Abstracts of Awards for Fiscal Year 2009 NIST SBIR Program

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**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.03-3.R Gigahertz Frequency Comb for Coherent Fourier Transform Spectroscopy

**Title:** Phase-stabilized 1-GHz Fiber-laser Frequency Combs at 2-5micron for Coherent Fourier Transform Spectroscopy

**NIST OU:** Chemical Science and Technology

**Firm:** Advalue Photonics, Inc.
4585 S. Palo Verde Rd., Suite 405
Tucson, AZ 85714

**Principal Investigator:** Jihong Geng
**Phone:** 520-790-5468
**Email:** jgeng@advaluephotonics.com

**Award Amount:** $89,977.00

**Abstract:** A GHz-rate phase-stabilized fiber-laser frequency comb system is proposed to be used as a light source for coherent Fourier transform spectroscopy. The system will be developed based on our proprietary glass/fiber technology, which features a low-cost, robust, highly stable, mid-infrared light source that enables the development of a robust portable c-FTIR spectrometer for absorption measurements of many important chemical/biological species. Both the pulse repetition rate and carrier-to-envelop offset frequency of the comb system are stabilized. High system stability is attributed to a sophisticated system design and a novel feedback design for the phase stabilization with an extremely high-bandwidth (>>50kHz). The Phase I program will achieve a proof-of-concept demonstration, and the Phase II program will result in two prototype units of such an octave-spanning frequency combs, that could be delivered to NIST at the end of program.

**Commercial Applications:** This proposed technology could offer a turnkey fiber comb system, which will be an ideal light source for c-FTIR spectroscopic applications. The successful accomplishment of the proposed system will enable a low-cost robust portable c-FTIR spectrometer for a variety of applications, such as remote sensing, real-time environmental monitoring, and chemical and bio-molecular screening. Also, a phase-locked frequency comb will be a very useful light source for other high-precision metrology R&D applications, such as high-precision molecular spectroscopy, gas remote sensing and analysis for environmental monitoring, pollution control, agriculture and life sciences, and non-invasive disease diagnosis through breath analysis.

**FY 2009 Phase I Award**

**Topic:** 9.06 Homeland Security

**Subtopic:** 9.06.01-1.TT Technology Transfer of Scanning Magnetic Field Imaging

**Title:** Technology Transfer of Scanning Magnetic Field Imaging

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Advanced Research Corporation
4459 White Bear Parkway
White Bear, MN 55110-7626

**Principal Investigator:** Vernon M. Cottle
**Phone**: 651-789-9000
**Email:** vcottles@arcnano.com

**Award Amount:** $85,200.00

**Abstract**: High resolution magnetic mapping is a technique that has shown great value in the forensic evaluation of magnetic audio recording tapes. The use of single element raster scan systems has shown that the technique has promise in diagnosing many other systems where internal currents or magnetized inclusions generate external measurable fields.

NIST has developed a 256 channel MR array sensor that has significantly increased the data collection rate for 2D magnetic field scans, with high resolution compatible with forensic evaluation of audio magnetic tape.

ARC believes that if a system is established that can demonstrate the diagnostic ability of magnetic imaging with high resolution and high data capture rate on samples including and beyond recording tape of government and commercial interest, then a market might be created for an integrated turnkey system following the business model for AFM systems.

**Commercial Applications:** 1) Forensic evaluation of magnetic media 2) high speed magnetic mapping at surface of magnetic objects 3) mapping of magnetic fields of electronic devices to analyze internal current 4) mapping of biomagnetic samples

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.09-4.R Generation of Violet and Near-UV Radiation

**Title:** Fabrication of Advanced Waveguide Structures for Efficient Violet and Near-UV Generation

**NIST OU:** Physics

**Firm:** AdvR, Inc.
2310 University Way, Bldg. #1-1
Bozeman, MT 59715

**Principal Investigator:** Christopher Kaleva
**Phone:** 406-522-0388
**Email:** kaleva@advr-inc.com

**Award Amount:** $89,943.00

**Abstract:** This SBIR Phase I effort will establish the feasibility of fabricating advanced waveguide structures in potassium titanyl phosphate (KTP) capable of efficiently generating 25 to 40 mW of frequency converted light in the 395 to 480 nm. The key innovation in this effort is to utilize KTP waveguides in a single-pass frequency doubling device to efficiently produce the desired laser wavelengths and power. This approach is enabled by advances in waveguide processing which allows for the fabrication of uniform waveguide structures to be formed in commercially available KTP in conjunction with AdvR’s patented submount poling technique. The results of this effort will lead to a compact, robust frequency doubling package suitable for operation in the 395 to 480 nm range with output powers of 25 to 40 mW which meets the objectives of the NIST SBIR topic 9.12.09-4.R Generation of Violet and Near-UV Radiation.

**Commercial Applications:** The optical frequency-doubling devices developed through this SBIR at the end of Phase II will generate more than 40 mW of narrow band output at wavelengths ranging from 395 nm to 480 nm in a highly efficient, single-pass configuration. Its immediate application will be by NIST in optical atomic clock research. Additional commercial markets include the identification and measurement of hazardous and trace gases, quantum computing, production of quantum degenerate atoms for secure communications, laser cooling, and manipulation of atoms for a host of biomedical applications.

**FY 2009 Phase I Award**

**Topic:** 9.02 Analytical Methods

**Subtopic:** 9.02.05-5.R Attogram-Level Single Nanoparticle Mass Sensing in Liquid Media

**Title:** Nanoparticle Characterization in Fluid by Resonant Mass Measurement

**NIST OU:** Material Science and Engineering

**Firm:** Affinity Biosensors, LLC
75D Robin Hill Rd.
Santa Barbara, CA 93117

**Principal Investigator:** Ken Babcook
**Phone:** 805-455-0181
**Email:** ken@affinitybio.com

**Award Amount:** $89,944.00

**Abstract:** This project will extend the microchannel resonator to the level of a few attograms, which will allow measurement of individual particles as small as 10 nanometers with unprecedented resolution. The Phase I effort will prove the feasibility of this approach by miniaturizing the MEMS sensors, thereby improving their intrinsic mass sensitivity up to 100-fold; and by simultaneously measuring the sensor resonant frequency with ultra-high precision. An eventual Phase II program would produce a complete nanoparticle measurement platform available for use at NIST and for commercial sale.

**Commercial Applications:** Nanoparticles are central to many emerging nanotechnology applications, serving as agents for the targeting, treating, and imaging of cancer; catalysts for advanced energy storage; new slurries used in semiconductor manufacturing; and source material for numerous high technology materials, including sintered ceramics and coatings. The ability to measure particle properties such as size, volume, and mass is crucial to development and quality control in these applications.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.05-4.TT High-Spectral-Purity, Millimeter-Wavelength Oscillator

**Title:** High-Performance Opto-Electronic Oscillator for Millimeter Wave

**NIST OU:** Physics

**Firm:** Agiltron, Inc.
15 Cabot Road
Woburn, MA 01801-1003

**Principal Investigator:** Dr. Geoffrey T. Burnham
**Phone:** 781-935-1200
**Email:** Gburnham@agitron.com

**Award Amount:** $89,986.26

**Abstract:** Leveraging Agiltron’s recent breakthrough in the broad band and tunable photonic high-Q factor RF filtering technique, we propose to develop a high-spectral-purity, low-phase-noise, spurs-free opto-electronic oscillator (OEO) operating at W-band for the NIST applications. Based on our unique technical approach and successful development in low loss fiber optics, RF photonic components/modules, and the drastic improvement in cost and performance of commercial electro-optical components, this OEO will provide a millimeter-wavelength source with ultra-high purity signal at 90 GHz to 110 GHz at room temperature. This RF source is a highly tunable module with high speed. The practicality of such an OEO scheme including photonic high-Q tunable RF filter in X-band operation has been demonstrated by Agiltron. In Phase I, the numerical simulation and the experimental evaluation of primary performance in the proposed novel scheme will be performed to design a full functioning OEO which will be implemented in the Phase II program. The performance and the cost of the source will be analyzed as well. Success in this program will significantly reduce mission cost, size and increase performance and utility of future telecommunication and radar sensor systems of commercial and military applications.

**Commercial Applications:** Advanced RF system, applying in surveillance, weapons detection, directional wireless power transfer, and communications applications, require NIST to provide a high performance millimeter wavelength source for wideband operating for precisely timed, high-spectral-purity, equally spaced carrier signals in order to reduce spectral density. This application can be used for DoD’s radar system and satellite communication, as well as the commercial wireless communication. The GPS system requires precise, low-jitter clock source for high accurately positing in the future. The high speed A/D converter in commercial, military, science research need a low-phase-noise source also. In military and commercial range, wideband applications including Electronic Countermeasures (ECM), radar, tunable microwave filtering and high spectral purity tunable source are key insertions for this technology. This new class of high performance tunable RF source and fast oscillator will enable advanced radar, electronic warfare (EW), and communications to support global intelligence, surveillance, and reconnaissance (ISR), global strike, and homeland security capabilities.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.07-4.TT Automated, Temperature-controlled High-power LED Measurement

**Title:** Development of Pulse/DC Characterization System for LEDs

**NIST OU:** Physics

**Firm:** Arroyo Instruments, LLC
373 Front St., Suite B
Grover Beach, CA 93433-1553

**Principal Investigator:** Paul Corr
**Phone:** 805-481-6684
**Email:** pcorr@arroyoinstruments.com

**Award Amount:** $82,390.00

**Abstract:** The purpose of this project is to implement the process for a new method for the measurement of LED performance, but in a form that is low-cost, integrated, and easy-to-use, so that the barrier to entry is as low as is possible.

**Commercial Applications:** The commercial potential of the application is significant, as it could ultimately reach into every LED R&D, test, and manufacturing facility. Arroyo Instruments would develop a kit which includes all the components necessary.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.04-4.TT Single-Photon Direct Detection of Lyman-alpha Radiation

**Title:** Silicon Carbide Avalanche Photodiodes for Single-photon Direct Detection of Lyman-alpha Radiation

**NIST OU:** Physics

**Firm**: Aymont Technology, Inc.
30 Saratoga Ave., Suite 6H
Ballston Spa, NY 12020

**Principal Investigator:** Larry B. Rowland
**Phone:** 518-884-2513
**Email:** rowland@aymont.com

**Award Amount:** $$89,965.07

**Abstract:** In the proposed Phase I SBIR program, Aymont Technology and CoolCAD Electronics will design and demonstrate prototype silicon carbide (SiC) avalanche photodiodes (APD) specifically designed for high-efficiency, single-photon counting of 121.6 nm Lyman-alpha photons. This detector will be provided to relevant personnel at NIST for calibration and testing. Both discrete APDs and arrays will be used to enable a 3 x 5 mm detector suitable for this prototype testing. The proposed research will build upon Aymont’s demonstration of a SiC APD with over one million multiplication gain and CoolCAD’s extensive modeling of 4H-SiC APDs for 135 nm applications. An absorption layer on the order of 10 nm thick will be used in Phase I to reduce wavelength and enable at least 5% quantum efficiency at the Lyman-alpha characteristic wavelength.

**Commercial Applications:** The APDs to be developed on this program can be used for a host of potential applications in the far ultraviolet. Most relevant for this particular research is its use in the Lyman Alpha Neutron Detector (LAND) recently developed at NIST. This detector can be used in place of a photomultiplier tube to efficiently detect neutrons in simple, compact, and potentially low-cost configuration. Additional applications for the APDs not involving neutron detection include space astronomy, far ultraviolet spectroscopy, and photolithography. Development of these 4H-Sic APDs for the LAND detector will also further the development of these APDs for the “solar blind” regime, where they can be used for medical imaging, biodetection, non-line-of-sight communications, and to replace PMTs in scintillation detection (e.g. handheld radiation detection).

**FY 2009 Phase I Award**

**Topic:** 9.02 Analytical Methods

**Subtopic:** 9.02.04-5.TT Development of a Multi-sample Multi-Slit Rheometer

**Title:** A Fully Integrated Commercial Multi-sample Multi-Slit Rheometer

**NIST OU:** Material Science and Engineering

**Firm:** Cambridge Polymer Group
53 Roland Street, Suite 310
Charlestown, MA 02129-1235

**Principal Investigator:** Dr. Gavin Braithwaite
**Phone:** 617-629-4400 x11
**Email:** gavin.braithwaite@campoly.com

**Award Amount:** $89,526.00

**Abstract:** Proposed here is the continued development of an innovative rheometer configuration design at NIST. It describes the determination of suitable detection, drive, control, software and assembly designs for a commercially viable, fully integrated device. The initial efforts will concentrate on examining the sub-systems of the design. An important feature of the proposed strategy is early commercial input to allow suitable performance specifications to be fixed early on. By examining competing instruments, and asking early questions of potential users, the design can be refined more accurately. In parallel to the development of the hardware and software modules, a detailed commercialization plan for the instrument will also be generated. This will examine target industries, required through-puts and potential market sizes, as well as likely instrument cost. Phase I will provide a robust, reliable and desirable design for the Multi-sample Multi-Slit Rheometer (MMR) that provides the critical subsystems in modular form, and a solid justification for the design choices as well as a roadmap for the commercialization of the instrument.

**Commercial Applications:** The primary application of the MMR is in polymer processing where it will provide a faster method for testing fluids in a rheologically rigorous instrument than is currently available. Because of its small sample volume, it is likely to also be useful in environments where small volumes of fluids are the norm. This may be in the biological arena, for diagnostic purposes, but may also be in applications where a large number of small amounts of sample need to be screened for further testing, such as in combinatorial chemistry applications. The MMR’s small footprint and rapid test turnaround may also be useful in quality assurance environments where robust, simple, and fast results are a necessity.

**FY 2009 Phase I Award**

**Topic:** 9.02 Analytical Methods

**Subtopic:** 9.02.03-3.TT Signal Processing Methods for High-Dimensional Microsensor Data Streams

**Title:** Chemometric Support for Temperature-programmed Sensing System

**NIST OU:** Chemical Science and Technology

**Firm:** Eigenvector Research, Inc.
3905 West Eagle Drive
Wenatche, WA 98801-9066

**Principal Investigator:** Barry M. Wise
**Phone:** 509-662-9214
**Email:** bmw@eigenvector.com

**Award Amount:** $79,660.00

Abstract: The Temperature=Programmed Sensing (TPS) system developed at NIST presents many opportunities and unique challenges. The data output from the system can be quite complex and there are many opportunities to optimize the system for specific sensing scenarios. We propose a program aimed at characterizing the system so that potential problems (such as system drift) can be solved early so that the full potential of the system can be realized. The plan includes studies on the stability and theoretical functionality of the sensors. This will result in procedures for instrument standardization and data base-lining. After this is accomplished, advanced preprocessing methods will be considered, along with the use of multi-way (“second order”) data modeling methods for use in calibration and classification. Finally, procedures for optimizing the system for specific applications will be developed.

**Commercial Applications:** With the proper data processing, the NIST TPS system could be employed in a wide variety of sensing applications ranging from homeland security to medical applications. The data analysis routines developed here will be incorporated into existing software, such as Eigenvector’s PLS\_Toolbox and Solo packages, for use with the TPS and other similar analytical systems.

**FY 2009 Phase I Award**

**Topic:** 9.11 Nanofabrication

**Subtopic:** 9.11.01-5.TT Developing Centrifugation Based Length Separation of SWCNTs for Advanced Applications

**Title:** Developing Centrifugation Based Length Separation of SWCNTs for Advanced Applications

**NIST OU:** Material Science and Engineering

**Firm:** Eikos Inc.
2 Master Drive
Franklin, MA 02038-3034

**Principal Investigator:** Michael O'Connell
**Phone:** 508-528-0300
**Email:** mjoconnell@gmail.com

**Award Amount:** $89,999.00

**Abstract:** Carbon nanotubes are one of the most studied and potentially useful nanoparticles known. However, presently even the purest are only commercially available in mixtures of chiralities and lengths. Even though numerous lab scale methods to separate them have been demonstrated, few offer the potential to be scaled and offered as a product. Eikos has found that, for many applications, nanotube length is a far more critical variable for performance than chirality or electronic type. Eikos proposes to separate single walled carbon nanootubes by length using rate-based superspeed centrifugation. Eikos will develop a low-cost scalable process by using low g-force, large capacity centrifuge separation and an inexpensive density medium. By choosing the appropriate equipment and materials, Eikos can meet a cost target of $2 per milligram. The project has two main objectives: (1) duplication of the NIST process on a small scale using a sucrose dense medium and (2) demonstration of large scale length separation using a large centrifuge rotor. Furthermore, all materials will be fully characterized and samples will be sent to NIST for verification.

**Commercial Applications:** Commercialization potential for length separated SWCNTs starts with offering a length sorted SWCNT Standard Reference Material (SRM) and providing commercial quantities of the SRM to customers. It is anticipated that biological researchers will gravitate towards NIST nanotube SRMs because they are well-characterized for FDA submissions. Based on a cursory market-driven needs estimation, we see the predominant near-term market for nanotube SRMS as being in academic research. Furthermore, we anticipate that transparent conductors made from long SWCNTs will be significantly more conductive and transparent than those made from unsorted materials. By creating more conductive films, Eikos will open new markets that are currently inaccessible with state-of-the-art coatings, such as LCD and photovoltaic electrodes. These materials will be suited for use in several other electronic applications, including sensors, electromagnetic shielding, anti-static coatings, and printable wires.

**FY 2009 Phase I Award**

**Topic:** 9.09 Micro- and Nano-fabrication Micromachining

**Subtopic:** 9.09.02-2.TT Integration of High Precision 6DOF Micropositioners with Microscopes for Micrometrology Applications

**Title:** Micro-Positioner Replacement of Piezo Actuators in Long-working Distance Interference Microscopes

**NIST OU:** Manufacturing Engineering

**Firm:** EM Optomechanical
13170B Central Ave. SE #310
Alburquerque, NM 87123-5549

**Principal Investigator:** Thomas A. Swann
**Phone:** 505-550-7031
**Email:** tswann@emopto.com

**Award Amount:** $89,444.00

**Abstract:** The NIST patented six-degree of freedom micropositioner technology associated with this subtopic has been identified by E M Optomechanical, Inc. (EMOM) as a technology that could be incorporated into the company’s long-working distance interference microscopes. A key element in these microscopes is a piezo-actuator device, installed in a manual pitch/yaw mount, which translates a small flat mirror in nanometer-scale motions. Drawbacks in using piezo-actuators include their cost, fragility, non-linear motion, hysteresis, and high dc voltages required. EMOM believes the NIST patented micro-positioner technology could be used to develop a three-axis actuator that could replace the piezo-actuator and the pitch/yaw mount thereby improving performance and reducing cost. For this project, EMOM has assembled a highly qualified technical team also experienced in the successful commercialization of work funded through the SBIR program and other government funded research.

**Commercial Applications:** In addition to replacing piezo-actuators in interference microscopes, there are many other optical devices that could benefit from a compact, precise, reliable, low-cost three-axis mirror positioner.

**FY 2009 Phase I Award**

**Topic:** 9.08 Manufacturing System Integration

**Subtopic:** 9.08.01-2.R Time Synchronization of Wireless Sensor Networks

**Title:** Time Synchronization of Wireless Sensor Networks

**NIST OU:** Manufacturing Engineering

**Firm:** Esensors Inc.
4240 Ridge Lea, Suite 37
Amherst, NY 14226

**Principal Investigator:** Darold Wobschall
**Phone:** 716-837-8719
**Email:** designer@eesensors.com

**Award Amount:** $89,978.00

**Abstract:** A wireless sensor and actuator network capable of providing precision time synchronization between the nodes of the network will be developed. The IEEE 1451.0 smart transducer interface and IEEE 1588 time synchronization standards will be combined, with additional software and hardware to provide synchronization between the clocks on the Wireless Transducer Interface Modules (WTIM) sensors/actuators, or nodes. The 6LowPAN option of the IEEE 1451.5 standard will be used to implement the network. The network will be demonstrated with several WTIMs and an NCAP or Internet gateway.

**Commercial Applications:** Time synchronization of wireless nodes using IEEE 1451/1588 formats will significantly enhance the value of wireless sensors and actuators for manufacturing applications. We intend to add this feature to the network sensors we currently produce and expect it will open up the market in the process manufacturing area.

**FY 2009 Phase I Award**

**Topic:** 9.05 Healthcare and Medical Physics

**Subtopic:** 9.05.02-9.R Trustworthy Networked Medical Devices

**Title:** Medical Network Traffic Recorder and Real Time Diagnostic System

**NIST OU:** Information Technology

**Firm:** IDX Group, Inc.
105 Leslie Road
Waltham, MA 02451-1324

**Principal Investigator:** Dr. Constantinos Boussios
**Phone:** 617-877-8758
**Email:** costas.boussios@idxgroup.com

**Award Amount:** $89,997.00

**Abstract:** The medical device market rises rapidly as innovation produces a stream of new applications. The added mobility offered by wireless telemetry is fueling a trend of wirelessly networked devices. Standard wireless interfaces like ISO/IEEE 11073 are increasingly being adopted for interoperability. This boosts the proliferation of wireless medical devices yet also generates reliability challenges due to wireless network overloading. Our proposal develops a Medical Network Traffic Recorder (MNTR) device that securely captures and logs medical wireless traffic over such standard storing and playing back this traffic. The real-time monitoring and data warehousing enabled by MNTR allows development of a real time Medical Network Diagnostic System (MNDS) using Data Mining technology. The MNDS monitors traffic and issues real-time warning on network quality. We will deploy a test bed MNTR at UTA’s HERACLEIA Lab’s Wireless Human Data Sensor Networks. In Phase II, we plan to develop a Patient Health Monitoring System using Data Mining techniques.

**Commercial Applications:** Commercial:
1. Healthcare Environments/Hospitals
2. Medical Devices Manufacturers
Government:
1. FDA

**FY 2009 Phase I Award**

**Topic:** 9.07 Information Technology

**Subtopic:** 9.07.01-9.TT Policy Machine

**Title:** First Steps in Transferring the Policy Machine Technology: Policy Machine Architecture and Functional Specification (PMAFS)

**NIST OU:** Information Technology

**Firm:** Intelligent Automation, Inc.
15400 Calhoun Drive, Suite 400
Rockville, MD 20855

**Principal Investigator:** Dr. Margaret Lyell
**Phone:** 301-924-5223
**Email:** mlyell@i-a-i.com

**Award Amount:** $90,000.00

**Abstract:** IAI proposes to first develop the functional specification and architecture for the Policy Machine that can be deployed on a local machine as well as a networked platform such as LAN, web services, clouds etc. The policy machine at its core is a meta-data (attribute) based access control engine which utilized policy-based rules to allow or dis-allow use of resources. The attributes may belong to either the requester or the resources, and may depend on context. Ultimately, the Policy Machine will extend its enforcement mechanism not only over access requests in which all resources are desktop –based but also over access requests in which the desired resources are objects that reside on another computer system and that would be accessed over the network.

**Commercial Applications**: The growth of the internet, electronic communication and digitization of work processes or flows in organizations has resulted in enormous electronic content generation and information sharing across possibly the entire globe. However, the security aspect has not kept pace with the advanced computing platforms and application services. There exists a huge potential for this technology in the marketplace environments where access control over the new type of content, users or applications can be readily invoked without the need to reconfigure the system security manually. Some example non-DOD environments are information assurance systems, identity theft protection, collaboration and content management systems etc.

**FY 2009 Phase I Award**

**Topic:** 9.06 Homeland Security

**Subtopic:** 9.06.04-1.R Accurate Human Biomechanical Model for Radio Frequency Surveillance and Imaging

**Title:** Multi-posed Virtual Family Models

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Intelligent Automation, Inc.
15400 Calhoun Drive, Suite 400
Rockville, MD 20855

**Principal Investigator:** Yu-Jiun Ren
**Phone:** 301-294-4635
**Email:** yren@a-i-a.com

**Award Amount:** $90,000.00

**Abstract:** A simulation platform to develop multi-posed models for micro-Doppler sensing is proposed. CAD model based human subject models, and hardware accelerated bio-electromagnetic modeling will be developed to understand EM interaction with human subject models. Since each organ is defined via a set of vertex coordinates, various morphing algorithm can be implemented. Consequently, the proposed models (virtual family model) can easily be opened and manipulated by open source software package OpenSim or other commercial software packages such as AMIRA, Rhino, and etc. Such flexibility in the CAD models allows for the following functions: 1) Simultaneous and realistic arbitrary positioning of the models; 2) Arbitrary placement and orientation of the human models; 3) Volumetrically accurate and tissue-depend EM properties for these models; 4) Rapid model and repositioning and placement. In house graphic processing unit accelerated finite-difference time-domain (FDTD) modeling tool will be used to perform preliminary electromagnetic simulations to understand the biometric feature of these models.

**Commercial Applications:** The military, law enforcement, and intelligence community will be the dominant customers for the proposed technology. The organizations and tactical units within the Office of the Secretary of Defense (OSD/Joint), Army, Navy, Air Force, and Marine Corps have been responsible for defining the requirements, acquiring, and operating systems. Many labs have teamed up with military organizations to develop new surveillance and imaging models or to adapt them to meet specific requirements. Our immediate target for technology transfer will be to support these DoD missions. IAI is already a contractor on the Future Combat Systems (FCS) program. We are teamed up with Northrop Grumman on the FCS-logistics decision support system and with Honeywell on the FCS-Platform Soldier Mission Readiness System. We will leverage these relationships to identify the end FCS customer, and work with these teams to transition our Phase II technology into the FCS program.

**FY 2009 Phase I Award**

**Topic:** 9.07 Information Technology

**Subtopic:** 9.07.02-9.R Tools to Automate and Visualize Computer Security Metrics

**Title:** A Toolkit for Scalable and Automatic Security Analysis Using Security Metrics

**NIST OU:** Information Technology

**Firm:** Intelligent Automation, Inc.
15400 Calhoun Drive, Suite 400
Rockville, MD 20855

**Principal Investigator:** Dr. Kun Sun
Phone: 301-294-4762
**Email:** ksun@i-a-i.com

**Award Amount:** $90,000.00

**Abstract:** Our society has become increasingly dependent on the reliability and proper functioning of a vast number of interconnected information systems. To improve the security of these systems, it is necessary to measure the amount of security provided by different systems and configuration since one cannot improve what cannot be measured. In this proposal, Intelligent Automation Inc. (IAI) and its consultant, Professor Sushil Jajodia from George Mason University, propose to develop a systematic toolkit including security metrics collection, security metrics integration, and data visualization components for scalable and automatic security analysis using security metrics. We will develop a security analysis toolkit using a bottom-up approach.. We first define which security processes, products, services, etc. are in place that can be or already are measured, then consider which meaningful metrics could be derived from those measurements, and finally assess how well those metrics link to objectives for the overall security program.

**Commercial Applications:** The proposed toolkit employs attack graph technique to provide scalable, efficient and in-depth security analysis using network metrics. Our scalable and automatic data collection and analysis toolkit can provide accurate, repeatable, and frequent measurement of security features in a system. Our toolkit can handle heterogeneous data sources and minimize the tedious data collection using the data integration service. We manage the challenges of visualizing large amount data in a scalable manner. Our toolkit can greatly relieve the administrators’ daily burden on network security analysis. The market for military applications of our toolkit is quite large. Other potential commercial applications include banking, ecommerce, and various civil applications, possibly with a large and complex network.

**FY 2009 Phase I Award**

**Topic:** 9.03 Assistive Technologies

**Subtopic:** 9.03.01-9.TT Pervasive Information Technology for Sensor Infrastructure for Multi Modal Interfaces and Smart Spaces

**Title:** Mark III Enhancement Program

**NIST OU:** Information Technology

**Firm:** KEYW-Wave Sciences Joint Venture
135 National Business Parkway, Suite 101
Annapolis Junction, MD 20701-1053

**Principal Investigator:** J. Keith McElveen
**Phone:** 919-349-1930
**Email:** keith.mcelveen@wavesciencescorp.com

**Award Amount:** $89,932.00

**Abstract:** The NIST array was the first public-domain digital array hardware design. It introduced the (then) novel idea of live capture and streaming of raw array microphone audio over Ethernet for use by one or more computers on a network. The design has been improved over the years to bring it to the Mark III version 2 (2005). The present system is an excellent tool for research into microphone arrays, audiovisual computer interfaces, and smart spaces. With some modification to address existing issues, as well as the addition of some useful features, the system can be successfully tailored for a variety of commercial, academic, and governmental applications. Our proposal focuses on fundamental enhancements to the motherboard and the microboards that will provide the most near-term benefit to the NIST research application and goals, while at the same time providing a solid foundation for Phase II and Phase III (commercialization) objectives. This approach precipitates Phase I objectives to reduce the digital noise in the system and improve the system’s multi-modal functionality (i.e. better fusion of audio, video and other sensor information).

**Commercial Applications:** Smart Spaces Meeting Room, Prison Surveillance, Security Surveillance, Law Enforcement, Home Automation, Mobile Surveillance, Instant-Replay Training, Traffic Monitoring and Enforcement, Personal and Health Care/Monitoring, Telemedicine, Automotive/Acoustic Diagnostics, In-Vehicle Noise Reduction, Gaming, Environmental/Industrial Monitoring, Bird Classification/Monitoring, Industrial Process/Quality Control, Oceanography, Sound Field Synthesis.

**FY 2009 Phase I Award**

**Topic:** 9.08 Manufacturing System Integration

**Subtopic:** 9.08.02-2.R Virtual Measurement Metrology for Economic Optimization

**Title:** A Method for Specification of Efficient and Effective Strategies for Measurement of a Measurement Article on a Coordinate Measuring Machine by Use of Measurement Simulation Techniques

**NIST OU:** Manufacturing Engineering

**Firm:** Metro Sage, LLC
26986 Shake Ridge Road
Volcano, CA 95689-9610

**Principal Investigator:** Daniel A. Campbell
**Phone:** 415-738-7366
**Email:** dcampbell@metrosage.com

**Award Amount:** $89,827.00

**Abstract:** We propose the definition, design, and prototype development of a software tool for use by the U.S. manufacturing community to enable the automated production of design-based measurement strategies of known reliability and high economic efficiency for coordinate measuring machines (CMMs). The measurement strategies so generated will meet the objective of reducing overall costs to near-minimal values, based on consideration of costs associated with both the direct use of the suggested measurement strategy and with its attendant risks of Type I and Type II accept/reject decision errors. The measurement programs will be created in a CMM-independent format (DMIS) to be applicable to any selected CMM software system. Design of the system will fully leverage existing, related software technologies. The resulting software, when fully developed and commercialized, will enhance the competitive position of manufactured products by reducing waste, both in manpower and raw materials, by improving the utilization of energy-intensive raw materials and will enhance the perceived quality of items so measured and certified.

**Commercial Applications:** The availability of an easily accessibly cost-of-measurement software toolset suitable for mechanical measurement and for CMM metrology in particular will constitute a valuable addition to the arsenal of tools for advancing U.S. manufacturing profitability. While the size of the customer organization may span the entire range from the one-person company to the very large multinational corporation, it is expected that the need for and value of our product will be recognized earliest among organizations at the high end of the size range, and in their first- and second-tier suppliers. It is chiefly in this arena that economies of scale and the complexity of the interaction between measurement practice and profit margin will be most evident. We anticipate three sales modes for our product: a) as a stand-alone system, primarily to end-user organizations, b) as a licensed “kernel”, primarily to other software writers and system integrators and c) as a service, with web-based distribution and specialized consultation, primarily to end users who cannot justify the cost of system ownership.

**FY 2009 Phase I Award**

**Topic:** 9.10 Microelectronics Manufacturing

**Subtopic:** 9.10.01-1.TT Autolimiting Transmission Lines using High Temperature Superconductors

**Title:** Auto-limiting Transmission Lines Using High Temperature Superconductors

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Out of the Fog Research LLC
2258 20th Avenue
San Francisco, CA 94116-1808

**Principal Investigator:** Stuart Berkowitz
**Phone:** 415-505-3827
**Email:** sberkowitz@outofthefogresearch.com

**Award Amount:** $89,999.00

**Abstract:** In this program, we propose to develop the Auto-limiting transmission lines using HTS. The first focus is to modify the NIST designs for fabrication by an outside vendor. The second focus is to fabricate the limiter designs using co-evaporation for deposition of the HTS material and compare the achieved device parameters. The third focus is the integration of the limiter onto a cryocooler. We will then have all the building blocks to develop a prototype HTS limiter subsystem in Phase II.

**Commercial Applications:** Microwave signal limiters are particularly valuable for high dynamic range receivers that typically operate in harsh electromagnetic environments, such as above military platforms or in electronic warfare systems. Such limiters are also important for commercial communications systems in crowded EM environments.

**FY 2009 Phase I Award**

**Topic:** 9.06 Homeland Security

**Subtopic:** 9.06.06-9.R Automated Interaction with Fingerprint Sensors

**Title:** Programmable Fingerprint Emulator

**NIST OU:** Information Technology

**Firm:** PHT Aerospace
155 Algonquin Parkway
Whippany, NJ 07981-1601

**Principal Investigator:** Patrick R. Antaki
**Phone:** 972-250-3800
**Email:** pat@PHTaerospace.com

**Award Amount:** $90,000.00

**Abstract:** This proposal is for the development of a technology apparatus which can dynamically synthesize a mechanical fingerprint pattern, from an electronic image or from a computer-generated artificial pattern, onto a 2-dimensional pliable surface whose surface height is modulated by protrusions in the z-axis direction. When mechanically applied to a fingerprint sensor-under-test, the synthesized modulated surface appears to be a human fingerprint. Thus, the instrument can be utilized to apply all sorts of pre-programmed, standardized, controlled and/or experimental fingerprint patterns to a variety of sensors-under-test. Some of the key parametric attributes of this technology are: greater-than-500dpi resolution, large contiguous active area (3.2”x2.0”), up to 80 um of z-axis displacement, 8-bit resolution for height displacement, fast response time, fully computer-controlled, and compatible with all known fingerprint sensing technologies.

**Commercial Applications:** This research will lead to the development, manufacturing and marketing of test equipment for use in the testing, characterization and calibration of fingerprint sensors, sensor systems, and of matching algorithms. Such equipment does not currently exist in the marketplace. The significant advance of this tester is in its ability to generate high resolution (over 500dpi) mechanical fingerprint patterns over a large area (compatible with the 4-finger slap requirement) in a computer-controlled programmable and dynamic manner. Potential customers include manufacturers of fingerprint sensors, test/calibration/certification service providers, biometric researchers, and governmental agencies internationally.

**FY 2009 Phase I Award**

**Topic:** 9.04 Energy: Alternative and Efficiency

**Subtopic:** 9.04.03-6.R Sensor Systems for Complete Residential Energy Monitoring

**Title:** Comprehensive Wireless Residential Energy-monitoring System

**NIST OU:** Building and Fire Research

**Firm:** Physical Optics Corporation
20600 Gramercy Place, Bldg. 100
Torrance, CA 90501-1821

**Principal Investigator:** Ninad Patnekar
**Phone:** 310-320-3088
**Email:** ATProposals@poc.com

**Award Amount:** $89,999.00

**Abstract:** To address the NIST need for a complete residential energy-monitoring system, Physical Optics Corporation (POC) proposes to develop a new Comprehensive Wireless Residential Energy Monitoring (CORE) system. This system is based on unique integration of multifunctional sensors into a novel wireless sensor network architecture. The innovation in the CORE system design, combining novel in-house sensors with commercial off-the-shelf (COTS) multifunctional sensors offers real-time comprehensive energy monitoring in a dwelling with low-power operation (battery/energy harvesting), long-lasting (about 5 years) performance, and low cost. Integration of these sensors on a wireless platform with a flexible radio node design offers expandability and 100% sensor connectivity at all times. In Phase I, POC will build a deliverable CORE prototype capable of transmitting sensor data from five sensors wirelessly. In Phase II, POC will optimize the CORE system to develop a comprehensive energy-consumption-monitor by incorporating additional sensors and integrated energy-harvesting methods.

**Commercial Applications:** The CORE system’s main application will be in residential energy monitoring, and will provide the user with complete details of his or her energy usage. It can be applied to commercial, industrial, and transportation sectors as well as military use. In the commercial and industrial sectors, it can be used to monitor energy usage in small- or large-scale offices, whereas in industries it can be used to monitor energy usage in big processors or plants. In the transportation world, the sensors can be modified to measure various parameters in a vehicle, ship, or airplane. In the military sector, it can be used to monitor energy usage in a bunker, camp, or vehicle.

**FY 2009 Phase I Award**

**Topic:** 9.05 Healthcare and Medical Physics

**Subtopic:** 9.05.01-3.TT Instrument for Detection of Inhaler Dose Concentration

**Title:** Compact Integrated System for Quantifying Inhaler Dose Concentration

**NIST OU:** Chemical Science and Technology

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

**Principal Investigator:** Krishnan R. Parameswaran
**Phone:** 978-689-0003
**Email:** parameswaran@psicorp.com

**Award Amount:** $89,995.00

**Abstract:** Aerosol delivery of pharmaceuticals is an effective means of treating numerous diseases. Proper administration of drugs in this form requires knowledge of the droplet size and concentration of the active pharmaceutical ingredient (API) within the aerosol. Optical imaging is a robust method for obtaining this information. Physical Sciences Incorporated proposes to develop, build, and test a novel measurement system including optical patternation that will monitor droplet size and API concentration produced by metered dose inhalers. The development program will enhance the NIST prototype system by adding optical patternation software capable of quantifying the API concentration using fluorescence intensity measurements and correlating droplet fluorescence and scattering images. The resulting system will provide a robust, cost-effective measurement solution for qualifying commercial inhaler use with new drug formulations.

**Commercial Applications:** Commercial manufacturers of drug delivery systems and therapies based on metered dose inhalers will be able to use the proposed system to characterize the droplet size and API distribution within aerosol sprays. These measurements will enable optimization of the combined drug formulation and delivery system for improved drug delivery and patient health. The instrument also has the potential of improving the results obtained during clinical trials, where the effectiveness of aerosol treatments can be correlated with aerosol properties. Other commercial applications of aerosol delivery systems that could benefit from this technology include pharmaceutical spray coating and drying operations, combustion diagnostics and environmental monitoring, where measurement of droplet size and composition are useful in diagnosing process and climactic conditions.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.11-5.TT Integrated Laser Source for Broadband CARS Microscopy

**Title**: Compact fs Fiber Laser Source for Broadband CARS Microscopy

**NIST OU:** Material Science and Engineering

**Firm:** PolarOnyx, Inc.
470 Lakeside Dr., Suite F
Sunnyvale. CA 94085-4720

**Principal Investigator:** Jian Liu
**Phone:** 408-245-9588
**Email:** jianliu@polaronyx.com

**Award Amount:** $89,238.00

**Abstract:** Based on our success in developing the world first commercial 10 W fs fiber laser and 100 uJ fs fiber laser, PolarOnyx proposes a compact 200 mW (> 2 nJ) and > 1000 nm spectral bandwidth (extending from 1000 nm to 2000 nm) dual band compact supercontinuum fiber laser source to address the NIST request. It will use the most advanced fs fiber laser at 1550 nm (developed in-house) and PCF technology to generate two required wavelength bands at 940 nm (with SHG) and 1370 nm.

**Commercial Applications:** The technology proposed by PolarOnyx will provide a vital tool medical equipment, biomedical instrumentation, imaging microscopy, and precision spectroscopy.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.13-6.TT Commercialization of a Novel Integrating Sphere-based Ultraviolet Weathering Device

**Title:** Design for Commercialization of a Novel Integrating Sphere-based Ultraviolet Weathering Device

**NIST OU:** Building and Fire Research

**Firm:** SphereOptics, LLC
One Horseshoe Pond Lane
Concord, NH 03301

**Principal Investigator:** Joe Jablonski
**Phone:** 603-715-3002
**Email:** jjablonski@sphereoptics.com

**Award Amount:** $34,420.00

**Abstract:** NIST has developed an ultraviolet weathering device – SPHERE (Simulated Photodegradation via High Energy Radiant Emission) based on integrating sphere technology that is used to accelerate the degradation of polymeric materials. SphereOptics is a manufacturer of integrating spheres and has experience in developing high radiance output uniform sources based on sphere technology. Given its manufacturing background and technical expertise, SphereOptics is perfectly positioned to commercialize the SPHERE technology from NIST and target the following goals:
1. Cost and size reduction to make this device simpler to install.
2. Maintain the functionality and precision and accuracy of measurements of research system and extend it to a commercial system.
3. Expand testing option beyond polymeric materials and offering a research tool for biological, medical, and agricultural applications.

**Commercial Applications:** A commercial version of the original NIST SPHERE technology can be used for:
1. UV weathering studies on a variety of polymeric samples such as coatings, sealants, composites, roofing and siding components, paints.
2. Extend UV weathering applications beyond polymeric materials and expand to any photogenic application including agriculture (e.g., the effect of ultraviolet radiation on the growth of fungi), biological (e.g., photosynthesis), or medical (e.g., sunscreen efficiency, skin cancer).
3. Extend the concept of delivering equal irradiance on multiple samples simultaneously beyond UV range. E.g. potential commercial opportunity can be doing infrared exposure studies on certain samples.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.10-4.TT Multiple Channel Coincidence Detection

**Title:** Multichannel Sub-nanosecond Coincidence Detector

**NIST OU:** Physics

**Firm:** Techne Instruments, Inc.
4066 Oakmore Rd.
Oakland, CA 94602-1855

**Principal Investigator:** Richard Raffanti
**Phone:** 510-531-5522
**Email:** rikraf@earthlink.net

**Award Amount:** $89,760.00

**Abstract:** We will design, build and test a multiple channel time-stamping coincidence detector capable of analyzing at least 32 TTL inputs and detecting complex combinatorial relationships among those inputs, time-stamping the detected event coincidences with a timing resolution no greater that 625 ps. User-friendly software will be provided to control the detector. Five copies of a prototype will be delivered.

**Commercial Applications:** The device will be useful in research involving multiple single-photon detectors, particle detectors, time-of-flight experiments, and any research employing multiple detectors whose responses much be accurately time-stamped.

**FY 2009 Phase I Award**

**Topic:** 9.04 Energy: Alternative and Efficiency

**Subtopic:** 9.04.03-6.R Sensor Systems for Complete Residential Energy Monitoring

**Title:** Sensor Systems for Complete Residential Energy Monitoring

**NIST OU:** Building and Fire Research

**Firm:** TIAX LLC
15 Acorn Park
Cambridge, MA 02140-2301

**Principal Investigator:** Dr. Robert Fricke
**Phone:** 617-498-5180
**Email:** fricke.robert@tiaxllc.com

**Award Amount:** $89,978.00

**Abstract:** A major challenge in assessing the effectiveness of energy conservation measures in buildings is conveying real-time information about energy consumption by particular end-use to occupants. Advances needed to address this challenge for commercial success include making these components inexpensive, easy to install and operate, and supportive of intuitive decision making about energy usage. The gap related to ease of installation is especially evident for sensors used to monitor residential infrastructure, such as furnaces, boilers, water heaters, and air conditioners. To address cost, TIAX proposes to use cost as an independent variable to develop a sensor suite and communication system at a price point that will permit a three year payback for the average consumer. Furthermore, TIAX will use a human centric design methodology to develop a system that is easy to install and operate while monitoring the energy usage of specific end-use devices and providing feedback to the user.

**Commercial Applications:** Current residential energy monitoring systems (R-EMS), with or without breakdowns of energy consumption by specific end uses, have negligible market penetration. The proposed TIAX R-EMS with its low installed cost, ease of installation, and user-friendly interface will enable significant market penetration. It is estimated that with a three-year payback period the proposed R-EMS will achieve a market share of just over 20 percent in new construction and around 70 percent in existing homes. These penetration levels suggest that, within a decade of commercial launch, a cost-effective R-EMS could be installed in at least 10 percent of the approximately 115 million U.S. households. If it realizes an average savings of 10 percent, after ten years the R-EMS would achieve annual energy and energy cost savings of approximately 0.2 quad and $20 billion in the U.S. alone.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.02-1.R High Efficiency Matched Pair Photodiodes at 1550nm

**Title:** High Efficiency, Large-area, 1550 nm InGaAs Photodiodes

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Voxtel, Inc.
12725 SW Millikan Way, Suite 230
Beaverton, OR 97005-1782

**Principal Investigator:** Andrew Huntington
**Phone:** 971-223-5646
**Email:** andrew@voxtel-inc.com

**Award Amount:** $89,998.00

**Abstract:** A stable, well characterized InGaAs materials growth and photodetector fabrication process will be used to fabricate matched photodiodes optimized for balanced homodyne detection. The 1-mm-diameter p-i-n photodetectors will be manufactured back-illuminated with a 5-micron absorber, allowing residual light to reflect off the front-side metal to make a double pass through the active layer. Ultra-high-purity InGaAs will be used so that the absorber can operate fully depleted at relatively low operating voltages (< -5 VDC). The ultra-pure InGaAs will also reduce variation across the 1-mm-diameter detector and prevent breakdown. Operating the detector fully depleted will decrease the carrier transport time and therefore reduce carrier recombination; it will also reduce the detector’s capacitance. So that stray capacitance is minimized, the detectors will be bump-bonded directly to a sub-mount; the detector will then be integrated with low-noise transimpedance amplifiers and integrated with a three-stage thermoelectric cooler in a hermetic TO-5 package. The matched detectors will be testing and characterized in an optical homodyne detection system.

**Commercial Applications:** In addition to the demand for high-responsivity photodetectors for quantum information applications, there are significant markets for the innovation in the fields of spectroscopy, industrial sorting of products and materials, and thermal sensing. Each application places different demands on the detectors, creating opportunities to fulfill the varying requirements, and to produce higher-quality, lower-cost imagers.

**FY 2009 Phase I Award**

**Topic:** 9.12 Optics and Optical Technology

**Subtopic:** 9.12.12-5.TT Dynamic Light Scattering Instrumentation Using Field Programmable Gate Array Based Digital Signal Processing

**Title:** Dynamic Light Scattering Instrumentation Using Field Programmable Gate Array-based Digital Signal Processing

**NIST OU:** Material Science and Engineering

**Firm:** Voxtel, Inc.
12725 SW Millikan Way, Suite 230
Beaverton, OR 97005-1782

**Principal Investigator:** George M. Williams
**Phone:** 971-223-5646
**Email:** georgew@voxtel-inc.com

**Award Amount:** $89,999.00

**Abstract:** An existing low-cost FPGA-based processing platform will be demonstrated with fiber-coupling to single-photon detectors, to perform photon-arrival time stamping with <25-ps jitter. Multi-channel auto/cross-correlation will be implemented along with dynamic light scattering (DLS) analysis algorithms for fitting multiple diffusion models to measured samples. Existing Matlab and Simulink tools will be used to model the instrument, to perform design tradeoffs, and to develop a user interface for DLS experiments. An instrument specification will be finalized, including any necessary sensor and laser configuration and control interfaces, host I/O, memory, and identification of the features necessary for compatibility with the flow reactor and other measurement systems. The DLS algorithms will then be demonstrated using simulated and existing data. A small-sized FPGA-based printed circuit board including a microcontroller and USB and Gigabit-Ethernet communications will be fabricated, the VHDL code will be implemented, and the DLS processing platform will be demonstrated, characterized, and delivered to NIST.

**Commercial Applications:** There is a growing interest in research and applications of photon-counting technology. An increasing number of research laboratories use single-photon technologies for various applications, such as quantum communication and computing, single-molecule monitoring, and precision measurements. Time-of-flight measurements are used in science research (experiments in nuclear physics and astronomy), industry (dynamic testing of integrated circuits and hard drives), telecommunications (evaluation of high-speed data transfer), geodesy, military equipment (laser ranging, laser tripwire intrusion detection systems and laser radar systems), and medical (PET, tomography, etc.) fields.

**FY 2009 Phase II Award**

**Topic:** 9.09 X-ray System Technologies

**Subtopic:** 9.09.2-3.R Digital Signal Processing for 1 to 10 MHz X-ray Event Streams

**Title:** Development and Prototyping of a Digital Pulse Processor for Improved Coincidence Detection, Rejection, and Pulse Recovery, for High Count-Rate Silicon Drift Detectors

**NIST OU:** Chemical Science and Technology

**Firm:** 4pi Analysis, Inc.
3500 Westgate Dr., Suite 403
Durham, NC 27707-2534

**Principal Investigator:** Stefan A. Jeglinski
**Phone:** 919-489-1757 x12
**Email:** jeglin@4pi.com

**Award Amount:** $300,000.00

**Abstract:** The recent emergence of the Silicon Drift detector (SDD), for use in energy dispersive x-ray spectrometry (EDS), has made possible x-ray event streams with count rates as high as 1-10 Mcps. A problem with existing digital signal processing, as applied to SDDs, is the significant presence of coincidence peaks above the x-ray background. These coincidence peaks occur with amplitudes comparable to low-concentration species. In specimens with x-ray peaks arising from two or more elemental constituents, the coincidence peaks can occupy a sizeable portion of the spectrum between the high abundance peaks, leading to false identification of elements and significant errors in quantification. NIST seeks advanced digital signal processing techniques to overcome this severe limitation to SDD application. The objective of the Phase II work is to provide NIST a prototype digital pulse processor that demonstrates an order-of-magnitude reduction in coincidence counting, at an output count rate of 500,000 cps. Our Phase I work and continuing development in anticipation of a Phase II award suggest that the requirement can be met and likely exceeded, with the additional bonus that other parts of the event stream can also be recovered instead of rejected, leading to significant improvements over current state-of-the-art pulse processing.

**Commercial Applications:** The Silicon Drift detector (SDD) is rapidly gaining acceptance as the standard of SEMs, with its ease of use (compact, no liquid nitrogen), high resolution, and high-count-rate capability. As its commercial penetration continues, especially for advanced or metrological work, demand will increase for digital pulse processing that can address spectral artifacts caused by coincidence in the event stream. This research directly supports instrumentation development for improved SDD coincidence rejection. The result will be a next-generation digital pulse processor for EDS that establishes new standards of accuracy. An added benefit is its likely applicability to related technologies, such as X-ray Fluorescence Spectroscopy.

**FY 2009 Phase II Award**

**Topic:** 9.03 Information Technology

**Subtopic:** 9.03.2-9.TT Wavelength Conversion Single-Photon-Detector for Telecom Wavelength Transmission

**Title:** High Efficiency Up conversion Single-Photon-Detector for 1550 nm Signal

**NIST OU:** Information Technology

**Firm:** AdvR, Inc.
2310 University Way, Bldg. #1-1
Bozeman, MT 59715

**Principal Investigator:** Mark W. Munro
**Phone:** 406-522-0388
**Email:** munro@advr-inc.com

**Award Amount:** $299,993.00

**Abstract:** This NIST Phase II SBIR effort will two low noise single photon detectors using MgO doped LiNbO3 (LN) periodically poled waveguides and a 980nm (or similar appropriate wavelength) pump to up convert 1550nm photons to 600nm to allow for detection by photomultiplier tube (PMT). The key innovation is using low noise periodically poled waveguides with a long wavelength (1800nm) pump leading to higher efficiency single photon detectors when used with PMTs or Silicon-based avalanche photo diode single photon detectors (Si-APD). Use of waveguide Sum Frequency Generation (SFG) for 1550nm to 600 nm up-conversion cou0pled with inexpensive and very efficient PMT or SI-APD technology is expected to significantly increase single photon detection efficiency while maintaining long fiber optic transmission distance for quantum communication networks and quantum-key-distribution (QKD) systems.

**Commercial Applications:** This type of single photon detection system is a key component needed to implement Quantum Key Distribution (QKD) based encryption over existing fiber networks, bringing about a new level of secure communication. Such a system could also be implemented in the Oil industry for fiber based distributed pressure and temperature sensing. The development of nonlinear frequency conversion capability in this material significantly enhances AdvR’s position as an engineered material solution provider, enabling us to address more frequency conversion needs than ever.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.5-4.R Compact, Frequency-Stable, and Efficient High-Power Laser Sources

**Title:** Frequency Stable Optically Pumped Semiconductor Lasers

**NIST OU:** Physics

**Firm:** Arete Associates
PO Box 2607
Winnetka, CA 91306-2607

**Principal Investigator:** Ryan J. Epstein
**Phone:** 303-651-6756 x158
**Email:** repstein@arete.com

**Award Amount:** $299,931.00

**Abstract:** Technology research and development in such areas as next-generation atomic clocks, quantum information processing with trapped ions, and atomic spectroscopy is impeded by the lack of commercially available laser sources that meet the required specifications of wavelength tuning range, output power, frequency-stability and reliability. Arete Associates is developing frequency-stable Optically Pumped Semiconductor Lasers (OPSLs) to meet these specifications. OPSL technology exhibits a unique combination of compactness, efficiency, high power, wavelength tunability, and excellent beam quality. The objective of the Phase 1 SBIR effort was to assess the feasibility and robustness of single-frequency operation of two different OPSL cavity designs. The successful designs will be subsequently developed in Phase 2, with the goal of delivering a system that NIST can use in its atomic clock and quantum information processing experiments.

**Commercial Applications:** Frequency-stable OPSLs will find commercial application in high resolution spectroscopy and metrology, gas analysis, sodium guide star laser systems, state-of-the-art atomic clocks, quantum information processing, and basic atomic, molecular and optical research. As there are currently no commercial sources of tunable single-frequency OPSLs, Arete will be able to provide custom laser products to niche markets that require the unique capabilities of OPSL technology.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.4-4.TT Hyperspectral Image Projector

**Title:** Visible Hyperspectral Image Projector Based on Spatial Light Modulators

**NIST OU:** Physics

**Firm:** Boulder Nonlinear Systems, Inc.
450 Courtney Way, Unit 107
Lafayette, CO 80026-8878

**Principal Investigator:** Jay Stockley
**Phone:** 303-604-0077
**Email:** jstockley@bnonlinear.com

**Award Amount:** $299,998.00

**Abstract:** There are many applications for hyperspectral image detectors, but for the detectors to be widely accepted standardized calibration protocols must be developed. This research aims to bridge this gap through the development of a commercially available hyperspectral image projector (HIP) system. The proposed effort is to build a prototype visible HIP system to generate calibrated, realistic imagery with enough fidelity such that, from the viewpoint of the sensor under test, the scene is indistinguishable from the real-world. This system will incorporate two liquid crystal on silicon spatial light modulators (SLM). The first SLM will be used in the spectral engine as a programmable amplitude modulator that will selectively transmit spectral components of a broadband input source. The output of the spectral engine will be fed into a spatial engine, where a second SLM will be used to generate two dimensional scenes. The scenes will be imaged onto a unit under test, and used to quantitatively calibrate the detector. This research will mark the first step toward the development of a commercially available hyperspectral detector calibration system.

**Commercial Applications:** The goal of the Phase II research will be to develop a stand-alone compact instrument capable of producing spectrally and spatially calibrated reference scenes for calibration of a variety of imaging sensors. One application for hyperspectral image detectors can be found in medical diagnostics, ranging from cancer and tumor detection to burn quantification. In order for the technology to be integrated into optical medical imaging systems, a standardized set of simulated scenes must be generated to calibrate hyperspectral detectors. Without the standardized calibration offered by the HIP system, hyperspectral detectors cannot be safely introduced into the medical community. Beyond medical diagnostics, applications can be found in: factory calibration of CMOS sensors, quality control of photographic film materials, remote sensing, and machine vision simulation. Additionally the spectral engine can be sold as a stand alone product that would fit well within pulse shaping systems.

**FY 2009 Phase II Award**

**Topic:** 9.05 Microelectronics Manufacturing

**Subtopic:** 9.05.1-3.TT Resistance Bridges for High-Accuracy Thermometry

**Title:** Model 8686H, Precision Resistance-Ratio Bridge

**NIST OU:** Chemical Science and Technology

**Firm:** Circuit Equipment Corporation
8686 Cardinal Dr.
Kirtland, OH 44094

**Principal Investigator:** Robert A. Miles
**Phone:** 440-951-8840
**Email:** bobm@circuitequipment.com

**Award Amount:** $299,996.95

**Abstract:** The result of this project will be a fully functional prototype of the Model 8686H Precision Resistance-Ratio AC Bridge. The unit is capable of measuring resistances from 0 to 400 ohms with better than 0.1 uohm resolution and an accuracy of better than +/-0.05ppm. The unit will have advanced features such as a built-in web-browser, USB interface and built-in complex functions. Examples of such complex functions are complimentary ratio-check and zero ohms power extrapolation for sensor measurements. The web-browser introduces features never before available in a Precision Resistance-Ratio AC Bridge.

**Commercial Applications:** Model 8686H will be used in Calibration laboratories for the calibration of SPRT’s and PRT’s. The laboratories can be either primary or secondary calibration type facilities. The sister product, Model 8686, will be used for SPRT’s and PRT’s in industry and research related applications.

**FY 2009 Phase II Award**

**Topic:** 9.04 Manufacturing System Integration

**Subtopic:** 9.04.1-2.R Validation tools for OWL Based Supply Chain Integration

**Title:** Expressive Integrity Constraint Validation with OWL

**NIST OU:** Manufacturing Engineering

**Firm:** Clark & Parsia, LLC
926 N St., NW Rear, Studio #1
Washington, DC 20001-4222

**Principal Investigator:** Evren Sirin
**Phone:** 202-408-8770
**Email:** evren@clarkparsia.com

**Award Amount:** $299,922.00

**Abstract:** We propose to develop a commercially adequate, robust and perfomant OWL-based Integrity Constraint (IC) validation system with several innovations, including novel debugging and explanation support for data integrity errors; incremental and optimized validation of data integrity; and a unified system for validating structured, semi-structured, and semantic data. A rigorous and formal specification of the semantics of OWL-based ICs will also be delivered.

The goal of Phase II works is to address two primary use cases:1) validation of data sources that are of arbitrary size and complexity, with arbitrary numbers of constraints, and non-trivial update rates; 2) validation of messages exchanged in Enterprise Service Bus (ESB) and Service Oriented Architecture (SOA) systems, where data sizes are relatively small but message throughput may be high and data validation times must be short. We will also develop a plugin for the popular ontology editor Protégé that will help users author and validate ICs.

**Commercial Applications:** The primary commercial application of OWL-based ICs is the integration of the IC validator with a semantic data store. An IC validation service would enhance the capabilities of existing commercial semantic data stores. The secondary commercial application is the integration of semantic data validation service as an extension to commercial Enterprise Service Bus (ESB) systems. This service will improve the message validation capabilities currently provided in ESB systems by attaching semantics to exchanged messages via ontologies and validate the message contents using OWL-based ICs.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.9-4.R High-Bandwidth, Low-Noise Photodetectors for Precise Timing

**Title:** Low Noise, InGaAs Dual Photodiodes for Precise Timing

**NIST OU:** Physics

**Firm:** Discovery Semiconductors, Inc.
119 Silvia St.
Ewing, NY 08628-3200

**Principal Investigator:** Dr. Shubo Datta
**Phone:** 609-434-1311 x227
**Email:** sdatta@chipsat.com

**Award Amount:** $300,000.00

**Abstract:** Conversion of highly stable optical clocks into electrical clocks through photodetection introduces excess phase noise, thereby degrading the frequency stability. This noise is primarily generated due to the conversion of optical intensity noise into electrical phase noise by photodiode’s non-linearity, specifically power-to-phase conversion. During Phase I, Discovery developed dual photodiodes having a power-to-phase conversion of 3 rad/W at 1550 nm and 900 nm wavelengths simultaneously, which presents a 10 fold improvement in state-of-the-art. During Phase 2, Discovery will optimize the photodiode structure in order to improve its responsivity at 900 nm by a factor of two, while ensuring a 3 dB bandwidth of 18 GHz and power-to-phase conversion of 3 rad/W. This will correspond to a 6 dB improvement in excess phase noise as compared to the Phase 1 photodiodes.

**Commercial Applications:** The proposed low noise dual photodiode is the enabling technology for developing ultra-high precision clocks that can provide improved system performance in several applications, such as:
1) Optical clock distribution networks for phased array radars
2) Navigation systems, such as next generation global positions system
3) Distributed frequency and time standards
4) Test and measurement systems
5) Laser metrology
6) Long baseline interferometry

**FY 2009 Phase II Award**

**Topic:** 9.01 Analytical Methods

**Subtopic:** 9.01.1-1.TT Improved Ionic Current Amplifier Requirements for Enhanced Polymer Detection and Characterization with Single Nanopores

**Title:** AC Amplifier and System for Nanopore Based DNA Sequencing

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Electronic Bio Sciences, LLC
5754 Pacific Center Blvd., Suite 204
San Diego, CA 92121-4206

**Principal Investigator:** Dr. Geoffrey A. Barrall
**Phone:** 858-228-3205
**Email:** gbarrall@electronicbio.com

**Award Amount:** $299,973.23

**Abstract:** The characterization of biologically relevant polymetric materials is a major focus of the bioinstrumentation industry. Of particular interest is the rapid, direct sequencing of DNA through a nanopore as well as the characterization of other biopolymers. Although progress has been made with nanopore sequencing, some fundamental instrumental and system issues have so far kept the method from realizing its potential. Electronic Bio Sciences has already developed a substantially lower noise single channel measurement system that has allowed the measurement of a number of DNA translocation phenomena that have not been previously recorded. Electronic Bio Sciences is proposing to further advance the performance features of the company’s low noise system by reducing the rate of translocation of DNA through temperature control, integrating AC and DC elements in a single electronics package and increasing the measurement bandwidth of the system. These improvements will provide the tools necessary to advance the state-of-the-art in nanopore sequencing methods and the characterization of biopolymers with nanopores.

**Commercial Applications:** The proposed low noise protein pore based DNA sequencing system has the potential to allow routine sequencing of the human genome. At 300 µs/base the system could read of order 3,300 bases/sec. A QNM based system could be scaled to a 50 channel system. In theory this would allow a 3 billion base mammalian genome to be sequenced in a few hours, a 1000 times improvement over current systems. Such rapid low cost sequencing could be used to obtain individualized information on predisposition to diseases and treatments and could thereby revolutionize medicine. Low cost sequencing systems will also find use in biological research laboratories around the world for the sequencing of full and partial genomes of a variety of species. In many applications it is only necessary to sequence a small part of the genome in order to match unknown DNA with known samples. An inexpensive sequencing system would allow for the more routine use of DNA matching for forensics and the detection of biological threats. In each of these areas there are both private sector and government markets.

**FY 2009 Phase II Award**

**Topic:** 9.03 Information Technology

**Subtopic:** 9.03.4-9.TT Refreshable Locking Tactile Image Array for Access

**Title:** Refreshable Locking Tactile Image Array for Accessibility

**NIST OU:** Information Technology

**Firm:** ELIA Life Technology, Inc.
354 East 66th St., Suite 4A
New York, NY 10065

**Principal Investigator:** Andrew J. Chepaitis
**Phone:** 212-327-2550
**Email:** ajc@elialife.com

**Award Amount:** $300,000.00

**Abstract:** This is an SBIR Phase II proposal to develop a tactile refreshable computer display prototype (TRCD) that will support multiple tactile alphabets (e.g. ELIA, braille, and Roman), multiple lines of text, and graphics to benefit the more than 1.8 million blind Americans. Commercially available TRCDs are expensive (~$12,000, or $19 per actuator), provide only one line of text (with 640 actuators) and don’t support tactile graphics. The researchers will develop an advanced prototype based on the patented NIST technology, using new technological approaches. This technology will support a TRCD with as many as 10,000 actuators at a cost of less than $1/ actuator. The researchers anticipate they can create a faster, more efficient prototype, addressing the commercial viability concerns of NIST’s current tactile image display prototype.

**Commercial Applications:** If the technology were commercialized, the access to its graphical information would enable the blind to compete on a more equal footing in the workplace and educational systems. It would also support new innovative assistive technology (the ELIA® Tactile Alphabet) to serve the 97% of the 1.8 million blind people who cannot read braille, as well as braille users. The company believes the blind person market would demand several thousand TRCDs per year.

**FY 2009 Phase II Award**

**Topic:** 9.01 Analytical Methods

**Subtopic:** 9.01.1-1.R Cryogenics for Kilopixel Sensor Arrays

**Title:** Kilopixel Array Cryostat (KPAC) System for Mulit-kilogram Transition Edge Sensor (TES) Arrays

**NIST OU:** Electronics and Electrical Engineering

**Firm:** High Precision Devices, Inc.
1668 Valtec Lane, Suite C
Boulder, CO 80301-4655

**Principal Investigator:** Charlie Danaher
**Phone:** 303-447-2558
**Email:** cdanaher@hpd-online.com

**Award Amount:** $299,903.00

**Abstract:** Transition Edge Sensor (TES) detector development at NIST has reached a level where arrays containing several thousand pixels (kilopixels) are practical and , indeed, necessary for fielding systems required for many industrial, research, and homeland security applications. Current easily deployable cryostat technology required to reach the ultra-cold operating temperatures of TES arrays (50 to 100 mK) can not cope with the size or the heat load of kilopixel arrays. The housings and shielding required to support such arrays have masses of several (~5) kilograms. Also, the heat load of several hundred wires traveling from room temperature down to the TES arrays in addition to the self-heat generated by the array itself (e.g., bias currents) is significant. By solving these issues in a compact system with the minimal amount of room temperature infrastructure, the Kilo Pixel Array Cryostat will eliminate a substantial barrier to the wide dissemination and use of NIST’s detector arrays in a variety of novel and critical applications.

**Commercial Applications:** TES array applications include ultra-high-resolution x-ray spectroscopy for the semiconductor industry (crucial for rapid and accurate understanding of wafer defects and hence processing line diagnostics), gamma ray spectroscopy for rapid isotopic plutonium and non-destructive nuclear fuel rod assay (a critical application which TES arrays can uniquely solve to monitor nuclear reactor use), quantum-key distribution, and many research applications such as sub-mm astronomy, polarimetry of the Cosmic Microwave Background (CMB), and energy resolving x-ray cameras for advance light sources.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.4-3.R High Power, Mid-Infrared Fiber Supercontinuum Light Source

**Title:** High Power, Mid-Infrared Fiber Supercontinuum Light Source

**NIST OU:** Chemical Science and Technology

**Firm:** Mesa Photonics, LLC
5 Bisbee Ct., Suite 109-305
Santa Fe, NM 87508-1419

**Principal Investigator:** Daniel J. Kane
**Phone:** 505-216-5015
**Email:** djkane@mesaphotonics.com

**Award Amount:** $300,000.00

**Abstract**: Modern supercontinuum (SC) light sources are generated by non-linear interactions between ultrashort laser pulses and optical fibers. These light sources have high brightness and are spatially coherent. Output in near-ultraviolet to near-infrared wavelength ranges has been demonstrated. SC wavelength ranges are constrained by the transmission and dispersion properties of the fibers. Previously, output to 4.5 microns was achieved using fluoride glass fibers. In Phase 1, we achieved supercontinuum output to 5.8 microns in tellurite glass fibers setting a record for mid-IR supercontinuum generation. Further improvements into the mid-infrared region (meaning 6 to 12 microns) would enable a plethora of new opportunities including high-resolution infrared microscopy, remote sensing (standoff detection), and IR countermeasures. Indeed, because of the stability of our supercontinuum source, entirely new applications such as mid-IR frequency combs could be developed. In Phase 2, we will further improve the Phase 1 results by using better mode control.

**Commercial Applications:** Detection and identification of chemical compounds is important for industrial applications, atmospheric monitoring, homeland security and hazardous waste identification and monitoring. Key to the development of badly needed improvements to optical detection of important compounds is the development of stable, bright and spatially coherent sources in the mid-IR (4-10 microns) where strongly absorbing fundamental ro-vibrational transitions can be accessed. Supercontinuum sources use highly nonlinear materials pumped by ultrafast lasers to shift and broaden the ultrafast pump to the wavelength regions of interest. While promising, they are unstable, relying on chaotic cascaded nonlinearities to shift available ultrafast laser sources to necessary wavelengths. The chaotic nature of supercontinuum light makes them too noisy for high-dynamic range detection that is so important to chemical identification. This SMIR project is designed to develop quiet, broad supercontinuum sources more suited for high-dynamic range spectroscopy.

**FY 2009 Phase II Award**

**Topic:** 9.02 Homeland Security

**Subtopic:** 9.02.4-5.TT One PicoTesla Magnetic Field Detection by Magnetoresistive Sensors for Homeland Security

**Title:** Optimized Soft Magnetic Electrodes for Ultra-sensitive Magnetic Tunnel Juction Field Sensors

**NIST OU:** Material Science and Engineering

**Firm:** Micro Magnetics, Inc.
421 Currant Rd.
Fall River, MA 02720-4712

**Principal Investigator:** Weifeng Shen
**Phone:** 401-863-3007
**Email:** shen@micromagnetics.com

**Award Amount:** $299,921.00

**Abstract:** This SBIR project aims to develop a new class of low-field magnetic sensors based on magnetic tunnel junctions with magnesium oxide (MgO) tunnel barriers. The Phase II effort will continue the optimization of sensor performance, based on three major research thrusts. First of all, we will continue the magnetic engineering effort, turning the properties of the two key magnetic electrodes, in order to ensure that the sensor response is linear and reproducible. Secondly, we will systematically attack the two dominant sources of electrical noise in our MTJ devices. By making careful choices of sensor shape, mask layout, and annealing and processing parameters, we will minimize the 1/f and shot noise in our devices. Finally, we conduct research into possible “field modulation” techniques for integration into our sensor design. The goal of such techniques will be to artificially modulate the DC magnetic field which is seen by the sensor, to avoid excessive sensor noise typically seen at low frequencies.

**Commercial Applications:** If successful, the project will result in a new class of magnetic sensors which can be mass-produced, and which feature the advantages of high sensitivity, low cost, low power consumption, and compactness. Currently, it is not possible to achieve sensitivities on the order of one picotesia without employing a more exotic and expensive sensor technology. Successful realization of picotesla-sensitivity MgO-MTJ sensors will open up a wide range of possible applications in military and industrial sectors. The Navy is interested in new sensors capable of remote detection of ships and submarines, while the Army is interested in using sensor modules to remotely monitor battlefields; both of these applications will benefit from a new and compact high-performance magnetic sensor device. Magnetic sensors are also widely used in commercial sectors including automotive applications, in navigation and compassing, in the measurement of position and velocity, and in science and engineering. Finally, emerging medical applications such as magnetocardiography and magnetoencephalography would benefit greatly from such a device.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.1-1.R 3D Laser Interferometer for Nanometrology

**Title:** Three Axis Interferometer for Distance and Tip-Tilt Measurement

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Optical Physics Company
26610 Agoura Rd., Suite 240
Calabasas, CA 91302

**Principal Investigator:** Chien-chung Chen
**Phone:** 818-880-2907 x231
**Email:** cchen@opci.com

**Award Amount:** $299,960.70

**Abstract:** During the Phase I SBIR project Optical Physics Company (OPC) investigated a three axis interferometer instrument which measures the one dimensional linear translation and the two-dimensional angular deflection in pitch and yaw of a 7 mm mirror 18-23 cm away. Lab demonstrations both before and during the Phase I effort showed performance parameters better than NIST requirements. The Phase I effort also produced the blueprints of the design of a three dimensional nanometrology instrument 3S-NI). Its design is simple and compact, fitting within a 12.5x12.5x10 cm envelope. During the proposed Phase II effort, OPC will build and test 3D-NI. This will be followed by installation and demonstration as part of NIST’s the calculable capacity metrology environment.

**Commercial Applications:** For nanotechnology and nanoscience to realize their potential, real products must be produced, which in turn requires simultaneous and coordinated evolution of measurement technologies, devices, and methods alongside nanomanufacturing processes. This project serves four application areas: The first area is the establishing of a new Calculable Capacitor for NIST. The NIST calculable capacitor is the primary standard in the US for the SI measurements of impedance and resistance, and it requires the most precise length measurement techniques. The second application area is for surface distance and orientation measurement for planar nanosystems. The third applications area is methods for manufacturing and assembly of Ultra Stable Optical Cavities. The fourth application area is wavelength meters, in particular Femtometer Class Wavelength Meters.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.8-4.R High-Resolution Solid Etalon Spectral Dispersers

**Title:** Development of Broadband VIPAs in Mid-to Long Infrared

**NIST OU:** Physics

**Firm:** Precision Photonics Corporation (PPC)
3180 Sterling Circle
Boulder, CO 80301-4655

**Principal Investigator:** Timothy Dinneen, Ph.D.
**Phone:** 303-444-9948
**Email:** tdineen@precisionphotonics.com

**Award Amount:** $300,000.00

**Abstract:** VIPA etalons are simple compact devices that offer many times more dispersion than gratings and are finding increasing application where higher spectral resolution is needed. Current VIPA designs do not work in the spectroscopically important mid- and long-infrared wavelengths, and do not have large operating bandwidths compatible with femtosecond combs. Incorporating resolution improvements from Phase I, Precision Photonics proposes to fabricate VIPA devices capable of operating anywhere in the 0.4-10-micron range, and capable of ultrawide optical bandwidths. New coating materials and designs will be developed for the 3-10 micron range. Precision polishing techniques will be adapted for infrared substrate materials. Coating designs will be developed for fractional bandwidths exceeding 50%. The proposed improvements will result in adapting VIPAs for high-resolution spectroscopy with new infrared comb sources, opening up new applications like breath analysis for medical diagnostics.

**Commercial Applications:** VIPA etalons have commercial interest both as a component product and as a part of an integrated system. Example applications include (1) arbitrary waveform generation, which has military applications, (2) multiplexing in optical communications systems, and (3) chemical detection using femtosecond combs. In optical communications, a multiplexing VIPA etalon can combine or separate multiple telecommunications signals at tighter channel spacings than grating-based devices. For chemical detection, cavity-enhanced spectroscopy based on a VIPA etalon and a femtosecond laser comb in a commercial system would significantly improve the accuracy, speed, and resolution over that of FTIR spectrometers, a market estimated at $200 million. Finally, multiplexed VIPA-based spectroscopy could also open up new applications, such as detecting toxins and metabolic chemicals in the breath of hospital patients in real time.

**FY 2009 Phase II Award**

**Topic:** 9.08 Technologies to Enhance Fire Safety

**Subtopic:** 9.08.3-6.R Innovative Residential Fire Detection

**Title:** Innovative Residential Fire Detection

**NIST OU:** Building and Fire Research

**Firm:** Southwest Sciences, Inc.
1570 Pacheco St., Suite E-11
Santa Fe, NM87505-3993

**Principal Investigator:** David Bomse
**Phone:** 505-984-1322
**Email:** dbomse@swsciences.com

**Award Amount:** $300,000.00

**Abstract**: Southwest Sciences’ Phase 2 SBIR project will lead to development of residential fire sensing systems based on recently developed, low cost temperature and optical imaging sensors combined with newly introduced highly miniaturized, micropower CO sensors. Sensor modules will be part of a low power wireless network. Each module will be about ½ the size of a business card, a few mm thick, and will operate for at least a year using a lithium battery. Volume production will keep prices low enough (we aim for $10) that it will be practical to install at least one in each room of a residence. Sensor modules will be unobtrusive and can be optimized to detect smoldering fires by attaching directly to furniture particularly for high risk residents including young children, the elderly and the physically handicapped.

**Commercial Applications:** We target the residential and hotel fire sensing markets. Our sensing system will avoid nuisance alarms common to existing commercial smoke and carbon monoxide sensors.

**FY 2009 Phase II Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.2-1.TT Large Area Domain Engineered Thin Film Ferroelectric Pyroelectric Detectors

**Title:** Large Area Domain Engineered Thin Film Pyroelectric Detectors

**NIST OU:** Electronics and Electrical Engineering

**Firm:** SRICO, Inc.
2724 Sawbury Blvd.
Columbus, OH 43235-4579

**Principal Investigator:** S. Sriram
**Phone:** 614-578-0684
**Email:** sri@srico.com

**Award Amount:** $299,999.00

**Abstract:** This SBIR Phase II project uses the “smart-cut” methods to produce high performance and advanced functionality lithium tantalate pyroelectric sensors. Phase I has been devoted to feasibility demonstration of the “smart-cut” process, preliminary design studies for the advanced pyroelectric detectors and prototype device fabrication and testing. The Phase I effort resulted in the first reported crystal ion slicing of lithium tantalate films. An ion sliced lithium tantalate film was successfully transferred to a silicon substrate. A bond process was developed to scale up the thin lithium tantalate film-on-silicon process to wafer scale. The large areas and film thickness targeted in this work will result in especially large aspect ratio detectors. The results of the Phase I effort have established the building blocks for the actual development and production in Phase II of a commercial prototype pyroelectric detector with significantly improved performance.

**Commercial Applications:** The proposed thin film platform would enable the production of new, high performance pyroelectric detectors, power meters, energy meters, broadband radiometers, custom OEM detectors, and multi-element imaging sensors.

**FY 2009 Phase II Award**

**Topic:** 9.02 Homeland Security

**Subtopic:** 9.02.1-1.TT Microcalorimeter Alpha Spectrometers for Analysis of Nuclear Material

**Title:** Microcalorimeter Alpha Spectrometer for Analysis of Nuclear Material

**NIST OU:** Electronics and Electrical Engineering

**Firm:** STAR Cryoelectronics
25-A Bisbee Court
Santa Fe, NM 87508

**Principal Investigator:** Robin Cantor
**Phone:** 505-401-5271
**Email:** rcantor@starcryo.com

**Award Amount:** $300,000.00

**Abstract:** A key factor of international efforts to identify and suppress the supply of and demand for nuclear materials, and thereby to deter potential traffickers, is the ability to accurately identify contradicted material and ultimately to trace it back to its origin. Alpha particle spectroscopy is widely used in nuclear forensics to assay trace quantities of sensitive nuclear materials, but the limited spectral resolution of conventional alpha spectrometers limits their effectiveness to perform high-accuracy assays of such materials. STAR Cryoelectronics proposes to develop a high-resolution alpha spectrometer based on microcalorimeter detectors offering nearly a ten-fold improvement in energy resolution, thereby enabling the detection of minute isotopic compositional differences in sensitive nuclear materials. The innovative spectrometer requires only electrical power to operate, is completely automated, and will greatly increase the accuracy and throughput of current protocols for alpha spectroscopy.

**Commercial Applications:** The proposed alpha spectrometer will both improve the sensitivity and increase the precision of alpha spectroscopy, providing essential improvements to one of the key analytical methods used in nuclear forensics. The primary target users of the alpha spectrometer are researchers and nuclear forensic scientists at government research and government agency laboratories worldwide. The improved alpha spectrometer will also be of interest for database development and for general research and development in the growing fields of nuclear forensics and environmental monitoring.

**FY 2009 Phase II Award**

**Topic:** 9.08 Technologies to Enhance Fire Safety

**Subtopic:** 9.08.2-6.R Barrier Fabrics for Fire Safe Furniture and Mattresses

**Title:** Development and Manufacturing of Lightweight Textile Fire Barrier for Furniture and Mattresses

**NIST OU:** Building and Fire Research

**Firm:** Tex Tech Industries
105 N. Main St.
North Monmouth, ME 04351

**Principal Investigator:** Stan Farrell
**Phone:** 207-933-9203
**Email:** sfarrell@textech.us

**Award Amount:** $300,000.00

**Abstract:** Through this NIST SBIR program, Tex Tech Industries is developing furniture and mattress fire blocking materials. Fire barrier methods are necessary to protect furniture and mattresses from fire. In Phase I, Tex Tech used a variety of fibers to make and evaluate fibers for fire barriers. In Phase II, Tex Tech proposed to continue to develop a fire protection barrier from textiles that can potentially provide better fire protection, are easy to use and put into production, and low cost. Tex Tech will work with Georgia Tech’s Dr. Satish Kumar, who has developed a polyacrylonitrile (PAN) and carbon nanofiber (CNF) fiber that has the potential to be produced into a high char yield product and lower shrinkage. The increased char may provide a stronger barrier during a fire to protect the inside of a mattress or the furniture from burning. In Phase II, Tex Tech proposes to carry this work to the next development stage. Specific solutions using unique fibers based on textile barrier solutions will be addressed.

**Commercial Applications:** As further regulations and increased safety come into play, the market potential for fire blocking fabrics for furniture, mattress and bed clothing continues to grow. Tex Tech is posed to take advantage of the mattress fire blocking material with there development work over the past 5 years to develop a non-chemical solution to fire blocking that is economically priced and effective. The total market potential is several hundred million for the mattress and an equal or larger market for the upholstered furniture market. Through this development, Tex Tech will also be able to provide a product with improved properties at potentially lower costs. Tex Tech has a proven record and system for developing new products through working relationships with key partners who are major contenders within the giving market place.

**FY 2009 Phase II Award**

**Topic**: 9.03 Information Technology

**Subtopic:** 9.03.1-9.TT Enacting Workflow using Role Based Access Control

**Title:** RBAC-based Workflow

**NIST OU:** Information Technology

**Firm:** Virtual Globe, Inc.
223 Sumac Circle
Morgantown, WV 26508

**Principal Investigator:** Cary Landis
**Phone:** 304-276-7625
**Email:** clandis@virtualglobal.com

**Award Amount:** $299,629.00

**Abstract:** Role-based workflow (RBW) is a NIST invention that used RBAC technology to implement workflow, with the goal of making workflow easier to maintain and more secure. At this time, Virtual Global has completed a Phase I SBIR effort, in which computer software was created to automate the invention in the form of web services. The Phase I effort was successful in proving the feasibility of the invention, as well as discovering commercial applications of the invention for secure software that manages healthcare records. Specifically, RBW provides hospital staff with momentary access to a single record on an “as needed” basis, rather than 24/7 access to thousands of records, thus dramatically improving security and reduce risks within the healthcare software systems. This Phase II proposal describes how Virtual Global will commercialize RBW, in order to bring the NIST invention into the mainstream. The proposed Phase II effort involves finishing software development, documentation and preparing for a successful product launch. Virtual Global will also prototype a real-world healthcare application using its TeamHost Cloud Computing System.

**Commercial Applications:** Virtual Global envisions a very large market for RBW in secure healthcare records management and drug manufacturing, and therefore intends to create industry specific applications in these segments using its TeamHost Cloud Computing System as the platform for rapid Web 2.0 Software as a Service engineering. Virtual Global further intends to assist NIST in licensing the RBW web services library to other software vendors to promote higher levels of security in their commercial software applications.

**FY 2009 Phase II Award**

**Topic:** 9.03 Information Technology

**Subtopic:** 9.03.1-4.R Efficient Low-Dark-Count Detector for Photon Counting

**Title:** Efficient Low-Dark-Count Detector for Photon Counting

**NIST OU:** Physics

**Firm:** Voxtel, Inc.
12725 SW Millikan Way, Suite 230
Beaverton, OR 97005

**Principal Investigator:** Andrew Huntington, Ph.D.
**Phone:** 971-233-5646
**Email:** andrewh@voxtel-inc.com

**Award Amount:** $299,998.00

**Abstract:** Voxtel has demonstrated efficient high-speed photon counting with thresholded linear-mode avalanche photodiode (APD) receivers using multi-gain-stage InGaAs/InAIAs APDs. In contrast to Geiger APDs, thresholded photon-counting linear APD receivers are thought not to suffer afterpulsing, and can support maximum count rates (MCR) up to 2 or 3 orders of magnitude faster than Geiger APDs. However, the early embodiments of this new photon-counting receiver have a much higher dark count rate (DCR) than InGaAs Geiger-mode APDs. In the Phase II project, Voxtel proposes to reduce the dark count contributions from both the APD and the transimpedance amplifier by developing a new embodiment of the multi-stage APD in the Phase II program that substitutes InP for InAIAs in the multiplier, and simultaneously by fundamentally improving the amplification using a new, ultra-low-noise capacitive-feedback transimpedance amplifier (CTIA).

**Commercial Applications:** The multi-stage InGaAs APD design is unique among detectors in that it combines the gain, noise, and modest cooling requirements of a silicon APD with high spectral responsivity between 950 and 1650 nm. Its largest potential commercial market is as a drop-in replacement for silicon APDs in systems where backward-compatibility with signals at 980 nm (short-haul fiber optics) and 1064 nm (existing LADAR) systems is required, but where there is a desire to extend operation to 1310 nm and 1550 nm (eye-safe LADAR and long-haul fiber optics). Photon counters based on the multi-stage APD will first find application in high count rate systems where the rate of false counts relative to the rate of photocounts is more important than the absolute false count rate. This includes quantum information and free-space optical communication applications in which the higher MCR will allow faster processing and data transfer. As the technology improves and DCR is reduced, single photon counters based upon the multi-stage APD will find application in systems where the signal rate is lower, and sensitivity to the absolute rate of false counts is higher.