Abstracts of Awards for Fiscal Year 2001 NIST SBIR Program

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FY 2001 Phase I Award

**Topic:** 7.02 Advanced Building Materials and Systems

**Subtopic:** 7.02.05 Development of Moisture Sensor for Building Envelopes

**Title:** Optical Fiber-Based Sensors for In-Situ Measurements of Moisture within Building Envelopes

**NIST OU:** 860

**Firm:** Luna Innovations Incorporated
2851 Commerce Street
Blacksburg,   VA  24060-6657

**Principal Investigator:** Mark Jones
**Phone:** (540) 953-4274

**Award Amount:** $74,993.00

**Abstract:** The presence of moisture in inaccessible building regions can lead to paint failure and rotting that reduces property values and creates dangerous habitat environments.  Secondarily, the presence of moisture can lead to mold growth with allergenic and toxic properties that present a significant health risk.  Diagnosis may include measurement of the moisture content of building materials, as well as measurement of water infiltration through the exterior barrier.  The current tools available for diagnosis are limited to bulky, electrical-based sensors that are not optimal for embedding in small crevices and often produce unreliable results over long-term evaluation.  To address the need for robust sensors and instrumentation to measure moisture content within building envelopes, Luna Innovations proposes to develop low profile, low cost, optical fiber-based instrumentation for in-situ simultaneous measurements of humidity and temperature, within inaccessible regions of buildings.  The proposed system will enable remote detection in an embeddable, multiplexed format, and offer a low cost solution that can be used in may commercial and industrial structures and meets the competitive price points of the housing industry.

**Commercial Applications:** The ability to measure moisture content and temperature gradients within inaccessible regions of infrastructures has many commercial and government applications.  In addition to providing a tool to the building research community, the proposed sensing system will also find widespread applications in structural health monitoring of composite structures, pipelines, bridges, and environmentally sealed electronic housings.

FY 2001 Phase I Award

**Topic:** 7.03 Advanced Detection and Suppression of Fires

**Subtopic:** 7.03.03 Fire Fighter Imaging

**Title:** A Low Cost Viewer for Fire Fighters

**NIST OU:** 860

**Firm:** En'Urga Inc.
1291-A Cumberland Avenue
West Lafeyette, IN  47906-1385

**Principal Investigator:** Yudaya Sivathanu
**Phone:** (765) 497-3269

**Award Amount:** $75,000

**Abstract:** This Phase 1 proposal seeks to evaluate the feasibility of a low cost infrared viewer for fire fighters.  There are four distinct components that comprise the novel infrared viewer. The first is a Nipkow disc, which allows a two dimensional scene to be scanned by a single element detector. The second is a four state thermoelectrically cooled lead selenide detector that is sensitive in the most appropriate part of the infrared spectrum for fire fighting applications. The third is a low cost infrared diode that is used for illuminating the fire scene. The fourth is a advanced single board processor that converts the analog signal from the single element detector into a NTSC compatible signal for direct viewing by a helmet mounted display panel. These four key components will allow the fabrication of an infrared fire fighter imager at less than thousand dollars, making a suitable for fire fighting applications.  During the Phase 1 part of the project, the feasibility utilizing a Nipkow disc with a single element detector to reliably image a two dimensional scene will be evaluated. During the Phase 11 part of the project, a prototype viewer will be fabricated and evaluated in a large scale fire experiment.

**Commercial Applications:** There are two potential uses for the proposed viewer.  The first is that firefighters can use it to locate and rescue fallen comrades and victims in fire fighting scenarios.  Currently, most fire departments do not have infrared viewers for every single fire fighter due to their high cost.  The second potential use is in industrial process monitoring.  For example, infrared viewers can be used power plants to ascertain the degree of slagging of the boiler pipes.  The proposal low cost infrared viewer will have instant acceptability for a wide ranging of monitoring applications in process industries.

FY 2001 Phase I Award

**Topic:** 7.04 Condition-Based Maintenance

**Subtopic:** 7.04.03 Development and Integration of Condition-Based Maintenance Technologies

**Title:** Development of a Intelligent Condition Based Maintenance System

**NIST OU:** 820

**Firm:** VerTech LLC
15470 Riddle Road
Chagrin Falls, Ohio  44022-3943

**Principal Investigator:** William H. VerDuin
**Phone:** (440) 247-8315

**Award Amount:** $74,973.26

Abstract: An opportunity exists to develop an Intelligent Condition Based Maintenance System (ICBMS) to provide "early warning" of equipment maintenance needs.  Adaptive process models will estimate changes in machine health from analysis of sensor inputs and machine usage.  A troubleshooting and repair knowledge base will provide advice on maintenance scheduling and procedures, and thus support ongoing operations and training of new staff.  ICBMS will minimize the cost and disruption of maintenance, repair and unscheduled downtime.  Innovations include the use of advanced modeling technologies including neural nets to provide "virtual sensors" and to estimate critical but unmeasurable process and machine health parameters and other available information.  Our Automated Knowledge Acquisition technology will extract structured rules by analyzing operational decisions and problem solving approaches provided by machine operators and maintenance staff.  Objectives include preliminary process modeling, acquisition of troubleshooting and maintenance expertise suitable for automated knowledge extraction, and a preliminary conceptual design of ICBMS outlying system elements integration strategies and functionality.

Commercial Applications: Failure prediction and intelligent scheduling of maintenance and repair for: (1) rotating machinery, including power generation, machine tools, propulsion systems, (2) thermal processes, (3) electromechanical systems, (4) high performance/extreme conditions systems

FY 2001 Phase I Award

**Topic:** 7.05 Infrastructure Security (Electronic Commerce)

**Subtopic:** 7.05.01 Automated Techniques for Syntactic Web Usability Evaluation

**Title:** Development of an Intelligent Assistant for Web Usability Design

**NIST OU:** 890

**Firm:** UserWorks, Inc.
1738 Elton Road, Suite 138
Silver Spring, MD  20903

**Principal Investigator:** Richard L. Horst
**Phone:** (301) 431-0500

**Award Amount:** $74,991.00

**Abstract:** Usability is increasingly being recognized a s a distinguishing aspect of successful applications on the web.  Many web design tools are available but most offer no guidance to the user as to how to design for usability or accessibility.  A number of syntactic evaluation tools, allowing an automated scan of the code and inferences about possible usability or accessibility shortfalls have been developed, including the WEBSAT tool developed by NIST, but all are limited in their scope and applicability.  The present effort will delineate the need for and conceptualize and overall design for an Intelligent Assistant for Web Usability Design.  This Assistant would include a syntactic analyzer, perhaps incorporating WEBSAT, but would extend the functionality by providing the web developer with more extensive design suggestions or guideline resources in a context sensitive manner.  The Phase 1 project will culminate in a working proof of concept demonstration of this Intelligent Assistant, illustrating the approach, architecture, and look and feel.

**Commercial Applications:** The envisioned Intelligent Assistant should be of interest to practically all web designer/developers, particularly those working on products for competitive markets where usability and accessibility might determine success. This software tool would be used by the developer, either in conjunction with or embedded in, other design tools. It might be commercialized either as a standalone tool or licensed to web design tool vendors.

FY 2001 Phase I Award

**Topic:** 7.05 Information Infrastructure Security (Electronic Commerce)

**Subtopic:** 7.05.05 Mobile Code Policy Toolkit

**Title:** Inlined Reference Monitors for Java Bytecode

**NIST OU**: 890

**Firm:** GrammaTech, Inc.
317 North Aurora Street
Ithaca, NY 14850

**Principal Investigator:** Dr. Paul Anderson
**Phone:** (607) 273-7340

**Award Amount:** $74,899.00

**Abstract:** Current state of the art technology for specifying and enforcing security policies for software is generally too inflexible and coarse-grained. In systems that make use of mobile code, such as Java applets, the situation is yet more difficult. A more flexible and powerful approach is needed that will allow a wide range of security policies to be set by various policy-setting authorities for different applications. We propose to commercialize mechanisms for specifying and enforcing security policies for mobile code that work by inserting fragments of code into programs in order to monitor their state and prevent them from violating security policies. The proposed system will allow arbitrary policies to be specified independently by different policy-setting authorities. We will apply this approach, named Inclined Reference Monitors(IRMs), to Java bytecodes. We believe that advanced static-analysis techniques, in particular those embodies in our own dependence-graph technology, are crucial to allow this to be done efficiently and fully automatically.

Commercial Applications: The software proposed has applications in computer security policy specification and enforcement.

FY 2001 Phase I Award

**Topic:** 7.06 Integration of Manufacturing Applications

**Subtopic:** 7.06.02 Discrete Event Simulation Reference Data Set

**Title:** Selection of Probability Distributions of Discrete-Event Simulation Models

**NIST OU:** 820

**Firm:** Averill M. Law and Associates, Inc.
2601 N. Campbell Avenue, Suite 110
Tucson, Arizona 85719-3163

**Principal Investigator:** Averill M. Law
**Phone:** (520) 795-6265

**Award Amount:** $73,600.00

**Abstract:** Discrete-event simulation is used by thousands of companies to design new manufacturing systems and to improve the performance of existing ones. Manufacturing systems contain numerous sources of randomness such as machine times to failure and machine repair times, which greatly impact on system performance. If each source of system randomness is not modeled by an appropriate probability distribution, then it is highly likely that the simulation model will produce erroneous performance results, resulting in costly decisions.

If the system of interest exists in some form, then it will often be possible to collect date and to use statistical techniques to determine an appropriate probability distribution. However, if the system does not exist, then collecting date is impossible and an analyst is forced to use a somewhat arbitrary distribution.

To address this real and important problem, we propose a Phase 1 research study to determine the technical feasibility of developing (in Phase 2) a library of probability distributions that would be appropriate for difference common sources of randomness encountered in simulation models of manufacturing systems.

**Commercial Applications:** The research is directly applicable to discrete-event simulation of manufacturing systems when data on system randomness (times to failure, times to repair, processing times, etc.) are not available - a commonly occurring situation. The results of the research will be implemented in a computer program in Phase 3.

FY 2001 Phase I Award

**Topic:** 7.09 Microelectronics Manufacturing Infrastructure

**Subtopic:** 7.09.05 Cryogenic Packaging for Programmable Voltage Standards

**Title:** A Closed Cycle Refrigerator-based, Programmable Voltage Standard System

**NIST OU:** 810

**Firm:** HYPRES, Inc.
175 Clearbrook Road
Elmsford, NY 10523-1109

**Principal Investigator:** Robert Webber
**Phone:** (914) 592-1190

**Award Amount:** $74,957.00

**Abstract:** Researchers at the NIST have demonstrated a programmable Voltage Standard (VS) chip based on SNS (superconductor-normal-superconductor) tunnel junction technology. Excellent programmable VS were demonstrated using this SNS technology in a liquid helium-based system. At HYPRES, we have developed and commercialized a Closed Cycle Refrigerator (CCR\_-based DC Voltage standard system using a VS chip previously developed and integrated into a liquid helium-based system at NIST. Under this program, we propose to develop a high performance cryogenic package for this programmable VS chip for integration with a CCR system. This developmental work will involve collaborations between HYPRES, NIST and Dr. Clark Hamilton to develop the package and integrate it with a NIST-provided CCR. In Phase 1 of the program, we deliver the complete cryogenic package to NIST upon completion of the program. In Phase 2, HYPRES will procure a CCR system and develop and demonstrate a complete CCR-based programmable VS system. This system has many other applications such as D/A converters and signal synthesizers. Phase 1 will establish the feasibility of the concept and Phase 2 will lead to a prototype system.

Commercial Applications: Metrology laboratories around the world, high precision instrumentation companies, and the military form a fairly large existing customer base for the new, efficient, programmable voltage standard. The D/A applications are numerous, including signal synthesizers, spectroscopy, and high accuracy instrumentation for signal processing.

FY 2001 Phase I Award

**Topic:** 7.09 Microelectronics Manufacturing Infrastructure

**Subtopic:** 7.09.07 Precision Optical Current Sensor

**Title:** Precision Optical Current Sensor

**NIST OU:** 810

**Firm:** Precision Lightwave Instruments
9232 N. Invergordon Road
Paradise Valley, AZ 85253

**Principal Investigator:** James Blake
**Phone:** (602) 538-7442

**Award Amount:** $75,000.00

**Abstract:** Optical current sensing has been in development for over a decade, and is beginning to grow in commercial popularity. Fiber optic current sensors developed at Honeywell, based on the Sagnac interferometer have demonstrated accuracy of better than 300 ppm over the temperature range -40 to +60 deg. C. This Technology has been made available to Precision Lightwave Instruments. In this program, we will build on this technology base, using the sensor architecture to realize a device that senses both rotation in inertial space and electrical currents flowing through a fiber optic sensing coil. By having a device that responds to both stimuli, we can tie the measurement of electrical current to the measurement of rotation. The final goal of this program is to construct a new optical current check standard for currents in the range 1 A to 10kA with uncertainties less than 10 ppm. The goals of Phase 1 are to build, test, and deliver a prototype capable of achieving 100 ppm stability,and to complete error analysis and design modifications for a Phase 2 build of a 10 ppm sensor.

**Commercial Applications:**
1. Supplying optical current sense-check standards to measurement labs.
2. Manufacture of high accuracy OCT's for the electric power industry

FY 2001 Phase I Award

**Topic:** 7.11 General

**Subtopic:** 7.11.03 Advanced Time-Resolved Planar Velocity Diagnostics for Spray Flames

**Title:** High Frequency, Time-Resoved Digital Particle Image Velocimetry System for Combustion Induced Flows

**NIST OU:** 830

**Firm:** Aeroprobe
2000 Craft Drive, Suite 1104
Blacksburg, VA 24060

**Principal Investigator:** Dr. Pavlos P. Vlachos
**Phone:** (540) 951-3858

**Award Amount:** $74,398.00

**Abstract:** A few years ago, an effort launched by members of this group to perform very high frequency Digital Particle Image Velocimetry (DPIV) measurements, resulted in a system capable of acquiring data with up to 1000Hz. A spectacular opportunity has recently emerged that will allow us to make a leap forward in DPIV technology. Speed and resolution of the new generation of cameras has increased by one order of magnitude. In short time, cameras will be available with maximum speed up to 60,000 frames-per-sec and maximum resolution of 1K x 1K pixels. It is proposed to capitalize on our previous experience and on recent technological advances to perform research towards the development of a system able to resolve turbulent multiPhase flow fields with frequencies of 4KHz or more. Emphasis is placed in this project on technology validation, demonstration and comparison of the proposed system with conventional well-established methods. In addition, great consideration will be given in the maturation of the technology and its transition all the way from research and development, in laboratory and industry applications.

**Commercial Applications:** There is no system commercially available today that can perform non-intrusive spatio-temporal measurements, with 4KHz frequency and the ability to resolve mult-Phase flow fields. It is believed that upon successful completion of the proposed work, a unique tool for the analysis of complex flows will be delivered. This tool will be useful to all types of basic research in fluid mechanics. Moreover it could prove valuable to all types of industries related to applications of fluid mechanics (i.e. aerospace, aeronautics, marine, power-generations ect).

FY 2001 Phase I Award

**Topic:** 7.11 General

**Subtopic:** 7.11.04 Integrated Omni-Directional Traversing Probe System for Mapping the Flow Field Within High-Temperature Reactors

**Title:** A Fast Omni-Directional Velocity-Temperature Probe for Hostile Flow Environments

**NIST OU:** 830

**Firm:** Aeroprobe Corporation
2000 Kraft Drive, Suite 1104
Blacksburg, VA 20460

**Principal Investigator:** Matthew D. Zeiger
**Phone:** (540)951-3858

**Award Amount:** $74,963.00

**Abstract:** Laser-Doppler velocimetry (LDV), particle-image velocimetry (PIV) and hot-wire anemometry (HWA) are the methods which are most often used in a laboratory environment to measure flows at high frequency. However, these systems have drawbacks in industrial settings such as intolerance to particulate flows (HWA) or two-Phase flows (LDV, HWA), requiring optical access (LDV, PIV), etc. Moreover are very expensive and require extensive training.

Aeroprobe has funded the development and recently licensed technology for the exclusive marketing of the Omniprobe, a nearly omni-directional multi-hole velocity probe capable of measuring reversed flows. Aeroprobe is proposing to push the multi-sensor probe technology envelope further by developing Omniprobes that have high frequency response, can withstand high temperatures and can operate in dusty environments, or in sprays. It is proposed to develop probes to meet one of the three challenges at a time, then combine the advances in the three technologies into one probe at a later Phase of the effort. A high-frequency Omniprobe requires that appropriate sensors be mounted near the surface of the probe. Surface mounting of the sensors will also increase the probe's ability to operate in dusty environments. High-temperature sensors of the MEMS-type and new cooling techniques for these sensors will be employed.

**Commercial Applications:** Aerospace Corporation is the leading manufacturer of multi-sensor velocity probes. Aeroprobe products are now employed by Boeing, Lockheed, Aurora Flight Sciences, and Orbital Sciences Corporation and other industries as well as universities and Government labs such as NASA, NSWC, NREL, and DIAL. Aeroprobe Corp. has been very successful in bringing this technology to non-aerospace industry as well, as it has placed units with ICI Films, Norton Inc. Shell development Co., Ford Motor Co., and United Technologies. It is believed that if the proposed work is carried out successfully, the Company will be able to market the new sensors to many of its present customers. Aerospace customers have repeatedly asked for measurements at higher frequency, and many of our industrial customers need probes for measurements in high-temperature hostile environments. There is truly nothing in the market now that could meet these needs.

FY 2001 Phase I Award

**Topic:** 7.11 General

**Subtopic:** 7.11.09 Three-Dimensional Imaging System for Low Activity Brachytherapy Sources

**Title:** A Slot Camera Imaging System for the Characterization of Line Brachytherapy Sources

**NIST OU:** 840

**Firm:** NeuTek
13537 Scottish Autumn Lane
Darnestown, MD 20878-3990

**Principal Investigator:** Dr. Yu-tarng Cheng
**Phone:** (301) 948-8172

**Award Amount:** $75,000.00

**Abstract:** More than 20 years after the advent of balloon angioplasty restenosis remains a major health risk and cost burden. Success in animal trials and treatments in other non-malignant lesions using radiotherapy has established a new branch of medical science, intravascular brachytherapy (IVB) in treating restenosis. In just over 6 years since the first application, there are today more than 500,000 operations a year in USA alone. Successful treatment will depend critically on the delivery of proper radiation dosage to the vascular site. Radioactive strength and uniformity of the IVB sources used are of primary concern. This program takes a sensitive, well proven radiation detection technology and couples it to an innovative imaging approach for the characterization of IVB line/seed-train sources. The end product is a fast, accurate and low-cost 3-D imaging systems for the profiling of IVB line sources. A 2-D system will be tested in Phase 1 for both gamma and ß IVB sources. The results will be used for the design of a 3-D system to be constructed in Phase 2.

**Commercial Applications:** This proposed radiation imaging technique will provide IVB manufacturers and practitioners a fast, accurate and low-cost mean to acquire the critical information on the strength and uniformity of an IVB line source. The technique is equally applicable to other types of medical radioactive sources, including brachytherapy sources in general. It is anticipated that the IVB field will continue its fast pace of growth and so will the demand for measurement technologies such as the one proposed here.

FY 2001 Phase I Award

**Topic:** 7.11 General

**Subtopic:** 7.11.12 Ultraviolet Detectors and Optical Components

**Title:** High Performance Far Ultraviolet Matrix Sensor by Micromachining

**NIST OU:** 840

**Firm:** LEEOAT Company
2631 Colibri Lane
Carlsbad,CA 92009

**Principal Investigator:** Dr. Eli Wiener-Avnear
**Phone:** (760) 438-1439

**Award Amount:** $75,000.00

**Abstract:** In Phase 1 of the SBIR program, LEEOAT company will develop and optimize the conceptual design and the fabrication process of the far ultraviolet focal-plane-array detector and readout system. Additionally, we will theoretically model the detector and readout system and reduce-to-practice the crucial elements of the innovation. We will estimate the cost/effort for the fabrication and testing of a prototype in Phase 2 of the SBIR program.

**Commercial Applications:** The development of the high-performance ultraviolet focal-plane-array detector with high discrimination against gamma rays will open a large window of opportunity with an estimated annual market of $40M.

FY 2001 Phase I Award

**Topic:** 7.11 General

**Subtopic**: 7.11.13 Two Dimensional Detection of Neutrons with High Spatial Resolution, High Dynamic Range and Low Noise

**Title:** Solid State Thermal Neutron Detectors Based on Boron-Doped Amorphous Selenium

**NIST OU:** 850

**Firm:** EIC Laboratories, Inc.
111 Downey Street
Norwood, MA 02062-2612

**Principal Investigator:** Dr. Krishna Mandal
**Phone:** (781) 769-9450

**Award Amount:** $75,000.00

**Abstract:** Thermal neutrons are among the most useful probes for investigation of the structural, magnetic and acoustic properties of materials. Current methods of thermal neutron detection by large cumbersome gas counters or scintillator-photomultiplier tube combinations are limited by their detection efficiency, stability of response, speed of operation, and physical size. To address these needs, EIC plans to construct a large-area, lightweight, high-resolution, and very fast position sensitive thermal neutron detector based on a highly B-doped a-Se (As, Cl) alloy semiconductor. The proposed detector would offer high detection efficiency over existing instruments, and would be inexpensive for industrial mass production. The Phase 1 project will focus on the development and optimization of the B-doped a-Se alloy materials, detector fabrication, and performance evaluation by radiation testing. The Phase 1 research will establish the basic feasibility studies followed by various characterizations to reach optimum detector performance. The resulting detectors will be compact, low power consuming devices, highly sensitive, and rugged. The developed detectors will find widespread use in nuclear non-proliferation, radiation safety, structural characterization in materials research, protein dynamics, monitoring chemical and biological reactions in "real time", and in characterizing polymer surfaces.

**Commercial Applications:** The resulting detectors will be compact, highly sensitive and rugged. The fabricated detectors will be useful for many applications in national nuclear physics laboratories including NIST. Techniques utilizing thermal neutron detectors will include neutron diffraction for structural biology, neutron scattering measurements, transmission imaging, and neutron tomography.

FY 2001 Phase I Award

**Topic:** 7.11 General

**Subtopic:** 7.11.14 High Efficiency Wavelength Dispersive X-ray Fluorescence Detectors

**Title:** Wavelength Dispersive Fluorescence Detectors in Soft X-ray Region

**NIST OU:** 850

**Firm:** HD Technologies, Inc.
7900 South Cass Avenue, Suite 255
Darien, IL 60561

**Principal Investigator:** Ke Zhang
**Phone:** (630) 241-9737

**Award Amount:** $74,951.00

**Abstract:** A wavelength dispersive x-ray fluorescence detector working in soft x-ray region has been proposed based on the diffraction principles of multilayers. Using graded multilayers, the detectors can be made tunable in a wide energy region, just the same way as the detector constructed for hard x-rays. The detector uses multilayers as analyzers to achieve good energy resolution and to avoid count rate problems encountered by solid state detectors. Initial evaluation shows that it is possible to achieve an energy resolution of 10-30 eV at 600 eV to 1KeV range. The proposed array detector will be able to cover 5 to 10% of solid angle at a reasonable cost. Phase 1 project will evaluate the performance of multilayer detector with various deposition and design parameters. A multilayer detector, containing 2-3 multilayer elements, will be fabricated and fully tested. Phase 2 will optimize the design based on the Phase 1I result, and a multilayer analyzer array detector will be constructed and tested.

**Commercial Applications:** The project covers the research and development of x-ray fluorescence detectors in soft x-ray region. With superb energy resolution, reasonable solid angle, and very large count rate limitations, it will have a better market potential than non-energy resolving detectors and solid state detector currently available. With different deposition and design parameters, the multilayer detector can be tailored to satisfy various applications.

FY 2001 Phase II Award

**Topic:** 8.8 Advanced Detection and Suppression of Fires

**Subtopic:** 8.08.07 Fire Fighter Locator

**Title:** Ultra-wideband Wireless Fire Fighter Locator

**NIST OU:** 860

**Firm:** Intelligent Automation, Inc.
7519 Standish Place, Suite 200
Rockville, MD 20855

**Principal Investigator:** Dr. Leonard Haynes
**Phone:** (301) 222-0450

**Award Amount:** $300,000.00

**Abstract:** The key innovation of this proposal is the use of Time Modulated Ultra-Wideband (TM-UWB) technology to develop a low cost radio system that allows both voice communication and tracking positions of fire fighters inside buildings. This radio has several characteristics which make it ideal for tracking multiple individuals without line-of-sight. During Phase 1 we have performed many tests, including basic ranging, 3-D position determination, communication through fire, smoke, steam, and different kinds of walls. We have developed a new system architecture to track the location of a fire fighter, which is more scalable, less sensitive to errors due to multipath and wall penetration than the multilateration based scheme, and does not require clock synchronization. This scheme uses a two-antenna array which transmits two consecutive TM-UWB pulses. The fire fighter carries a receive-only TM-UWB tag which will receive these pulses. By measuring the Time Difference of Arrival (TDOA) of these pulses, the mobile unit can calculate the Angle of Arrival (AOA), which in turn gives the 3-D location. During Phase 2, we will conduct more extensive tests to characterize the multipath effects, noise problem, material penetration, etc. We will implement the AOA architecture and construct prototype tags and a base unit.

**Commercial Applications:** The potential market for a technology able to track persons in buildings is very large. We have initially segmented that market in accordance with our current thrusts into "fire-fighting" and "military" applications. IAI has had extensive discussions with its partner company Time Domain Corporation and with three other companies with specific interest in the commercialization of this technology. These companies are Golden West Communications; On Scene, Incorporated; and Sage Technologies, Incorporated. An enclosed letter from Golden West Communication commits $100k of in-kind support during Phase 2, and $500k during Phase 3 to support the development of TM-UWB radios and position location tracking systems for fireman, police, and similar applications. a similar letter from OnScene, Inc., commits $70,000 in-kind during Phase 2 and $500,000 during Phase 3.

FY 2001 Phase II Award

**Topic:** 8.8 Advanced Detection and Suppression of Fires

**Subtopic:** 8.08.10 Drop Size and Velocity in Industrial Fire Sprinklers

**Title:** Real-time Technique to Measure Particle Size and Velocity of Polydisperse Sprays with Large Dynamic Size Range

**NIST OU:** 860

**Firm:** MetroLaser, Inc.
18010 Skypark Circle, Suite 100
Irvine, CA 92614-6428

**Principal Investigator:** Dr. Cecil F. Hess
**Phone:** (949) 553-0688

**Award Amount:** $299,969.00

**Abstract:** This is a Phase 2 proposal to develop an instrument to simultaneously measure particle size, velocity, and concentration in applications characterized by a large size range and high particle concentration. The instrument will be based on the Pulse Displacement Technique whose feasibility was demonstrated during Phase 1. Experiments performed during Phase 1 demonstrated a high accuracy in measuring spherical particles and the ability to measure nonspherical particles undergoing oscillation. The technique bases its measurement on accurate time-domain algorithms that are immune to fluctuations in laser intensity. The Phase 2 work will consist of developing a system prototype including all the hardware and software for real-time measurement of sprays, system testing with known-size particles, and system testing with realistic sprays. Phase 1 measurements with calibrated glass beads and calibrated liquid sprays showed a remarkable accuracy that placed the measurement within the particle manufacturer's tolerances. Based on the results of Phase 1 we anticipate that the system prototype will be able to measure the size of 10 µm to 4 mm and a downpour of 200 cm/hr as stated in the solicitation.

**Commercial Applications:** The laser-based technique proposed here should have broad commercial applications given its large dynamic range and its abilities to measure either liquid or solid particles. Potential users include industries and Government agencies interested in spray atomization and powder technology such as food, pulverized coal combustion, and sand blasting.

FY 2001 Phase II Award

**Topic:** 8.11 Intelligent Control

**Subtopic:** 8.11.02 Simulation and Animation Tools Supporting RCS Control Systems Development

**Title:** Intelligent Software and Animation Tools for RCS Architecture Based Development

**NIST OU:** 820

**Firm:** Pathway Technologies Incorporated
510 Township Line Road, Suite 110
Blue Bell, PA 19422

**Principal Investigator:** Ananthakrishnan (Andy) Suri
**Phone:** (267) 625-3292

**Award Amount:** $300,000.00

**Abstract:** Based on the outline for a theory of intelligence, and using NIST's hierarchical real-time control system (RCS) architecture, in Phase 1, we developed proof-of-concept OpenSim and OpenAnimation toolboxes consisting of the following innovations, namely, (i) Simulation and Animation Software Design that will seamlessly interface with RCS Hierarchy, (ii) Knowledge hierarchy consistent with the four key paradigms and four key elements of the theory of intelligence, (iii) Identification of an extensive collection of simulation models and algorithms that will lead to implementation level software for the knowledge hierarchy, (iv) Real-time Simulation that reduces computational load through efficient numerical algorithms, intelligent dynamic modeling, and real time planning, and (v) Structured Approach to GUI and Animation Development. Unlike existing software tools that cover one or two aspects of intelligent systems design and implementation, OpenSim & OpenAnimiation toolboxes provide a unified environment for design and rendering of intelligent systems with features that allow seamless transition from non real-time simulation to real-time simulation and subsequent hardware testing using industry standard mechatronics hardware. In Phase 2 we will develop detailed software that incorporate the innovations described above leading the commercial OpenSim and OpenAnimation toolboxes.

**Commercial Applications:** OpenSim and OpenAnimation toolboxes will be well suited for real-time simulation and hardware-in-the-loop testing using commercial vendor boards such as dSPACE, PC 104 and DSP boards. Our tools, because of its open, modular, hierarchical, and structured approach can provide an easy means of developing real-time interface to these types of boards and other vendor software. With increasing focus on integrated mechatronic systems that control several subsystems, there is wide application scope for the software in automotive, aerospace, and manufacturing industry. We believe that our innovations will lead to a unique real-time environment for design and testing of large-scale intelligent systems.

FY 2001 Phase II Award

**Topic:** 8.11 Intelligent Control

**Subtopic:** 8.11.08 X-ray Optics for Spectrometers in X-ray Microanalytical Systems

**Title:** Improve X-Ray Microanalysis in Low-Vacuum and Environmental Scanning Electron Microscope Systems by using Monolithic Polycapillary X-Ray Optics

**NIST OU:** 830

**Firm:** X-Ray Optical Systems Inc.
30 Corporate Circle
Albany, NY 12203-5619

**Principal Investigator:** Dr. Ning Gao
**Phone:** (518) 464-3334 x 212

**Award Amount:** $298,963.00

**Abstract:** This SBIR Phase 2 project will significantly improve the quality of elemental analysis in SEMS under partial pressure conditions by using a polycapillary x-ray optic in front of the energy dispersive spectrometer (EDS) in low-vacuum scanning electron microscopes (LV-SEM) or environmental SEMs (ESEM). LV-SEMS and ESEMs are designed to work at elevated sample chamber pressures to allow analysis of nonconductive or moist specimens. An undesirable consequence results from the broadening electron beam due to the presence of the gas. This degrades the elemental-detection sensitivity, because the fluorescent x rays generated far from the center of the electron probe create high background. It also greatly reduces spatial resolution for elemental mapping. The Phase 1 results have successfully demonstrated the feasibility of the proposed approach. In the Phase 2, a fully-functional prototype polycapillary optic-based EDS will be built and demonstrated in a commercial LV-SEM system. This will include an optimized polycapillary x-ray optic with a large collecting angle, optic detector mounting, detector-SEM mounting which provides fine alignment, an operating procedure, and examples of application data. The team involved world leaders in developing and commercially providing x-ray optics and EDS systems.

**Commercial Applications:** The additional of polycapillary optic between the sample and the detector has commercial applications for a focused beam analytical system applied to advanced microanalytical problems including materials, semiconductor devices and environmental applications. The immediate commercial application to be pursued by XOX and Thermo NORAN Instruments (EDS supplier)is the addition of a polycapillary optic to the EDS detector in ESEM and LVSEM systems.

FY 2001 Phase II Award

**Topic:** 8.13 Infrastructure for Distributed Electronic Commerce

**Subtopic:** 8.13.03 Infrastructure for Interoperable MPI (IMPI) Parallel Algorithms

**Title:** Collective, Performance-Oriented Algorithms for Interoperable MPI (IMPI)

**NIST OU:** 890

**Firm:** MPI Software Technology, Inc.
101 S. Lafayette Street, #33
Starkville, MS 39759-2946

**Principal Investigator:** Rossen Dimitrov
**Phone:** (662) 320-4300 x 21

**Award Amount:** $300,000.00

**Abstract:** This Phase 2 SBIR Project will provide optimization framework and technology for Interoperable Message Passing Interface Technology, and the underlying Message Passing Interface Standard. This effort represents a challenge and Opportunity. With the emergence of cluster computing, there are many opportunities to connect diverse parallel programming Environments based on the MPI programming model; currently interoperation is almost non-existent between such Environments. The IMPI standard by itself addresses basic interoperability, and the results of this effort will drive performance of collective communication higher, in order to promote wider use of interoperable MPI for demanding performance situations. Interestingly, the practical support for high performance interoperable MPI's, and collective operations places important Technical constraints on the underlying MPI implementations, including the ability to handle multiple network protocol stacks efficiently (called "devices" in MPI nomenclature). Proposer's underlying technology is particularly suited to adaptation to this task, moreso than are public-domain implementations of MPI.

The effort will lead to wider use of interoperable parallel programming environments through the IMPI standard, and will widen the space of potential applications of IMPI-oriented parallel programming to additional Commercially valuable applications which need support for such heterogeneity. Proposer will commercialize the technology Devised here through incorporation into MPI products.

**Commercial Applications:** Proposer already conducts its primary business activities in the area of parallel processing message passing software with Government, university and commercial clients in the United States and overseas. The added capability of the IMPI-tuner Described in this proposal would provide competitive advantage for situations where customers want to interoperate several Parallel machines or clusters, and demand high performance, which is becoming an increasingly high demand for Commercial and research uses of parallel clusters and parallel machines.

FY 2001 Phase II Award

**Topic:** 8.16 Microelectronics Manufacturing Infrastructure

**Subtopic:** 8.16.01 Co-axial Atomic Force Microscope Probes for Electrical Measurements

**Title:** Co-Axial AFM Probes for Near Field Microwave and Electrical Measurements

**NIST OU:** 810

**Firm:** Manufacturing Instrumentation Consulting company, LLC (MICC)
11000 Cedar Avenue, Suite 427
Cleveland, OH 44106

**Principal Investigator:** Jon Collister
**Phone:** (216) 721-8030

**Award Amount:** $299,924.00

**Abstract:** Scanning Probe Microscopy (SPM) has become a very popular tool in many areas of inquiry including surface science, semiconductor electronic devices and integrated circuit design and testing, biology and chip-tissue interface, to name a few. Here we propose to develop and commercialize a relatively new family of local probes capable of performing electromagnetic measurements with nearly atomic resolution over a wide frequency range covering up to 100 GHz. Potential applications of these so called near-field or evanescent probes (EMP) are in surface science, chemical sensing, molecular electronics and molecular spectroscopy, biological studies, quantum computing, IC industry and manufacturing quality control to name a few. Composed of a co-planar wave-guide terminated by an AFM compatible cantilever beam with a co-axial tip, these EMP's were designed and tested during a Phase 1I SBIR and the current proposal is to optimize the performance and fabrication technology. To facilitate their wide spread use by the SPM community, we will also develop a microwave instrumentation unit (MIU) that can be used to retrofit commercial SPM units and enable them to use our EMP's for microwave imaging of various specimens. We will also develop, design and fabricate a variety of calibration samples as standards for EMP calibration and quantification of its output signal. We have estimated that about 100 laboratories around the world would be interested in an add-on package and would be valued at $20000 for a total of $2,000,000. The market for replacement tips would be about 5000 tips at $100 per tip for a total market of $500,000 per year.

**Commercial Applications:** Quality Control of Semiconductors Microwave Imaging of biological materials, Quality control for the coating market.

FY 2001 Phase II Award

**Topic:** 8.16 Microelectronics Manufacturing Infrastructure

**Subtopic:** 8.16.06 Measurement of Trace Alpha-Radiation in Polymeric Microchip Material

**Title:** Alpha Detector with Active Background Suppression for Electronic Materials Characterization

**NIST OU:** 840

**Firm:** X-Ray Instrumentation Associates
8450 Central Avenue
Newark, CA 94560-3430

**Principal Investigator:** John E. Wahl
**Phone:** (510) 494-9020

**Award Amount:** $300,000.00

**Abstract:** As flip-chip bonding becomes the predominant standard in the electronics industry, the increased proximity between dice surfaces and packaging materials will require a significant reduction in the latter's alpha particle activity in order to avoid soft errors. Emission rates at or below 0.001 *a*/cm2/hr are desirable, which is well below the 0.0050 *a*/cm2/hr capability of today's best detectors. We have developed an active background suppression scheme that dramatically improves the performance of a gas-filled parallel plate chamber, yielding a sensitivity of 0.00017 *a*/cm2/hr. In Phase 2, we propose to design and build a prototype commercial detector using this scheme to achieve a sensitivity of 0.00005-0.0001 *a*/cm2/hr. To achieve this goal, we will improve both our background suppression scheme and the instrumentation on the detector. Phase 3 development would then be carried out at XIA to produce a marketable commercial detector.

**Commercial Applications:** The initial commercial application will be a detector for screening polymeric and other packaging materials for the electronics industry at 0.0001 *a*/cm2/hr activity levels. We will then work to replace the Si barrier detectors used for environmental and health physics screening applications since our background level will be over 100 times smaller and our active area 100 or more times larger.

FY 2001 Phase II Award

**Topic:** 8.16 Microelectronics Manufacturing Infrastructure

**Subtopic:** 8.16.10 High Speed/Low Power Magnetic Field Sensing Devices

**Title:** High Speed/Low Power GMR/SDT Devices for Magnetic Field Sensing

**NIST OU:** 850

**Firm:** NVE Corporation (formerly Nonvolatile Electronics, Inc.)
11409 Valley View Road
Eden Prairie, MN 55344

**Principal Investigator:** Dr. Dexin Wang
**Phone:** (952) 996-1608

**Award Amount:** $300,000.00

**Abstract:** This SBIR Phase 2 program will demonstrate prototype galvanic isolating devices of high-speed/low-power by incorporating high-speed magnetic films into giant magnetoresistive structures and by combining with high-speed IC electronics. The new devices will have five important improvements over existing devices, a factor of 10 faster, without a drive IC chip, a flip-chip approach, a lower supply voltage, and without incidental latching. High-speed magnetic films require less power to switch at the same speed in the ns range. The elimination of the driver chip will lower the power requirement, complexity and cost. Flip-chip technology will enhance the yield and provide a fast way for prototyping new devices at a low cost. A low voltage is intrinsic in reducing power and increasing speed. These improved isolating receiver and transceiver devices will meet the demand of the next generation high-speed data communications. Based on the results achieved in Phase 1I program, we plan to fabricate spin valve bridges using high-speed magnetic films, and make them compatible with fast IC electronics. The end devices will have the state of the art static properties, a high operating speed of 1 GBaud, a reasonably low budget, and a low cost.

**Commercial Applications:** There are several commercial applications for the devices proposed mainly for high-speed data communications, field bus isolation and telecommunication.

FY 2001 Phase II Award

**Topic:** 8.18 Photonics Manufacturing

**Subtopic:** 8.18.02 Actively Quenched IR Avalanche Photodiode

**Title:** SWIR Photon Counting Avalance Photodiode

**NIST OU:** 840

**Firm:** VOXTEL Inc.
2640 SW Georgian Place
Portland, OR 97201

**Principal Investigator:** James Gates
**Phone:** (503) 806-4041

**Award Amount:** $300,000.00

**Abstract:** High performance NIR APDs suitable for photon counting are presently unavailable. New high sensitivity, high speed photodetectors operating from 1.0 to 1.6 microns are needed for both military and commercial applications. New research has demonstrated APD structures, which use a Si multiplication region and an InGaAs absorption region. This device shows high sensitivity, very high speed, low noise and high temperature and voltage stability. However, the developed for high speed 1540 nm optical fiber communication, specifically high GB product, these APDs have high dark current (dark count) and low gain (10-20) and are not suited for lower speed photon counting applications. Our Phase 1 research identified new detector architectures suitable for photon counting:. These detectors provide high internal gain (50-500) and low dark current. The high gain can be achieved at relatively low bias (below breakdown) such that photon counting is possible without passive or active quenching. On Phase 2, we propose to fabricate the NIR photodiodes and monolithically integrate these detectors with low noise CMOS readouts by a new epitaxial layer process and calibrate the detectors at NIST facilities.

**Commercial Applications:** A NIR APD is well suited for applications that require high sensitivity and fast response times in the 1.Q to 1.8 micron spectral range. These include: communications systems, eye-safe laser detectors, confocal microscopy, particle detection, photon correlation studies, lidar, astronomical observation, optical range finding, optical fiber test and fault location, ultra sensitive florescence, etc.

FY 2001 Phase II Award

**Topic:** 8.20 Integration of Manufacturing Applications

**Subtopic**: 8.20.03 Ontological Engineering Applied to Manufacturing System Integration Research

**Title:** Broadening Effective Participation in Distributed Collaborative Ontology Development

**NIST OU:** 820

**Firm:** Stottler Henke Associates, Inc.
1660 S. Amphlett Blvd., Suite 350
San Mateo, CA 94402

**Principal Investigator:** Eric Domeshek
**Phone:** (650) 655-7242

**Award Amount:** $300,000.00

**Abstract:** As ever more of industry and commerce moves onto electronic networks, there is a growing appreciation for the usefulness of expressive general models of enterprise activities, such as design and manufacturing. Ontologies are commitments to formal declarative multi-purpose representations with clear semantics that can serve as a solid foundation for such models. While there has been much work on representation languages, and on tools for creating, browsing, editing, and translating expressions in such languages, there has been relatively little attention to supporting the larger process of figuring out what ought to be encoded in an ontology. Some existing tools support collaborative teams, but by and large they seem to assume that all team members will be AI experts and that the work will focus on generation and manipulation of formal expressions. In this project, we propose to develop a complete prototype of a Domain Expert Collaborative Ontology Development environment (DECODE) that ensures those who best understand the domain, but least understand the technology of ontology, can make necessary contributions to the development process. DECODE will support development of ontologies in the context of solving systems integration problems; this systems integrations payoff will help to motivate investment in ontology development.

**Commercial Applications:** By enabling effective participation in the ontology development process by those who actually understand the target domain and will use the ontology, this technology will lower the cost and increase the quality of ontologies developed to integrate functions in a particular organization.

FY 2001 Phase II Award

**Topic:** 8.21 General

**Subtopic:** 8.21.08 Fast-Scanning FTIR Spectrometer for Measurements In Spray Flames

**Title:** A Fast-Scanning FT-IR Emission/Transmission Spectrometer for Spray Combustion Diagnostics

**NIST OU:** 830

**Firm:** Advanced Fuel Research, Inc.
87 Church Street
East Hartford, CT 06108-3728

**Principal Investigator:** James R. Markham
**Phone:** (860) 528-9806 x 104

**Award Amount:** $299,701.00

**Abstract:** This subtopic solicited Phase 1 R&D for an advanced Fourier transform infrared (FT-IR) system that would provide fast-scanning high resolution (3 scans/sec at 1cm-1 resolution), low noise, mid-infrared measurements for characterization of spray flames. In Phase 1, Advanced Fuel Research, Inc. (AFR) demonstrated FT-IR emission/transmission (E/T) measurements from the NIST spray combustion facility at 7 scans/sec 1 at cm-1 resolution. Significant Phase 1 work designed the low noise optical system that could be coupled to the NIST spray chamber, and as expected, the high scan rate was successful in removing droplet/particle transit noise from interfering in the mid-infrared spectrum. Tomographic reconstruction of multiple lines of sight through a non-sooting spray flame provided spatially resolved (3 mm) measurements of multiple gas species concentrations and temperatures and initial qualitative information on fuel spray droplets. Phase 2 R&D will result in further improvements to the optics and coupling design. Spectral resolution is to be improved to 0.5 cm-1 and spatial resolution to 2 mm. Phase 2 will result in delivery and installation of an advanced FT-IR E/T system for routine use on the NIST spray combustion facility. NIST researchers will have the capability to non-intrusively probe and characterize the spray flame in more detail than ever before with a single instrument for gases, droplets and soot.

**Commercial Applications:** The instrument to be developed through Phase 2 will have wide applicability as a research and development tool in many areas of combustion. The Phase 2 installation at NIST will lead to a point of reference for other Government facilities and universities concerned with gas combustion and spray combustion diagnostics. Several applications of the measurement technology exists in private sector industries that are based on spray combustion, including the turbine engine industry and combustion boiler industry, flame assisted synthesis of commodity chemicals such as TiO2, SiO2 and Al2O3, and also in the synthesis of nanomaterials and deposition of high performance electronic materials. Improvements in process efficiency and quality can result in substantial energy, environmental, and manufacturing savings, thus making advanced diagnostics cost effective tools.

FY 2001 Phase II Award

**Topic:** 8.21 General

**Subtopic:** 8.21.22 Ultra High Efficiency Solid State Soft X-Ray Detectors for Low Z Fluorescence

**Title:** X-Ray Detectors for Low-Z Fluorescence Measures (No. 7241-050)

**NIST OU:** 850

**Firm:** Physical Sciences, Inc.
20 New England Business Center
Andover, MA 01810-1077

**Principal Investigator:** Willi G. Schwarz
**Phone:** (703) 941-0495

**Award Amount:** $299,895.00

**Abstract:** The goal of the proposed program is to develop detectors for X-ray fluorescence that have enhanced efficiency and energy resolution for low energy (<1 keV) X-rays. The better performance will be achieved through (1) determination of a process to reduce the "dead layer" in the crystal that, in existing detectors, limits the penetration of low energy X-rays into the active semiconductor material, and (2) realization of a process for depositing the window isolating the detector from the environment directly on the crystal. In Phase 2, a multi-element Si(Li) detector will be fabricated and tested. That detector is expected to have a collection efficiency at Carbon Ka (277 eV) a factor of two greater than current standard Si(Li) X-ray detectors and an energy resolution of <100 eV FWHM at 277 eV for 100 kcps total throughput.

**Commercial Applications:** (1) applications utilizing energy dispersive X-ray microanalysis with scanning and transmission electron microscopes, (2) industrial applications using X-ray tube fluorescence, (e.g., quality control of semiconductor wafer fabrication), and (3) fundamental materials research by fluorescing samples from a monochromatic synchrotron beam.