Abstracts of Awards for Fiscal Year 2005 NIST SBIR Program

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**FY 2005 Phase I Award**

**Topic:** 9.01 ADVANCED BIOLOGICAL AND CHEMICAL SENSING

**Subtopic:** 9.01.1-3 Instrument for Characterization of Environmental Soot

**Title:** Development of a High Sensitivity Laser-induced Incandescence Instrument for Characterizing Soot and Carbanaceous Particles

**NIST OU:** 830 Chemical Science and Technology

**Firm:** Artium Technologies, Inc.  
150 W. Iowa Avenue, Suite 202  
Sunnyvale, CA 94086-6184

**Principal Investigator:** Dr. William D. Bachalo  
**Phone:** 650-941-4233

**Award Amount:** $74,989.00   
  
**Abstract:** A high sensitivity laser-induced incandescence system is proposed for the detailed characterization of environmental soot. Specifically, innovative approaches have been proposed to (1) reduce the lower detection limit of soot volume fraction and increase the overall measurement range by an order of magnitude from what is currently achievable, and (2) provide PM particle size and number density measurement capability. The proposed LII technique will be capable of real-time particulate matter measurements over any engine transient operation. It will also have orders of magnitude more sensitivity than the gravimetric technique. The wide dynamic range and lower detection limit of LII make this technique a potentially preferred standard instrument for particulate matter measurements.

**Commercial Applications:** The primary application for the LII system is for monitoring the soot particulate emissions from vehicles (diesel and gasoline). Artium believes that the LII instrument could be used for enforcing EPA regulations on particulate emissions. A version of the instrument can also be used for R&D purposes. Specifically, this instrument will help engine manufacturers develop low emission engines and development of products by emissions control equipment manufacturers. Regulators looking for better measurements to develop new emissions regulations will find the LII system to be attractive. It will provide them with real time analytical capabilities for exhaust gas particulates, particularly diesel soot emissions. It is also expected that the LII method can be developed into a field portable compact rugged system that can make roadside measurements of diesel exhaust, be used in test centers for monitoring vehicle emissions, or installed on stationary power plants and operated remotely.

**FY 2005 Phase I Award**

**Topic:** 9.04 HOMELAND SECURITY

**Subtopic:** 9.04.1-2 Wireless Smart Sensor Network with Localization Capability

**Title:** Wireless Transducer Interface Module for Smart Sensor Network with Localization Capability

**NIST OU:** 820 Manufacturing Engineering   
  
**Firm:** Complete Test and Measurement Systems, Inc.  
720 S.W. 14th St.  
Loveland, CO 80537-6349

**Principal Investigator:** Victoria K. Sweetser  
**Phone:** 970-663-0006

**Award Amount:** $75,000.00   
  
**Abstract:** Homeland security and first responders need high quality & timely information upon which to make critical decisions. In a number of homeland security scenarios, the information will be a distillation of data gathered from an array of sensors. Such data can consist of temperature, vibration and the like along with the position of each sensor. This project proposes meeting this need through an innovative combination of GPS technologies and wireless sensors using the IEEE 1451 family of standards. Each sensor or actuator will connect to a Transducer Interface Module (TIM) that provides the necessary sensor communications capability. Each TIM contains standard GPS that will be augmented with a variation of differential GPS and inertial navigation to meet the positional accuracy requirements.

**Commercial Applications:** The Department of Homeland Security has a wide variety of people and places to protect - 240 cities over 100,000 residents, 213 commercial airports, 385 stadiums, water supplies, bridges, hospitals, schools and office buildings. The Department of Defense, the Transportation Security Administration, the Department of Energy and the EPA all have reasons to locate and neutralize hazards, particularly ones that may be in transit from one location to another. In Manufacturing, the earlier a problem is found, the less waste and rework result. Installing wireless sensors saves 2/3 of the cost of wired sensors because of reduced labor costs. OnWorld's research team projects a market of 165 million sensors worth $662 million in 2010.

**FY 2005 Phase I Award**

**Topic:** 9.03 HEALTHCARE AND MEDICAL PHYSICS

**Subtopic:** 9.03.1-5 An Optical Coherence/Multi-photon Fluorescence Microscope for Imaging of Tissue Engineered Medical Products (TEMPs)

**Title:** Design and Realization of a Dual Function OCM/MPM for Imaging TEMPS

**NIST OU:** 850 Materials Science and Engineering

**Firm:** Distant Focus Corporation  
60 Hazelwood Dr., Room 230  
Champaign, IL 61820-7460

**Principal Investigator:** Rick L. Morrison, PhD  
**Phone:** 217-384-8350

**Award Amount:** $74,884.00   
  
**Abstract:** Regenerative medicine is an emerging, interdisciplinary field that will result in new engineered medical products. The introduction of a high-resolution, non-destructive imaging technique that is capable of penetrating deeply into the highly-scattering scaffold medium has the means to accelerate the development and commercial utilization of these novel materials. Multi-photon microscopy (MPM) is based on the detection of the fluorescence emitted by endogenous or exogenous markers. Optical coherence microscopy (OCM) delivers information on the sample's scattering properties. These modalities provide different imaging contrast mechanisms. It is highly desirable to combine both imaging functions into a single instrument. We propose to design and construct a dual function OCM/MPM platform based on expertise developed building a similar system for a biophysics research program at the University of Illinois.

**Commercial Applications:** The unique configuration of the proposed setup, and the opportunity to obtain both anatomical and functional imaging information will make the combined microscope a very useful and attractive imaging tool that could be widely exploited by the scientific community. Particular useful applications can be found in the field of tissue engineering. Other possibilities exist in the field of plant biology to study for example the localization and interaction of different proteins attached to fluorescent proteins in different plants in relation to their development. The combined microscope would also be of potential interest to major microscope vendors that already market two photon microscopes.

**FY 2005 Phase I Award**

**Topic:** 9.09 MICROFABRICATION AND MICROMACHINING

**Subtopic:** 9.09.2-2 Very High Accuracy Probe for Micrometer Scale Structures

**Title:** Construction of a Force Probe for Characterization of Microscale Features

**NIST OU:** 820 Manufacturing Engineering

**Firm:** InsituTec Inc.  
2750 East WT Harris Blvd.  
Charlotte, NC 28213-4108

**Principal Investigator:** Shane Woody  
**Phone:** 704-503-6908

**Award Amount:** $74,967.40   
  
**Abstract:** The pressing need exists within industry to accurately measure high aspect ratio microscale structures. For example, diesel injector nozzles are manufactured with microscale holes ranging from 50-200 micrometers in diameter and 3-5 mm depths. One fundamental challenge is to nondestrucvely measure these features in order to validate models, enhance manufacturing processes, and reduce fuel emissions. Current measurement technologies are limited due to probe size (i.e. > 30 micrometers in diameter) and often produce unwanted adhesive forces during the measurement process. The objective of this SBIR program is to develop a 2D high aspect ratio microscale force probe; representing a collaborative effort between InsituTech Inc., a North Carolina based instrumentation manufacturer, and the Center for Precision Metrology at University of North Carolina at Charlotte. The sensing technology developed through this program employs revolutionary concepts in probing technologies which include a high aspect ratio probe generating minimal adhesive forces, providing 7 micrometer contact diameters, 5 mm free lengths and 5 nms sensitivity.

**Commercial** **Applications:** InsituTec's commercialization efforts will focus on meeting the industry need for microscale probing technology. It is envisaged that the first products will include gauge heads with microscale probes retrofitted to the quill of standard CMMs. Clearly, once the design tools have been thoroughly evaluated it will be possible to rapidly adapt these designs to meet the demands from other customers. There are also a number of other industries that could use microscale probes for quality inspection. For example, these may include diesel injectors, chip vias, turbine blade cooling holes, and optical fibers. Experiences gained by these projects will be used to develop OEM products to be marketed for general application.

**FY 2005 Phase I Award**

**Topic:** 9.08 MICROELECTRONICS MANUFACTURING

**Subtopic:** 9.08.3-1 STEP AP210-based Stackup Design & Warpage Analysis Tool for Printed Circuit Board Manufacturing

**Title:** A Multi-Representation Architecture for STEP AP-210-based PCB Stackup Design and Warpage Analysis

**NIST OU:** 810 Electronics and Electrical Engineering

**Firm:** InterCAX, LLC  
2402 Lively Trail  
Atlanta, GA 30345

**Principal Investigator:** Russell S. Peak  
**Phone:** 678-369-0628

**Award Amount:** $74,996.00   
  
**Abstract:** The objective of this Phase I effort is to demonstrate the feasibility of printed circuit assembly (PCA) warpage simulation through a novel combination of advanced AP210-based printed circuit board (PCB) simulation methods and cutting-edge general-purpose mesh generation tools. Our proposed solution, the extended multi-representation architecture (MRA), embodies an innovative approach that combines rich product models based on open standards, idealization knowledge capture, advanced analytical modeling and FEA meshing, and modular architecture. The specific technical aims are to demonstrate the effective integration of MRA and advanced meshing approaches, evaluate the required fidelity of PCB and component models, and compare the simulation results for s simple board-component assembly with experimental results using temperature-dependent shadow moiré.  
  
**Commercial Applications:** Evaluation and correction of PCB warpage at the design stage offers major improvements in manufacturing yield and reliability of electronic products. The integration of warpage analysis tools with established ECAD and MCAD software through a standards-based engineering framework offers benefits of speed and efficiency in new product development. The new tools could be sold as part of a larger product lifecycle management (PLM) system for large OEMs and their subcontractors, or as a freestanding web-based engineering service for small or low frequency users.

**FY 2005 Phase I Award**

**Topic:** 9.02 ANALYTICAL METHODS

**Subtopic:** 9.02.2-1 Adiabatic Demagnetization Refrigerator Precision Controller for X-ray Microanalysis

**Title:** Integrated Control System for an Adiabatic Demagnetization Refrigerator

**NIST OU:** 810 Electronics and Electrical Engineering  
  
**Firm:** Lake Shore Cryotronics, Inc.  
575 McCorkle Blvd.  
Westerville, OH 43082

**Principal Investigator:** Joe Yeager  
**Phone:** 614-891-2243

**Award Amount:** $74,405.00   
  
**Abstract:** There are emerging markets that are driven by advances in x-ray micro-calorimeters. These detectors allow an energy resolution 10x better than existing commercial x-ray detectors. The primary application is the detection and analysis of nanoscale particle contaminates in IC production. The temperature stability of the micro-calorimeter is critical for real-time analysis and maintaining the x-ray line positions. A cryogen-free ADR is used to provide temperatures less than 100 mK. However, there is not an existing control system that can provide the required temperature stability and complete cooling cycle automation. Lake Shore will develop a complete control system. This includes thermometry, magnet supply, precision sourcing, feedback loop and communication interface within a self-contained rack-mounted instrument. The control system will provide stability required for TES detector applications.  
  
**Commercial Applications:** TES detectors are being used in new markets where the simplicity and compactness of an ADR and its control system is important. The ADR and its control system should be invisible to users, many of which will be unfamiliar with cryogenics. Micro-calorimeter enabled applications include the detection and analysis of nanoscale particle contaminates in integrated circuit production. This has an enormous potential for semiconductor manufacturing process improvement. Minimizing downtime, which can cost up for $500,000 per hour, and improving process yields will have a wide reaching national economic benefit. Other applications include material analysis of ceramic and metals, large-molecule (DNA) spectrometry, gamma and neutron radiation detectors, and astrophysics detectors.

**FY 2005 Phase I Award**

**Topic:** 9.07 MANUFACTURING SYSTEM INTEGRATION

**Subtopic:** 9.07.3-4 High-Resolution, Two-Dimensional Electronic Neutron Detectors for Imaging

**Title:** High-Resolution, Two-Dimensional Neutron Imaging Detector

**NIST OU:** 840 Physics  
  
**Firm:** NOVA Scientific, Inc.  
660 Main St., PO Box 928  
Sturbridge, MA 01566-0928

**Principal Investigator:** W. Bruce Feller  
**Phone:** 508-347-7679

**Award Amount:** $75,000.00   
  
**Abstract:** Nova Scientific proposes a high-resolution neutron imaging detector having a specialized neutron-sensitive electron amplified detection stage integrated with a cross-strip electronic readout capable of centroid averaging. This detector system will have direct application to two-dimensional imaging of hydrogen fuel cells and support the diagnostic capabilities of the Neutron Imaging Facility (NIF) at NIST. Applications include high-resolution neutron radiography for fuel cells and nondestructive testing, neutron scattering, SANS experimentation, neutron beam diagnostics, and materials research.  
  
**Commercial Applications:** High-resolution neutron imaging will provide improved diagnostics of transport across hydrogen fuel cell membranes, permit enhanced experimentation for neutron scattering, small angle scattering, materials research, and non-destructive testing of high density components. It will provide the NIST Neutron Imaging Facility (NIF) with state-of-the-art neutron radiographic capabilities and re-establish neutron imaging leadership back into the United States.

**FY 2005 Phase I Award**

**Topic:** 9.09 MICROFABRICATION AND MICROMACHINING

**Subtopic:** 9.09.4-5 Mixing/Dispensing System for Combinatorial Polymer Formulations Libraries

**Title:** Active Mixing of Polymers in a Dispensing Head

**NIST OU:** 850 Materials Science and Engineering  
  
**Firm:** nScrypt, Inc.  
2721 Discovery Dr., Suite 400   
Orlando, FL 32826

**Principal Investigator:** Kenneth H. Church, Ph.D.  
**Phone:** 407-249-3650

**Award Amount:** $75,000.00   
  
**Abstract:** A method to take three polymers with varying viscosities and mixing those polymers together at the point of interest or more specifically through a micro dispensing nozzle, is being proposed. An active mixing scheme to ensure proper mixing at the pen tip is a feasible approach to this problem. The materials being mixed will not only range in viscosity but also in particle loading, which will be handled appropriately without clogging the tip. The mixing, polymer ratios and dispensing volume will all be under computer control for consistent and repeatable results. This will also allow for a combinatorial approach to material discovery. While many applications and benefits will be observed, one true benefit will be the small volumes required for testing. The dispensed material will be less than micro liters in volume.  
  
**Commercial Applications:** The research opportunities and optimization this type of tool offers will facilitate the next generation of materials development. This tool would allow an extremely wide range of materials and material combinations to be tried on a variety of substrates under computer control, thus reducing the time, effort and costs for new developments. Additional impacts will affect manufacturing capabilities such as the ability to mix and then place at the nozzle tip or at the substrate nozzle interface "any" material. This would allow fabrication of structures with a two part epoxy or varying biopolymers with livings cells placed in a 3D structure.

**FY 2005 Phase I Award**

**Topic:** 9.05 INFORMATION TECHNOLOGY

**Subtopic:** 9.05.5-9 Multi-user Collaborative Tools for Immersive Scientific Visualization

**Title:** Collaborative Tools and Extinsible Object Interaction Techniques for Virtual Environments

**NIST OU:** 890 Information Technology  
  
**Firm:** Open Tech, Inc.  
1872 Pratt Dr., Suite 1500  
Blacksburg, VA 24060-6392

**Principal Investigator:** Patrick Roye  
**Phone:** 540-557-7636

**Award Amount:** $75,000.00   
  
**Abstract:** Open Tech proposes to develop a fully extensible collaborative tools framework that combines powerful features, and intuitive user interface, and the ability to easily implement new and imaginative object interaction techniques. The tools will allow users of both local and remote immersive VE systems to join together in a single shared VE that allows them to interact with each other and with objects in the VE simultaneously. Desktop and immersed users can collaboratively leverage the strengths of both platforms simultaneously to conduct research. Communication and collaboration are important aspects in most scientific research, and our proposed collaboration technologies will bring these aspects to a new level in the field of scientific visualization.  
  
**Commercial Applications:** The collaborative tools package developed under the SBIR will benefit any company that has multiple researches working on a project that requires the use of a VE for data visualization. The collaborative tools will help the researches become more productive by facilitating cooperation and communication in the shared VE. The collaborative tools can be marketed along with DIVERSE and VEWL in order to continue to build the user bases of these tools. Open Tech will leverage its relationships with companies like Fakespace and Vis Box in order to make the collaborative tools more available to users of immersive virtual environments. Open Tech will also attend conferences such as the annual Supercomputing conference in Pittsburgh in order to develop new relationships with potential customers.

**FY 2005 Phase I Award**

**Topic:** 9.05 INFORMATION TECHNOLOGY

**Subtopic:** 9.05.2-4 High Efficiency Low Dark Count InGaAs Detector for IR Photon Counting

**Title:** Avalanche Photodiodes for Enhanced Photon Counting Performance at 1.5 um

**NIST OU:** 840 Physics

**Firm:** Princeton Lightwave Inc.  
2555 US Route 130 South, Suite 1  
Cranbury, NJ 08512-3509

**Principal Investigator:** Mark Itzler  
**Phone:** 609-495-2551

**Award Amount:** $74,828.00   
  
**Abstract:** APDs offer tremendous potential for the numerous applications in which photon densities are extremely low and the ability to count single photons is essential. Researchers have recently found that the optimization of InP-based APDs for counting photons may require innovative design approaches that are quite distinct from those shown to optimize APD linear mode performance. For this program, we propose to design and fabricate InP-based APDs for which the avalanche dynamics are optimized specifically for photon counting using design concepts that incorporate novel bandgap engineering approaches. In particular, these concepts will allow us to achieve increased detection efficiency at 1.5 um with simultaneous reduction of the dark count rate through the use of impact ionization engineering multiplication regions.  
  
**Commercial Applications:** There are numerous optically power-starved applications for which the ability to effectively count photons at 1.5 um is critical, including: quantum cryptography and quantum key distributions, lidar systems and active remote sensing optical instruments; eye-safe military lidar applications, including range-finding and three-dimensional imaging; optical time domain reflectometry; detection of photoemission process, as in semiconductor diagnostics; and free-space optical communications. In some cases, the development of higher performance photon counting detectors will vastly improve overall system performance, In other cases, the advent fo better detectors will make these systems far more cost effective, e.g., by relaxing the present requirements on transmitter performance.

**FY 2005 Phase I Award**

**Topic:** 9.14 X-RAY SYSTEM TECHNOLOGIES

**Subtopic:** 9.14.1-3 High Acceptance Area X-ray Detector for Analytical Electron Microscopy

**Title:** Large Solid Angle X-Ray Detector for Electron Microscopy

**NIST OU:** 830 Chemical Science and Technology  
  
**Firm:** Radiant Detector Technologies, LLC  
19355 Business Center Drive, Suite 9  
Northridge, CA 91324

**Principal Investigator:** Carolyn Tull  
**Phone:** 925-389-0647

**Award Amount:** $75,000.00   
  
**Abstract:** One of the standard analytical tools on almost all electron microscopes (EM) is an energy dispersive x-ray spectroscopy (EDS) detector used for chemical analysis. However, there are many limitations with the current generation of EDS detectors for EM. The best potential for achieving larger detector active areas, superb energy resolution and an order of magnitude higher count rate compared with conventional EDS detectors, comes from a new detector technology - the silicon drift detector. We will develop a large solid angle detector (up to 0.8 srad), with low noise electronics, specifically for the high vacuum, demanding environments of the analytical EM. Phase I will include evaluation and selection of one of three preliminary spectrometer designs; Phase II will include optimization of the selected design, construction and full evaluation of the prototype spectrometer on the NIST analytical EM.  
  
**Commercial Applications:** Energy dispersive x-ray spectrometers (EDS) are used on virtually all electron microscopes (EM), as well as in many other industrial and scientific applications. The market for EDS detectors on EMs is in the multi-million dollar range. The spectrometers developed here could also be used in process control in the metals and chemicals industries, in powder diffraction detectors in materials analysis, high performance x-ray detectors for synchrotron experiments, and contamination control in the semiconductor industry.

**FY 2005 Phase I Award**

**Topic:** 9.13 TECHNOLOGIES TO ENHANCE FIRE SAFETY

**Subtopic:** 9.13.2-6 Development of a High Throughput Foam Fabrication Device

**Title:** A Coded Alternating Micromachined Retroreflector Array (CAMERA)

**NIST OU:** 860 Building and Fire Research

**Firm:** Research Support Instruments, Inc.  
20 New England Business Center  
Andover, MA 01810-1077

**Principal Investigator:** John F. Kline  
**Phone:** 732-329-3700

**Award Amount:** $74,911.00   
  
**Abstract:** RSI will develop a technology to improve fire fighter visibility and enable tracking of position/identity. The Coded Alternating Micromachined Retroreflector Array (CAMERA) will use RSI's microscale retroreflectors, a near-infrared (IR) coating and near-IR sources pulsing on alternating video frames to encode fire fighter identities, and a near-IR video camera. These grain-of-sand-sized markers would have different spectral signatures. To filter out IR-emitting fires and provide spectral information, a pulsed light interrogation scheme will be used. The IR diodes will alternate, and an inexpensive near-IR-capable camera will be used to observe the scene. The ratio between the signal on alternating frames will identify the target. The Phase I program will involve improvement in the optical quality, creating a unique IR coding scheme, development of a laboratory interrogation unit, and a demonstration of the concept.  
  
**Commercial Applications:** The usefulness of a micro-fabricated optically interrogated tags and markers would not end with their pervasive use in firefighter identification. Police and other first responders could use them for a variety of marking purposes, identifying evidence, locations, victims, and suspects. Commercial markets include building security (hospital patient management or inventory control, for instance), wildlife management, and currency and document validation.

**FY 2005 Phase I Award**

**Topic:** 9.05 INFORMATION TECHNOLOGY

**Subtopic:** 9.05.3-9 Cross-Layer Design for Mobile Ad hoc Networks

**Title:** Cross-Layer Optimization for Mobile Ad Hoc Networks Using SCA Compatible Smart Radio

**NIST OU:** 890 Information Technology

**Firm:** SCA Technica, Inc.  
17 Port Chester Drive  
Nashua, NH 03062-1639

**Principal Investigator:** David K. Murotake, Ph.D.  
**Phone:** 603-321-6536

**Award Amount:** $75,000.00   
  
**Abstract:** Homeland Security/First Responder networks require increased bandwidth and reliable connectivity. Future networks such as Project SAFECOM may deploy software-defined radios (SDR) compatible with Joint Tactical Radio System (JTRS) Software Communications Architecture (SCA). We leverage our SCA compatible, high assurance “Smart Radio” prototype being developed under an AFRL sponsored Phase II SBIR as a infrastructure testbed accesible by academic and industry researchers. Our prototype includes a CC EAL4+ laptop with SCA core framework, PCMCIA module with NSA Type I AIM CS/S, Xilinx Virtex II Pro FPGA, and a High Assurance Wireless Computing System (HAWCS™) security layer which defeats blended wireless and Internet hacking attacks. In Phase I we define requirements and design cross-layer optimizer components, using MATLAB/SIMULINK to simulate their performance.  
  
**Commercial Applications:** Develop innovative applications of mobile ad-hoc network (MANET) technologies to effectively increase the digital bandwidth and reliable connectivity to wirelessly connected users. Exploit the dense concentrations of wireless users to support high bandwidth but bursty applications such as image and video transfers. Develop new SCA compatible cross layer optimizing components which can be used in Smart Radio testbed. licensable commercial off the shelf (COTS) waveform stacks and JTRS waveform development. Develop SDR networking infrastructure testbed.

**FY 2005 Phase I Award**

**Topic:** 9.05 INFORMATION TECHNOLOGY

**Subtopic:** 9.05.2-4 High Efficiency Low Dark Count InGaAs Detector for IR Photon Counting

**Title:** Manufacturable Geiger-Mode InGaAs/InP Avalanche Photodiodes for Near-Infrared Photon Counting

**NIST OU:** 840 Physics

**Firm:** Sensors Unlimited, Inc.  
2490 Route 1, Building 12  
Princeton, NJ 08540

**Principal Investigator:** Keith Forsyth  
**Phone:** 609-520-0610

**Award Amount:** $75,000.00   
  
**Abstract:** Application of NIR photon counting technology is impeded by the marginal performance of available detectors. We will develop new InGaAs/InP APD designs optimized for Geiger mode photon counting, delivering ten re-designed APDs, having detection probability greater than 50% and dark count rate less than ten thousand per second. During Phase II we will develop a new computer model of the Geiger mode APD, and use the model to produce improved designs with higher photon detection probability, lower dark count rate, and less afterpulsing. At the conclusion of Phase II we will deliver a turnkey photon counting detector module to NIST incorporating these enhanced APDs.  
  
**Commercial Applications:** Potential commercial applications of the research include quantum-key distribution, silicon VLSI failure analysis, advanced wind profile and Raman LIDAR, three-dimensional imaging LIDAR, ultrasensitive Raman spectroscopy, and real-time measurement of singlet oxygen in biomedicine.

**FY 2005 Phase I Award**

**Topic:** 9.13 TECHNOLOGIES TO ENHANCE FIRE SAFETY

**Subtopic:** 9.13.3-6 Distributed Multi-Nodal Voice/Data Communication for Fire Fighters

**Title:** Distributed Automatic Reconifigurable Transponder (DART)

**NIST OU:** 860 Building and Fire Research

**Firm:** Williams-Pyro, Inc.  
200 Greenleaf St.  
Fort Worth, TX 76107-1471

**Principal Investigator:** Kartik Moorthy  
**Phone:** 817-872-1500 x125

**Award Amount:** $75,000.00   
  
**Abstract:** This proposal focuses on developing Distributed Automatic Reconfigurable Trasponder (DART) system that is capable of achieving distributed multi-nodal voice/data communication for firefighters. Specifically, Williams-Pyro, Inc. proposes to develop an enhanced prototype of distributed Automated Reconfigurable Intelligent Radios, which consists of a series of distributed nodes that will relay voice transmission and data to the incident commander located outside the building. The proposed DART system will allow several distributed DARTs to communicate between individual team members inside the structure, as well as with the incident commander located outside the structure. This system will allow faster, more accurate information transmission, resulting in timely fire detection and safer firefighting.  
  
**Commercial Applications:** Commercial applications of the proposed Distributed Automatic Reconfigurable Transponder (DART) system vary widely, with possibilities including police and fire departments; emergency management services; petroleum companies; water, gas, and electric utilities; mining companies; and transportation companies such as railroads, taxicab operations, and airlines. With such wide-ranging potential applications, DART will benefit from a strategic marketing plan that focuses on a specific initial market. Therefore, due to NIST's interest in firefighting technology and the firefighting community's need for improved equipment, WPI has chosen to first focus on firefighting applications.

**FY 2005 Phase II Award**

**Topic:** 9.10 MICROFABRICATION AND MICROMACHINING

**Subtopic:** 9.10.02 Development of Meso Scale Machine Tools

**Title:** Microfabrication and Micromaching

**NIST OU:** 820 Manufacturing Engineering

**Firm:** Atometric, Inc.  
6280 Vicksburg Rd.  
Rockford, IL 61107-2642

**Principal Investigator:** Thomas J. Lindem  
**Phone:** 815-399-7334

**Award Amount:** $280,670.00  
  
**Abstract:** During Phase I Atometric developed and demonstrated principles of a four-axis micro machine. This machine is capable of machining metal parts that are sized within 50mm cube to an accuracy within one micron. Our goal is to develop a micro machine that is applicable to a broad commercial market. Three additional features need to be added to make the machine fully commercially viable. These three features are: an automatic tool sensor; an automatic tool changer; and, automatic part programming utilizing data from computer aided design programs. The proposed Phase II research focuses on developing those three features. Our proposed research will also focus on developing a micro machine that is to be operated in an office or laboratory environment, away from the usual manufacturing factory settings. When this capacity is fully developed a significant reduction in initial investment, energy usage, shipping costs and delay times will occur, with corresponding benefits throughout this now untapped market.

**Commercial Applications:** The present technology for making micro sized parts uses large and costly machines. Typically these machines are Swiss-made turning centers that cost between $300,000 and $600,000 each. The technology developed by Atometric during the proposed Phase II research will enable micro sized parts to be manufactured at a greatly reduced cost. The parts will be made at the point where they are needed, not at a remote factory location. The capital investment required to support the manufacturing process will be reduced by a factor of four. The energy required will be reduced by, at a minimum, a factor of ten. The procurement time required to actually acquire the micro part will be reduced by eliminating the need to work through distant factories. Therefore, the commercial application for the Atometric micro machine is wherever micro sized parts are now made and/or utilized. This market is now large and is expanding.

**FY 2005 Phase II Award**

**Topic:** 9.15 X-RAY SYSTEM TECHNOLOGIES

**Subtopic:** 9.15.01 Very Large Area High Efficiency Soft X-ray Fluorescence Detectors

**Title:** Large Soft X-Ray Fluorescence Detector

**NIST OU:** 850 Materials Science and Engineering  
  
**Firm:** Detector Technology, Inc.  
9 Third Street   
Palmer, MA 01069-1542

**Principal Investigator:** Jay Ray  
**Phone:** 413-284-9975

**Award Amount:** $284,429.14  
  
**Abstract:** Detector Technology will develop and manufacture a 10cm2 large format cone. The cone will be based on a ceramic substrate then coated with glass frit. The cone will then be attached to a standard single channel multiplier. Detector Technology will also investigate different low work function coatings to improve the first strike statistic of fluorescence. Simultaneous research in conjunction with sub-contractor, Nova Scientific, will include a large format microreticular, microfiber, or microsphere plate, which would also be enhanced by Detector Technology with a low work function coating. The final unit will be tested at Brookhaven National Labs for efficiency of the detection of fluorescence.

**Commercial Applications:** The manufacturer of a large area high efficiency soft x-ray detector would open a $50,000,000 market to Detector Technology, Inc. Not only can Synchrotron Ring application be sought after, but also Wavelength-Dispersive X-Ray Fluorescence mass spectrometers. The knowledge gain on low work function coatings will also be applicable to other detection markets, such as environmental, medical, semiconductor, homeland defense and space.

**FY 2005 Phase II Award**

**Topic:** 9.04 HEALTHCARE AND MEDICAL PHYSICS

**Subtopic:** 9.04.01 Thermal Imaging of Water with µK Resolution at 22°C

**Title:** Acoustic Pulsed Phase Locking Energy Sensor (APPLES)

**NIST OU:** 840 Physics   
  
**Firm:** Luna Innovations Inc.  
2851 Commerce Street  
Blacksburg, VA 24060-6657

**Principal Investigator:** Dr. Joseph S. Heyman  
**Phone:** 757-224-0687

**Award Amount**: $286,828.28  
  
**Abstract:** Luna Innovations has developed for NIST a low-cost, yet high resolution acoustic sensor system capable of determining ten micro-degree changes in a water path caused by clinical medical radiation devices. A system will be delivered to NIST for their evaluation and testing. The sensors are external to the water and play a negligible role in error sources from thermal transfer in contrast to current thermocouple devices in use today. Luna has identified a commercialization path and a partner (Varian) who has voiced product support if we are successful in the Phase II. This breakthrough technology can result in the ability to image the three dimensional thermal dose absorbed in the tissue phantom, a critical pre-treatment parameter that could alter medical protocols. The product from this technology has an important role for both economics and health care.

**Commercial Applications:** There are two major products that will come from this research breakthrough. The first is calibration device that can become a secondary standard in place at all 1800 treatment facilities in the US. A second device will be launched as a research instrument for radiotherapy research centers that will permit the characterization of thermal distribution in 3-D in a tissue phantom for beam profile absorbed dose assessment. The second device can become a system built in place on treatment facilities for pre-treatment set-up. Such a system could see nearly a million uses a year in the US alone.

**FY 2005 Phase II Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

**Subtopic:** 9.06.04 Device Independent Interaction Framework for Immersive Scientific Visualization

**Title:** VEWL: Virtual Environment Windowing Library for Device Independent User Interaction

**NIST OU:** 890 Information Technology

**Firm:** Open Tech, Inc.  
1872 Pratt Dr., Suite 1500  
Blacksburg, VA 24060

**Principal Investigator:** Patrick Roye  
**Phone:** 540-557-7636

**Award Amount:** $286,862.14  
  
**Abstract:** Open Tech, Inc. seeks to develop a Virtual Environment Windowing Library (VEWL) that will provide users with an intuitive user interface and device independent interaction methods. The interface will allow users in a virtual environment to run applications and configure the environment using the same windows and controls that they are used to using on desktop systems. The software will provide for complete device independence, allowing users of any system to use the software regardless of the input devices that they are using (e.g. wands, mice, keyboards, PDAs, etc). The software will help facilitate the application development process for programmers, while simultaneously helping programmers provide users with more flexible and intuitive applications.

**Commercial Applications:** The end product, VEWL, will be useful to both application developers and end users of virtual environments. VEWL will provide application developers with tools such as message passing capabilities, cross-platform support, standard user interaction techniques, and a device independent framework. This will help companies to accelerate their application development by reducing the amount of time required to develop fully functional applications. End users will benefit from applications that use VEWL, since these applications will utilize the same user interaction techniques as desktop systems, which most users are already comfortable using. Open Tech, Inc. will partner with existing distributors of Virtual environment applications in order to leverage the commercialization capabilities that these companies have already established.

**FY 2005 Phase II Award**

**Topic:** 9.15 X-RAY SYSTEM TECHNOLOGIES

**Subtopic:** 9.15.02 Ultra-high-vacuum (UHV) Compatible Analytical Wavelength Dispersive X-ray Spectrometer

**Title:** Ultra-High Vacuum Compatible Wavelength Dispersive X-ray Spectrometer

**NIST OU:** 830 Chemical Science and Technology

**Firm:** Parallax Research, Inc.  
2818-H Industrial Plaza Dr.  
Tallahassee, FL 32301-0001

**Principal Investigator:** David Ohara  
**Phone:** 850-580-5481

**Award Amount:** $286,835.00  
  
**Abstract:** Parallax Research, Inc. proposes to build an Ultra-High Vacuum compatible Wavelength Dispersive X-ray Spectrometer (WDS) that can be used on small spot Auger, XPS, TEM and FESEM analytical instruments for elemental analysis. The effort draws upon Parallax's experience in designing WDS systems for Scanning Electron Microscopes (SEM) and for XRF. This new type of x-ray spectrometer will eliminate the sources of leakage that plagued previous WDs systems used on UHV systems by using UHV compatible materials, motion feedthroughs and by replacing the leak prone gas flow proportional counter x-ray detector. During Phase I, Parallax tested a potential proportional counter replacement with sufficient success to be very confident of Phase II success. The proposed spectrometer is conceptually based on Parallax's new 6-diffractor HeXLEXS extended energy range Wavelength Dispersive X-ray Spectrometer.

**Commercial Applications:** The largest and most direct commercial application of this technology will be for a WDS system to be used on Transmission Electron Microscopes. Although it is intended for use on a small spot Auger system, these represent only a few systems/yr. In addition, the technology will by immediately applicable for WDS systems to be used on Field Emission Scanning Electron Microscopes (FESEM) where manufacturers are hesitant to warranty systems with existing WDS spectrometers.

**FY 2005 Phase II Award**

**Topic:** 9.02 ANALYTICAL METHODS

**Subtopic:** 9.02.05 Microcalorimeter Instrumentation for X-ray Microanalysis

**Title:** Low-Cost Microcalorimeter Spectrometer for X-Ray Microanalysis

**NIST OU:** 810 Electronics and Electrical Engineering

Fir**m:** STAR Cryroelectronics, LLC  
25-A Bisbee Court  
Santa Fe, NM 87508-1412

**Principal Investigator:** Robin Cantor  
**Phone:** 505-424-6454

**Award Amount:** $286,811.00  
  
**Abstract:** A low-cost superconducting transition edge sensor (TES) microcalorimeter spectrometer is described for high energy and high spatial resolution X-ray energy dispersive spectroscopy and microanalysis. The proposed microcalorimeter instrument offers an energy resolution that is comparable to and potentially even better than wavelength dispersive spectrometers, thereby enabling the resolution of interfering peaks at low energies, while the energy dispersive nature of the microcalorimeter also means that the full X-ray spectrum is immediately available for qualitative and quantitative analysis. The TES microcalorimeter spectrometer will address and meet a critical need for new, cost-effective analytical tools for high resolution X-ray microanalysis in materials research.

**Commercial Applications:** The primary commercial application for the proposed low-cost microcalorimeter spectrometer is high resolution X-ray microanalysis for qualitative and quantitative defect analysis in semiconductor device fabrication and materials research at university and government research laboratories.

**FY 2005 Phase II Award**

**Topic:** 9.14 TECHNOLOGIES TO ENHANCE FIRE SAFETY

**Subtopic:** 9.14.04 Sensing for Advanced Warning of Structural Collapse

**Title:** A Non-Contact Sensor for Advanced Warning of Structural Collapse

**NIST OU:** 860 Building and Fire Research

**Firm:** Summit Safety, Inc.  
94 Jackson Road, #303  
Devens, MA 01432

**Principal Investigator:** Wayne C. Hasse  
**Phone:** 978-772-9009

**Award Amount:** $286,840.12  
  
**Abstract:** Summit Safety will develop an ultrasonic, non-contact sensor and system capable of detecting small displacements of structure - such as roof sagging and structural bending - and the acoustic sounds and fire-induced vibrations of structures that are precursors of structural collapse. The system will provide advanced warning to the Incident Commander of potential or imminent structure collapse. In Phase I, the basic sensor was built, with the capability of measuring displacements under a thousandth of an inch at a distance of up to 12 feet from the structure. Velocity and acceleration signals provide additional motion sensing. For acceleration measurements, the sensor's performance is comparable to commercial accelerometers. By being non-contact, the sensor can measure motion at otherwise inaccessible locations. The sensor can be set up and aligned in a matter of seconds.

**Commercial Applications:** The total U.S. market for this product includes the over 1 million firefighters in over 26,000 fire departments and 40,000 fire stations, potential monitoring and tactical military and law enforcement applications, as well as Search and Rescue (such as FEMA USAR teams). The total U.S. market is estimated to be in excess of $200 million.