Abstracts of Awards for Fiscal Year 2004 NIST SBIR Program

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**FY 2004 Phase I Award**

**Topic:** 9.12 OPTICS AND OPTICAL TECHNOLOGY

**Subtopic:** 9.12.01 High Efficiency High Speed Optical Switch

**Title:** High Speed Low Loss Optical Switch

**NIST OU:** 840 Physics

**Firm:** Agiltron Incorporated
220 Ballardvale Street, Suite D
Wilmington, MA 01887-1050

**Principal Investigator:**  Jing Zhao
**Phone #:** 978-694-1006

**Award Amount**: $74,908.00

**Abstract:** High performance fiberoptic switch is an enable technology for new generation optical telecommunication and fully secured quantum communication/cryptography applications. Current fiberoptic switches do not simultaneously meet the requirements of high speed, low loss, high extinction ratio, and high reliability. Based on the successful development/production of a variety of industrial leading solid-state high speed fiberoptic switches, Agiltron Incorporated proposes to fabricate a novel total reflection switch, using electro-optical crystals with large electro-optic effect and excellent thermal stability. The small loss tangent of the new crystal at high frequencies permits operation of these devices at high speed. This breakthrough fiberoptic switch platform holds the promise of realizing practical high-speed optical switches with performance and cost that is not attainable before. By using novel material engineered, the proposed electro-optic switch offers leading edge performance attributes, which include high-speed, low optical insertion loss, and easy binary drive. The design eliminates the need for organic materials and waveguides, as well as temperature compensation and feedback control, which introduce intrinsic drawbacks. Moreover, the design is extremely simple, compact, lightweight, ultra reliable, temperature insensitive and polarization independent, and cost effective. It is anticipated that state-of-the-art performance in several key specifications can be achieved through this program. Prototype electro-optic 1x4 switches will be fabricated to demonstrate functionality in Phase I.

**Commercial Applications:** It is anticipated that the proposed high performance switch will have wide application in government systems. The anticipated commercial communication switching market is very large with forecasted reaching billion dollars by year 2006.

**FY 2004 Phase I Award**

**Topic:** 9.05 HOMELAND SECURITY

**Subtopic:** 9.05.02 Mobile Robot Platform for Urban Search and/or Rescue and Explosive Ordnance Disposal Applications

**Title:** Standard Robot Platform Designed for Unstructured Environment Research

**NIST OU:** 820 Manufacturing Engineering

**Firm:** American Standard Robotics, Inc.
625 11th Ave. NE
Saint Petersburg, FL 33701-1407

**Principal Investigator:** Jennifer Casper
**Phone #:** 727-821-7588

**Award Amount:** $74,516.00

**Abstract:** Robotic researchers currently are using insufficient and varying robot platforms to investigate issues crucial to the successful development of a remote reconnaissance tool for the urban search and rescue (USAR) community. USAR robotic researchers need a standard robot platform designed for research in unstructured environments. This platform would accelerate the research essential to advancing remote reconnaissance technology for emergency response professionals. The project utilizes three innovative approaches: tailoring the platform for USAR research, assigning robotic and USAR specialists to the project, and incorporating the robotic and USAR field requirements that influence the platform development. The objective for Phase I of this work is to determine a practical and economical platform to satisfy the needs of researchers.

**Commercial Applications:** Although research in emergency service robotics has been performed for over five years, the establishment of a standard robot platform is still in its infancy. This has been demonstrated through two insights. First, robotic researchers focusing on unstructured environments have expressed need for improved equipment to enhance locomotion and sensor modularity. Second, search and rescue competitions held by RoboCup and AAAI have yet to exhibit robots capable of operating in all levels within the NIST Reference USAR Testbed. The need for a platform designed for evaluating the performance of intelligent systems is clear. This platform can be utilized in research for other applications, in addition to the USAR field. Other fields include the explosive ordnance disposal, military, construction, mining, structural engineering, below-grade utilities, hazardous materials inspection, and manufacturing.

**FY 2004 Phase I Award**

**Topic:** 9.13 RADIATION PHYSICS

**Subtopic:** 9.13.01 An Advanced Electron Beam System for Highly-Charged-Ion Production & Trapping

**Title:** Carbon Nanotube Field Emission Electron Beam System for Electron Beam Ion Trap

**NIST OU:** 840 Physics

**Firm:** Applied Nanotechnologies, Inc.
308 West Rosemary Street, Suite 209
Chapel Hill, NC 27516

**Principal Investigator:** Bo Gao
**Phone #:** 919-423-1832

**Award Amount:** $75,000.00

**Abstract:** High density, uniform electron beam (e-beam) is required in the EBIT to produce highly charged ions (HCIs), better confinement of HCIs, and facilitate analysis and interpretation of data. A novel high density e-beam system using carbon nanotube (CNT) field emitters is proposed to upgrade NIST EBIT system. Due to the extraordinary attributes of CNT emitters, the proposed e-beam system will have many advantages over the thermionic e-beam system: high e- beam density, small beam size, room temperature operation to eliminate thermal radiation related problems, voltage controllable emission for quick switching and low power consumption. After the phase II work, the novel e-beam system is expected to achieve following features: total current of 150 ~ 200mA from 0.3cm in diameter emission area, lifetime of more than 2 years, beam size <50um after magnetic focusing (7650-10200A/cm2 beam current density).

**Commercial Applications:** The CNT based field emission electron beam system with high current density (up to 104 A/cm2) and small beam size (<50 µm) will be able to replace the current thermionic system used in the NIST EBIT and other EBIT / HCI facilities to upgrade their capabilities. Due to its structural and performance advantages, the new electron beam system will benefit any analytical instruments and manufacturing facilities (i.e., lithography and e-beam welding), where high density, small focus electron beam is required. The techniques developed through this project will be also very useful for numerous other applications such as free electron lasers, high power vacuum electronic amplifiers for communication applications, electric propulsion systems, x-ray / CT scanners for medical or inspection applications, and electron microscopy, etc.

**FY 2004 Phase I Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

**Subtopic:** 9.06.05 Applying Software Test Generation Methods to Large Programs

**Title:** TIGer: A Test Instance Generator for Large Programs

**NIST OU:** 890 Information Technology

**Firm:** ATC-NY
33 Thornwood Drive, Suite 500
Ithaca, NY 14850-1250

**Principal Investigator:** Dr. David Guaspari
**Phone #:** 607-257-1975

**Award Amount:** $74,927.00

**Abstract:** Testing accounts for a large and growing share of software development costs. Developing tests is labor-intensive; and significant savings would result from tools that could automatically generate tests meeting some given criterion of completeness. ATC-NY proposes to build a set of modules, Tiger, that can be incorporated into existing test generators and will allow the generation of test cases for large systems. Recent work has explored ways to generate tests by model-checking. The limiting factor in model-checking is the size of the state space to be explored and much research has been devoted to strategies for reducing the state spaces to be checked. Nearly all of it addresses the problem of program verification and, as a result, is not directly applicable to generating tests. Nonetheless, this work contains a rich body of ideas, which we will adapt to define and implement Tiger.

**Commercial Applications:** Testing is ubiquitous, and the government and private sector markets for automatic test generation is potentially huge. In addition, a standards body such as NIST could use automatic test generation to develop acceptance tests for implementation of its standards. ATC-NY will address the DoD market by going through the prime contractors with which ATC has collaborative relationships.

**FY 2004 Phase I 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.
1603 Greenmount St.
Rockford, IL 61107

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

**Award Amount:** $75,000.00

**Abstract:** Biotechnology, aerospace, automotive and communications industries need small ultra-precise, three dimensional parts for component miniaturization. Present metal cutting technology is rapidly reaching its limits. A new technology is required to accelerate this trend. Atometric will pursue innovations in ultra-precision multi-axis machine tools. The machining capacity will be within a cube of 50 mm. The machines will be orders of magnitude smaller and less expensive than existing processes, and operating in an office rather than "factory" environment. Phase 1 project objectives are to develop a "first commercial prototype" and deliver it to NIST. Anticipated results will be a prototype 4-axis machine tool with 25-50 mm capacity fitting within a 400 mm volume, axis positioning precision of 0.1 to 1.0 micron, spindle speeds up to 125,000 rpm and an appropriate control module. Technical consequences are to move research from the lab into commercial reality. Atometric will develop pre-process measurement and verification, fixturing, contamination protection, tool change, and development of high speed spindles in the 500,000 rpm range. Potential commercial applications are the economical manufacturing of ultra-precision three dimensional miniature parts far beyond present process capabilities. Our objective is to meet present and future commercial needs of the micro machining world.

**Commercial Applications:** Economical multi-axis machining of small cubic metal parts to micron and sub-micron tolerances, without the need for large machines and a factory, using micromachines that match product sizes and tolerances.

**FY 2004 Phase I Award**

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

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

**Title:** The Manufacturing of Large Soft X-ray Flourescence Detectors

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

**Firm:** Detector Technology, Inc.
9 Third Street
Palmer, MA 01069-1542

**Principal Investigator:** Jay S. Ray
**Phone #:** 413-284-9975

**Award Amount:** $74,274.00

**Abstract:** At present the need for a large area, 100 square centimeters or greater, soft x-ray fluorescence detector with high detection efficiency is required for material science and x-ray absorption spectroscopy. The current methods of detection used in x-ray absorption spectroscopy are subject to poor collection efficiency, large background and vacuum risk. It is the task of this grant to develop a multiplier device that can offer good detection efficiency and optimal collection of the fluorescence signal without risk of affecting the vacuum. To do this a multiplier device comprising of Lead Silicate glass will be manufactured with a large collection area. The device will be made utilizing a glass frit process on a machined substrate with a specially enhanced coating. At present these manufacturing methods are not known and will be investigated. The manufacturing processes will be researched using small sample sizes. Substrate material, glass material, fritting process, and coatings will be investigated for the detection of fluorescence. The grant will finalize these materials and processes.

**Commercial Applications:** This new device will enhance instruments for surface science applications which will open the field across electronics and magnetic materials, steel and nonferrous metals, ceramics, cement, machines, food, medicine, fruit trees, paints, cosmetics, and moreover, crime investigations and environmental pollution analysis.

**FY 2004 Phase I Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

**Subtopic:** 9.06.03 Safety and Privacy in Managing Credentials

**Title:** Credential Management

**NIST OU:** 890 Information Technology

**Firm:** ECleide (VKD Shoppe, Inc.)
56 Beaver St., Ste 305
New York, NY 10004-2436

**Principal Investigator:** Yiannis Tsiounis, Ph.D.
**Phone #:** 917-660-3913

**Award Amount:** $74,900.00

**Abstract:** The ability to electronically identify users and their devices is increasingly becoming an integral part of our interaction with computing platforms. Whether an operating system is contacting the manufacturer's web site to confirm its proper registration and payment today, or a cell phone is broadcasting entrance credentials to a secure physical site tomorrow, it is apparent that identifying information about ourselves, our computers and the devices that we carry or use is being disseminated at an accelerated pace. This highlights the need for guaranteeing the security of these credentials as well as safeguard user privacy in the face of such wide credential dissemination. Here we propose a credential system that guarantees security and privacy. In addition, since unconditional privacy can create significant problems, such as anonymous threats by users, or untraceable virus distribution by devices, the proposed credential system includes a distributed version of privacy control - i.e., the user has the ability to select which party (or authority) is allowed to revoke his privacy. This provides similar controls to, e.g., a corporation selecting a given State in which to defend against litigation, or a parent deciding that he trusts his neighbor, but not the government, to trace the whereabouts of his children.

**Commercial Applications**: In the military, a secure and private credential system could enable agents to relay critical intelligence information back to decision makers and other forces without revealing their identity. Government agencies can also use a secure and private credential system to allow access of different clearance levels to central databases, with disclosing to the system administrators the identity of the person who is making the access. Or, departments like NIH and the Centers for Disease Control may choose to track the movement of infected persons during outbreaks, or to control movements of livestock in order to prevent outbreaks, with revealing that information to others. Commercial applications include usage of credentials on a device level to control software piracy, media piracy, to facilitate software collaboration, etc., and on a user level to allow remote collaboration, remote access, and so on.

**FY 2004 Phase I Award**

**Topic:** 9.09 MICROELECTRONICS MANUFACTURING

**Subtopic:** 9.09.02 Rapid Thermal Annealing System with Temperature-Time Gradient

**Title:** Rapid Thermal Annealing System with Controlled Temperature Gradient and Annealing Time

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

**Firm:** GT Equipment Technologies, Inc.
243 Daniel Webster Highway
Merrimack, NH 03054-4807

**Principal Investigator:** Yuepeng Wan
**Phone #:** 603-883-5200 x313

**Award Amount:** $75,000.00

**Abstract:** Rapid thermal annealing (RTA) has been widely used in microelectronics fabrications. The current RTA system only provides uniform temperature distribution across the whole annealing chamber at any given time. Therefore, it greatly limits the implementation of combinatorial methodology in one single trial. This SBIR Phase 1 proposal investigates the feasibility of developing a temperature-time gradient RTA system by using a combination of distributed lamp heating and cold finger cooling. The successful development of this technology will create a new type of RTA system that can generate prescribed temperature gradient and controlled annealing time for different areas across the wafer. This new RTA system will enable the implementation of the combinatorial method that will greatly improve the efficiency and throughput of the experimentations on the process development and optimization.

**Commercial Applications:** The RTA system developed through this project is capable of generating prescribed temperature gradient over the processed wafer and controlling the annealing time across the wafer, thus enables the implementation of the combinatorial method for processing and characterization of thin film electronic materials. This is an ideal tool for researchers on RTA process development and optimization in all sorts of application areas. There is a niche market for this new RTA system among research organizations, industrial development groups, and academic educational institutes.

**FY 2004 Phase I Award**

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

**Subtopic:** 9.14.03 Distributed Multi-Nodal Voice/Data Communication for Fire Fighters

**Title:** Technologies to Enhance Fire Safety

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

**Firm:** Innovative Wireless Technologies, Inc.
1047 Vista Park Dr., Suite A
Forest, VA 24551-4253

**Principal Investigator:** Eric J. Hansen
**Phone #:** 434-316-5230

**Award Amount:** $74,944.00

**Abstract:** Communications between fire fighting teams traditionally consists of two-way, trunked and conventional radios that severely degrade once inside of a building or tunnel. The proposed research is focused on solving the uninterrupted in-building and in-tunnel voice and data services which are critical for fire fighter safety. Innovative Wireless Technologies (IWT) of Forest, Virginia proposes a feasibility study for an Ultra Wideband (UWB) network that is rapidly deployable, low cost, small in size, and power efficient. This study will determine UWB's capabilities inside buildings via simulation and UWB hardware measurements. Ad-hoc networking algorithms relative to the fire fighting application will be explored with a focus on redundant routing and latency. Through IWT's alliances with leading public safety equipment providers, such as M/A Com and Thales Communications, interoperability concerns with existing radio services will be examined.

**Commercial Applications:** Post 911 initiatives are driving new and innovative research to further protect First Responders. IWT's close ties with public safety equipment providers such as M/A-COM and Thales Communications, coupled with our relationships with simulation and RFIC providers, Agilent and RF Micro Devices, provide an excellent opportunity for partnering and commercial of UWB technology. By requiring that our technological advancements are backward compatible with existing Fire Safety technology, the commercial market will embrace the deployment of safety enhancing subsets that compliment their equipment. Another commercial application of IWT's concept is the use of this UWB network in Homeland Defense initiatives. The basic framework will be in place for a rapidly deployable, low cost, small in size, and power efficient system that can be interfaced to CBNR sensors for terrorist threat reduction.

**FY 2004 Phase I Award**

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

**Subtopic:** 9.14.01 Advanced Building Information Systems

**Title:** Intelligent Fire Information System

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

**Firm:** Intelligent Automation Corporation
13029 Danielson Street, Suite 200
Poway, CA 92064-8811

**Principal Investigator:** Jesse Ma
**Phone #:** 858-679-4140

**Award Amount:** $74,911.00

Abstract: Modern technology has significantly impacted advanced fire alarm systems. As the sophistication of new devices increases, so has the quantity of data they are capable of collecting. However in current alarm systems only a small portion of the available information is used. Without the continuous utilization of data from each detector it is difficult to gain an accurate view on the fire's progression. IAC proposes a novel intelligent fire information system that will significantly enhance the usage of information acquired by the modern addressable analog fire detectors. The system will use artificial intelligence (AI) techniques designed to function at various system levels. At the sensor level fire detection is optimized while reducing false alarms. At the system level, fire progression is automatically and continuously tracked. Risk areas are identified and constantly updated.

Commercial Applications: The system proposed includes different layers of artificial intelligence and a graph theoretic approach to perform signal processing, event detection, data mining and data fusion for an intelligent fire information system. Potential application to this technology may extend to various fields that involve complex distributed information systems. Immediate extension of this method to be the foundation of a comprehensive building information system may serve to monitor both fire and structural integrity during events of emergency. Other applications may include machine health monitoring, medical diagnostics, utilities and traffic management, manufacturing quality inspection, security monitoring, etc. All these fields share the common property that multiple sensors are deployed to monitor different segments of a complete system.

**FY 2004 Phase I Award**

**Topic:** 9.02 ANALYTICAL METHODS

**Subtopic:** 9.02.04 Adiabatic Demagnetization Refrigerator for X-ray Microanalysis

**Title:** Next Generation Cryogen-free ADR Cryostat

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

**Firm:** Janis Research Co.
2 Jewel Drive
Wilmington, MA 01887

**Principal Investigator:** Zuyu Zhao
**Phone #:** 978-657-8750

**Award Amount:** $73,290.00

**Abstract:** We propose to develop the next generation cryogen-free Adiabatic Demagnetization Refrigerator (ADR) system. It is a two stage ADR system that employs a self-shielded conductively cooled superconducting magnet and non-filamentary support for the paramagnetic pills. This is an improved version from Janis current cryogen-free ADR system product line, and the new system will be more user-friendly and cost effective. The self-shielded magnet has approximately 5 gauss stray field at the end of the horizontal cold finger before further magnetic shield is added. The non-filamentary support employs vespel tubing with very thin wall, supported by the specially designed supporting mechanism. The design might be further simplified by using a single stage ADR, and details will be discussed.

**Commercial Applications:** Due to its applications in various fields, such as astrophysics, quantum computing, bio-physics, and etc., Janis current ADR systems has a very stable market during the past years. The next generation ADR systems as described in this proposal is expected to become more desirable since it will be more user-friendly and cost effective. One example will be what was mentioned in the NIST SBIR solicitation :"It is anticipated that a successful refrigerator would be immediately marketable to the X-ray microanalysis market and to other users of very low temperature refrigerators".

**FY 2004 Phase I Award**

**Topic:** 9.09 MICROELECTRONICS MANUFACTURING

**Subtopic:** 9.09.04 Development of a Laboratory Scale CD-SAXS Device

**Title:** Development of a Laboratory Scale CD-SAXS Device for Semiconductor Metrology Applications

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

**Firm:** Jordan Valley Semiconductors, Inc.
2211 Denton Drive, Suite A
Austin, TX 78758-4532

**Principal Investigator:** Dileep Agnihotri
**Phone #:** 512-832-8470

**Award Amount**: $75,000.00

**Abstract:** A semiconductor metrology tool will be developed employing the technique of small-angle x-ray scattering (SAXS) to measure the critical dimension (CD) of patterned device structures. The feasibility of the SAXS technique to measure CD has been shown using high-power synchrotron radiation facilities which are not of practical use to the semiconductor industry. The ultimate project goal is to produce a practical CD-SAXS tool for use within semiconductor fabs.

**Commercial Applications:** Currently, CD-SAXS measurements can be performed at synchrotron radiation facilities available at various National Laboratories around the country and government-sponsored facilities around the world. These facilities, while accessible to industry, cannot be considered practical outlets for routine semiconductor production CD-SAXS measurements. A goal of this project would be to produce a commercial CD-SAXS tool for use within semiconductor fabrication facilities. While there exist numerous analytical techniques which offer useful information for semiconductor production, only those which can be integrated into the production facility are able to meet the requirements of production throughput. The resulting commercial product would complement Jordan Valley's existing product line of x-ray metrology tools and would be offered to industry through the company's existing worldwide sales channels.

**FY 2004 Phase I Award**

**Topic:** 9.08 MANUFACTURING SYSTEM INTEGRATION

**Subtopic:** 9.08.01 Computational Tools to Support

**Title:** Ontology based Computational Tools

**NIST OU:** 820 Manufacturing Engineering

**Firm:** Lateral Eye, Inc.
9030 Michael Douglas Dr.
Clarence Ctr., NY 14032

**Principal Investigator:** Mini P. Kesavadas
**Phone #:** 716-741-8174

**Award Amount:** $75,000.00

**Abstract:** CAD CAM technologies have had an immense impact on the product development process in the last two decades. Current technologies, however, have limited knowledge representation and computational capabilities to enable collaboration of design decisions beyond commercial Internet based collaboration tools. In the Phase 1 Lateral Eye proposes to develop a new framework for Knowledge Integrated computational tools for the capture, storage, retrieval and reuse of design knowledge among geographically and temporally distributed design teams. The proposed approach will be based on developing an ontological based product system. This will significantly reduce the number of iterations and redesigns that are common in a distributed design environment, potentially yielding a saving of over 100 - 200 million dollars for companies in the United States each year.

**Commercial Applications:** This research can lead to a new design knowledge and representation system for collaborative design environment. Further the Ontology builder may also have commercial applications in other engineering applications where complicated data and relationships have to be captured.

**FY 2004 Phase I 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 #:** 757-224-5692

**Award Amount:** $74,955.00

**Abstract:** Luna Innovations proposes to develop for NIST a low-cost, yet high resolution acoustic sensor system capable of determining micro-degree changes in a water path caused by clinical medical radiation devices. The sensors are external to the water and play a negligible role in thermal transfer in contrast to current thermocouple devices in use today. An exciting element in this proposal is APPLES' ability to resolve parts per ten million parameter change through resonance feedback and phase locking. Multiple external sensors can also be used to determine the spatial uniformity of the absorbed clinical energy.

APPLES will be built and tested in Phase I with close interactions with NIST to ensure the project achieves the desired outcomes. Luna has already successfully applied this physics to diverse diagnostic measurement science needs including fastener tension, medical compartment syndrome, railroad rail stiffness sensor, and adhesive bond strength. Based on preliminary tests, Luna believes this to be an ideal application of this award-winning acoustic system.

**Commercial Applications:** APPLES can become a secondary standard for measurement of small changes in temperature for medical calibration. The potential low-cost of this technique may open the commercial door to on-site calibration for medical radiation systems including other high-power radiation devices such as ultrasound. Other applications include industrial process control monitoring.

**FY 2004 Phase I Award**

**Topic:** 9.02 ANALYTICAL METHODS

**Subtopic:** 9.02.02 High-Accuracy, High-Stability, High-Pressure Transducers

**Title:** Microresonator-based High-performance High-pressure Sensor

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

**Firm:** Nomadics, Inc.
1024 S. Innovation Way
Stilwater, OK 74074

**Principal Investigator:** Shijou-jyh Ja
**Phone #:** 405-372-9535

**Award Amount:** $74,998.00

**Abstract:** In this Phase I SBIR, Nomadics will build on our past experience with micro-structure resonators and quartz-based sensors to develop a pressure sensor suitable for high pressure applications such as oil and gas industry applications. In the Phase I work, the outstanding measurement resolution of our sensing technology will be demonstrated and the feasibility of this technology for pressure sensing will be demonstrated. Pressure tests with ranges up to 140 MPa will be performed. The pressure sensing range and sensitivity of a commercially available structure will be tested. The material property, behavior, and the mechanical integrity of the chip assembly including the fiber connector under high-pressure environment will be understood. The interaction of pressure fluid in the testing facility and material at various pressures and temperatures will be tested. These efforts will include collaboration with a leader in the oilfield test and measurement industry. Successful completion of the Phase I tasks will warrant continuation into Phase II prototyping.

**Commercial Applications:** The proposed technology will permit direct, real-time monitoring of high pressures with the accuracy equal or better than the current standard. The immediate application will be for oil and gas well monitoring, and Nomadics has already established contacts that will facilitate commercialization in this market. Additional commercial applications include industrial processes that involve high pressures, such as plastic extrusion and hydroforming.

**FY 2004 Phase I Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

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

**Title:** DIVERSE WIMP Framework

**NIST OU:** 890 Information Technology

**Firm:** Open Tech, Inc.
1336 Mockingbird Drive
Blacksburg, VA 24060

**Principal Investigator:** Daniel J. Larimer
**Phone #:** 540-239-1863

**Award Amount:** $74,816.00

**Abstract:** Open Tech proposes to adapt the WIMP (Window Icon Menu Pointer) interface for immersive applications. Using logical input devices like windows, menus, sliders, and buttons applications can be built to be device independent. Open Tech’s innovative approach uses a laser pointer like mouse to control a 3D WIMP interface. Scientists will be able to quickly build interfaces that are easier to learn, more flexible, and more powerful than many current applications. This approach is particularly useful for scientific visualization where realism and presence is less important than the data being visualized.

**Commercial Applications:** The creation of the DIVERSE WIMP Framework will allow many applications to be written and reused in many environments. This will create a market for support services for both DIVERSE and the DIVERSE WIMP Framework. Open Tech would be available to contract for the development of immersive applications based on DIVERSE.

**FY 2004 Phase I 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.
PO Box 12212
Tallahassee, FL 32317-0001

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

**Award Amount:** $73,567.00

**Abstract:** Parallax Research, Inc. proposes to develop an Ultra-High Vacuum Compatible Wavelength Dispersive X-ray Spectrometer for use on Field Emission Scanning Electron Microscopes, Transmission Electron Microscopes, Auger Spectroscopy Systems, and X-ray Photo-electron Spectroscopy Systems. We propose to build on Parallax's designs of innovative parallel beam x-ray spectrometers and incorporate new types of detectors, drive systems and internal components that offer UHV compatibility. This system will be capable of operating at energies from 100 to 10,000 eV, will feature various scanning techniques, will have the high Peak to Background ratios of WDS, and the very high energy resolution of WDS spectrometers. We propose to investigate novel fixed detector systems along with novel detector/x-ray optic combinations that will enable UHV compatibility.

**Commercial Applications:** There are now many FESEM systems being sold each year and we expect this to be the largest commercial market for this UHV WDS. Although Parallax Research, Inc. has managed to obtain approval from one FESEM manufacturer to place the LEXS spectrometer on its instruments, others are still very skeptical of WDS due to the use of proportional counters with thin windows. This UHV compatible system would dispel those concerns and result in many sales that are now lost.

Every year we have several inquiries about the use of LEXS on Auger or XPS systems and we have to decline because the LEXS is not UHV compatible. Although this is not a large market, the incremental cost of a UHV WDS is reasonable compared to the total cost of an Auger or XPS system as it would significantly increase these systems capabilities.

Full development of the UHV WDS must be covered by internal Parallax Research, Inc. IR&D funds because the market is too small to interest larger companies. Once the prototype is built, development of the first sales version will be covered by internal Parallax funds with subsequent units covered by previous sales as we have done with LEXS.

**FY 2004 Phase I Award**

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

**Subtopic:** 9.01.01 CW Terahertz Sources

**Title:** ErAs:GaAs Photomixers for High-Resolution THz Spectroscopy

**NIST OU:** 840 Physics

**Firm:** Physical Domains
3700 Cedarbend Dr.
Glendale, CA 91214-3241

**Principal Investigator**: Elayne B. Brown
**Phone #:** 310-713-8030

**Award Amount:** $74,972.00

**Abstract:** A new type of THz photomixer will be developed using a submicron interdigitated-electrode structure fabricated on an Eras:GaAs ultrafast photoconductive layer, an AIAs heat spreader and an AIGas/AIAs dielecric mirror. The Eras:GaAs-based photomixer will provide extremely wide tuning bandwidth (>1 decade) and a continuous-wave output power of roughly 10 microwatt around 100 GHz, at least 1 microwatt and 1 THz, and > 100 nW between 2 and 3 THz. The research will focus on the materials growth and fabrication issues, the electrical and optical performance, and the reliability and packaging necessary to deliver working devices to NIST.

**Commercial Applications:** Phototmixer diodes for generation of coherent THz radiation between ~30 GHz and 3 THz. Will be the basis for a benchtop THz spectrometer without cryogens, high voltages, or high magnetic fields.

**FY 2004 Phase I Award**

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

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

**Title:** UHV Solid State Detector for Wavelength Dispersive X-Ray Spectrometer

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

**Firm:** Radiant Detector Technologies, LLC
15770 Rica Vista Way
San Jose, CA 95127-2731

**Principal Investigator:** Larry Feng
**Phone #:** 818-280-0745

**Award Amount:** $75,000.00

**Abstract:** Wavelength dispersive spectrometers (WDS) are widely used in both scanning electron microscopes and scanning transmission electron microscopes for x-ray elemental analysis and mapping. The WDS systems are typically used to detect x-rays in the 100 eV - 2000 eV energy range, for chemical analysis of elements Be through P. Despite the excellent energy resolution of the WDS systems, they rely on gas flow proportional counters for detection of x-rays from the diffractor, which pose a serious problem in terms of the compatibility with the ultra-high vacuum (UHV) of the microscope. For the detection of very low energy x-rays, the gas proportional counter must have an extremely thin entrance window, which is permeable to the gas in the proportional counter, such that the proportional counter gas slowly leaks into the UHV chamber of the microscope. The newer generation field emission microscopes will not be able to tolerate the gas from the proportional counter leaking into the UHV of the microscope. In this project, we propose to develop a high performance solid state x-ray detector that will be compatible with the UHV environment, and will offer a more reliable, low cost alternative to replace the gas proportional counters in electron microscopes.

**Commercial Applications:** The commercial market for improved WDS detectors to replace the gas proportional counters on electron microscopes is as large as the market for the electron microscopes themselves. There are 1000's of electron microscopes sold each year, by companies such as Hitachi, JEOL, and LEO, as well as smaller microscope companies. In addition, the new WDS detectors to be developed here can be inserted as replacements for existing gas proportional counters in current electron microscopes already in use. Radiant Detector Technologies already has the production and marketing capabilities to commercialize this as a product, and will invest its own internal money, as well as seek outside investment money if necessary, to bring this product to the market. Radiant Detectors has experience commercializing radiation detector products, as is demonstrated by our successful sales and marketing of our VortexTM and Radiant200TM detector products (see also www.radiantdetectors.com).

**FY 2004 Phase I Award**

**Topic:** 9.02 ANALYTICAL METHODS

**Subtopic:** 9.02.02 High-Accuracy, High-Stability, High-pressure Transducers

**Title:** Optically Coupled Resonant Pressure Sensor

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

**Firm:** RPIC Systems
15770 Rica Vista Way
San Jose, CA 95127-2731

**Principal Investigator:** David W. Burns
**Phone #:** 408-729 6375

**Award Amount:** $75,000.00

**Abstract:** RPIC Systems proposes to develop a compact, optically coupled precision MEMS-based resonant high-pressure transducer that provides primary national standards from 280 MPa to 500 MPa, having <0.0001% resolution and <0.001% accuracy, the ability to operate over a wide temperature range (<-65°C to >300°C), the capability of oil or gas fill, and characteristics of quartz resonant gauges at lower pressures. The proposed sensor of RPIC Systems also will address the need of industrial and commercial markets for precision, high-pressure sensors having low hysteresis, electromagnetic interference (EMI) immunity, and increased safety in harsh, volatile, or explosive environments.

Commercial Applications: Optically-coupled high-accuracy resonant pressure sensors for high-pressure measurements to 500 MPa have potential applications in numerous military, aeronautic, automotive, gas/oil, down-hole drilling, and high-end consumer products. Segments of the pressure sensor market such as military, aerospace, commercial avionics, process control, and industrial automation are increasing demand for more compact, accurate and reliable solutions for harsh, volatile, and explosive environments. The integration of digital communications, and internetworking within sensor systems is expanding the number of potential applications and capabilities of optically coupled pressure sensors.

**FY 2004 Phase I Award**

**Topic:** 9.12 OPTICS AND OPTICAL TECHNOLOGY

**Subtopic:** 9.12.03 Optical Simulation and Image Analysis Suite (Semiconductor Manufacturing)

**Title:** Next-generation Simulation Suite for Advanced Optical Metrology

**NIST OU:** 820 Manufacturing Engineering

**Firm:** RSoft Inc. (RSoft Design Group Inc.)
200 Executive Blvd.
Ossining, NY 10562

**Principal Investigator:** Mingming Jiang
**Phone #:** 914-923-2164

**Award Amount:** $74,940.00

**Abstract:** This proposal is aimed at developing a full software solution for the next generation advanced optical metrology. Existing simulation tools cannot meet the current and future needs of scattering-based optical metrology for semiconductor manufacturing. Our proposed work will first focus on developing an enhanced RCWA-based simulation engine with advanced algorithms for fast convergence and stability, which can be applied to periodic and non-periodic 3D problems with arbitrary polarizations, structure profiles and material systems. A versatile and user-friendly CAD interface will also be developed based on the RSoft existing, industry-leading CAD technology for optoelectronics device simulation. Within the CAD, a 3D openGL display engine will be implemented for 3D data display and manipulation. Other potential methods, including FDTD, FEM and FMM, will also be investigated and implemented to address the full range of optical metrology applications.

**Commercial Applications:** The research and development effort in this proposal will create commercial design and simulation software for advanced optical metrology. The software can be used in the semiconductor manufacturing process for CD measurement, profile analysis, process monitoring, real-time and inline control. The software suite will provide a full-functional GUI and efficient and accurate algorithms for the above commercial applications. In addition, the same software suit can also be used in a broad range of other commercial application including (nano-) lithography, nano-photonic device, high-resolution optics, sub-wavelength surface grating devices, optical data storage, polarization sensitive devices, artificial dielectrics, three-dimensional displays, optical interconnection designs, spectroscopy, microlens arrays, spectral filtering, beamsplitting, and beamshaping.

**FY 2004 Phase I Award**

**Topic:** 9.02 ANALYTICAL METHODS

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

**Title:** Advanced Microcalorimeter Instrumentation for X-ray Microanalysis

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

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

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

**Award Amount:** $74,992.00

**Abstract:** An innovative superconducting transition edge sensor (TES) microcalorimeter array with superconducting quantum interference device (SQUID) readouts 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 will address and meet a critical need for increasingly high spatial resolution X-ray microanalysis in semiconductor integrated circuit manufacturing and materials research as minimum feature sizes are reduced well below 1 micron.

**Commercial Applications:** The primary commercial application for the proposed spectrometer with advanced transition edge sensor (TES) microcalorimeter and SQUID readout instrumentation is high resolution X-ray microanalysis for qualitative and quantitative defect analysis in semiconductor manufacturing and materials research.

**FY 2004 Phase I Award**

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

**Subtopic:** 9.14.02 Enhanced Fire Fighter Visibility

**Title:** A Multi-Tracker Navigation System for Firefighters

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

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

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

**Award Amount:** $75,000.00

**Abstract:** A lightweight, low-cost system for each firefighter to detect the location and direction of other nearby firefighters will be provided. A heads-up display will allow hands-free operation. The system will be integrated with the Personnel Ultrasonic Locating and Safety Equipment, or PULSE, developed by Summit Safety. This system uses ultrasound -- sound waves above the normal hearing range -- to enable a firefighter or Rapid Intervention Team (RIT) to quickly locate and rescue a disabled firefighter and to quickly locate exits in dense smoke.

**Commercial Applications:** The total US market for this product includes the over one million firefighters in over 26,000 fire departments, military firefighters, police departments (including SWAT personnel), and Search and Rescue personnel (such as FEMA teams). The total US market is estimated to be in excess of $200 million.

**FY 2004 Phase I 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. Haase
**Phone #:** 978-772-9009

**Award Amount:** $74,998.00

**Abstract:** Summit Safety will develop an ultrasonic, non-contact sensor and system capable of detecting 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 structural collapse.

**Commercial Applications:** The total US market for this product includes the over 1 million firefighters in over 26,000 fire departments and 40,000 pumpers, potential monitoring and tactical military and law enforcement applications, as well as Search and Rescue (such as FEMA USAR teams). The total US market is estimated to be in excess of $50 million.

 **FY 2004 Phase I Award**

**Topic:** 9.09 MICROELECTRONICS MANUFACTURING

**Subtopic:** 9.09.01 Superconducting Phase Reference Device for Nonlinear Measurement Systems

**Title:** Superconducting Phase Reference

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

**Firm:** SuperconductorTechnologies Inc.
969 W. Maude Ave.
Sunnyvale, CA 94086-2802

**Principal Investigator:** Dr. Stuart Berkowitz
**Phone #:** 408-523-9439

**Award Amount:** $74,993.00

**Abstract:** We propose to develop the technology to address the need for better harmonic reference devices in order to support the field of non-linear device characterization. Superconducting delay lines can be used to generate nonlinear harmonic signals with a known magnitude and phase relationship to the fundamental signal. In order to make such a reference device, we will need to make superconducting delay lines of at least 20 cm length on a standard 5 cm wafer. This will require careful simulation and fabrication of a spiral meander line. Then we will package the delay line using interconnects to room temperature that have been optimized for stable phase response on thermal cycling. Finally, we will deliver the delay line packaged on a cryocooler with integrated PID to ensure stable temperature operation. Successful completion of this effort will form a solid foundation for building and testing an optimized laboratory prototype in Phase II.

**Commercial Applications:** Successful implementation of this technology will be useful as a reference device for comparing and/or calibrating a variety of different nonlinear measurement systems. Such a device could be used by wireless equipment companies to test and optimize their products with respect to reducing nonlinear device effects. This capability would allow HTS filter companies to optimize their products, which improve the call quality in the cellular and PCS markets.

**FY 2004 Phase I Award**

**Topic:** 9.09 MICROELECTRONICS MANUFACTURING

**Subtopic:** 9.09.03 High Throughput Modification of Wide Bandgap Semiconductors for Device Performance Optimization

**Title:** Novel Technical Approach to Produce III-N Sample Libraries

NIST OU: 850 Materials Science and Engineering

**Firm:** Technologies and Devices International, Inc.
12214 Plum Orchard Dr.
Silver Spring, MD 20904-7800

**Principal Investigator:** Vladimir Dmitriev
**Phone #:** 301-572-7834

**Award Amount:** $74,998.37

**Abstract:** TDI proposes to produce combinatorial GaN and AlGaN samples library having a wide range of doping and fabricated using a variety of surface treatment conditions. These samples will be grown using novel technological approach based on advanced hydride vapor phase epitaxy (HVPE). This method is known to produce bulk GaN materials with low defect density. Recently, TDI has demonstrated high throughput HVPE growth for both (1) doped GaN and AlGaN layers and (2) undoped layers with record low background impurity concentrations. These results opened an opportunity to develop GaN and AlGaN samples library to optimize material sheet resistivity and minimize ohmic contact resistivity using a multi-parameter space experiments. Phase I project is focused on HVPE growth of n-type and p-type samples having wide doping range and investigation of several metallization schemes for ohmic contact fabrication. Unique ability of HVPE to control defect formation in grown layers will allow us to investigate defect influence on sheet resistivity and contact resistance. The main goal of the Phase I is to prove the concept and demonstrate p- and n-type GaN and AlGaN materials with continues and discrete variation in sheet resistivity. Novel sample preparation schemes allowing combinatorial experiments on samples produced under the same conditions are proposed. Doping in grown layers will be varied from 5x1015 to 1x1020 cm-3. Fabricated samples will be delivered to NIST for testing and evaluation.

**Commercial Applications:** Optimization of ohmic contacts for GaN and AlGaN materials is very important for design, development and commercialization of a variety of GaN-based devices for both electronic and optoelectronic applications. Thermally stable low-resistance ohmic contacts to n- and p-type GaN and AlGaN materials will find a host of applications for GaN-based devices and will leverage commercialization of advanced devices such as blue and ultra-violet laser diodes and high power high frequency transistors. Tremendous commercial potential is projected for solid-state lighting devices, which also require low-resistivity ohmic contact to GaN and AlGaN materials.

**FY 2004 Phase I Award**

**Topic:** 9.05 HOMELAND SECURITY

**Subtopic:** 9.05.03 Millimeter-wave Multipliers for High Peak Power

**Title:** High Pulsed Power Varactor Multipliers for Imaging

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

**Firm:** Virginia Diodes, Inc.
321 West Main Street
Charlottesville, VA 22903

**Principal Investigator:** David W. Porterfield
**Phone #:** 434-297-3257

**Award Amount:** $75,000.00

**Abstract:** We will focus our diode based multiplier technologies toward achieving a source suitable for the NIST imaging system in the 200 – 400 GHz band. To date our best doubler to 200 GHz generates up to 55 mW of (CW) power with 30% efficiency and 15% (3dB) bandwidth. However, the NIST imaging system requires pulsed performance with more than an order of magnitude higher peak input power. Thus, the multipliers must be fundamentally redesigned. This will include optimization of components for pulsed operation, a vast increase in the peak power handling and reconsideration of the fundamental design trade-offs. Through our innovative terahertz integrated circuit designs and fabrication technologies we will create an innovative new multiplier that will enable the final development of the proposed NIST imaging system and also be useful for a host of other important scientific and commercial applications.

**Commercial Applications:** At Virginia Diodes we believe that the terahertz frequency range will be equally as useful as the microwave and infrared bands are today, once a suitable technology base has been established. Through previous SBIR support we have developed a range of CW sources. This proposed SBIR effort will allow us to extend our expertise into high peak power sources that will be useful for imaging systems, pulsed ESR experiments and plasma diagnostics measurements. There is now a very serious need for improved security at airports and other portals. Our pulsed sources will play an important role in making terahertz imaging technologically feasible. We foresee a major commercial market for imaging systems that will require the type of compact, reliable and affordable sources we propose.

**FY 2004 Phase I Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

**Subtopic:** 9.06.06 Native Continuous Mesh Support in X3D for HANIM-2001 Utilizing the Cg Language

**Title:** The H-Anim+ System: An Open Source Hardware Accelerated Human Avatar Browser API

**NIST OU:** 890 Information Technology

**Firm:** Yumetech, Inc.
999 Third Avenue, Suite 3800
Seattle, WA 98104-4023

**Principal Investigator:** Alan D. Hudson
**Phone #:** 206-340-8900

**Award Amount:** $75,000.00

**Abstract:** Adopting open standards such as the X3D and H-Anim reduce costs and ensure the longevity of applications involving human avatars. However, graphics hardware currently requires customized of vertex shader programming to optimize rendering. Yumetech, Inc. and Vcom3D propose the H-Anim+ Browser API: a generic vertex-skinning scheme for the H-Anim specification. The Phase 1 objective is to develop a generic scheme for applying a vertex-skinning program to an H-Anim compliant model using NVIDIA's Cg language. The technical approach for Phase 1 is to adapt the Xj3D Toolkit-a Java-based, open source API for creating VRML 97 and X3D applications-for the prototype H-Anim+ browser. Both companies will perform benchmark performance tests and document Phase II objectives and tasks based on results of the proof-of-concept implementation.

**Commercial Applications:** Both Yumetech, Inc. and Vcom3D envision a wide range of commercial applications growing out of the Phase 1 work. Potential markets extend to all areas of the economy. Computer-based training and simulation using realistic, digital human actors are primed for for rapid growth. Ergonomic design and safety testing are also potential markets for this application. The Yumetech Team has identified the general markets for this product to include military, law enforcement, emergency response units and the gaming industry.

**FY 2004 Phase II Award**

**Topic:** 9.11 OPTICS AND OPTICAL TECHNOLOGY

**Subtopic:** 9.11.04 Tunable Lasers For Molecular Spectroscopy

**Title:** High Power Single Frequency Source for Cavity Ring-Down Spectroscopy

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

**Firm:** Aculight Corporation
11805 North Creek Pkwy S., Ste. 113
Bothell, WA 98011-8803

**Principal Investigator:** Angus Henderson
**Phone #:** 425-482-1100

**Award Amount:** $300,000.00

**Abstract:** NIST is using a sensitive optical technique called cavity ring-down detection to permit detection of impurities in semiconductor process gases, which cause substantial losses in manufacturing yield. In order to increase the sensitivity and range of application of this technique, improved single frequency laser sources are required. In particular, lasers providing more power, narrower line-width, better beam quality and access to a wider range of wavelengths would allow detection of a wider range of species with greater sensitivity. Aculight has developed a novel laser technology which meets all of these requirements. As a final result of this program, we will deliver a packaged, fiber-based laser system which provides 1 Watt of tunable, single frequency output between 1.6 and 1.8 um. This is two orders of magnitude more power than diode lasers currently used for the application. In order to verify the utility of the laser for the application we will show that greatly increased efficiency of coupling into a ring-down cavity can be demonstrated when compared with that observed with diode laser.

**Commercial Applications:** Single frequency sources in the near to mid-infrared have a wide range of applications in trace gas detection for environmental and industrial process monitoring, gas leak detection, combustion diagnostics, telecom test and measurement, and laboratory spectroscopy. We propose to initially develop these sources as laboratory scientific lasers comparable to tunable diode lasers, but with much greater power and wavelength access. Further development of such sources for low cost and compact packaging will allow their use in sensor applications.

**FY 2004 Phase II Award**

**Topic:** 9.02 ANALYTICAL METHODS

**Subtopic:** 9.02.03 Ultra-High Resolution Capacitance Bridge

**Title:** Super-Precision Capacitance Bridge

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

**Firm:** Andeen-Hagerling, Inc.
31200 Bainbridge Road
Solon, OH 44139-2231

**Principal Investigator:** Dr. Carl Andeen
**Phone #:** 440-349-037

**Award Amount:** $300,000.00

**Abstract:** NIST desires to develop a standard of pressure in the range 0.3 MPa to 10 MPa based on measurements of the dielectric constants of gaseous helium and argon. This requires capacitance measurements having a better linearity than can be made with any currently available product. It is proposed that the design of the currently most precise commercial capacitance bridge be modified to improve its linearity by at least an order of magnitude. Resolution, stability and temperature coefficient are also to be improved.

**Commercial Applications:** A Super-Precision Capacitance Bridge will be useful for: making high pressure measurements, the development of more precise sensors, extremely precise capacitance calibrations, quantum hall effect measurements, low-temperature capacitance thermometry and any research where a physical or material property can be determined directly or indirectly by studying very small changes in very high quality capacitance measurement data.

**FY 2004 Phase II Award**

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

**Subtopic:** 9.14.02 Large Area Imaging Two-Dimensional Electron Energy Analyzer

**Title:** Realizaiton of Large Area Imaging Magnetic Analyzer

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

**Firm:** E.L. Principe and Associates
P.O. Box 3742
Redwood City, CA 94064

**Principal Investigator:** Peter Sobol
**Phone #:** 408-315-8165

**Award Amount:** $300,000.00

**Abstract:** Two distinct designs with performance characteristics for analyzers consistent with the solicitation requirements were delivered in Phase 1. The Phase 1 research and modeling results have been sufficiently conclusive to indicate feasibility of both designs. The more novel of the two designs is proposed: a hybrid magnetic/electrostatic analyzer that features very high collection and transmission efficiencies. In this design, the specimen is immersed in a magnetic field parallel to the axis of the analyzer. The proposed design provides for extremely uniform collection efficiency over a large area while preserving excellent lateral resolution. In one application this design, combined with a tunable wide area soft-xrays illumination will provide the ability to identify chemical bond information utilizing the NEXAFS technique.

**Commercial Applications:** There are several relevant industries that should find use for a spectrometer that can offer practical large area chemical mapping capabilities combined with the sub-monolayer surface sensitivity and precision achievable through electron spectroscopies. These capabilities are particularily important in the semiconductor industry for a number of processes, such as nitrided gate oxide uniformity mapping and statistical analysis of advanced thin-film desposition technologies such as atomic layer deposition (ALD) processes. Other possible application areas include mesoscopic chemical distribution studies of surfaces in the biological and biomedical industries and time dependent studies of chemical distribution changes over large scale dimensions. Capabilities would also be of interest in the Magnetic thin-film disk industries for tribological studies for the head disk interface.

 **FY 2004 Phase II Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

**Subtopic:** 9.06.02 Pervasive Computing, Accessible Computing Technology Integration And Demonstration

**Title:** SMART Life Science Laboratory Solution

**NIST OU:** 890 Information Technology

**Firm:** Entara Technology Group, LLC
14412 Delaware Ave.
Lakewood, OH 44107-5939

**Principal Investigator:** Sharon Martin
**Phone #:** 330-715-3522

**Award Amount:** $300,000.00

**Abstract:** A SMART Life Science prototype that facilitates the management of instrumentation data has far reaching implications. As much as the benefit is to an individual scientist, the greater impact affects the entire economy by facilitating the rapid launching of new scientific discoveries that cure disease and product new economic channels for firms. By improving process efficiencies in R&D organizations, SMART research environments will greatly improve the competitiveness of US firms by clearing the administrative barriers associated with innovation.

**Commercial Applications:** SMART technologies can have a strong impact on improving researcher productivity by providing advanced and accurate metadata based knowledge frameworks and ontologies; facilitating workflows that reduce the amount of time spent on identifying community efforts; and providing evolvable interfaces that allow for individual preference in searching, annotating and publishing results to the scientific community.

**FY 2004 Phase II Award**

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

**Subtopic:** 9.13.04 Sensing For Advanced Warning Of Structural Collapse

**Title:** Monitor for Risk of Structural Collapse

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

**Firm:** Sekos, Inc.
12321 Middlebrook Rd., Suite 150
Germantown, MD 20874-1591

**Principal Investigator:** Loland A. Pranger
**Phone #:** 301-428-9818

**Award Amount:** $300,000.00

**Abstract:** The proposal is to develop a system to monitor fire-induced structural vibrations that provide real time data correlating with structural integrity. The system is designed to bridge an "information void" and provide firefighters with information that can warn of impending collapse. The system, based on accelerometer technology, will monitor structural integrity through the algorithmic analysis of structural vibrations that have been shown to reliably detect changes in structural integrity. We believe that a careful application of this sensor system would accurately provide timely warning to fire fighters and would reduce the risk of death and disability due to structural collapse.

**Commercial Applications:** The commercial market for this system includes the US fire service and international fire companies. Further testing of the system may enable marketing the device to search and rescue/disaster operations, military applications, mining operations, and general construction. The primary application of the research and efforts proposed herein will be a rapidly installed sensor system which will be used to assist fire personnel in understanding and assessing the risk of a structural collapse.

**FY 2004 Phase II Award**

**Topic:** 9.06 INFORMATION TECHNOLOGY

**Subtopic:** 9.06.01 Direct Digital Noise Measurement System

**Title:** Direct-Digital Phase-&-Amplitude-Noise Measurement-System

**NIST OU:** 840 Physics

**Firm:** Timing Solutions Corporation
4775 Walnut Street, Suite 1B
Boulder, CO 80301-2579

**Principal Investigator**: Samuel R. Stein
**Phone #:** 303-939-8481

**Award Amount:** $299,904.36

**Abstract:** The Direct Digital Phase Noise Measurement Phase 1 SBIR demonstrated the feasibility of the technology to make the measurements required by the commercial marketplace. This new approach to phase noise measurements uses fast digital-to-analog converters to digitize the input RF signal and performs all down-conversion and phase detection functions by digital signal processing. It has several significant advantages over analog phase noise measurements techniques: there is no external phase-lock loop, oscillators can be compared at different frequencies, amplititude and phase noise spectra and Allan variance may be measured simultaneously, and complex calibration techniques are eliminated.

**Commercial Applications**: Direct digital phase noise measurement instruments will replace analog measurement instruments wherever they are competitive in performance for two reasons. They will have lower acquisition cost resulting from the elimination of expensive low noise analog electronics. They will also have lower operating cost since they will not require skilled personnel to make good measurements. Phase noise measurements are routinely made for oscillators used in communications, radar, signal intelligence, and navigation.

 **FY 2004 Phase II Award**

**Topic:** 9.09 MICROELECTRONICS MANUFACTURING

**Subtopic:** 9.09.01 Calibration Methods To Remove Probe Shape Effects From Scanned Probe Microscope Measurements Of Semiconductor Linewidth

**Title:** Dual-Probe CD-AFM Calibration

**NIST OU:** 820 Manufacturing Engineering

**Firm:** Xidex Corporation
8906 Wall Street, Suite 105
Austin, TX 78754

**Principal Investigator:** Vladimir Mancevski
**Phone #:** 512-339-0608

**Award Amount:** $300,000.00

**Abstract:** Xidex proposes to demonstrate the feasibility of calibrating a critical-dimension atomic force microscope (CD-AFM) without the use of a reference artifact in such a way that high-precision critical dimensions can be generated independently of changes in probe tip shape. We plan to demonstrate sub-nanometer repeatability for tip-to-tip calibration, and demonstrate single-point critical-dimension measurements which verify that tip-to-tip calibration removes the effects of tip shape variation and tip wear from linewidth measurements. Phase II will provide critical design guidance for controller design and MEMS fabrication of probes and tips for use with a commercial dual-probe system. These are our next critical steps on the path to the commercial NanoCaliperTM CD-AFM tool we are developing.

**Commercial Applications:** Xidex Corporation is in the business of developing, and bringing to market critical-dimension (CD) metrology equipment for use by major semiconductor chip manufacturers. Our product, NanoCaliperTM Critical-Dimension Atomic Force Microscope (CD-AFM), based on our proprietary dual-probe AFM technology, is positioned to capture the lead in the CD metrology equipment market at a time when the semiconductor industry is seeking a transition from mature scanning electron microscope (SEM) technology to its next-generation measuring technology. This kind of industry-wide transition in the dominant measurement technology comes along only once every 10-15 years.