Abstracts of Awards for Fiscal Year 2008 NIST SBIR Program

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**FY 2008 Phase I Award**

**Topic:** 9.03 Information Technology

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

**Title:** High Efficiency Single Photon Up-Conversion in Waveguides and Pump Wavelength Longer than the Signal Wavelength

**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:** $89,974.00

**Abstract:** This NIST Phase I SBIR effort will demonstrate the feasibility of low noise single photon up conversion using KTiOPO4 (KTP) or LiNbO3 (LN) or Stoichiometric LiTaO3 (SLT) periodically poled waveguides and an 1800nm pump for a high efficiency single photon detector. 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 Silicon-based avalanche single photon detectors (Si-APD). Use of waveguide Sum Frequency Generation (SFG) for 1535nm to 828.5nm up-conversion coupled with inexpensive and very efficient 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:** The result of this project will have an enormous effect on the development of quantum communications and quantum-key-distribution (QKD) systems. Until now, the primary bottle-neck in quantum communication was the difficulty in providing a suitable SPD for practical applications. This technique offers a potential breakthrough in reducing the detection noise, in the form of dark counts, and in the mean time improving the performance of the system in terms of detection efficiency and speed. Therefore it significantly accelerates quantum related R&D. This system will impact both laboratory level research by providing researchers with better detection efficiency at a lower cost and product development by providing better product performance.

 **FY 2008 Phase I Award**

**Topic:** 9.07 Optics and Optical Technology

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

**Title:** MWIR Spatial Light Modulators for Hyperspectral Image Projectors

**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:** $89,709.00

**Abstract:** The proposed effort is to build a high resolution, high speed spatial light modulator (SLM) to be used in infrared (IR) spectral projectors. An IR spectral projector produces programmable spectra by dispersing light onto a programmable array, currently digital micromirror devices (DMDs), which either transmit or block selected components of the light. the light is then recombined to form complex spectral signatures. Due to small pixel sizes and binary operation per pixel, diffraction from the DMD creates severe problems for many applications. This proposal addresses these problems through the development of a SLM that is spatially continuous within each spectral line and provides analog intensity modulation using liquid crystal (LC) technology. The SLM will be designed for use in the 3 - 5 um spectral range, and it will eliminate the intra-spectral diffraction associated with the DMD device without sacrificing speed or resolution.

**Commercial Applications:** Dynamic spectral filters as described in this proposal would be useful in a number of applications. In spectroscopy, a tunable filter can be used to scan and select spectral bins across a range of interest, measuring the radiance in each band. With broadband illumination, dynamic spectral filters can be used to produce color-balanced red-green-blue (RGB) illumination for displays or to produce complex spectral signatures equivalent to those measured from "real-world" sources (e.g. rocket plumes, ocean-water, chemical signatures etc.). This approach can also be used a s a tunable notch filter for sensor protection where it is necessary to dynamically null bright sources to prevent saturation and/or sensor damage. The completion of this effort will also result in a versatile high resolution 2D SLM product designed for use in the MWIR that can be driven through a conventional video interface. This will move commercially available SLM technology forward into spectral bands that are currently unsupported. The product can be used for spectrally tuning light sources, optical code division multiple access communication systems, and pulse shaping.

**FY 2008 Phase I Award**

**Topic:** 9.05 Microelectronics Manufacturing

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

**Title:** High-Accuracy, AC Resistance-Ratio Bridge

**NIST OU:** Chemical Science and Technology

**Firm:** Circuit Equipment Corporation
7547 Mentor Ave.
Mentor, OH 44060-5432

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

**Award Amount:** $89,995.00

**Abstract:** This SBIR deals with developing a commercial AC Resistance-Ratio Bridge based on research work done by R. D. Cutkosky at NIST during the 1980's. His initial work will be extended by this Phase I project to allow for a new state-of-the-art product design and development. The product, the Model 8686 Precision Resistance-Ratio Bridge, will have an operating current range from 0.1mA to 10mA user selectable. It will have two measurement ranges: a 40-ohm range (with 0.1uohm sensitivity) and a 400-ohm range. The unit will be able to work from any line voltage worldwide. The Model 8686's intended use is in the standards industry for measuring Platinum Resistance thermometers on the International temperature scale 1990 (ITS-90).

**Commercial Applications:** AC Resistance-Ratio Bridge measuring equipment, for use in industry, university and government research facilities.

**FY 2008 Phase I 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:** $89,974.00

**Abstract:** In order to realize robust, inexpensive and routine DNA sequencing for medical, forensic, security and defense applications, new approaches must be pursued. One approach is the rapid readout of individual nucleotides as a single strand of DNA is drawn through a nanometer scale aperture. Although progress has been made with nanopore sequencing, some fundamental instrumental and system problems have so far kept the method from realizing its potential. The solution is to develop a system with low inherent noise and an ability to improve current sensitivity without driving the polynucleotide faster. Electronic Bio Sciences is proposing to develop an alternating current (AC) measurement system with the lowest noise achievable today. With an AC measurement system it is possible to drive the polynucleotide through the protein pore at a relatively slow rate while observing the conductance of the protein pore using a high frequency AC drive potential. This proposed system will allow the current system noise and rapid polymer translocation rate limitations to be overcome to allow for a practical nanopore based DNA sequencing system.

**Commercial Applications:** 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 2008 Phase I Award**

**Topic:** 9.03 Information Technology

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

**Title:** Extended Refreshable Tactile Graphic Display (with Linear Actuation Array)

**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:** $90,000.00

**Abstract:** New innovative technology for the visually impaired has been developed by NIST. If commercialized, it would provide refreshable tactile graphical information to the visually impaired, enabling them to compete on a more equal footing in the workplace and the education system. Currently, accessing graphical tactile information is expensive and cumbersome. This is a huge impediment for the visually impaired as graphical information is a core asset in the computer age – conveying essential complex information efficiently. The research team will advance the NIST display technology by improving its pin density, screen size, refresh rates, reset mechanisms and user interface. Phase I efforts will result in designs and prototypes of key components of the display – including the pins, locking mechanisms, and linear actuation arrays. The researchers will approach the R&D by 1) evaluating existing and potential applicable technologies, 2) designing and/or integrating those technologies that meet project requirements, 3) analyzing potential integrations, 4) prototyping the most efficient integrations and 5) producing a comprehensive design strategy document that delineates both the progress of the Phase I research and the research plan for the Phase II efforts.

**Commercial Applications:** The research findings will lead to a low-cost device capable of presenting information in two-dimensional graphical form. Commercial applications for the device include presenting tactile text and graphics for the visually impaired, thereby enabling the visually impaired to compete more effectively in our economy. The device could also be modified to present other tactile graphical information for varied industries. For example, it could represent three-dimensional maps of our plant’s and other planets’ surfaces (and below), for use by natural resource companies, infrastructure and construction projects, the military and space exploration.

 **FY 2008 Phase I Award**

**Topic:** 9.03 Information Technology

**Subtopic:** 9.03.3-9.TT Data Management and Visualization Techniques for Improving Cyber Security

**Title:** Detecting Intrusion from Network Anomalies (DINA)

**NIST OU:** Information Technology

**Firm:** Michigan Aerospace Corporation
1777 Highland Dr., Suite B
Ann Arbor, MI 48108-2285

**Principal Investigator:** Juan Esteva
**Phone:** 734-975-8777 x144
**Email:** jesteva@michiganaero.com

**Award Amount:** $89,608.00

**Abstract:** This proposal introduces the Detecting Intrusion from Network Anomalies (DINA) system, which uses data mining tools to automatically detect anomalous behaviors that can be related to undesired intrusion and/or attacks upon computer networks, as well as other use patterns which may indicate behaviors which are non-hostile but still problematic. The application will make use of Ensembles of Decision Trees (EDTs) to mine the data and detect those anomalous behaviors. The system will utilize a Relational Database (RDBMS)/Data Warehouse (DW) Architecture that can be used to build, manage, deploy, score, and detect anomalies, all within the database. The model and approach described in this proposal will be adopted to build a prototype using the capabilities of a number of open-source products. Moreover, the system will provide crucial visualization tools aimed at helping users diagnose performance issues and understand communication patterns between nodes.

**Commercial Applications:** The proposed effort will result in an effective contemporary production-quality data warehouse-centric Intrusion Detection System that will provide an array of diverse components and features, including:

• Centralized view of the data
• Analytic and data mining methods
• Real-time detection and alert infrastructure
• Reporting and visualization capabilities
• High system availability
• Data transformation capabilities
• Flexible detector deployment, including scheduling that enables periodic model creation and distribution
• Distributed processing potential
• Scalability with system load

**FY 2008 Phase I 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 Junction Field Sensors

**NIST OU:** Material Science and Engineering

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

**Principal Investigator:** Benaiah Schrag
**Phone:** 508-672-4665
**Email:** schrag@micromagnetics.com

**Award Amount:** $89,978.00

**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 I effort aims to maximize the high-frequency sensitivity of the MgO-MTJ sensor devices by optimizing the magnetic characteristics of the free electrode. By using new and novel combinations of magnetic materials, in conjunction with proper post-deposition thermal magnetic treatments, the free layer's magnetic anisotropy will be greatly reduced, improving device sensitivity. We will develop improved annealing procedures to minimize the effects of interlayer magnetic coupling on the new sensor devices, and to linearize the sensor transfer curves. If suitable high-frequency noise characteristics are demonstrated, we will then be in a position to integrate the MgO-MTJ sensors with oscillating MEMS flux concentrators, currently in development, which will allow greatly improved noise performance (~1 pT/rtHz) 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 picotesla without employing a more exotic and expensive sensor technology. Successful realization of picotesla-sensivitiy 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 mass-market commercial applications including automotive applications, in navigation and compassing, in the measurement of position and velocity, and in science and engineering.

**FY 2008 Phase I 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 Ferroelectric 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:** $89,991.00

**Abstract:** This SBIR technology transfer program offers the opportunity to produce a new generation of advanced large area and monolithic pryoelectric detector arrays that fully exploit the benefits of domain engineering and "smart-cut" technologies. SRICO will Investigate domain-engineering patterns to reduce acoustic noise as well as techniques to optimize a thin film absorber to enhance the detector absorptivity without substantially increasing thermal mass. Also, a method to extend domain engineering to create monolithic broadband position sensors and arrays will be explored. Smart-cut transfer of domain patterned crystal films on order of a few microns thick to silicon would enable formation of uniform large area pyroelectric detector arrays that are at the same time ten times more sensitive than state of the art sensors. The proposed domain engineered 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.

**Commercial Applications:** Broadband Detectors for THz Measurement, Control or Calibration; Optical Calibration Transfer Standards; High Precision Broadband Radiometers; Broadband THz Power Sensors; IR Detectors for Blood Gas Analyzers and FTIR Systems; THz Image Sensors for Non-Invasive Medical Diagnostics; Non-Destructive IR or THz Material Testing; Improved Pulsed Laser Sensors; Horizon Sensor for Satellite Applications; Calibration System for IR Target Designators; Detectors for Laser Targeting and Alignment; THz Field Communications Systems

**FY 2008 Phase I Award**

**Topic:** 9.02 Homeland Security

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

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

**NIST OU:** Electronics and Electrical Engineering

**Firm:** STAR Cryoelectronics
25-A Bisbee Court
Santa Fe, NM 87508-1338

**Principal Investigator:** Robin Cantor
**Phone:** 505-424-6454
**Email:** rcantor@starcryo.com

**Award Amount:** $89,997.00

**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 difference 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 and development in the growing fields of nuclear forensics and environmental monitoring.

 **FY 2008 Phase I 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 26508-5249

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

**Award Amount:** $82,598.00

**Abstract:** Under this proposal, Virtual Global, Inc. proposes to work with NIST to develop RBAC-BASED WORKFLOW, a workflow system that will use RBAC in a web services model as a form of middleware that can be "packaged" accessed, configured, and reused by integrating with existing trusted RBAC implementations.

RBAC-BASED WORKFLOW will be developed in accordance with web services standards and protocols so that it may be accessed by a number of web-based applications, including Virtual Globals's enterprise team management and collaboration software application, TeamLeaderTM.

**Commercial Applications:** The RBAC-BASED WORKFLOW system will be a NIST standard middleware product, likened to database connectivity middleware such as ODBC. As such, Virtual Global will access the middleware, and commercially benefit from the middleware, although the middleware is a NIST-owned and patented product.

This project will create a significant private sector opportunity for Virtual Global, as the RBAC-BASED WORKFLOW system developed under the Phase I and Phase II projects can be integrated into TeamLeader. It is believed that the integration of a cutting edge RBAC-BASED WORKFLOW system will be a strong competitive advantage that can catapult TeamLeader into market leadership.

**FY 2008 Phase I 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:** Improved Silicon Drift Detector Coincidence Rejection for Digital Pulse Processors

**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:** $90,000.00

**Abstract:** The recent emergence of the Silicon Drift detector (SDD), for use in Energy Dispersive x-ray Spectroscopy (EDS), has made possible x-ray event streams with input count rates in the range of 1-10 Mcps. Modern digital pulse processors are therefore required to run at fast time constants to achieve reasonable throughput; however, this causes significant coincidence artifacts to appear in the spectrum, thus complicating analysis. Phase I will design and demonstrate an improved coincidence rejection system based on 4pi's digital pulse processor development, and earlier pulse-shape analysis and recovery research.

**Commercial Applications:** The Silicon Drift detector (SDD) is rapidly gaining acceptance as a standard EDS instrument on 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.

**FY 2008 Phase I 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:** $89,888.00

**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 this Phase I SBIR effort is to assess the feasibility and robustness of single-frequency operation of two different OPSL cavity designs. The design that is identified as superior through this Phase I effort will be subsequently developed in Phase II, with the end goal of delivering a system that NIST can use in its cutting-edge 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 guidestar laser systems, stateof-the-art atomic clocks, quantum information processing, and basic atomic, molecular and optical research.

 **FY 2008 Phase I Award**

**Topic:** 9.04 Manufacturing System Integration

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

**Title:** Closing and Opening Worlds: Integrity Constraints and Expressive Keys in 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:** $84,480.00

**Abstract:** We propose to evaluate tree dominant semantics for description logic integrity constraints, as well as multiple proposals for adding syntax for integrity constraint axioms, to the Web Ontology Language standard, OWL. Further, we propose to implement a semantics, in the form of a syntax compiler and data set validator, in order to establish the feasibility and utility of such work for the validation of supply chain management messages, as well as for other, related forms of information integration based on ontologies. Being able to selectively manage open world an closed world reasoning assumptions allows the use of OWL as an expressive schema language for data models. We further propose to consider the applicability of existing description logic explanation and debugging services in Pellet, an OWL DL reasoner, to increase the usability and comprehension of integrity constraints for ontology developers and users of supply chain messaging validators.

**Commercial Applications:** As attested by commercial letters of support included in the proposal, we believe there are existing and potential customers for whom the proposed research, including successful completion of Phase II development, would constitute a viable commercial option for using OWL as an expressive schema language to validate a wide-range of data models, including legacy data sources, databases, web services, and message passing systems, including SCM. We further believe that expressive keys and integrity constraints, together with the explanation and debugging capabilities of Pellett, will broaden the commercial appeal and utility of OWL-based systems by allowing users to carefully manage the relationship between OWL and its semantics with other data sources that assume closed world semantics.

 **FY 2008 Phase I Award**

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

**Subtopic:** 9.08.1-6.R Innovative Fire Measurements

**Title:** Innovative Fire Measurements Using Thermal Imaging

**NIST OU:** Building and Fire Research

**Firm:** Critical Imaging LLC
2306 Bleecker St.
Utica, NY 13510-1746

**Principal Investigator:** Justin Weller
**Phone:** 315-732-1544
**Email:** jweller@criticalimaging.net

**Award Amount:** $89,613.00

**Abstract:** The most practical arrangement for investigating moving fires within a restricted space is to use a high- resolution stand off technique. One such method that fits this description is the use of a staring infrared (IR) sensing device (i.e. imager). Infrared imagers (also known as thermal imagers) respond to thermal energy radiating from an object surface. For flame measurements, this technique has the added benefit of sampling high-energy content, which will effectively boost the signal-to-noise ratio – a critical metric for imaging systems A robust thermal imaging device with a digital data processing engine and prescribed multi-spectral filtering presents an innovative technique for fire measurement applications. It allows for simultaneous measurement of several parameters, some of which can be evaluated using existing infrared camera technology. The non-contact, or standoff, method reduces domain and measurement restrictions, and provides a more comprehensive platform for data collection.

**Commercial Applications:** When considering the scope of scientific applications, R&D, process control scenarios, and industrial monitoring, such a tool has almost unlimited potential. Many of the features that are applicable to fire measurement, such as surface tracking and spectral characterization, carry over to many other applications. Anticipated benefits from enhanced understanding of flame characteristics are expected to lead to improved combustion performance and hence reduced emissions of greenhouse gases, energy conservation and reduced dependence on foreign energy sources.

 **FY 2008 Phase I 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, NJ 08628-3200

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

**Award Amount:** $90,000.00

**Abstract:** Conversion of highly stable optical clocks into electrical clocks through photodetection introduces excess phase noise and degrades the frequency stability by two to three orders of magnitude. This noise is primarily generated due to the conversion of optical intensity noise into electrical phase noise by the photodiode’s nonlinearity, specifically power-to-phase conversion. We will enhance the photodiode linearity through optical beam shaping using axially varying graded index (AV-GRIN) lens. The proposed AV-GRIN lens coupled InGaAs/InP p-i-n photodiode will have a power-to-phase conversion factor of 3rad /W over a bandwidth of 18GHz, and will reduce the excess phase noise by an order of magnitude as compared to the current state-of-the-art. The photodiodes will be pigtailed to PM fibers in order to minimize phase noise arising from polarization fluctuations. To facilitate device testing, matched pairs of photodiodes will be packaged in a single microwave package in the dual photodiode configuration.

**Commercial Applications:** The proposed low noise 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 positioning system
3) Distributed frequency and time standards
4) Test and measurement systems
5) Laser metrology
6) Long baseline interferometry

**FY 2008 Phase I Award**

**Topic:** 9.06 Micro- and Nano-fabrication Micromachining

**Subtopic:** 9.06.2-5.R Multiple Polytype SiC Nanowire Fabrication Process and Equipment Development

**Title:** CVD-based Polytype Controlled SiC Nanowire Growth

**NIST OU:** Material Science and Engineering

**Firm:** GeneSiC Semiconductor, Inc.
43670 Trade Center Place, Suite 155
Dulles, VA 20166-2123

**Principal Investigator:** Siddarth Sundaresan
**Phone:** 703-996-8200 x113
**Email:** sid@genesicsemi.com

**Award Amount:** $90,000.00

**Abstract:** A novel chemical vapor deposition (CVD) based step-flow epitaxy process is proposed for controllable growth of SiC nanowires with high polytype integrity. The SiC nanowires will be grown in a modified commercial high-temperature CVD reactor, used by industry for growing high-quality SiC epitaxial thin films. Different polytypes of SiC nanowires will be grown by choosing appropriate substrate materials as well as tuning the Si/C molar ratio in the precursor species. The nanowires will be grown on off-oriented substrates, in an attempt to ensure polytype purity. Various techniques for controlling the diameter, orientation and doping type / concentration of the SiC nanowires will be explored. Several strategies for patterning the nanowires on specific locations on the substrates will be investigated. Finally, a prototype gas sensor device will be constructed using the SiC nanowires grown in this project. This gas sensor will allow the detection of greenhouse gasses like Nitrous Oxide and CO2 with extremely high sensitivity.

**Commercial Applications:** SiC Nanowires provide significant advantages over conventional chemical and biological sensors due to their better thermal, electrical, chemical and mechanical properties. As chemical sensors, they offer high sensitivity towards greenhouse gases under chemically corrosive environments such as automobile, aircraft and rocket engine exhaust systems. SiC nanowires based biosensors applicable in cancer detection, genetic engineering and drug discovery offer lower auto-fluorescence in the visible spectrum, a higher electrical resistivity that translates into enhanced detection sensitivity. Blue and Ultraviolet emitting SiC nanowires are promising solid state lighting alternative to LEDs due to their higher projected electrical to photonic energy conversion efficiency. Like diamond, SiC also offers excellent field emitting properties, particularly suitable for high brightness, compact display applications. SiC nanowires represent revolutionary advancements in these application areas.

 **FY 2008 Phase I Award**

**Topic:** 9.01 Analytical Methods

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

**Title:** Kilopixel Array Cryostat (KAC) System for Multi-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:** $89,977.00

**Abstract:** Identify and study candidate architectures for supporting and cooling massive (~5 Kg) arrays of transition edge sensors, achieving hold times for one week at temperatures below 100mK.

**Commercial Applications:** Pulse tube driven cryostats that have capacity to cool and hold stable massive (~5 Kg) transition edge sensor (TES) arrays. These cryostats will be for X-ray spectroscopy, gamma ray spectroscopy, nuclear fuel rod assay, sub-mm astronomy & polarimetry of cosmic microwave background.

 **FY 2008 Phase I Award**

**Topic:** 9.06 Micro- and Nano-fabrication Micromachining

**Subtopic:** 9.06.1-5.R Elevated Temperature Quartz Crystal Microbalances for Nanoanalysis

**Title:** An Elevated-Temperature Nanobalance Based on Piezoelectric Shear Mode Resonators (quartz, gallium phosphate, and langasite)

**NIST OU:** Material Science and Engineering

**Firm:** Masscal Corporation
96 A Leonard Way
Chatham, MA 02633-1303

**Principal Investigator:** Allan L. Smith
**Phone:** 508-241-8628
**Email:** allan.smith@masscal.com

**Award Amount:** $90,000.00

**Abstract:** The work proposed will provide a demonstration of feasibility and specific design recommendations for building an elevated-temperature resonating crystal balance with nanogram sensitivity. The approach will build upon existing technology commercialized by Masscal for operating a QCM in a temperature-controlled calorimeter. Precise temperature control and new types of crystal sensors will be used to greatly extend the temperature range of operation, reduce measurement errors at higher temperatures, and increase practical usability of the final product. In Phase I, we will (1) demonstrate current capability in gases under 100°C; (2) extend the capability to include aqueous solutions up to 85°C (3) fabricate new candidate crystal sensors from quartz, gallium phosphate and langasite for operation up to 250°C and then further to 600°C; (4) design and assemble a breadboard instrument and use it to perform preliminary testing of new sensors; (5) develop specific recommendations for a high-temperature instrument up to 600°C; and (6) demonstrate capabilities by measuring oxidation in a nanostructured thin film from NIST up to 250°C.

**Commercial Applications**: Many advancements in medicine, electronics, biochemistry, material science and manufacturing are based on the application of ultra thin films or on the purity and reactions of very small amounts of materials and so-called nanomaterials under the conditions of manufacture, storage and end use. The proposed technology would provide nanogram-precision of mass under precisely controlled conditions at elevated temperatures for a broad range of industries. It may also have the potential to provide simultaneous calorimetric measurements when combined with a heat flow transducer as in Masscal U.S. patent #6,189,367. Most current QCM instruments are limited to near-ambient temperatures. The current Masscal nanobalance is limited to measurements under 100°C. The need for higher temperature capability has been directly requested by customers in the electronics, films & coatings, carbon nanotubes, structural materials and other markets. These markets are currently served by traditional TGA for temperatures above 100°C and are limited by 1-3 orders of magnitude less sensitivity or to extrapolated results made from bulk sample measurements.

 FY 2008 Phase I 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
174 Galisteo Lane
Santa Fe, NM 87505-4634

**Principal Investigator:** Daniel J. Kane
**Phone:** 505-401-5271
**Email:** djkane@mesaphotonics.com

**Award Amount:** $90,000.00

**Abstract:** Modern supercontinuum (SC) light sources are generated by non-linear interactions between ultrashort pulse lasers and optical fibers. Output in near-ultraviolet to near-infrared wavelength ranges has been demonstrated. These light sources have high brightness and are spatially coherent. Recently, output to 4.5 µm was achieved using fluoride glass fibers; optical absorption by the fiber prevents longer wavelength output. Challenges to extending SC sources to the mid-IR (out to 12µm) are the development of low-loss fiber materials (propagation in conventional glass fibers is limited by material absorption), the development of new, highly nonlinear materials, and designs that allow for mode confinement within the fiber. Mesa Photonics, LLC, and Prof. Fiorenzo Omenetto of Tufts University propose development of mid-infrared supercontinuum sources based on newly available optical fibers. Our goal is the development of a spatially coherent SC source operable in the 4.5-12 µm spectral region with an output power exceeding 100 mW in a band at least 800 cm-1 wide and a minimum power per unit bandwidth of 0.125 mW/cm -1. In Phase I we will characterize mid-infrared generation and demonstrate a simple application by acquiring molecular absorption spectra using the SC source.

**Commercial Applications:** Applications include telecommunications and biomedical imaging such as optical coherence tomography (OCT). SC operating wavelength ranges are constrained by the transmission and dispersion properties of the fibers. Recently, output to 4.5 µm was achieved using fluoride glass fibers; optical absorption by the fiber prevents longer wavelength output. Further improvements, into the mid-infrared region (meaning 4 to 12 µm) would enable a plethora of new opportunities including high-resolution infrared microscopy, remote sensing (standoff detection), and IR countermeasures.

**FY 2008 Phase I Award**

**Topic:** 9.04 Manufacturing System Integration

**Subtopic:** 9.04.2-2.R Time Synchronization of Wireless Sensor Networks

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

**NIST OU:** Manufacturing Engineering

**Firm:** NAVSYS Corporation
14960 Woodcarver Rd.
Colorado Springs, CO 80921-2370

**Principal Investigator:** Alison K. Brown
**Phone:** 719-481-4877 x102
**Email:** abrown@navsys.com

**Award Amount:** $89,974.00

**Abstract:** The 1588 Precision Time Protocol (PTP) protocol has significant advantages for relative time synchronization on wireless networks. To synchronize the sensors into an absolute universal time coordinate system (UTC), the Grandmaster Clock needs to be synchronized to an external “clock”, e.g. a GPS-based clock. Dedicated GPS Grandmaster Clocks exist, but are expensive in both power-consumption and hardware required, especially given the infrequency with which external synchronization between the local clock of the grandmaster and the UTC time is needed. Under this effort, we propose an innovative solution based on NAVSYS’ GPS and ZigBee technology to develop a low cost timing product that will provide Synchronization with External-time via ZigBee (SyncEZ). Under Phase I we expect to work collaboratively with the NIST staff on the evaluation of the operating parameters and implement and test a prototype wireless sensor network integrated with the IEEE 1588 time synchronization protocol. This will be used to demonstrate accurate time stamping across a ZigBee sensor network under the Phase I effort.

Commercial Applications: Precise time stamps will be available to wireless systems to allow traceable and reliable correlation between events, measurements and actions for application to machine monitoring, predictive maintenance, process optimization, data fusion, medical treatment control, legal verification of events and a whole host of applications that are now beyond the reach of current technology in cost effective instantiations.

 **FY 2008 Phase I 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:** Richard A. Hutchin
**Phone:** 818-880-2907 x201
**Email:** rahutchin@opci.com

**Award Amount:** $89,976.89

**Abstract:** Optical Physics Company is proposing 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. The design is simple and compact, fitting within a 5x5x7.5 cm volume. An initial lab demonstration has already been completed showing performance parameters better than NIST requirements. The linear displacement precision was shown to 0.0089 nm (versus the 0.1 nm requirement) covering a working range from 18 cm to 23 cm. The demonstrated angular precision is 0.071 arc-seconds (versus the 0.1 arc-second requirement) with a range of +/- 50 arc-seconds. The Phase I work will build and test a prototype interferometer which will confirm the design and prepare for fabrication of a deliverable unit in Phase II.

**Commercial Applications:** The main application targeted is the one NIST is most interested in, namely the NIST calculable capacitor. The proposed technology addresses adding angular control and encoding mechanisms to realize and maintain alignment between the electrical axis of the capacitor and the optical axis of the interferometer within 0.1 arc-second to ensure parallelism of plates. Moreover, there are additional semiconductor manufacturing and nano device fabrication applications, such as lithography mask (reticle) writers, lithography scanners/steppers, CD metrology tools, pattern placement and overlay metrology tools, circuit and mask repair tools, coordinate measuring tools, and diamond turning machines. Furthermore, one can consider the three axis interferometer as the precursor of more versatile instruments for molecular observation leading to applications which do not yet exist in chemical and biological technologies.

 **FY 2008 Phase I Award**

**Topic:** 9.07 Optics and Optical Technology

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

**Title:** Development of Improved Virtually-Imaged Phased Arrays

**NIST OU:** Physics

**Firm:** Precision Photonics Corporation (PPC)
3180 Sterling Circle
Boulder, CO 80301-2362

**Principal Investigator:** Dr. Kurt Vogel
**Phone:** 303-444-9448 x313
**Email:** kvogel@precisionphotonics.com

**Award Amount:** $90,000.00

**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 fabrication methods limit efficiency, spectral resolution, filter response, and spectral bandwidth. Precision Photonics proposes to use its enhanced optical fabrication capabilities to build advanced VIPA prototypes that improve upon each of these areas. A photolithographic mask will lower the incident angle, improving VIPA efficiency. Thin-film coatings will be developed that are ultra-broadband and result in higher finesse values for the VIPA, thus improving spectral bandwidth and resolution. Improvements to the VIPA optical surface geometries will result in more narrow linewidths and better filter response. The proposed advances in VIPA design depend critically on core technologies unique to PPC: advanced ion beam sputtered (IBS) thin-film coatings, nanometer-level surface metrology, and state-of-the-art adhesive-free contacting.

**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 2008 Phase I Award**

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

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

**Title:** Innovative Residential Fire Sensor

**NIST OU:** Building and Fire Research

**Firm:** Southwest Sciences, Inc.
1570 Pacheco St., Suite E-11
Santa Fe, NM 87505-3993

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

**Award Amount:** $90,000.00

**Abstract:** Southwest Sciences proposes development of residential fire sensing systems based on low cost optical imaging sensors combined with newly introduced highly miniaturized, low power CO sensors. Sensor modules will also include temperature sensors. The 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. Our approach targets the types of residential fires that are difficult to detect using conventional smoke detectors and carbon monoxide monitors.

**Commercial Applications:** Although our proposed fire sensing technology is intentionally designed for easy installation in new and existing residences, new housing defines the stronger market. Our hope, of course, is for the proposed technology to achieve the same level of mandated installation that is now nearly universal for conventional smoke detectors. New housing completions in the US increased from 1.6 million units in 2002 to 1.9 million in 2006 (including both single family and multiple family dwellings). Full coverage within all new single-family residence would likely cost between $300 and $1000 depending on the number of sensor modules and the possibility of including our fire sensing technology in a home security network. Thus the potential annual market based on US recent new home construction rates is between $500 million and $1.9 billion. While this number seems like pipe dream territory, a recent market study estimates the worldwide market for fire alarm equipment and systems to the $14 billion with an 8% annual growth rate. Our plan is to partner with a manufacturer currently in the market.

 **FY 2008 Phase I 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:** $87,292.00

**Abstract:** New fire barrier methods are necessary to protect furniture and mattresses from fire. Current California (and soon National) regulations require mattresses to be able to pass the mattress fire burn test. Typical barrier fabrics use self extinguishing fibers with high limiting oxygen index (LOI) to create a barrier that the flame cannot pass. A second approach creates a carbon barrier that is formed during the fire. The carbon barrier is formed through the carbonization of the fibers in the fiber. Tex Tech plans to demonstrate the ability to manufacture lightweight felt barriers that can stop the flame spread, eliminate foam melt through, and be strong enough to handle any water damage.

**Commercial Applications:** The potential market for effective fire blocking materials for furniture and mattress is in the many millions of dollars. Effective July 1, 2008 all mattresses manufactured and sold in the United States must be resistant to open flame sources, such as candles, matches and cigarette lighters. This follows California that became the first state in the nation to require that mattresses be resistant to open flame sources in 2005. According to the International Sleep Products Association, U.S. mattress producers shipped nearly 24 million new mattresses, while federal statistics show another 4 million mattress sets were imported.

 **FY 2008 Phase I Award**

**Topic:** 9.07 Optics and Optical Technology

**Subtopic:** 9.07.3-1.R Low-Loss in-Fiber Optical filter at 860 nm

**Title:** Low-Loss, FemtoEtch, in-Fiber Fabry-Perot 860-nm Optical Filter

**NIST OU:** Electronics and Electrical Engineering

**Firm:** Translume, Inc.
655 Phoenix Dr.
Ann Arbor, MI 48108-2201

**Principal Investigator:** Philippe Bado
**Phone:** 734-528-6330
**Email:** pbado@translume.com

**Award Amount:** $89,993.00

**Abstract:** Most commercial filters have significant loss even in the passband of the filter. This problem is further exacerbated when the filter must be integrated or inserted within an optical fiber. Translume has developed over the last few years means and expertise to micromachine single-mode fiber using a combination of femtosecond laser pulses and highly anisotropic hydrofluoric acid etching. We propose to use this unique knowledge to fabricate in-fiber Fabry-Perot filters that meet NIST requirements. Furthermore, our integrated monolithic Fabry-Perot filters will be immune to the long-term drift and sensitivity to the environment that is plaguing other Fabry-Perot filter designs.

**Commercial Applications:** The overall objective of Translume is to develop and commercialize optical instruments and optical analyzers. The Fabry-Perot filter to be developed under this SBIR program fits perfectly in our overall product development and commercialization plan. Low-loss, in-fiber Fabry-Perot filters will find use in the telecommunication industry, and in various optical instruments, including in biomedical devices such as flow cytometers. If they can be produced at sufficiently low-cost, and we believe this can be achieved with our direct-write laser fabrication process, large volumes may be used in disposable lab-on-chip applications. Translume has previously successfully turned SBIR concepts into commercial products.

 **FY 2008 Phase I 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:** $90,000.00

**Abstract:** Voxtel proposes to develop fiber-coupled near-infrared avalanche photodiode (APD) receivers with photon detection efficiency (PDE) and dark count rate (DCR) with more than two orders of magnitude faster maximum count rate (MCR) than Geiger-mode APDs, which are constrained by a fundamental tradeoff between DCR and MCR: if the APD is cooled to reduce DCR, then its dead time must increase to avoid afterpulsing, which reduces MCR. Linear APDs are not subject to this constraint, and so can be operated with dead times less than 1 ns. This improvement in MCR translates into a proportional improvement in single photon bit rate, and when the DCR is measured relative to the enhanced MCR, it will enable the solicited improvement in the frequency of spurious counts. Voxtel’s excess noise measurements indicate that its unique multi-stage InGaAs APD design is a viable path toward realizing linear-mode photon-counting receivers. In Phase I, quantity 10, fiber-coupled, thermoelectrically-cooled multi-stage APD receivers will be delivered.

**Commercial Applications:** High-bandwidth single-photon-sensitive linear-mode APDs are an enabling technology for deep space optical communications and 3D sensing. Linear-mode receivers support much higher data rates than those based upon Geiger-mode APDs, as the detector need not be reset after each detection event. In a focal plane array embodiment, NIR APDs offer a compact and reliable alternative to tube-based imagers for laser radar (LADAR) cameras, reducing the size, weight, and power requirements of the instrument, and its risk of failure. Specific military applications include lighter man-portable eye-safe range-finders with longer battery life, vehicle-borne 3D cameras for penetration of obscurants and camouflage, and target discrimination on hit-to-kill missile defense seekers. Civilian applications of such cameras include 3D aerial surveying, search-and-rescue (vision through smoke), and vehicle collision avoidance. Finally, the availability of high-MCR photon-counting receivers with superior DCR and PDE will support commercialization of civilian quantum information applications such as quantum cryptography and quantum computing.