and amount of data obtained from fast detectors. Practical applications include gamma/neutron pulse-shape discrimination in the signals of fast liquid scintillators, which is increasingly used in cargo imaging applications for homeland security.

86098S08-II

Optical Detector with Integrated ADC for Digital Readout—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Dr. James Christian, Principal Investigator; JChristian@RMDInc.com
Dr. Gerald Entine, Business Official; nmarshall@rmdinc.com
DOE Grant No. DE-FG02-08ER84977
Amount: $749,999

Many nuclear physics experiments use photomultiplier tubes (PMTs) coupled to scintillators, which require a readout using BNC cables, HV cables, HV suppliers, analog-to-digital converters (ADCs), and possibly additional modular electronics and mainframes for signal processing. These items tend to account for a significant amount of the cost per detector channel, which limits the size of the experiment and the number of detector channels. A novel method for signal digitization is required to reduce these costs. This project will investigate the use of a CMOS solid-state photomultiplier (SSPM), integrated with an on-chip ADC, as a cost effective method for digitizing the photodetector signal. Phase I showed that a detector designed with large-area solid-state photomultiplier can provide energy resolution equivalent to that of a traditional photomultiplier tube, but at a fraction of the cost. Phase II will develop a large area (~1 cm x 1 cm) device with on-chip signal processing and integrated digitization. The work will provide the required schematics, processes, and mask sets for full production of these devices, so that they can be implemented for nuclear physics experiments.

Commercial Applications and other Benefits as described by the awardee: These devices should find use in a variety of experiments as a viable alternative to the traditional method for scintillator readout. Furthermore, a standardized design for an SSPM with integrated ADC would provide a functional platform for a myriad of low-cost, compact products for gamma-ray spectroscopy, flow cytometry, neutron detection, dosimetry, and even nuclear imaging applications, such as PET and SPECT.

85875S08-II

Low Temperature Deposition and RF Analysis of Nb3Sn, an A-15 Superconductor for SRF—Alameda Applied Sciences Corporation, 626 Whitney Street, San Leandro, CA 94577-1116; 510-483-4156
Dr. Mahadevan Krishnan, Principal Investigator; krishnan@aasc.net
Dr. Mahadevan Krishnan, Business Official; krishnan@aasc.net
DOE Grant No. DE-FG02-08ER85162
Amount: $750,000

The proposed Ph-II research project will be led by Alameda Applied Sciences Corporation, in collaboration with Jefferson National Accelerator Facility (JLab) and Norfolk State University (NSU) via subcontracts. This team covers the gamut of fundamental research into new Superconducting Radio Frequency (SRF) materials: (i) to first characterize the materials properties such as morphology, grain size, crystalline structure, defects, and impurities; (ii) to then measure electrical properties such as T_c and RRR; (iii) to follow this with 'in-cavity' measurements of the Surface Impedance of the films at cryogenic temperatures. These three progressive steps are essential preludes to design of actual SRF cavities for eventual testing at high fields in accelerator structures, to measure Q-slope and other performance parameters. In Ph-I, AASC took the first steps towards development of Nb_3Sn as a new type of SRF thin-film, to complement our earlier successful results with pure Nb films. One breakthrough of this Ph-I project is that we have produced Nb_3Sn films in a single step in vacuum, by judicious choice of source composition for a given substrate temperature. In parallel with the Nb_3Sn coating development, we continued to deposit pure Nb films using our CED™ process and these films were analyzed by our partners JLab and NSU. This collaboration has had a paper accepted for publication in JVS, which describes large (~50μm) crystal grain sizes (unprecedented) in thin-film Nb deposited using our proprietary CED™ cathodic arc technique.

86014S08-II

Integrated Multiple Effects Software for Nuclear Physics Applications—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. David N. Smithe, Principal Investigator; smithe@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85184
Amount: $749,314

The design, analysis, and computer modeling of hardware for nuclear physics accelerators is a complex process, usually involving different software for different physical aspects of the same hardware. For example, electromagnetic modeling of RF sources, waveguides, couplers, and cavities is handled by one piece of software, while heat load analysis of the same components is handled by completely different software. The use of separate software tools for modeling the same hardware has a number of disadvantages: (1) duplicative efforts in terms of specifying the same hardware in different software packages, (2) difficulties in moving data from one package to another, and (3) reduced overall speed of the design cycle. This project will extend a leading electromagnetic particle simulation code, VORPAL, by adding a thermal and temperature analysis capability. In Phase I, a prototype thermal analysis capability was demonstrated and benchmarked in one and two dimensions, a new capability to treat non-linear material properties was added, and various boundary treatments were demonstrated. In Phase II, the thermal analysis capability will be realized for arbitrarily complicated geometries, the user interface will be refined to improve usability, and the computational algorithms will be optimized to assure fast and effective operation of the software.

Commercial Applications and other Benefits as described by the awardee: The new thermal capability in the VORPAL software should have an immediate commercial market in the RF, accelerator, and microwave industries. Virtually any high-power RF application has thermal design constraints which will be addressable with this new technology.

85670S08-II

Development of SRF Multi-Spoke Cavities for Electron Linacs—Niowave, Inc., 1012 N. Walnut Street, Lansing, MI 48906; 517-230-7417
Dr. Terry Grimm, Principal Investigator; grimm@niowaveinc.com
Dr. Jerry Hollister, Business Official; hollister@niowaveinc.com
DOE Grant No. DE-FG02-08ER85172
Amount: $750,000.

Superconducting radio frequency (SRF) accelerating cavities are being successfully used for acceleration of electron beams worldwide. If today's multispoke accelerating structures could be applied to future SRF electron linacs, a further reduction in the accelerator's overall size could be achieved without compromising its performance. This project will develop a 500 MHz superconducting multispoke cavity capable of accelerating electrons to an energy of more then 7.5 MeV in a single unit. Phase I demonstrated technical feasibility by completing the preliminary cavity and cryomodule designs. An alternative design, which emphasized the electromagnetic properties of the accelerating structure instead of the simplification of fabrication, also was considered. Phase II will finalize the design, then fabricate and test the SRF multispoke cavity. Cryogenic tests will be carried out at Thomas Jefferson National Laboratory (JLAB) to make use of their test facilities and cryogenics systems.

Commercial Applications and other Benefits as described by the awardee: This new type of SRF multispoke cavity should create many new possibilities for scientific and industrial applications. In addition, compact accelerators utilizing SRF cavities should find use in a broad range of commercial applications, from x-ray machines for cancer therapy and sterilization to tunable x-ray and gamma sources, to high energy electron accelerators.

86004S08-II

Designing a Coherent Electron Cooling System for High-Energy Hadron Colliders—
Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. David L. Bruhwiler, Principal Investigator; bruhwile@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85182
Amount: $749,546

The future electron-ion collider will have an ion luminosity that is orders-of-magnitude higher than current systems. This high luminosity will require cooling of the ion beam. An exciting concept known as "coherent" electron cooling (CEC) combines the best features of electron cooling and stochastic cooling, to enable the cooling of >250 GeV proton bunches and other high-energy hadron beams with order-of-magnitude shorter cooling times. However, the CEC concept is unproven and requires detailed simulation of its key components. This project will develop a code suite for the design of future CEC systems. The challenge is to accurately characterize the effective velocity drag on an ion, as a function of its initial velocity. Phase I demonstrated the correct simulation of a single ion in the "modulator" of a CEC section, in which ions imprint a signature (i.e., wake) on the electron density and velocities. Phase II will involve characterizing the effective velocity drag on an ion. Possible mechanisms for reducing the velocity drag – including shot noise, overlapping wakes due to the presence of many ions, boundary effects in a finite-sized electron beam, and transverse ion dynamics between the modulator and the kicker – will be explored.

Commercial Applications and other Benefits as described by the awardee: The new capability should directly benefit DOE funded scientists working to design electron cooling systems for future electron-ion collider concepts. In addition, the proposed work would further enhance the parallel VORPAL framework, which is already a successful commercial product.

85298B08-II

Magnetometer for the Neutron Electric Dipole Moment Experiment—Southwest Sciences, Inc., 1570 Pacheco Street, Suite E-11, Santa Fe, NM 87505-3993; 505-984-1322
Dr. David Christian Hovde, Principal Investigator; dchovde@swsciences.com
Alan C. Stanton, Business Official; astanton@swsciences.com
DOE Grant No. DE-FG02-08ER84989
Amount: $750,000

The neutron electric dipole moment experiment is a Department of Energy project that seeks to test the standard model of the electroweak and strong interactions within a nucleon by measuring the precession of neutrons in superimposed magnetic and electric fields. To achieve the desired sensitivity to a dipole moment, the magnetic field must be homogeneous to 1 part in one million. However, existing instruments lack the sensitivity needed for verifying the field's homogeneity and stability, and they are too bulky to fit in the shielded measurement region. This project will develop advanced instrumentation for precision magnetometry, based on novel atomic spectroscopy techniques. Phase I showed that an all-optical magnetometer head, measuring just a few centimeters in size, coupled to electronic controllers and read-out electronics by optical fibers, can achieve the precision, accuracy, and compactness required for the neutron electric dipole moment experiment. In Phase II, a complete system will be built, and its performance will be demonstrated in laboratory experiments. Finally, the system will be used to verify the performance of the magnetic field developed for the neutron electric dipole moment experiment.

Commercial Applications and other Benefits as described by the awardee: In addition to the application to nuclear physics, commercial applications of magnetometers include instrumentation for geophysics and mineral exploration, buried object detection, and defense applications such as detection of improvised explosive devices and submarines. Emerging applications include low-field magnetic resonance imaging and medical diagnostics.

85680T08-II

Small Business
NOVA Scientific, Inc.
10 Picker Road
Sturbridge, MA 01566-1251
Mr. W. Bruce Feller, Principal Investigator
bfeller@novascientific.com
Dr. Paul L. White, Business Official
pwhite@novascientific.com
508-347-7679

DOE Grant No. DE-FG02-08ER86353
Amount: $507,928

Research Institution
University of California

New neutron radiographic imaging facilities at the Spallation Neutron Source (SNS) will require detectors with better position resolution and rate capability. This project will develop a novel type of compact thermal neutron collimator for these detectors. These compact collimators will be able to (1) collimate more divergent neutron beams, which will permit high resolution imaging, and (2) reduce post-scattered neutrons arriving at the detector, providing improved contrast and higher spatial resolution. In Phase I, the cold and thermal neutron performance of selected collimators was assessed; the performance closely followed the theoretical computer modeling. Using a high resolution neutron-sensitive detector, the collimators exhibited significant improvements in beam quality and scatter rejection for both cold and thermal neutrons. Phase II will further optimize the collimators and the alignment, permitting improved beam characteristics for high resolution radiography and improved contrast through reduction in neutron scattering.

Commercial Applications and other Benefits as described by the awardee: The development of improved and compact neutron collimator hardware should provide neutron radiographic imaging systems with significantly higher spatial resolution for neutron studies of biological and material science specimens. The improvement in detection sensitivity expected from these new thermal neutron components already has generated interest within the larger scientific community, supporting such diverse areas as biological imaging, inspection of nuclear fuel, explosives detection, and analysis of museum objects.

85750S08-II

Next-Generation Readout Electronics and Sensor Subsystem for nEDM—STAR
Cryoelectronics, LLC, 25-A Bisbee Court, Santa Fe, NM 87508; 505-424-6454
Dr. Robin Harold Cantor, Principal Investigator; rcantor@starcryo.com
Dr. Robin Harold Cantor, Business Official; rcantor@starcryo.com
DOE Grant No. DE-FG02-08ER84990
Amount: $647,001

Ultra-sensitive Superconducting Quantum Interference Device (SQUID) sensors, which are critical components of key experiments in nuclear physics, are the most sensitive detectors of magnetic flux available. However, currently available SQUID readout electronics are extremely dated in terms of component availability, ultimate performance, and data acquisition and computer interface options. This project will develop next-generation flux modulation-based SQUID readout electronics. A novel, modular design will provide excellent flexibility for a wide variety of multi-channel applications to ensure the highest possible noise immunity for critical low-noise measurement applications. In Phase I, prototype SQUID electronics with a USB 2.0 computer interface was designed, built, and tested. The system bandwidth was much higher than any known modulation-based electronics that is currently available. Phase II will complete the development of a multi-channel SQUID readout electronics based on the Phase I designs, along with new, high-performance SQUID sensors, a precision optically-isolated data acquisition unit, and control software.

Commercial Applications and other Benefits as described by the awardee: Beyond the application to nuclear physics, a complete SQUID-based readout electronics system should find use in a broad range of commercial applications including biomedical imaging (e.g., magnetoencephalography and magnetocardiography), geophysical exploration (e.g., for oil and mineral exploration, and to analyze core samples), and non-destructive testing of materials (e.g., detection of impurities and contaminants in food).

86096S08-II

Fast, Low Noise Photodetectors for Nuclear Physics—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Mr. Kanai Shah, Principal Investigator; KShah@RMDInc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER84988
Amount: $749,994

Current and next generation experiments in nuclear and particle physics require detectors with high signal-to-noise ratio, fast response, accurate energy information, and high spatial resolution. This project will investigate a promising compact detector design that can be operated with very high gain. This detector should provide high signal-to-noise ratio and excellent timing, position, and energy resolution, and should be low cost. Phase I demonstrated the feasibility of producing a solid-state, high gain photodetector, which achieved high resolution detection of scintillation light. In Phase II, the new photodectors will be optimized and scaled-up, their basic properties will be extensively characterized, and they will be evaluated for nuclear physics experiments.

Commercial Applications and other Benefits as described by the awardee: The proposed detectors should be very useful in fundamental studies conducted for nuclear physics, high energy physics, and astronomy. In addition, these detectors would be useful in commercial applications such as medical imaging, non-destructive studies, and well-logging.

85152S08-II

Neodymium-Containing Single Crystals for Neutrinoless Double Beta Decay Detection—
Integrated Photonics, Inc., 132 Stryker Lane, Hillsborough, NJ 08844; 908-281-8000
Dr. George W. Berkstresser, Principal Investigator; gwberkstresser@integratedphotonics.com
Dr. Vincent Jerome Fratello, Business Official; vjfratello@integratedphotonics.com
DOE Grant No. DE-FG02-08ER84984
Amount: $750,000

The Neutrinoless Double Beta Decay Underground Detector for the determination of the neutrino mass has been identified by DOE as a high scientific priority. Unfortunately, the current generation of proposed experiments would require 500 kg of isotopically enriched germanium (Ge). The cost of this specialized Ge would exceed $100 million. 150Nd is an alternate parent isotope for neutrinoless double beta decay, which could substantially reduce the size and cost of cooling and detection infrastructure. However, the favorable theoretical decay rate of 150Nd can be exploited only by using a detector with high detection efficiency and excellent energy resolution. The only known approach for constructing such a detector is to construct a bolometer of a single crystal from a compound that contains a significant fraction of neodymium. Therefore, this project will develop technology for growing bulk crystals of a high-purity single-crystal neodymium-containing oxide optimized for bolometer applications. In Phase I, neodymium gallate was identified theoretically as the preferred compound for this application, and small cubes were fabricated for initial bolometer testing. In Phase II, the growth conditions identified in Phase I will be realized and scaled-up to produce high-yield optimum-size crystals, and cubes will be delivered for a prototype bolometer.

Commercial Applications and other Benefits as described by the awardee: The primary application of single crystal neodymium-containing oxides would be for cryogenic bolometers for neutrinoless double beta decay. The value of the scientific goal of determining neutrino mass is inestimable. Neodymium gallate also should find use as a substrate for high temperature superconductors.

85673S08-II

Integrated Spin System for Production of Large Quantities of Stable Isotopes—Nonlinear Ion Dynamics, LLC, 13704 Saticoy Street, Panorama City, CA 91402; 781-883-4091
Prof. Alfred Y. Wong, PhD, Principal Investigator; nidllc@aol.com
Dr. Rong Wang, Business Official; rwang@nidnano.com
DOE Grant No. DE-FG02-08ER84985
Amount: $750,000

Large quantities of separated isotopes are needed for rare particle and rare decay detection in basic nuclear physics research. The demand for these isotopes cannot be met by existing inventory or through foreign supplies. Meanwhile, existing isotope separation technologies have limitations in cost and quantity. Therefore, this project will develop a next generation isotope separation technology, the Integrated Spin System (ISS), for producing large quantities of stable isotopes efficiently and economically. In Phase I, proof-of-concept was demonstrated experimentally through the separation of different gas species and gaseous isotopes. Engineering data showed that the ISS was adept in separating metallic isotopes directly, without the use of chemicals. In Phase II, a detailed engineering prototype will be designed and constructed, and the separation of large quantities of Ge-76, Xe-136 and other isotopes will be demonstrated.

Commercial Applications and other Benefits as described by the awardee: The use of stable isotopes is strategically important to the U.S., encompassing broad areas of scientific research, medical applications, and industries. The ISS would establish the first domestic stable isotope supply center and would insulate the country from geopolitical influences on foreign supplies.

86482S08-II

High-Purity Germanium Crystals for Low Background Counting Arrays—PHDs Co., 777 Emory Valley Road, Suite B, Oak Ridge, TN 37830; 865-481-3725
Mr. Ethan Hull, Principal Investigator; ethanhull@phdsco.com
Mr. Ethan Hull, Business Official; ethanhull@phdsco.com
DOE Grant No. DE-FG02-08ER84987
Amount: $750,000

The next generation of DOE low-background user facilities will require suitable germanium crystal production capabilities. These crystal-growth techniques must accommodate the handling of highly enriched germanium in a manner consistent with low background counting. In this project, germanium crystal growth techniques will be experimentally developed specifically for the growth of crystals for low-background counting arrays. The approach will include the development of (1) inexpensive and modular crystal pullers that are suitable for installation in low-background facilities, and (2) crystal-growth techniques that minimize the contamination of highly enriched germanium. In Phase I, an inexpensive and modular prototype germanium crystal puller was developed. Using this puller, germanium crystals were successfully grown and demonstrated to have properties well suited to the fabrication of low-background germanium detectors. During the Phase II, the crystal growth techniques will be refined to grow large high-purity germanium crystals suitable for the fabrication of large low-background germanium detectors.

Commercial Applications and other Benefits as described by the awardee: The germanium crystal growth technique should greatly decrease the cost of large arrays of low background germanium detectors. These detector arrays are at the forefront of physics in the search for rare processes such as neutrinoless double-beta decay. Such detector arrays also could be used for low-level counting facilities to characterize radioactive materials.

85650S08-II

A New Class of Nanocomposite Treatment Media for Efficient Mercury Remediation—NEI Corporation, 400 Apgar Drive, Suite E, Somerset, NJ 08873; 732-868-3141
Dr. Mohit Jain, Principal Investigator; mjain@neicorporation.com
Dr. Ganesh Skandan, Business Official; gskandan@neicorporation.com
DOE Grant No. DE-FG02-08ER85144
Amount: $749,955

Historically, releases of mercury have resulted in contamination of soil, groundwater, surface water, sediments, and biota, posing difficult assessment and cleanup challenges at a number of DOE sites. Although a variety of sorbent materials for capturing mercury in contaminated water are available commercially, an opportunity exists to drastically increase the efficiency of the adsorption process, thereby lowering cost and remediation time. This project will develop a new class of nanoparticle-based sorbents wherein the reaction sites are highly accessible to mercury ions, thereby providing efficient and fast removal. In Phase I, nanoparticle-based sorbents were produced and tested for reaction kinetics and sorption capacity for mercury removal. Preliminary results showed that the sorbent performed significantly better than commercially available sorbents in terms of both reaction kinetics and loading capacity. In Phase II, the morphology of the sorbent particles will be optimized, the sorbent will be incorporated in a filter cartridge, and the sorbent will be field tested at a contaminated DOE site.

Commercial Applications and other Benefits as described by the awardee: An estimated 300,000 contaminated sites exist in United States, and the estimated cleanup cost over the next 25 years is in excess of $200 billion. Capturing mercury from contaminated soil and water is a major component of the treatment process. The new sorbent promises to be superior to currently used technologies. Additionally, the technology could be used in other water treatment processes.

85596S08-II

Codebook: Accelerating Transformations in How the World Does Science Through Collaboration, Social Networking, and Semantic Analysis to Maintain and Support Computational Software—Harmonia, Inc., 202 Kraft Drive, Suite 1000, Blacksburg, VA 24060-6747; 540 951-5900
Dr. Marc Abrams, Principal Investigator; mabrams@harmonia.com
Mr. Michael Bame, Business Official; mbame@harmonia.com
DOE Grant No. DE-FG02-08ER85142
Amount: $749,414

With the increased proliferation of software applications, there exists a need to ensure that an orderly and efficient mechanism exists to (1) shorten the time required for computational packages to transition from pre-publication algorithms to packaged products; (2) build, package, and distribute the products; and (3) ensure that users of the computational packages can easily locate and integrate packages best suited to solve a problem. This project will build an innovative solution called *CodeBook* that utilizes Web 2.0 and Web 3.0 social networking and semantic analysis concepts. In Phase I, a prototype CodeBook was developed and demonstrated to DOE employees and members of the computational community at SciDAC, NERSC, and three national laboratories. In Phase II, the prototype will be expanded into a product designed to help bring about the transformation of the way in which computational-based methods are utilized.

Commercial Applications and other Benefits as described by the awardee: The product developed under Phase II should promote collaboration among developers and users of computational packages, providing the following benefits: (1) exponential content growth rather than incremental, (2) dramatic increase in availability of numerical software libraries, (3) site maintenance independent of the availability of a single person or the willingness of a given entity to donate that person's time, and (4) improved quality of content as the result of peer reviews and contributions.

86011S08-II

Sparse Algebraic Multigrid Preconditioners for High-Order Finite Element Systems—
Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Travis Austin, Principal Investigator; austin@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85154
Amount: $749,877

Hundreds of millions of dollars have been committed toward the study of complex natural phenomena on today's massively parallel computers. Access to such computing power is enabling scientists to employ highly-accurate high-order finite element methods to solve previously intractable problems. However, these high-order finite element methods present new challenges to existing solution methods, because of fundamental differences in corresponding matrices and the need for higher memory consumption. This project will investigate the use of algebraic multi-grid preconditioners generated from sparser matrices as a cheaper alternative to the algebraic multi-grid preconditioners generated from high-order finite element matrices. Phase I compared the two algebraic multi-grid approaches: (1) the original high-order finite element matrix, and (2) a sparser matrix equivalent to using tri-linear finite elements on a mesh of equivalent order. It was demonstrated that the sparser approaches yield faster simulation times and reduced memory costs for most problems of interest. In Phase II, new capabilities will be added to two codes (HYPRE and PETSc), enabling users to construct a sparse approximation of a dense matrix generated from high-order finite element discretizations. This matrix will be used to construct cheaper algebraic multigrid-based preconditioners that still will enable fast simulations with nearly optimal convergence behavior.

Commercial Applications and other Benefits as described by the awardee: DOE projects employing high-order finite elements should gain greater efficiency in their simulations on today's supercomputers when using these preconditioners. In addition, the new computational approach should generate consulting opportunities to assist users in optimally employing these preconditioners in their code.

85821S08-II

Provenance-Enabling DOE Visualization Applications—VisTrails, Inc., 220 Chase Street, Salt Lake City, UT 84113; 801-556-1116
Dr. Steven Paul Callahan, Principal Investigator; stevec@vistrails.com
Dr. Steven Paul Callahan, Business Official; stevec@vistrails.com
DOE Grant No. DE-FG02-08ER85157
Amount: $750,000

In the collaborative computing environment, the absence of provenance information (e.g., basic information regarding who created or modified a data product and when, the process used to create the data product, whether two data products were derived from the same raw data) makes it difficult to reproduce and share results, to solve problems collaboratively, to validate results with different input data, to understand the process used to solve a particular problem, and to re-use the knowledge involved in the analysis process. This project will design and develop an add-on mechanism to provide provenance information for the top three DOE visualization applications: Para View, Visit, and Insight. In addition, a general provenance management infrastructure, which can be applied to a wide range of third-party applications, will be developed. In Phase I, functional add-on prototypes were developed for both Para View and Visit. In Phase II, production-ready add-ons will be developed for Para View, Visit, and Insight, and a Provenance Explorer software tool and soft ware development kit (SDK) will be designed and developed.

Commercial Applications and other Benefits as described by the awardee: The Provenance Explorer SDK should provide significant value in applications that make heavy use of simulations, data mining, and visualization. Such applications are widely used in oil and gas exploration, computational hedge funds, energy transportation, computer-aided design and manufacturing, and 3D modeling and animation, to name a few.

86050S08-II

Collaborative Visualization for Large-Scale Accelerator Electromagnetic Modeling—

Kitware, Inc., 28 Corporate Drive, Clifton Park, NY 12065; 518-881-4901
Dr. William J. Schroeder, Principal Investigator; will.schroeder@kitware.com
Dr. Kenneth M. Martin, Business Official; ken.martin@kitware.com

DOE Grant No. DE-FG02-08ER85143
Amount: $749,546

As the complexity and scale of numerical simulation and experimentation increases, larger teams of researchers and scientists, located at geographically different sites, are required to address the resulting technical challenges. The success of research projects typically requires that such teams, with heterogeneous skills and resources, work together to address the technical challenges. Thus, collaborative research tools are required to share, visualize, manipulate, annotate, and compute the data. Furthermore, these tools must be easily deployed and used to facilitate the collaborative experience. This project will address these requirements by extending the widely-used open-source ParaView system to support large-scale, collaborative data visualization. Phase I identified the set of features required to create an effective collaborative system and demonstrated a functional two-person collaborative visualization environment. In Phase II, the visualization environment will be expanded to enable multiple researchers to simultaneously view, manipulate, and compute large data sets located at remote sites. In addition, synchronization and annotation methods will be developed to enable researchers to explore data locally and then rejoin the collaborative experience to share a common view.

Commercial Applications and other Benefits as described by the awardee: The technology should generate sales of an expanded ParaView product, ParaView Professional, a supported and pre-packaged version of the open-source ParaView application.

86003S08-II

Analyzing and Visualizing Next Generation Climate Data—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Alex Pletzer, Principal Investigator; Pletzer@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85153
Amount: $749,927

The continuous effort to improve global warming predictions has led numerous computer climate models to abandon longitude-latitude grids in favor of assemblies of structured meshes. However, these novel "Mosaic" grids exhibit complex folding patterns, which are posing severe problems to post-processing and visualization applications. This project will develop a Mosaic Data Analysis and Visualization Extension (MoDAVE) software package that will allow post-processing applications to correctly interpret data on large Mosaic grids. In Phase I, visualizations of atmospheric data were produced on the Mosaic cubed-sphere grid, and strategies were devised to accelerate post-processing and visualization tasks, using parallel computations on multi-cores and Graphical Processing Units (GPUs). In Phase II, software will be developed that will lead to a product capable of performing interpolation, ghosting, visualization, and spatial averaging tasks on Mosaics using parallel/GPU processing.

Commercial Applications and other Benefits as described by the awardee: MoDAVE should provide parallel/accelerated Mosaic data-processing back-end support for programs of the Earth System Grid and other climate forecasting applications. In addition, MoDAVE should benefit other DOE sponsored research, including fusion, where the magnetic axis plays a similar role to the north and south poles.

85441S08-II

High Performance Networks - Compilation and Optimization of Protocol Analyzers—
Reservoir Labs, Inc., 632 Broadway, Suite 803, New York, NY 10012-2614; 212-780-0527
Dr. Jordi Ros Giralt, Principal Investigator; giralt@reservoir.com
Dr. Jordi Ros Giralt, Business Official; giralt@reservoir.com
DOE Grant No. DE-FG02-08ER85046
Amount: $749,991

In times when critical national infrastructure depends more than ever on digital networks, the prevention of cyber attacks, as opposed to reacting after security has been compromised, becomes a chief concern. Intrusion Detection and Prevention (IDP) systems serve an indispensable role in proactively preserving the integrity of computer networks under cyber attacks. However, two independent trends are driving IDP solutions to a breaking point: (1) typical pattern-matching IDP solutions deploy low-coverage signatures that can be easily bypassed by new classes of exploits; and (2) as network data rates increase, IDP boxes are overwhelmed by the quantity of computation they must perform to secure the system. This project will explore the use of a new signature generation framework that produces protocol-aware polymorphic-proof signatures with larger coverage. In addition, a novel protocol compiler perspective will be developed to enable the rapid mapping of signature and protocol specifications onto hardware. Phase I identified the core reason leading to the IDP breaking point: lack of protocol-awareness limits the coverage of signatures and makes polymorphic attacks a powerful weapon for bypassing existing security measures. Phase II will use a theoretical and practical framework to implement a commercial-ready high-performance IDP solution based on our compiler approach.

Commercial Applications and other Benefits as described by the awardee: High-speed, protocol-aware intrusion detection systems should be useful to organizations (companies, governments, utilities, armed forces, and even individuals) whose valuable assets make them targets of sophisticated cyber attackers. Security and cost savings benefits would accrue when assets are better and more efficiently protected, and commercial enterprises can secure their business operations more effectively and cheaply.

85514S08-II

Control and Data Plane Security of High Performance Networks—ANGEL Secure Networks, Inc., 20 Godfrey Drive, Orono, ME 04473-3610; 207-866-6537
Mr. Fred Hewitt Smith, Principal Investigator; fredsmith@angelsecurenetworks.com
Ms. Cynthia Smith, Business Official; cynthiasmith@angelsecurenetworkds.com
DOE Grant No. DE-FG02-08ER85047
Amount: $749,81

High performance dynamic networks, which support scientific experiments with high bandwidth requirements, consist of a control plane and a data plane, neither of which, at present, is secure against cyber attack. Careless or malicious tampering with these networks could disrupt the network, invalidate data, and otherwise ruin experiments supported by the networks. Security measures – fire walls, intrusion detection, etc. – used with regular networks are inadequate to protect these high-performance networks, which run at 10 Gbps to 40 Gbps. Therefore, this project will develop robust, user-friendly security measures for both the control plane and the data plane, without sacrificing network speed, performance, or availability. The approach will utilize a software security system that relies on a network of intelligent agents. Phase I demonstrated the feasibility of using this system to protect control messages on a high performance network from cyber attack, with no loss of network speed, performance, or functionality. In Phase II, the system will be implemented on the same hardware used by real-world high-performance networks. Then, the system will be evaluated by an independent laboratory that will try to defeat the system.

Commercial Applications and other Benefits as described by the awardee: The control and data plane security system should be applicable to the high performance networks now being used in several key government agencies. It is likely that these networks will become more widespread in the commercial environment as demand for high bandwidth increases.

85440S08-II

Advanced Static and Dynamic Scheduling of HPC Applications on Petascale Computer Systems with GPU Accelerators—Reservoir Labs, Inc., 632 Broadway, Suite 803, New York, NY 10012-2614; 212-780-0527
Dr. Benoit Meister, Principal Investigator; meister@reservoir.com
Dr. Benoit Meister, Business Official; meister@reservoir.com
DOE Grant No. DE-FG02-08ER85149
Amount: $749,978

What has been holding back General Purpose Graphics Processing Units (GPGPUs) until now has been programmability. At present, to take advantage of GPGPUs' potential, application developers must hand-optimize their code, which is expensive and difficult. This project will develop an advanced compiler that, when combined with a GPGPU, will enable the code optimization process to be conducted automatically, for a broad class of compute-intensive applications. Phase I demonstrated the automatic method for some important kernels. In Phase II, the scope of kernels that can be automated via GPGPU computing will be broadened, and the compiler solution will be completed, thereby dramatically reducing the cost of porting massively parallel applications to GPGPUs.

Commercial Applications and other Benefits as described by the awardee: The technology should make supercomputing less expensive and much more accessible, facilitating scientific breakthroughs and economic growth. Commercial applications include molecular biology, drug development, cancer research, oil and gas exploration, global warming modeling, etc.

86393S08-II

Enhancing Sca/LAPACKrc with Extremely-Fast Least-Squares Solvers for Heterogeneous CPU/FPGA Supercomputers—Accelogic, LLC, 609 Spinnaker, Weston, FL 33326;
954-249-4711
Dr. Juan Guillermo Gonzalez, Principal Investigator; juan.gonzalez@accelogic.com
Dr. Juan Guillermo Gonzalez, Business Official; juan.gonzalez@accelogic.com
DOE Grant No. DE-FG02-08ER85136
Amount: $750,000

An estimated 70% of supercomputing cycles worldwide are dedicated to solving numerical linear algebra problems, and large-scale "least-squares" computational problems are an important subset of numerical linear algebra. Sca/LAPACKrc, a multimillion dollar program to develop FPGA-accelerated linear algebra software, already has demonstrated speedups larger than 100x per commodity processor for a wide class of linear equation solvers. Despite its tremendous success, Sca/LAPACKrc still lacks a much needed functionality for least squares solvers. This project will enhance Sca/LAPACKrc with a comprehensive set of FPGA-accelerated sparse and dense least squares solvers that will be portable and easy to use and integrate. The use of these solvers within a supercomputing network will be 1 to 2 orders of magnitude less expensive than CPU-based technology with similar performance. Phase I demonstrated the world's first FPGA-accelerated least-squares solver, achieving speedups larger than 40x at 64-bit accuracy. Phase I also established the architectural foundations for the entire solver set. Phase II will complete the development of this solver set, which will include accelerated implementations of the QR algorithm, and most flavors of QR-based least squares solvers (in both dense and sparse direct forms), as well as large-scale sparse iterative least squares solvers of the Krylov type.

Commercial Applications and other Benefits as described by the awardee: The ability to solve large least-squares problems fast and at affordable costs, has implications across a wide array of applications within the DOE mission, including energy fusion research, weather/earthquake/tsunami prediction, oil exploration, bioinformatics, geodetics, structural analysis, tomography, astrophysics, power grid control, and statistical data analysis.

85408B08-II

Small Business
RNET Technologies, Inc.
240 West Elmwood Drive
Suite 2010
Dayton, OH 45459
Dr. Gerald M. Sabin, Principal Investigator
gsabin@rnet-tech.com
Dr. Vaidnathan Nagarajan, Business Official
vnagarajan@rnet-tech.com
937-433-2886

DOE Grant No. DE-FG02-08ER86360
Amount: $750,000

Research Institution
Ohio State University

Parallel file systems are a key component of any high performance compute cluster used to perform cutting edge research. As larger compute systems are developed, and as applications become more data intensive, it is crucial that file systems do not become the primary bottleneck. In this project the meta-data server will be parallelized using low overhead operations, and application-aware hardware offload techniques (e.g., dynamic caching, hardware consistency protocol implementation, networking atomic operations) will be developed. In Phase I, a client-side metadata delegation scheme was designed to distribute the metadata workload and improve performance and scalability. Locking and distributed caching were demonstrated to perform much more efficiently when offloaded to network hardware. In Phase II, client-side delegation and associated SmartNIC offload modules will be integrated with Lustre and LNET (Lustre's networking layer).

Commercial Applications and other Benefits as described by the awardee: The technology would enable the development of the scalable parallel file systems needed to build the larger supercomputers and data centers required to perform cutting edge scientific research and support large scale business applications.

86002S08-II

Common Component Architecture for Electron Cloud Accelerator Simulations—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Stefan Muszala, Principal Investigator; muszala@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85152
Amount: $749,991

Electron cloud generation is one of the most scientifically important effects relating to the dynamics of particle beams. The build up of an electron cloud is a potentially limiting factor in the performance of high-intensity electron and proton machines. However, electron cloud simulation presents computational challenges because the number of particles is large and because efficient code coupling of beam physics with electron cloud generation code is required. This project will develop technology for composing electron cloud simulations on leadership-class supercomputing hardware. Phase I demonstrated an electron cloud simulation using TxPhysics and Synergia2 accelerator code components within the Common Component Architecture framework. In addition, a single processor and multiprocessor performance model was developed to characterize the behavior of the space charge kick calculation in Synergia2. Phase II will create new accelerator components for use on leadership-class supercomputers.

Commercial Applications and other Benefits as described by the awardee: The modeling of electron cloud effects is important for high energy accelerators and the Fermilab main injector. By focusing on the development and distribution infrastructure within the computational science community, a unique niche within the much larger software engineering market would be addressed .

86024S08-II

Schema-Based Environment for Configuring, Analyzing and Documenting Integrated Fusion Simulations—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Svetlana Shasharina, Principal Investigator; sveta@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85155
Amount: $749,366

Software is currently being developed to support the comprehensive full-device modeling needed for the successful operation of ITER. For this software to become a productive tool, a user-friendly interface will be needed to facilitate the configuration of components, to set up integrated simulations, and to perform simulation analyses. This project will develop a schema-based environment for configuring, analyzing, and documenting (SECAD) integrated fusion simulations. The SECAD system will be a user-friendly environment for setting up integrated fusion simulations and their analyses, for performing visualization, and for improving performance. Phase I developed a prototype SECAD capable of editing partial configuration files and running parameter studies for simulations. In Phase II, the SECAD system will be fully developed and will consist of (1) infrastructure for integrating the software with an analysis tool; (2) a Graphical User Interface (GUI) that will allow users to edit and validate software inputs, visualize their simulation data, set up parameter studies, and visualize the output; and (3) performance enhancements for components developed for a variety of platforms.

Commercial Applications and other Benefits as described by the awardee: In addition to fusion projects, the SECAD system should be applicable to many scientific and industrial efforts including the upcoming Fusion Simulation Project, Integrated Tokamak Modeling for ITER, Earth Science Modeling Framework, Global Nuclear Energy Partnership, climate modeling, automotive and aerospace engineering, and other projects that need to integrate multiple software components.

85950S08-II

A Field-Portable Polarization Imaging System for Remote Sensing—Boston Applied Technologies, Incorporated, 6F Gill Street, Woburn, MA 01801-1721; 781-935-2800
Dr. Hongzhi Zhao, Principal Investigator; hzhao@bostonati.com
Dr. Yingyin Kevin Zou, Business Official; kzou@bostonati.com
DOE Grant No. DE-FG02-08ER85109
Amount: $750,000.

With respect to its remote sensing responsibilities for verifying the nonproliferation of weapons of mass destruction, the DOE is seeking instrumentation for the detection and analysis of polarized light. This project will develop an innovative field-portable polarization imaging device based on a high performance electro-optic polarization management technology. The device will contain no moving parts and will accommodate most existing CCD cameras. Based on polarization features, effective classification algorithms will be developed for target discrimination and classification. In Phase I, an experimental set-up was built, and the feasibility of the imaging technique was demonstrated. Using this technique, targets in shadow were easily identified and enhanced, an achievement that is difficult with other imaging techniques. In Phase II, the spectral response range will be extended to cover wavelengths from visible to mid-infrared, and a large-aperture Stokes imaging sensor will be developed. Based on polarization features, effective classification algorithms will be developed for target discrimination and classification.

Commercial Applications and other Benefits as described by the awardee: The proposed technology and devices covering visible through middle-infrared wavelengths should find wide application in environmental monitoring, medical diagnosis, biological fingerprint detection, remote optical sensing and imaging, target discrimination, and minefield detection.

86369S08-II

Polarimetry in Remote Sensing Applications to Enhance Signal-to-Noise Ratios, Man-made Object to Natural Background Material Contracts, and Provide Increased Image Stability in the Infrared Region—Polaris Sensor Technologies, Inc., 200 Westside Square, Suite 320, Huntsville, AL 35801; 256-562-0087
Dr. Dennis H. Goldstein, Principal Investigator; dennis.goldstein@polarissensor.com
Mrs. Michele Ruggiero Banish, Business Official; Michele.banish@polarissensor.com
DOE Grant No. DE-FG02-08ER85130
Amount: $748,784

Remote sensing technologies are used to identify activities associated with the proliferation of weapons of mass destruction. Remote sensing requires the extraction of as much information as possible from the available measured energy, in order to identify objects of interest in the scene. Polarization is a fundamental property of light that is not typically exploited because of the additional difficulties in sensing and processing the information. However, polarization has the potential to increase signal-to-noise ratios, enhance man-made objects in contrast to a natural background, provide increased image stability in the infrared region of the spectrum, and characterize the shape and orientation of objects. This project will design, build, and deliver a small, portable, and affordable imaging polarimeter system for the detection and identification of important image features. Phase I developed two viable multi-camera imaging infrared polarimeter designs, tested algorithms that enhance the recognition of polarized scene elements, and collected and tested tools needed for simulation and analysis. Phase II will build, calibrate, and test the two infrared imaging polarimeter systems.

Commercial Applications and other Benefits as described by the awardee: A small, portable, and inexpensive polarization-sensitive infrared imaging system would be useful in many environmental monitoring applications where changes of texture occur. These applications include the detection of ice in surfaces, oil slicks, anti-personnel land mines, and other human-induced changes in natural scenes.

85679S08-II

Rapidly Tunable Optical Filter—Nova Photonics, Inc., One Oak Place, Princeton, NJ 08540; 609-258-5631
Dr. Fred M. Levinton, Principal Investigator; flevinton@novaphotonics.com
Dr. Fred M. Levinton, Business Official; flevinton@novaphotonics.com
DOE Grant No. DE-FG02-08ER85126
Amount: $749,993

Current tunable optical filter technology is limited in aperture size, field-of-view, and to switching times of tens of milliseconds. For some applications, including for video, faster response time is necessary. Nova Photonics proposes to design and develop a rapidly tunable tuning element will allow for fast (~ 1 msec) switching times. The imaging optical filter, with a large aperture, based on a wide field birefringent type filter. An electro-optic flexible design permits optical bandwidths ranging from ~100 nm to less than 1 nm. In Phase I we demonstrated a liquid crystal technology capable of switching times of less than 1 ms with a large field of view (±25°). We have verified that the additional optical components necessary to construct the filter are also capable of the required wide field-of-view. Our results from Phase I have verified the design of the proposed filter and demonstrated the feasibility of the key technical issues. In Phase II we propose to fabricate two large aperture (~100 mm), wide field-of-view (~±25°) tunable filters with a switching time of less than 1 ms, that will operate in the visible (450-750 nm). One filter will be narrow bandwidth (~10 nm) and the other will have a broad bandwidth (~100 nm).

Commercial Applications and other Benefits as described by the awardee: Electronically tunable optical filters can provide valuable information in many applications including medical sciences, remote sensing, and environmental monitoring.

85708B08-II

Small Business
Optra, Inc.
461 Boston Street
Topsfield, MA 01983
Mr. Craig Richard Schwarze, Principal Investigator
cschwarze@optra.com
Mrs. Dianne Young, Business Official
dyoung@optra.com
978 887-6600

DOE Grant No. DE-FG02-08ER86355
Amount: $749,706

Research Institution
Drexel University

Weapons of Mass Destruction (WMD) are a threat to society and national security, and Hyperspectral Imaging (HSI) provides a means for their detection. This project will develop improvements to a core element of a HSI system, the tunable wavelength filter. Phase I developed and demonstrated a tunable wavelength filter based on a Holgraphically-formed Polymer Dispersed Liquid Crystal (H-PDLC). These devices consist of a composite of a polymer and micron sized LC droplets, which result in improved electro-optical properties compared to traditional LC materials. Advantages include faster switching times, a wide wavelength operating range across the ultraviolet to infrared, narrow wavelength resolution, and high transmission. In Phase II, development will continue with an increase in the filter clear aperture to greater than 2 inches, an increase in reflection efficiency to greater than 70%, single wavelength operation over 90 degree full-field acceptance angles, a faster switching speed, and a lower switching voltage. Phase II will culminate with the fabrication and testing of a single-substrate H-PDLC tunable filter that operates across 400-800 nm and provides 10 nm wavelength resolution.

Commercial Applications and other Benefits as described by the awardee: A HSI network of multiple sensors could be used to monitor a given location and acquire spectral content that *uniquely* provides information on materials. The collected spectral information then could be analyzed through the use of libraries and databases to identify materials characterizing potential threats. Within the private sector HSIs could be adopted for natural resource assessment and management, particularly in the areas of agriculture and sylvaculture.

85951S08-II

High-Throughput Ultra-Fast Tunable Filter for Multispectral Imaging—Boston Applied Technologies, Incorporated, 6F Gill Street, Woburn, MA 01801-1721; 781-935-2800
Mr. Quincy Chen, Principal Investigator; qchen@bostonati.com
Dr. Yingyin Kevin Zou, Business Official; kzou@bostonati.com
DOE Grant No. DE-FG02-08ER85110
Amount: $750,000

Airborne multispectral remote sensing has been an enabling technology for the identification of activities associated with proliferation of weapons of mass destruction. However, existing technologies have limitations on color-switching speed, temperature range, throughput, and spectral range. This project will develop a unique tunable imaging filter based on an extremely large electro-optic effect and a novel-structure. The tunable filter will be able to change transmission wavelengths in microseconds without moving parts. Phase I demonstrated the feasibility of the fast tunable imaging filter through prototyping and testing. An aperture filter of up to one inch was constructed and used to take multicolor pictures. Key issues such as speed, field of view, uniformity, imaging quality, and polarization-independency transmission were measured and determined to be completely satisfactory. Phase II will involve production-level prototyping of the tunable filters at vast spectral range, extending the aperture and field of view, and developing an imaging system that could be adapted for field testing.

Commercial Applications and other Benefits as described by the awardee: The multispectral remote sensing technology should fulfill a wide variety of government mission needs, especially situational awareness military/security missions such as object detection and identification, surveillance through clouds, and detection of WMD. In civil applications, improved spectral information would benefit applications in environmental protection, agriculture productivity, emergency response to disaster, and many more.

85743S08-II

Full Spectral Signature Simulation Models for Chemical Releases—Spectral Sciences, Inc., 4 Fourth Avenue, Burlington, MA 01803-3304; 781-273-4770
Dr. Alexander Berk, Principal Investigator; lex@spectral.com
Dr. Leslie Joy McCarthy, Business Official; lmccarthy@spectral.com
DOE Grant No. DE-FG02-08ER85132
Amount: $749,931

Technologies enabling remote detection, identification, and quantification of trace chemical species in the atmosphere can provide critical information for uncovering activities associated with proliferation of weapons of mass destruction (WMD). A key requirement for efficient development of advanced WMD sensors and analysis algorithms is the availability of well-validated, user-friendly software for modeling the spectral signatures of the large number of target trace species . This project will develop validated atmosphere-embedded trace gas signature tools for remote monitoring of WMD production facilities. Phase I demonstrated that available trace gas infrared absorbance spectra can be converted to band model data and incorporated into standard radiative transfer models for automated calculation of atmosphere-embedded plume signatures. Validated contrast spectral signatures, defined as the difference between observed radiance in the presence and absence of the chemical release, were generated for several gases and scenarios of interest. In addition, a synthetic thermal hyperspectral image of a chemical plume against a mountainous background was generated. Phase II will develop chemical plume signature capabilities for the standard atmospheric radiance model and for two well-established synthetic hyperspectral image generation models.

Commercial Applications and other Benefits as described by the awardee: The technology should directly benefit academic, commercial, and government groups involved in the design and development of optically-based remote sensors for virtually any application, including intelligence, surveillance, and reconnaissance; natural resource assessment; urban planning; fire detection; and natural disaster damage assessment.

85047S08-II

Detached Growth of Nuclear Detector Materials—CapeSym, Inc., 6 Huron Drive, Suite 1B, Natick, MA 01760-1325; 508-653-7100
Dr. Shariar Motakef, Principal Investigator; motakef@capesim.com
Dr. Shariar Motakef, Business Official; motakef@capesim.com
DOE Grant No. DE-FG02-08ER85086
Amount: $750,000

Significant improvements in cost and performance of X-ray and γ -ray detectors, needed to fulfill DOE responsibilities with respect to nuclear nonproliferation, can be achieved through the availability of high-quality radiation detector materials. This project will develop a novel method for the production of these radiation detector materials. In Phase I, the production process was demonstrated for the growth of germanium and cadmium zinc telluride, and the viability for the growth of other materials, such as lathanum Bromide, was established. The results to date indicate that the materials grown by this technique have a low density of crystalline and point defects, with high single-crystal yield. In Phase II, the process will be further developed, leading to a commercially viable technology for growth of large size, high quality detector materials.

Commercial Applications and other Benefits as described by the awardee: Large-volume, high-quality, single-crystal detector materials, such as cadmium zinc telluride would enable the fabrication of sensitive and compact radiation detectors with applications in nuclear nonproliferation monitoring, medical diagnostics, homeland security, and the nuclear industry.

86104S08-II

New Approach for Lanthanide Halide Crystal Growth—Radiation Monitoring Devices, Inc., 44 Hunt Street, Watertown, MA 02472-4699; 617-668-6800
Mr. William Higgins, Principal Investigator; BHiggins@RMDInc.com
Dr. Gerald Entine, Business Official; NMarshall@RMDInc.com
DOE Grant No. DE-FG02-08ER85104
Amount: $749,995

Gamma-ray spectrometers based on lanthanide halide and related scintillators are a very promising class of detectors for nuclear non-proliferation monitoring, providing excellent energy resolution and fast response. However, the growth of large crystals of lanthanide halide scintillators, using traditional melt based processes, has been difficult, due to the physical and chemical properties of lanthanide halides and the limitations imposed by melt-based crystal growth processes. This project will develop technology to grow large crystals of lanthanide halide compositions by a solution growth technique that overcomes many of the problems faced by traditional melt-based approaches. In Phase I, lanthanide halide crystals of size 1 –2 cm^3 were grown from solution. Their scintillation properties were evaluated, and overall feasibility was demonstrated. Phase II will optimize the solution growth process, including a scale-up of the growth technique. Large crystals of the lanthanide halides and elpasolites (up to 1 –2 in^3) will be grown from organic solutions.

Commercial Applications and other Benefits as described by the awardee: In addition to the application to nuclear non-proliferation monitoring, the materials should find use in detectors used in gamma-ray imaging systems for astronomy, nondestructive studies, and medical imaging.

85190S08-II

Real-Time Optical MEMS-Based Seismometer—Michigan Aerospace Corporation, 1777 Highland Drive, Suite B, Ann Arbor, MI 48108-2285; 734-975-8777
Dr. Dominique Fourguette, Principal Investigator; dfourguette@michaero.com
Dr. Peter Tchoryk, Business Official; ptchoryk@michaero.com
DOE Grant No. DE-FG02-08ER85099
Amount: $749,578

Currently, nuclear tests are monitored by the International Monitoring System (IMS), a network of automated seismic stations that operate to record any evidence of clandestine nuclear explosions. Although geographically extensive and relatively accurate, this system does not adequately detect low-yield nuclear detonations, and there is a delay in information dissemination. This project will develop a low-cost miniature seismometer based on the latest developments in micro-opto-electromechanical systems technology. The seismometer will be capable of detecting accelerations as small as 1 nano-g, with a dynamic range of 120 dB. In addition, it will be rugged, rapidly-deployable, and capable of unattended operation and interrogation in real time. During Phase I, a prototype instrument was designed and proof-of-principle was established analytically and experimentally. In Phase II, the seismometer will be fabricated and demonstrated, based on the Phase I design. A manufacturing study will be conducted to advance the prototype to a production-quality design.

Commercial Applications and other Benefits as described by the awardee: In addition to making the assessment of nuclear detonations available immediately, the new seismometer should find use in a broad range of activities including geological research (mining and oil prospecting), earth sciences (early warning for earthquakes, volcanoes, and tsunamis), space exploration (satellite drag measurements, docking, navigation), homeland security (footstep detection, tampering, entry, and illicit activities), and building and vehicle safety.

85571S08-II

Seismic Detection Mini Seismometer—Eentec, 1100 Forest Avenue, Kirkwood, MO 63108; 314-984-8282
Dr. Robert Leugoud, Principal Investigator; rleugoud@att.net
Dr. Robert Leugoud, Business Official; rleugoud@att.net
DOE Grant No. DE-FG02-08ER85090
Amount: $719,055

The development of very small, versatile, rugged, low power, low noise, one or three-axis short-period seismometers is needed to monitor nuclear detonations. Specifications include total sensor size less than 1 cubic inch, low power consumption, low sensor self noise below the USGS Low Earth Noise Model, and dynamic range of at least 120 dB over a frequency band of 0.2 to 40 Hz. However, all commercially available high performance seismometers are large, heavy, and consume high power. Users therefore must choose between using instruments with significantly lower performance characteristics or reducing the size of the network. This situation is untenable, given the DOE responsibility to deploy detection systems for nuclear treaty monitoring and the current tight budget climate. This project will develop a new type of seismometer based on liquid inertial masses and electrochemical transducers**.** The approach involves the further miniaturization of a medium-period seismometer while maintaining low self noise and low power consumption. In Phase I, the concept was proven by building a working prototype, which was the size of a quarter. Phase II will improve sensor specifications and reduce the size.

Commercial Applications and other Benefits as described by the awardee: The new seismometer should provide invaluable information on near-field and remote earthquakes, dynamic processes in the mantle, offshore oil exploration, and the behavior of structures subjected to seismic activity. With respect to the latter, engineers would be better able to understand the nonlinear behavior and failure modes of structures that are susceptible to collapse or significant damage, leading to improved designs and building codes.

86126S08-II

Micro-Seismometers via Advanced Meso-Scale Fabrication—Silicon Audio, LLC, 2124 East 6th Street, Suit 105, Austin, TX 78702; 505-306-9296
Mr. Matthew Ellis, Principal Investigator; matt@siaudiolabs.com
Dr. Neal Hall, Business Official; neal@siaudiolabs.com
DOE Grant No. DE-FG02-08ER85106
Amount: $737,698

The DOE is seeking revolutionary innovations with respect to miniature seismic sensors for the monitoring of nuclear detonations. The performance of these sensors must match the specifications of the best products available today, but with orders of magnitude reduction in size, weight, power, and cost. This project will develop these sensors via a new fabrication technology that combines silicon microfabrication, advanced meso-scale fabrication and assembly, and the use of advanced photonics-based displacement/motion detection methods. In Phase I, a "macro" prototype was used to demonstrate (1) mass elements capable of achieving noise below 1ng , and (2) the high-fidelity, ultra-miniature motion detection principle. Phase II will address low frequency noise challenges, low power consumption, ultra-miniature size, and low cross axis sensitivity.

Commercial Applications and other Benefits as described by the awardee: Successful implementation should result in a commercial product, roughly the size of a 9 volt battery, that has the ability to immediately address national security needs for nonproliferation monitoring. Additional commercial market sectors should include scientific instrumentation, oil and gas exploration, inertial navigation, and civil infrastructure monitoring.

86219S08-II

Laser Interferometric Miniature Seismometer—Symphony Acoustics, Inc., 103 Rio Rancho Blvd. NE, Suite B-4, Rio Rancho, NM 87124-1441; 505-892-1195
Dr. Dustin W. Carr, Principal Investigator; dwcarr@symphonyacoustics.com
Dr. Michael Camp, Business Official; michael.camp@symphonyacoustics.com
DOE Grant No. DE-FG02-08ER85108
Amount: $749,878

The threat of nuclear proliferation remains a critical issue in our society. Prevention requires knowledge, and there is no greater indicator of the capability and intent of a nation than observation of actual detonation tests being conducted. Ground-based monitoring systems have proven to be very capable in identifying nuclear tests, and can provide somewhat precise information on the location and yield of the explosive device. Making these measurements, however, currently requires very expensive and bulky seismometers that are difficult to deploy in places where they are most needed. A high performance, compact device can enable rapid deployment of large scale arrays, which can in turn be used to provide higher quality data during times of critical need. The work that is proposed herein utilizes a proven optical sensing modality, and will combine this with a new mechanical system design in order to achieve the required sensor self-noise that is quieter than the natural motion of the earth at points far away from manmade noise, with a dynamic range as wide as any state of the art sensors. This will be accomplished in a form factor that is smaller than a golf ball, and a power consumption below 100 milliWatts. These metrics would represent substantial advancements over the existing state of the art. Our Phase I work resulted in significant advancement of the technology. We built advanced prototypes that demonstrated the potential of our approach, and identified the key issues that remain in the development of these sensors. The Phase II work will help to fund the next generation of deployable prototypes. This will include field testing of arrays in the first year, as well as the development of sensors with digital output in the second year.

Commercial Applications and other Benefits as described by the awardee: Lower cost, smaller sensors will enable wide scale deployment of sensor arrays, which will greatly enhance our understanding of the earth and provide early-warning systems for earthquakes and tsunami. These sensors will also find extensive use in oil and gas exploration. Currently, there are no manufacturers of low noise seismic sensors in the USA, and so this project will lead directly to the creation of new domestic high wage technology jobs.

85431S08-II

YFS, a High Performance Global File System That is Backward Compatible with AFS—
Your File System Inc., 255 W 94TH Street PHB, New York, NY 10025; 212-769-9018
Mr. Jeffrey Eric Altman, Principal Investigator; jaltman@your-file-system.com
Mr. Jeffrey Eric Altman, Business Official; jaltman@your-file-system.com
DOE Grant No. DE-FG02-08ER85057
Amount: $649,937

The High Energy Physics community has used the Andrew File System (AFS) for the last fifteen years in order to provide collaborative data access that collectively reaches petabyte scale. Transitioning to alternative file systems has proven difficult due to the number of deployed clients, the quantity of stored data, and dependencies on functional behaviors unique to AFS. AFS protocols no longer can provide acceptable scalability or throughput performance at the speed of current day networks and CPUs. As a result, a need exists for a new global file system that is backward-compatible with AFS and provides the scalability, throughput, and client-operating-system compatibility required to satisfy the needs of applications throughout the next decade. This project will improve upon the scalability and performance of AFS, while providing backward-compatibility with existing clients and permitting a smooth server transition. During Phase I, feasibility was demonstrated by improving the performance of the existing OpenAFS Rx/UDP protocol implementation. Phase II will focus on improving Rx/UDP retransmission algorithms, optimizing data structures and algorithms, and providing an improved user experience.

Commercial Applications and other Benefits as described by the awardee: In addition to the application to DOE laboratories that use AFS, the technology should benefit private companies in the financial, manufacturing, and service industries. Beyond that, it is believed that the next generation of mobile devices, such as the Nokia N-series Internet Tablet and the Google Android cell phone, could take advantage of a secure global-access data storehouse, preventing the need to copy data onto each and every device and flash disk.

85084S08-II

Voltage Droop Compensation for High Power Marx Modulators—DULY Research Inc.,
1912 MacArthur Street, Rancho Palos Verdes, CA 90275-1111; 310-548-7123
Dr. Ping Chen, Principal Investigator; davidyu@pacbell.net
Dr. David U. L. Yu, Business Official; davidyu@pacbell.net
DOE Grant No. DE-FG02-08ER85052
Amount: $700,000

The International Linear Collider (ILC) will need hundreds of modulators to power the 10-MW, long pulse (1.4 ms) klystrons. A Marx modulator controlled by solid-state switches promises higher efficiency, longer lifetime, and reduced cost compared to existing hard tube modulator options. However, voltage droop is one of the critical challenges that limit the application of the Marx modulators. The current approach to minimizing this problem, using vernier cells, is unable to smooth the flat top of the voltage pulse output, requiring an additional high voltage charging source and a large number of cells, which complicate the design of the Marx circuit. This project will develop a new compensation scheme that exploits the high speed of solid-state switches and the circuit characteristics of additional inductance. Phase I demonstrated that simple compensation circuitry based on this scheme can be implemented on an existing Marx main cell structure. Simulations of the modified vernier cell showed compensation to within 1%. In Phase II, an 11 kV modified vernier cell will be designed and built. After initial high voltage laboratory testing, the modified cell will be integrated into SLAC's Marx modulator for a real-time application test.

Commercial Applications and other Benefits as described by the awardee: The new compensation circuits should benefit the ILC project directly by meeting its stringent requirements for hundreds of modulators. It also would complement SLAC's Marx modulator program and other accelerator facilities that require long pulse modulators. Examples of such facilities include the TTF at DESY (hundreds of modulators, pulse width of 1.6 e ms) and the KEK in Japan (pulse width of 600 s).

85905S08-II

Development of Reduced-Cost Helium Vessels for ILC Cavities—Advanced Energy Systems, Inc, 27 Industrial Blvd, Unit E, Medford, NY 11763-2286; 631-345-6264
Mr. Joseph Sredniawski, Principal Investigator; joe_sredniawski@mail.aesys.net
Mr. Timothy Myers, Business Official; tim_myers@mail.aesys.net
DOE Grant No. DE-FG02-08ER85054
Amount: $698,224

The International Linear Collider (ILC) represents the next great undertaking for the worldwide high energy physics community. In addition to technical challenges posed by the project, the political realities demand a reduction in the cost of the components of this massive facility. The helium vessels that enclose each of the 16,000 superconducting cavities have been identified as a cost driver for the cryomodules. For reasons of thermal compatibility, the helium vessels for the ILC cavities are currently made from titanium, which is very expensive. This project will fabricate a prototype stainless steel helium vessel system along with a modified ILC cavity for validation testing. The Phase I effort indicated a potential $130M savings to the ILC. Phase II will fabricate the prototype stainless steel system, which will undergo validation testing at the Fermi National Accelerator Laboratory.

Commercial Applications and other Benefits as described by the awardee: The lower cost helium vessel design should provide significant cost savings to the ILC project. In addition to the ILC, the design should be applicable to all future superconducting radio frequency cavity systems.

85237B08-II

Small Business
Muons, Inc.
552 N. Batavia Avenue
Batavia, IL 60510
Dr. Rolland Johnson, Principal Investigator
rol@muonsinc.com
Dr. Thomas Roberts, Business Official
tjrob@muonsinc.com
630-840-2424

DOE Grant No. DE-FG02-08ER86351
Amount: $750,000

Research Institution
Thomas Jefferson National Accelerator Facility

Neutrino Factories and Muon Colliders require rapid acceleration of short-lived muons to multi-GeV and TeV energies. Recruiting Linear Accelerators (RAL) can provide exceptionally fast and economical acceleration, mainly limited by the extent of the focusing range of the RLA quadrupoles. However, the technical feasibility and cost effectiveness of such schemes have not been fully developed, and the ultimate limitations have not been fully analyzed. This project will develop a new concept for changing the strength of the RLA focusing quadrupoles as a function of time, in order to increase the number of passes that each muon will make through the RF cavities. Phase I developed a solution for a 3-to-50 GeV, 400 MHz RLA, which uses beta function beating to preserve the RLA beam quality by varying the quadrupole strength along a bisected linac. A Non-Scaling Fixed Field Alternating Gradient (NS-FFAG) lattice was designed for the return arcs of that RLA. Phase II will design a single-Linac RLA at 1.3 GHz, using fast pulsed quadrupoles and droplet arc magnets, for use with ILC-type SRF accelerating structures. Cost-effective options for very high energy arcs will be explored.

Commercial Applications and other Benefits as described by the awardee: Future large scale facilities such as Neutrino Factories and Muon Colliders will be very expensive national investments. More effective use of RF cavities through the use of pulsed RLA designs would save hundreds of millions of dollars.

85279S08-II

Novel Linac Structure for Electron and Proton Accelerators—FAR-TECH, Inc., 3550 General Atomics Court, Building 15, Suite 155, San Diego, CA 92121; 858-455-6655
Dr. Nikolai Barov, Principal Investigator; barov@far-tech.com
Dr. Jin-Soo Kim, Business Official; kim@far-tech.com
DOE Grant No. DE-FG02-08ER85034
Amount: $700,000

Novel accelerator structures are of great interest for accelerators used for high energy physics, nuclear physics, and medical purposes. Even a slight improvement could have a significant impact in the research community and in industry. This project will investigate the use of slot resonators to simplify accelerating structures. In Phase I, it was shown that the simplified design appeared to perform better or comparably to current designs, and would be useful for both proton and electron accelerators. In Phase II a prototype 9-cell linac structure, which will be capable of significantly boosting the beam energy, will be designed, fabricated, and tested. .

Commercial Applications and other Benefits as described by the awardee: The novel accelerating structure would significantly reduce the design complexity, leading to significant cost savings in large accelerators. Many new accelerators that are under consideration or in an expansion phase could benefit from the simplified design.

86210S08-II

Development of a Diamond-Based Cylindrical Dielectric Loaded Accelerating Structure—
Euclid TechLabs, LLC, 5900 Harper Road #102, Solon, OH 44139; 440 519-0410
Dr. Paul Schoessow, Principal Investigator; paul.schoessow@euclidtechlabs.com
Mr. David Dunay, Business Official; daved@euclidtechlabs.com
DOE Grant No. DE-FG02-08ER85033
Amount: $749,998

High energy particle accelerator structures based on dielectric tubes are presently being studied as a promising technology for next generation linear colliders. This project will develop a diamond-based accelerating structure that can sustain an accelerating gradient larger than 600 MV/m, significantly in excess of the limits experimentally tested for conventional accelerating structures. In Phase I, a cylindrical diamond-based DLA structure was designed. Using a plasma CVD process, very high quality diamond tubes (5.5 mm diameter, thickness ~ 0.5 mm, and 2.5 cm long) were fabricated. Surface quality was established using electron microscopy, and the electronic parameters of the diamond were measured using micro Raman and micro-photoluminescence spectroscopy. Phase II will complete the CVD fabrication of the diamond tubes needed to build a full-size K-band prototype accelerator structure. Numerical studies will be conducted to optimize the accelerating structure parameters. Wakefield acceleration experiments using the diamond structure will be performed at the Wakefield Accelerator Facility at Argonne National Laboratory.

Commercial Applications and other Benefits as described by the awardee: The diamond tubes should be applicable to the development of high-efficiency next-generation accelerators and to cylindrical diamond components for high-voltage and microwave applications. These diamond tubes also could be used for molecular filters, drilling tools, waveguides, and hypodermic needles.

86408S08-II

High Efficiency Fiber Laser for Advanced Accelerator—AdValue Photonics Inc, 4585 S. Palo Verde Road, Suite 405, Tucson, AZ 85714; 520-790-5468
Dr. Shibin Jiang, Principal Investigator; sjiang@advaluephotonics.com
Dr. Shibin Jiang, Business Official; sjiang@advaluephotonics.com
DOE Grant No. DE-FG02-08ER85029
Amount: $746,515

The DOE needs a single-polarization mode-locked high-power 2-micron fiber laser for an advanced laser electron accelerator. The 2-micron laser wavelength allows for larger accelerator dimensions and the acceleration of more charge, compared to the 0.8 micron Ti:Sapphire laser. The other advantage of a 2-micron wavelength is the possibility of using silicon as opposed to quartz as a material for the accelerator. This project will develop a highly efficient high-power 2-micron mode-locked fiber laser using innovative polarization-maintaining Tm-doped fibers, with an extremely large single-mode core diameter. Phase I designed and fabricated Tm-doped glasses and fibers, characterized the spectroscopic properties of Tm ions, demonstrated a highly efficient near-2-micron fiber laser with a slope efficiency of 68%, and successfully demonstrated a mode-locked 2-micron fiber laser. In Phase II, the mode-locked 2 micron fiber lasers will be further optimized, and a prototype high-power mode-locked 2-micron fiber laser will be built.

Commercial Applications and other Benefits as described by the awardee: A high-power mode-locked 2-micron fiber laser should find a wide range of uses, including materials processing, remote sensing, and bio-medical applications.

85723S08-II

Study of a Final Cooling Scheme for a Muon Collider Utilizing High-Field Solenoids—
Particle Beam Lasers, Inc., 18925 Dearborn Street, Northridge, CA 91324-2807; 818-885-8956
Mr. Robert Weggel, Principal Investigator; bob_weggel@midspring.com
Mr. James J. Kolonko, Business Official; kolonko@pacbell.net
DOE Grant No. DE-FG02-08ER85037
Amount: $700,000

A muon collider with center of mass energy of 1.5-4 TeV would probe fundamental physics phenomena at energies well above the CERN Large Hadron Collider or the proposed International Linear Collider. Unlike electrons, muons have sufficient mass to suffer negligible synchrotron radiation and can be circulated, thus decreasing the machine footprint and cost. This project will develop high-field solenoids for the final cooling of muons in a collider. In the Phase I design, the resistive coils were replaced by superconducting coils: first a Nb_3Sn coil operating below 2 K, and then a high temperature superconducting coil (either YBCO or Bi 2212). Simulations conducted in Phase I demonstrated that the required ~25 pi mm-mrad emittance could be achieved with final-stage cooling in 50 T solenoids. Phase II will build and test two insert coils: (1) a 4 T coil using Bi-2212, and (2) a ~12 T coil using YBCO. One or both of the new coils would be tested inside a background field of 19 T. In addition, the needed quench protection for these tests will be designed and constructed. Finally, magnet and quench protection designs for 40-50 T systems will be studied.

Commercial Applications and other Benefits as described by the awardee: Beyond the application to high energy physics research, commercial applications include muon radiography for condensed matter studies, nanotechnology, medical applications (particularly for MRI magnets), and homeland-security applications.

85881S08-II

A Novel Gas Jet for Laser Wakefield Acceleration—Alameda Applied Sciences Corporation, 626 Whitney Street, San Leandro, CA 94577-1116; 510-483-4156
Dr. Mahadevan Krishnan, Principal Investigator; krishnan@aasc.net
Dr. Mahadevan Krishnan, Business Official; krishnan@aasc.net
DOE Grant No. DE-FG02-08ER85030
Amount: $700,000

There are numerous fields in which fast pulses of supersonic gas jets are useful. One such application is for the laser wakefield acceleration of electrons. Currently, valves with opening times on the order of hundreds of microseconds and closing times that are even longer are used to supply the gas or small capillaries that are used to control the gas density. This project will develop technology to achieve faster opening and closing puffs of gas for the laser interaction, which would reduce the load on the vacuum system and enable higher repitition-rate operation of the accelerator. Phase I involved the demonstration of a gas valve that opened in less than 100μs and closed in less than 500μs, while operating reliably at up to 2Hz repitition rates without cooling. Valve operation was confirmed at three separate facilities. Phase II, will increase the repetition rate of the valve and further reduce the opening and closing times.

Commercial Applications and other Benefits as described by the awardee: Beyond the application to wakefield acceleration, further reductions in the opening and closing times of valves should benefit applications related to traumatic brain injury, Raman amplifiers, and proton accelerators.

86033S08-II

Inverse Cyclotrons for Intense Muon Beams—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Kevin Paul, Principal Investigator; kpaul@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85044
Amount: $649,821

Intense muon beams are sought for their role in the future of both the high-energy and medium-energy physics programs at national laboratories, such as Brookhaven and Fermilab. Inverse cyclotrons are a promising alternative to more expensive methods of cooling muon beams, but their ability to cool intense muon beams is untested. This project will develop a software suite capable of providing a complete, end-to-end simulation of an inverse cyclotron, in order to determine the acceptance of such a device for intense muon beams and what kind of losses can be expected. In Phase I, a numerical study of the space-charge limitations in various trapping-field configurations was performed. Software was developed to simulate the muon interaction with matter, and various loss mechanisms were included in the simulation. Phase I showed no significant limitations due to space charge in containing or extracting the beam from the cyclotron core. In Phase II, full end-to-end simulations of the inverse cyclotron will be performed. Because simulating the entire inverse cyclotron is computationally intensive, performance-enhancing techniques will be developed and employed.

Commercial Applications and other Benefits as described by the awardee: This project will provide enhancements to the electromagnetic particle-in-cell code, VORPAL, which is already a successful commercial product. The inclusion of detailed particle-matter interactions would make VORPAL a desirable tool for many applications, such as muon cooling, electron scraping, and collimation.

86048S08-II

Micro-Pulse Amplified Electron Injector—FM Technologies, Inc., 4431-H Brookfield Corporate Drive, Chantilly, VA 20151-1691; 703-818-9400
Dr. Frederick M. Mako, Principal Investigator; fmako@erols.com
Dr. Frederick M. Mako, Business Official; fmako@erols.com
DOE Grant No. DE-FG02-08ER85036
Amount: $674,961

The development of high-current, short-duration pulses of electrons has been a challenging problem for many years. High current pulses are widely used in injector systems for electron accelerators, both for industrial linacs as well as for high-energy accelerators for linear colliders. Also, short-duration pulses have been used for microwave generation, in klystrons and related devices, for injectors to perform research on advanced methods of particle acceleration, and for injectors used as free-electron-laser (FEL) drivers. This project will develop a high current, picosecond S-band injector system, the Micro-Pulse Amplified Electron Injector (MPAI), based on a self-bunching electron gun, the Micro-Pulse Gun (MPG). In Phase I, electron amplification with diamond in the MPG was demonstrated, and measurements of electron current gain, charge per bunch, RF power, beam power, and other key parameters were performed. Phase II will involve the design, fabrication, and testing of an S-band MPAI to 5-6 MeV. Experiments will be conducted to establish the baseline for characterizing the device, and the MPAI's suitability for a variety of potential applications will be validated.

Commercial Applications and other Benefits as described by the awardee: The micro-pulse electron amplifier injector (MPAI) would provide a high power, low emittance, picosecond-long electron source that is suitable for many applications, including linear colliders, free electron lasers, medical and industrial RF linacs, and high-harmonic, high-frequency drivers for RF sources, and accelerator test facilities.

86145B08-II

The Micro Accelerator Platform: A New Particle Source for Industrial, Medical, and Research Applications—RadiaBeam Technologies, LLC, 13428 Beach Avenue, Marina Del Rey, CA 90292-5624; 310-822-5845
Dr. Salime Max Boucher, Principal Investigator; boucher@radiabeam.com
Dr. Salime Max Boucher, Business Official; boucher@radiabeam.com
DOE Grant No. DE-FG02-08ER85038
Amount: $699,764

Sources of relativistic electrons are utilized in applications ranging from cancer therapy to industrial inspection, but such devices are presently large and very expensive. New applications in high-energy physics demand smaller radiation and charged particle sources. This project will develop a new kind of particle source, the Micro Accelerator Platform (MAP), which will be powered by a laser, delivered over a fiber optic, and be about a cubic millimeter in size. The MAP will be based on a microstructure fabricated from dielectric materials, much the way microelectronic chips and MEMS devices are produced. In Phase I, a proof-of-principle MAP structure was optimized, and the feasibility of relativistic particle acceleration in the all-dielectric MAP structure was demonstrated. Fixturing and instrumentation for a proof-of-principle experiment in Phase II was designed. Phase II will finalize the design of the structure, fabrication processes will be developed, and prototype structures will be fabricated and tested. An acceleration greater than or equal to 1GeV/m over a ≥100 μm long, relativistic structure will be demonstrated.

Commercial Applications and other Benefits as described by the awardee: In addition to the application for high energy physics research, the MAP holds great promise as a new form of cancer radiation therapy, delivered through a minimally invasive procedure to the tumor site, thus avoiding damage to healthy tissue. This new tool potentially could provide a safer, more effective, and less expensive alternative to the radiation treatment available today. At the same time, the MAP technology should provide a new source for non-destructive testing and cargo inspection.

86027S08-II

Service-Oriented Architecture for Next Generation, Large-Scale Accelerator Control Systems—Tech-X Corporation, 5621 Arapahoe Avenue, Suite A, Boulder, CO 80303-1379; 720-974-1856
Dr. Nanbor Wang, Principal Investigator; nanbor@txcorp.com
Mr. Laurence D. Nelson, Business Official; lnelson@txcorp.com
DOE Grant No. DE-FG02-08ER85043
Amount: $649,926

Traditional frameworks for the development of accelerator control systems do not scale for the control of next-generation large scale accelerators, which will consist of many sub-accelerators and operation teams. This project will develop a reference Service-Oriented Architecture (SOA) that promotes multiple levels of loose coupling to increase the robustness and adaptability of overall control applications. In Phase I, key middleware technologies were surveyed and sample control system processes were implemented. It was determined that a SOA for control systems must integrate two separate service buses to provide the required capability. Phase II will involve the systematic implementation of the dual-bus SOA environment for accelerator control systems. The implementation will ensure vertical propagation of data from various low-level systems and horizontal data exchange between subsystems. A generic optimization framework will be developed to guide the overall design. Finally, several control applications will be developed, using the SOA environment to demonstrate the results.

Commercial Applications and other Benefits as described by the awardee: In addition to the application to accelerator control, the SOA for control systems should find application to any large scale industrial control or mission-critical system, such as air traffic control and industrial manufacturing process control.

85593S08-II

Gradient Enhancement Research for Linear Accelerator Structures—Haimson Research Corporation, 3350 Scott Boulevard, Building 60, Santa Clara, CA 95054-3104; 408-988-6007
Dr. Jacob Haimson, Principal Investigator; Haimson@aol.com
Ms. Beverly L. Mecklenburg, Business Official; BLMecklenburg@aol.com
DOE Grant No. DE-FG02-08ER85197
Amount: $699,220

For traveling wave electron linear accelerators, considerable difficulty has been encountered in demonstrating accelerating gradients in excess of 100 megavolts per meter. Attempts to operate at higher gradients suitable for future linear colliders have resulted in radio-frequency breakdown and related surface damage. In recent high-gradient accelerator tests using a resonant ring power amplifying system, an ability to minimize surface damage was demonstrated. This result was achieved by automatically responding to a breakdown event with rapid re-routing of accelerator input power and immediate restriction of energy deposition. In this project, this protection strategy will be combined with an advanced design structure to overcome the presently limited threshold of high gradient operation. In Phase I, the conceptual layout and microwave design parameters of a high power dual resonant ring system were established. During Phase II, the design and development of specialized high power components will be completed, the dual resonant ring system will be fabricated, and the overall system will be fine-tuned with a candidate high-gradient test structure embedded in the network. Resonant ring high-power tests will be conducted, and the high gradient performance of the linac structure will be evaluated and compared with that of a directly driven structure.

Commercial Applications and other Benefits as described by the awardee: Success of the Phase II effort would lead to a better understanding of radio-frequency breakdown in traveling wave linear accelerators and would provide design guidance for further miniaturization of commercial accelerators for medical, radiographic, and homeland security applications.

85700S08-II

High-Power Microwave Switch Employing Electron Beam Triggering—Omega-P, Inc., 258 Bradley Street, New Haven, CT 06510-1106; 203-789-1165
Dr. Jay Hirshfield, Principal Investigator; jay@omega-p.com
Dr. George P. Trahan, Business Official; enid@omega-p.com
DOE Grant No. DE-FG02-08ER85206
Amount: $675,000

Development of accelerator structures that can sustain acceleration gradients of ~150 MeV/m are required in order to build a future multi-TeV collider. High-power facilities for testing these structures do not generate sufficiently-high peak powers, hence RF pulse compressors are needed to provide power multiplication. However, active RF pulse compressors are limited in peak power due to RF breakdown, mainly on the surfaces of non-metallic elements within their active switches. This project will investigate a high-power RF switch concept in which the active element is a pulsed electron beam. In this approach, the switch could operate at higher peak power levels, because no insulating elements – where breakdown might occur – would be present within the switch. In Phase I, three prototype electron-beam-triggered switches were designed and built, each with different cathode and anode geometries. With these switches connected to an RF storage resonator, low power tests were conducted, and compressed pulses with peak power gains in the range of 10:1 to 20:1 were observed. In Phase II, a high-power version of electron-beam-triggered switches will be designed, and prototypes will be built and tested. The goal is to produce compressed pulses in the range of 150-200 MW, with pulse widths in the range of 50-100 ns, power gains in the range of 10:1-15:1, and efficiency higher than 60%.

Commercial Applications and other Benefits as described by the awardee: Development of structures that can sustain high accelerating gradients without an undue probability of breakdown, and which can be the basis for a future multi-TeV electron-positron collider, should hasten the day when the multi-TeV collider will be built. Once the multi-TeV collider is ready for construction, many commercial companies will benefit from the multi-million dollar manufacturing contracts for the accelerator structures and other elements in the collider.

85521S08-II

Optically Pumped High Power Solid State Switch—Applied Pulsed Power, Inc., 2025 Dryden Road, P.O. Box 348, Freeville, NY 13068; 607-844-3426
Mr. Steven Glidden, Principal Investigator; scg@appliedpulsedpower.com
Mrs. Vicki Case, Business Official; vlc@appliedpulsedpower.com
DOE Grant No. DE-FG02-08ER85188
Amount: $649,956

Advanced high-power solid state switches are desired to improve energy efficiency, increase lifetime, and decrease operating costs of RF accelerators. This project will develop compact, low cost, optically pumped silicon switches that can achieve (1) current risetimes less than 50 ns while operating at up to 10 kA peak current, (2) di/dt > 100 kA/μs, and (3) a capability of blocking >5 kV. The fast turn-on time of these switches will minimize switching losses, resulting in lower cooling requirements, as well as higher average power and greater repetition rate operation, compared to other high power silicon switches. In Phase I, optically pumped switches demonstrated 50ns current risetimes to 1kA. This result was achieved by modifying existing electrically-triggered high-power silicon devices. In Phase II, new high-power silicon devices will be developed, based on the results from Phase I. Improved optical sources also will be developed. These two components will be integrated with the goal of achieving a commercial product.

Commercial Applications and other Benefits as described by the awardee: Advanced high power solid state switches should increase the efficiency of power generation, electrical transmission, radar, and medical instruments, and increase the reliability of the electrical power grid. Customers would include utility companies, medical instrument manufacturers, power supply manufacturers, and the Department of Defense.

85343S08-II

Homogenous BSCCO-2212 Round Wires for Very High Field Magnet—SCI Engineered Materials, Inc., 2839 Charter Street, Columbus, OH 43228; 614-486-0261
Dr. Scott Campbell, Principal Investigator; scott@sciengineeredmaterials.com
Dr. Scott Campbell, Business Official; scott@sciengineeredmaterials.com
DOE Grant No. DE-FG02-08ER85025
Amount: $649,543

With the drive toward higher-field dipole magnets, material requirements for superconductors are becoming stringent. Although the processing and application of existing metal-based materials have advanced to a significantly higher level than those of their ceramic high-critical-temperature counterparts, these counterparts have exhibited higher critical field values. Therefore, the ceramic superconductor, bismuth strontium calcium copper oxide (BSCCO-2212), in the form of a multifilamentary Ag alloy composite, is beginning to attract the interest of the DOE. This project will produce a commercially viable BSCCO-2212/Ag composite multifilamentary round wire with a Jc value exceeding 2100 A/mm^2 and Je value equal to or exceeding 600 A/mm^2 at 12T and 4.2K. In addition, the powder processing conditions for the BSCCO-2212 powder, needed to maximize the uniformity of the Jc and Je throughout the length of the composite wire, will be determined. In Phase I, an understanding of the effect of powder calcining conditions on the powder properties and the wire fabrication process was developed. In addition, a wire fabrication process was demonstrated, in which composite wires free of superconductor phase leakage were produced. In Phase II, the superconductor properties of the composite wire will be further improved by tailoring the powder processing method.

Commercial Applications and other Benefits as described by the awardee: The initial commercial application of BSCCO-2212/Ag composite wire should be in high field magnets for high energy physics experimentation. Other uses of the technology should include medical MRI and other commercial applications where high field magnets are required.

85359S08-II

Manufacture of Fine-Grained Niobium Bar—Shear Form, Inc, 207 Dellwood, Bryan, TX 77801; 979-693-4102
Mr. Robert E. Barber, P.E., Principal Investigator; rbarber@shearform.com
Prof. Karl Ted Hartwig Jr., Business Official; kthartwig@shearform.com
DOE Grant No. DE-FG02-08ER85026
Amount: $649,970

For advanced magnets used in high energy physics research, commercially available NB_3Sn superconductor wire needs to have smaller superconducting filament regions, while retaining a high critical current density (Jc). However, the currently available Nb bars used in such conductors have a large grain structure, which cause poor deformation behavior as the Nb is worked into fine filaments in Nb-Sn-Cu composite wire. When isolated Nb filaments deform irregularly, they can break or contact other nearby filaments, which decreases conductor performance. In this project, the problem of large grains in the starting Nb will be addressed by breaking up the original coarse and nonuniform microstructure with carefully applied plastic deformation and annealing. These procedures can be applied via Equal channel angular extrusion (ECAE) at high efficiency and reasonable cost. The approach demonstrated in Phase I included (1) processing bulk Nb to a fine-grained microstructure, (2) observing improved deformation behavior of grain-refined Nb in Cu-Nb composite wire, and (3) demonstrating a high yield of fully-worked material for multipass ECAE processing of single bars. In Phase II, the equipment for ECAE processing will be scaled up, tested, and evaluated for economic viability. The larger equipment will be used to produce large fine-grained Nb bars for prototype Nb_3Sn conductor experiments.

Commercial Applications and other Benefits as described by the awardee: The technology should be suitable for the commercial production of advanced high Jc, fine-filament Nb_3Sn wire for high energy physics and fusion energy applications. In addition, the ECAE approach should be applicable to the fabrication of Ta, Ti, interstitial free steel, and superalloys, with improved mechanical properties for a host of applications.

85776T08-II

Small Business
Supercon, Inc.
830 Boston Turnpike
Shrewsbury, MA 01545-3386
Dr. Justin Schwartz, Principal Investigator
Schwartz@magnet.gsu.edu
Mr. Terence Wong, Business Official
twong@supercon-wire.com
508-842-0174

DOE Grant No. DE-FG02-08ER86363
Amount: $750,000

Research Institution
Florida State University

NbTi and Nb_3Sn, the materials primarily used for high field magnets, are limited to magnetic field generation of about 10.5 T and 20 T respectively. Bi2212 is a high field superconductor that has the highest Jc of any practical superconductor at fields above 15 T. However, Bi2212 is a highly reactive compound and must be heat treated in oxygen at temperatures in the range of 890 °C. At these temperatures, the currently-used insulating materials tend to react with Bi2212, degrading magnet performance or even causing the loss of the magnet. This project will develop an improved insulating material and a method for manufacturing Bi2212 magnets. In Phase I, the factors leading to leakage during heat treatment of Bi2212/Ag superconductors were investigated. It was found that the material used for insulating the wire reacted with the silver sheath of the conductor causing the formations of pits, which lead to leakage and degradation of the conductor. Several alternate insulation schemes were evaluated for their effect in reducing the reaction with the silver sheath. Phase II will develop an alternate approach to insulating Bi2212/Ag conductor using materials that are non reactive with silver. In addition, the processing conditions for making coils from this material will be determined.

Commercial Applications and other Benefits as described by the awardee: A high field superconductor such as Bi2212 would find its primary application in accelerator magnets for high energy physics. The other major application for the technology would be in high field nuclear magnetic resonance systems for imaging complex organic compounds and biological materials.

86373S08-II

A New Multifilament Round Wire with Enhanced Bi2212 Texture for HEP High Field Magnet Applications—SupraMagnetics, Inc., 214 Canal Street, Plantsville, CT 06479; 860-426-1961
Dr. Leszek Richard Motowidlo, Principal Investigator; LMOTO@cox.net
Dr. Leszek Richard Motowidlo, Business Official; LMOTO@cox.net
DOE Grant No. DE-FG02-08ER85028
Amount: $650,000

The study of fundamental physics phenomena at higher energy collisions will require more energy and luminosity. More luminosity means larger apertures and bigger magnets. In turn, higher field magnets will require higher performance Bi2212 conductors at lower cost. This project will develop technology for improving the critical current density and lowering the processing cost of powder-in-tube (PIT) Bi2212 wire, enabling this wire to be a potential candidate for use in high field magnets for future accelerator research. Phase I demonstrated a new approach for Bi2212 round wire, in which random-oriented two-dimensional filaments were incorporated in a single stack design. Phase II will optimize (1) the rectangular Bi2212 filaments – in particular, the aspect ratio of the filaments – to maximize the interface area between the Bi2212 and the conductor's silver sheath; and (2) the fill factor, or superconducting area, to take advantage of the novel single-stack design.

Commercial Applications and other Benefits as described by the awardee: The new PIT Bi2212 conductor should have an immediate benefit for high field magnets in high energy physics applications. Fusion reactors represent another potential application – the successful demonstration of a prototype fusion machine based on an advanced cost effective Bi2212 conductor would have enormous economic and social benefits. Finally, these superconductors could help bring NMR tools into wider use, with applications in biochemistry, pharmaceutical chemistry, polymer science, petroleum research, and medicine.

85235B08-II

Multi-Purpose Fiber Optic Sensors for HTS Magnets—Muons, Inc., 552 N. Batavia Avenue, Batavia, IL 60510; 630-840-2424
Dr. Rolland Johnson, Principal Investigator; rol@muonsinc.com
Dr. Thomas Roberts, Business Official; tjrob@muonsinc.com
DOE Grant No. DE-FG02-08ER85024
Amount: $700,000

Magnets using new high temperature superconductor (HTS) materials are showing great promise for high magnetic field and/or radiation environment applications such as particle accelerators. However, the development and operation of these magnets is limited because appropriate sensors and diagnostic systems are not yet available for monitoring the manufacturing and operational processes. In this project, optical fibers will be imbedded within HTS magnets to monitor strain, temperature, and irradiation, and to detect quenches. In the case of Bi2212 superconductor, the fiber will be used as a heat treatment process monitor to ensure that the entire magnet has reached thermal equilibrium. In Phase I, the optical fibers were shown to be compatible with HTS magnets by processing them in contact with Bi2212 wire in an oxygen environment up to 890^{o}C. Techniques were investigated for imbedding the fibers in coil packages for process monitoring, local strain and temperature monitoring, irradiation accumulation, and quench detection. In Phase II, other coating materials will be deposited onto optical fibers and tested for compatibility with HTS materials and processing methods, and for improved temperature and strain sensitivity at low temperature.

Commercial Applications and other Benefits as described by the awardee: The sensitive diagnostics for monitor strain and temperature should benefit the development and operation of magnets constructed from HTS, thereby facilitating the use of HTS magnets for many scientific (including plasma-confinement systems for fusion reactors), medical (including NMR), military, and power applications.

85542S08-II

High Performance Diamond Detectors—Coating Technology Solutions Inc., 36 B Munroe Street, Somerville, MA 02143-2009; 617-669-0472
Dr. Roy Gat, Principal Investigator; roy@generalcvd.com
Dr. Roy Gat, Business Official; roy@generalcvd.com
DOE Grant No. DE-FG02-08ER85167
Amount: $699,887

Charged particles accelerators are important tools in the study of fundamental properties of matter and energy. The accelerators often cost billions of dollars; yet, they are only as effective as the detectors in them. Man made (CVD) diamond combines unusual radiation hardness with the ultimate in charge carrier mobility to enable far superior detectors. Thus, this project will develop a method for joining single crystal man-made diamond into a large area mosaic, providing for the first time low cost high performance large area diamond detectors. Diamond detectors exhibit tissue equivalence- a property important for accurate radiation dose monitoring. Charged particle radiation therapy (such as Proton therapy) is found effective in prolonging life and leading to recovery in cancer patients. The proposed detectors are anticipated to improve the precision of this treatment thereby improving survival rates.

Commercial Applications and other Benefits as described by the awardee: High quality diamond offers unusual ability to provide electronic functionality at extremely high temperature. Large area single crystal may ultimately enable a wide array of superior electronics. First to benefit will likely be high temperature electronics such as in power grid management and conversion applications. Other common high power density electronic products such as millimeter wave telecommunication devices, civilian and military radars will also benefit.

85002S08-II

Thermally Conductive, Carbon Foam Material for Constructing Silicon-Based Detector Structures—Allcomp Incorporated, 209 Puente Avenue, City of Industry, CA 91746;
626-369-1273
Mr. William O. Miller, Principal Investigator; bill.miller@allcomp.net
Mr. Wei Shih, Business Official; WeiShih@aol.com
DOE Grant No. DE-FG02-08ER85223
Amount: $696,605

The next generation of silicon-based detectors for tracking charged-particles in high energy physics experiments will impose demanding requirements. One of these requirements involves the need for thermally efficient, low mass, dimensionally-stable support structures exposed to high radiation fields. This project will develop specially processed carbon foam for use in sandwich structures that support silicon-based detectors. The approach will be based on a thermally enhanced, very-low-density carbon foam material, ideally suited for transporting electronic heat to an embedded cooling tube in the structural sandwich member. In Phase I, test articles, with a 600 fold increase in thermal conductivity over virgin foam, were produced and tested. Cooling tests, with pre- and post- temperature cycling, demonstrated good results, and no failure of the foam was observed. In Phase II, the thermal resistance in high flux regions will be lowered by adding high conductivity fibers that are uniquely oriented to enhance joint thermal and structural properties. Performance enhancements will be evaluated using representative sandwich structures with the thermally enhanced foam cores. Extensive thermal cycling tests will be conducted to verify joint integrity.

Commercial Applications and other Benefits as described by the awardee: The carbon foam should find use as a replacement for honeycomb core materials in physics detectors where lightweight thermally conductivity is needed. In addition, the carbon foam technology could have applicability to the core material for high temperature heat exchangers for military and commercial aircraft, replacing Inconel and Hastelloy X fins.

85510B08-II

Wireless Sensors for Predictive Maintenance of Rotating Equipment in DOE's Research Reactors—Analysis and Measurement Services Corporation, 9111 Cross Park Drive, Building A, Knoxville, TN 37923; 865-691-1756
Mr. Hashem M. Hashemian, Principal Investigator; hash@ams-corp.com
Mr. Darrell W. Mitchell, Business Official; mitchell@ams-corp.com
DOE Grant No. DE-FG02-08ER85004
Amount: $749,736

Research reactors in the United States use numerous motors, compressors, fans, turbines, and other rotating equipment that need systematic maintenance. These devices could benefit from advanced predictive maintenance techniques that have become available in recent years. Although some reactor facilities currently incorporate some of these techniques, many lack an adequate complement of test sensors for predictive maintenance. This project will combine wireless sensors with other advanced predictive maintenance techniques to improve the safety, reliability, and efficiency of DOE research reactors. In Phase I, several wireless sensor systems were installed at an operating research reactor, and the feasibility of using wireless sensors for condition monitoring of rotating equipment was established. A conceptual design for a prototype wireless condition monitoring system was developed. Phase II will develop an integrated wireless monitoring system consisting of (1) ruggedized hardware for use in outdoor installations, and (2) custom software algorithms for processing and analyzing data collected from the wireless sensor arrays.

Commercial Applications and other Benefits as described by the awardee: The technology should help with both the safety and economy of research reactors by significantly improving the facility's predictive maintenance program, while at the same time reducing the amount of labor required to perform predictive maintenance tasks. In addition to research reactors, the technology should benefit commercial nuclear power reactors and all industrial installations that involve rotating equipment.

86074T08-II

Small Business
Luna Innovations Incorporated
1 Riverside Circle
Suite 400
Roanoke, VA 24016
Mr. Matthew Palmer, Principal Investigator
Subsmissions301@lunainnovations.com
Mr. Michael Pruzan, Business Official
Subsmissions301@lunainnovations.com
540-769-8430

DOE Grant No. DE-FG02-08ER86348
Amount: $749,740

Research Institution
Idaho National Lab

No method exists for testing fiber optic sensors in environments relevant to Gen-IV reactors, especially in environments related to very high temperature reactors (VHTR). Therefore, this project will develop a methodology and hardware to test prototype optical fiber sensors to near Gen-IV fluence (5x1020 cm-2) and temperatures (up to 1200°C). In Phase I, the Massachusetts Institute Technology Nuclear Reactor (MITR) facility was selected as the most viable facility for generating prototypical Gen-IV irradiation for testing sensors. Measurements made on previously irradiated sensors confirmed that no significant damage occurred in the sensor fiber leads at elevated temperatures (up to 700 °C). In Phase II, a facility for testing fiber optic sensors to prototypical VHTR irradiation will be modeled, designed, and constructed. A series of test sensors will be constructed and calibrated, and a data acquisition system for monitoring the sensors in real time will be assembled.

Commercial Applications and other Benefits as described by the awardee: The testing methodology would enable the advancement of the technology readiness level (TRL) of fiber optic sensors for use in future Gen-IV designs. Once these sensors are validated to be radiation tolerant and high-temperature capable, they also should find application in space probes, rocket engine monitoring, and gas turbine health monitoring.

85566S08-II

Search Enhancement with Adaptive Thesaurus and Ontology Resources—Edgewater Technology Associates, Inc., 3528 Worthington Blvd., Suite 301, Urbana, MD 21704; 301-275-5041
Dr. Antonio Zamora, Principal Investigator; tony.zamora@edgewaterit.com
Mr. David Yockman, Business Official; david.yockman@edgewaterit.com
DOE Grant No. DE-FG02-08ER85089
Amount: $749,094

The lack of suitable data structures and ranking mechanisms hinder the effective utilization of semantic repositories in operational scientific and technical retrieval systems. Such systems could greatly benefit from semantic knowledge to improve the recall and precision of search queries. This project will create rich semantic networks that can be interfaced with search engines to enhance query formulation and increase the precision and recall of better organized search results. In Phase I, a prototype Energy Semantic Network was developed and integrated with a state-of-the-art meta-search and discovery engine that organizes the search results into meaningful semantic clusters to facilitate exploration and new discoveries. Phase II will create a capability to adaptively augment the Energy Semantic Network with new concepts and relationships. Then, the Energy Semantic Network will be tested, evaluated, and interfaced with DOE retrieval systems.

Commercial Applications and other Benefits as described by the awardee: The new semantic network technology should improve the quality and usefulness of search results from scientific and technical databases. In addition to the DOE application, the semantic network technology could be adapted to other scientific domains and technology applications.

86241S08-II

Enabling Comprehensive One-Stop Access to World-Wide Scientific and Technical Research—Deep Web Technologies, LLC, 301 North Guadalupe, Suite 201, Santa Fe, NM 87501; 505-820-0301
Dr. Abe Lederman, Principal Investigator; abe@deepwebtech.com
Dr. Abe Lederman, Business Official; abe@deepwebtech.com
DOE Grant No. DE-FG02-08ER85088

Amount: $749,694

The Department of Energy, particularly through the Office of Scientific and Technical Information (OSTI), provides access to high quality scientific and technical content to scientists, researchers, and the public through a number of science portals. Despite this service, thousands of additional information sources are hard to identify and access; yet, the availability of such sources would lead to an acceleration of scientific discovery. This project will develop a software application aimed at building a large clearinghouse or repository of detailed information about science sources. This repository will enable quick identification and access to the most comprehensive list of scientific information sources anywhere. Phase I built a set of capabilities that support the easy integration of complementary content into search results and demonstrated the feasibility of building a large-scale clearinghouse and repository of science sources. Phase II will build a repository that will enable the science community to query and find the most relevant information sources available anywhere. In addition to containing detailed metadata about each information source, the repository also will contain performance and rating information about each source.

Commercial Applications and other Benefits as described by the awardee: The technology should enable the search of thousands of information sources simultaneously, paving the way for the creation of a marketplace for information sources. This marketplace would greatly extend the volume of quality science available to researchers and the public.

86272S08-II

Interactive Peer-to-Peer Scientific Communication in the Digital Library Environment—
Information International Associates, Inc., 1055 Commerce Park Drive, Suite 110, Oak Ridge, TN 37830-8028; 865-298-1262
Mr. Edrick Gerald Coppock, Principal Investigator; edrick@iiaweb.com
Ms. Stephaine Cusatis, Business Official; scusatis@iiaweb.com
DOE Grant No. DE-FG02-08ER85096
Amount: $749,943

Government digital libraries – such as the DOE's Office of Scientific and Technical Information's Information Bridge, Energy Citation Database, and other resources – have a unique opportunity to facilitate communication between scientific communities of common interest. This project will add functionality to these libraries by allowing users to communicate and collaborate about the technical information they seek, using this information as a catalyst for discussion and collaboration. In Phase I, a limited functionality prototype tool was developed to demonstrate the feasibility of enabling interactive peer-to-peer scientific communication in the digital library setting. Phase I also included a comprehensive survey of available commercial technologies to determine whether any commercial-off-the-shelf products could support the peer-to-peer communications that are anticipated. In Phase II, this survey information will be synthesized in order to develop and refine the final requirements for the enhanced prototype. An enhanced system design – including a plan for the configuration, development, integration, and testing of a peer-to-peer system – will be developed.

Commercial Applications and other Benefits as described by the awardee: The technology should benefit any research institution or information provider that makes a body of scientific information available. The communication mechanism would enable members of scientific communities to discover other professionals with common interests, facilitating a broader perspective on specific topics and increasing and enhancing the amount and quality of information available.

85497S08-II

Foil Gas Bearing Supported High Temperature Cathode Recycle Blower—R&D Dynamics Corporation, 15 Barber Pond Road, Bloomfield, CT 06002; 860-726-1204
Dr. Giri Agrawal, Principal Investigator; agragiri@rddynamics.com
Mr. Dennis Burr, Business Official; dennisb@rddynamics.com
DOE Grant No. DE-FG02-08ER85020
Amount: $749,994

Large multi-megawatt-size Integrated Gasification Fuel Cell power plants based on Solid Oxide Fuel Cells are being developed and planned for the near future. The efficiency of these plants can be improved by recycling part of the high temperature (800 °C to 850 °C) cathode air or anode gas effluent back to the system. In order to enable this recycling, this project will develop blowers that can handle high temperature gases; are reliable, energy efficient, and affordable; and will not contaminate the recycle gas with oil or grease. Phase I designed a high temperature cathode recycle blower supported by a foil gas bearing. The blower was designed such that it can be used dually, either as a cathode recycle blower or as an anode recycle blower. In Phase II the blower will be designed in detail, manufactured, and tested as both a cathode recycle and anode recycle blower.

Commercial Applications and other Benefits as described by the awardee: The new blower should provide high reliability, low operating cost, low life cycle cost, oil-free operation, high system efficiency, and maintenance free operation. In addition to the fuel cell application, the new blower should find use in other commercial applications (e.g., heat treating furnaces), where other blowers could not be used because of oil-contamination and temperature limitations.

85056B08-II

Liquid Tin Anode Direct Coal Fuel Cell—Celltech Power, LLC, 131 Flanders Road, Westborough, MA 01581-1031; 508-898-2223
Dr. Thomas Tao, Principal Investigator; tao@celltechpower.com
Mr. Jeffrey Bentley, Business Official; jbentley@celltechpower.com
DOE Grant No. DE-FG02-08ER85006
Amount: $750,000

Although most power produced in the U.S. comes from coal, the environmental footprint of coal has made it difficult to site and build new plants. Many new options for coal power generation involve techniques to capture CO_2 emissions, but these often require additional costly and inefficient process steps. A simple, efficient technology for directly converting coal to power while producing a pure CO_2 stream would preserve coal's place in the U.S. power generation mix and enhance energy security. This project will develop a direct coal-power-generation concept by using the Liquid Tin Anode Solid Oxide Fuel Cell (LTA-SOFC), which has the potential for converting coal to electric power at very high efficiency while capturing CO_2. In Phase I, several feasible cell designs were developed for scaling the LTA-SOFC to the required size for utility applications. In Phase II, experimental work will focus on evaluating the durability of the technique in a coal environment. In these experiments, long term testing of the LTA-SOFC will establish the impact of coal contaminants on the electrolyte and other cell components. Techniques to eliminate any observed failure modes will be developed.

Commercial Applications and other Benefits as described by the awardee: The LTA-SOFC should significantly improve the environmental footprint of coal power production. The projected efficiency of over 60%, with CO_2 capture, would be higher than any other advanced coal technology. The LTA-SOFC also could be used to efficiently generate power from biomass and other renewable resources – because the technology is scalable, the LTASOFC could be deployed as a distributed generation resource, improving access to renewable fuels while providing power generation close to the point of use.

86115S08-II

Compact and Streamlined Oxy-Syngas Reheat Combustor—Precision Combustion, Inc., 410 Sackett Point Road, North Haven, CT 06473-; 203-287-3700
Dr. Shahrokh Etemad, Principal Investigator; setemad@precision-combustion.com
Mr. John T. Scanlon, Business Official; jscanlon@precision-combustion.com
DOE Grant No. DE-FG02-08ER85015
Amount: $749,990

Zero-emission power generation, via an economical carbon capture and storage (CCS) process, offers a sustainable future for coal-derived fuels. Successful oxy-fuel combustion technology is a candidate for satisfying this objective, provided that the cycle efficiency can be boosted to levels that are equal to or greater than that of other fossil fuel power generating cycles. In order to achieve this increase in cycle efficiency, a robust reheat combustor, capable of driving the working fluid temperature up to 1760C, will be required. However, no existing re-heat combustor design can operate in the harsh steam/CO_2 environment expected in the cycle. This project will utlize a novel injector for oxy-syngas reheat combustion. This technology offers the potential to be simple, robust and cost-effective as a reheat combustor for the high temperature working fluid of an intermediate-pressure steam/CO2 turbine, thus enabling higher cycle efficiencies. Phase I used Computational Fluid Dynamic (CFD) and kinetics modeling to demonstrate the proof-of-concept. In Phase II, a subscale module will be fabricated and tested to demonstrate stable combustion and low emission performance. An optimized single injector module will be fabricated for testing at a high pressure/temperature test facility at simulated engine conditions.

Commercial Applications and other Benefits as described by the awardee: The reheat combustor should become a major component for the development of zero-emissions technology for coal combustion. The new combustor technology for the reheat cycle would help enable the use of coal for power generation through IGCC combined cycles.

85796S08-II

Selenium Speciation and Control Technologies in Sulfate-Rich Wet FGD Systems—
Trimeric Corporation, P.O. Box 826, Buda, TX 78610; 512-295-8118
Ms. Katherine Searcy, Principal Investigator; katherine.searcy@trimeric.com
Ms. Katherine Searcy, Business Official; katherine.searcy@trimeric.com
DOE Grant No. DE-FG02-08ER84948
Amount: $743,667

Historically, coal, which is used to generate more than half of the electricity in the United States, has been an abundant and low-cost source of energy for electricity generation. However, coal has a range of environmental disadvantages, which include emissions of selenium via the flue gas and via environmental releases during the subsequent processing and disposal of byproducts. The development of selenium management technology is complicated by a limited understanding of selenium chemistry in pollution control systems and by challenges in measuring the amount and form of selenium in these systems. This project will develop technology to reduce selenium water discharges from coal-fired power plants equipped with flue gas desulfurization units. In Phase I, a selenium control strategy was developed, and laboratory tests were conducted to identify the conditions under which selenium could be converted into a chemical form that can be removed easily from the wastewater. In Phase II, additional laboratory tests will be conducted to further refine the selenium control strategy. Then, pilot-scale tests at an electric utility will be conducted to demonstrate the technology on a larger scale using actual flue gas from a coal-fired power plant.

Commercial Applications and other Benefits as described by the awardee: The technology should have extensive commercial applications in the electric utility industry at both new and existing coal-fired power plants equipped with wet flue gas desulfurization scrubbing systems. The public will benefit from reduced exposure to selenium and reduced environmental discharges of selenium.

86236S08-II

Intelligent Actuation Control Using Model-Free Adaptive Control Technology—CyboSoft, General Cybernation Group, Inc., 2868 Prospect Park Drive, Suite 300, Rancho Cordova, CA 95670-6065; 916-631-6313
Dr. George S. Cheng, Principal Investigator; gscheng@cybosoft.com
Dr. George S. Cheng, Business Official; gscheng@cybosoft.com
DOE Grant No. DE-FG02-08ER84944
Amount: $719,760

For the U.S. to reach its future energy objectives, ultra-clean and highly efficient energy plants must be built. The control and optimization of coal-fired power plants is highly dependent on coordinated and integrated sensing, control, and actuation technologies and products. Prior efforts to develop novel sensing and control technologies have been successful, but little work has been devoted to the coordinated control and actuation of power plant processes. Studies have shown that as many as 2/3 of all control loop oscillations are caused by control valve or damper problems. This project will design and develop an intelligent actuation control solution that can provide robust and precise control for large coal-fired power plants. Phase I developed a novel actuation controller that can effectively control valve position processes that have nonlinear backlash problems and large changes in valve gain, time constant, and delay time. Phase II will optimize fuel-air-ratio control, improve flow-loop control, develop actuation control software that can be embedded in commercial actuation control devices, build a flexible air flow control test system and a liquid flow control test system, and demonstrate the ability of the actuation control products to run a coal-fired power plant.

Commercial Applications and other Benefits as described by the awardee: The actuation control solution should addresses an urgent need for clean coal technology and should help the power and process industries to improve efficiency, quality, safety, and emission reduction.

85782S08-II

Novel Diode Laser Cladding of High Temperature Alloys for Used in Ultrasupercritical Coal-Fired Boilers—Titanova, Inc, 12724 Pennridge Drive, Bridgeton, MO 63304;
314-209-0071
Mr. John M Haake, Principal Investigator; johnhaake@titanovalaser.com
Mr. John M Haake, Business Official; johnhaake@titanovalaser.com
DOE Grant No. DE-FG02-08ER84958
Amount: $750,000

The future use of coal, which is projected to remain a mainstay of energy consumption well into the 21st century, will require efficient, low emission ultra-supercritical coal-fired boilers. The high operating temperature, along with the oxidizing, corroding, and slag-deposition-induced microclimate environment of these systems have generated a critical need for new cladding techniques. Due to the high cost of the alloys used for cladding, this project will develop reduced-thickness cladding materials that maintain their high temperature corrosion resistance. Phase I developed and demonstrated a high-power diode laser cladding process that yielded low-dilution high-performance alloy clads that were less than 750microns (0.030”) in thickness. Very thin and smooth low-slag-adhesion clad layers of alloy C22 were welded onto supercritical tube components at economical deposition rates. Phase II will develop laser cladding processes for ultra-supercritical alloys (IN72, IN52, Alloy 33), test these corrosion resistant alloys at temperatures exceeding 760°C, and code-certify the processes for pressure tubing and water wall panels. Manufacturability will be enhanced via improvements to the laser cladding nozzle and power feeder, laser cladding optics, and overall laser system robustness.

Commercial Applications and other Benefits as described by the awardee: For supercritical coal-fired boilers, the technology should satisfy the demand for cladding of super heater and reheater pipe, tubes and panels, and upper and lower water wall components. These techniques also should find use in critical nuclear power plant infrastructure, military combat and transportation vehicle engines, and drive train components for our war fighters and peacekeepers.

85544S08-II

Demonstration of Advanced Technology for Surface Processing of Oil Shale—Combustion Resources, 1453 West 820 North, Provo, UT 84601-1343; 801-374-5474
Dr. L. Douglas Smoot, Principal Investigator; dsmoot@crllc.com
Dr. Craig N. Eatough, Business Official; ceatough@crllc.com
DOE Grant No. DE-FG02-08ER84951
Amount: $749,934

U.S. and world petroleum supplies are limited, causing substantial increases and fluctuations in the cost of liquid fuels and national energy insecurity. If the vast western oil shale reserves could be economically and cleanly recovered, the country's transportation fuel problems would be alleviated. Earlier shale surface processes used complicated and costly equipment, released substantial CO_2, had high water use, and produced oil that required upgrading. This project will develop a new surface process technology that is simple and clean, and can be commercialized in a shorter time. Phase I yielded a unique surface process with high processing capacity, on-site oil upgrading, and near-zero carbon dioxide emissions. Lower costs resulted from process simplicity, the use of nearby low-cost natural fuels for process energy, the use of hydrogen for upgrading, and very low water use. Phase II plans include (1) a full pilot-scale demonstration, including shale oil recovery and separation units; (2) a demonstration of technology for upgrading shale oil to transportation fuels; and (3) planning and design for scale-up to a commercial-scale kiln, including the identification of commercialization paths.

Commercial Applications and other Benefits as described by the awardee: The technology should lead to the commercial production of on-site shale oil, with low water use and near-zero CO2 emissions, for the domestic production of transportation fuels. Plans to process 1000 tpd shale fines, in order to enhance a commercial 6000 tpd shale plant in eastern Utah, are currently being evaluated by a major international oil company.