**Abstracts of Awards for Fiscal Year 2003 NIST SBIR Program**

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**FY 2003 PHASE I AWARD**

**Topic:** 9.02 Analytical Methods

**Subtopic:** 9.02.04 Ultra Low Energy Sputter Ion Beam Deposition for Depth Profiling

**Title:** Low Damage Ion Beam Etching Technique and Method for Compositional Profiling Of Thin Multilayer Films

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

**Firm:** 4Wave, Inc
22977 Eaglewood Court, Suite 120
Sterling, VA 20166-9549

**Principal Investigator:** Todd Hylton
**Phone #:** (703) 787-9033

**Award Amount:** $73,342.00

**Abstract:** Thin film multilayers of nanometer scale thickness are fundamental to the future of electronics and communications technologies. Chemical depth profiling by ion etching techniques are critical to the characterization of these structures. A fundamental problem with current ion etching technologies is that typical ion energies (~1k eV to 20 keV) create extensive damage and intermixing of nanometer thick multilayer structures, thereby degrading depth profile analysis. In this Phase 1 project, processes and equipment will be developed and feasibility will be demonstrated for effective compositional depth profiling of nanometer scale multilayer films using low-energy ion etching. In addition, the research to be performed will determine the applicability of low-energy ion etching to the fabrication of nanometer scale multilayer devices. Phase II will develop and deliver to NIST a commercial prototype of a low-energy ion etching system for compositional depth profiling. 4Wave is uniquely qualified owing to its ongoing business in ion beam systems and its unique low-energy ion source technology.

**Commercial Applications:** Equipment and processes for analysis and fabrication of nanometer scale structures in the electronics, semiconductor, magnetic storage, and optical industries, including:
1) low-energy ion etching systems
2) low-energy ion sources
3) intellectual property to be disseminated by licensing and right-to-manufacture agreements.

**FY 2003 PHASE I AWARD**

**Topic:** 9.11 Optics and Optical Technology

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

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

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

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

**Principal Investigator:** Angus Henderson
**Phone #:** (425) 482-1100 Ext. 165

**Award Amount:** $74,998.00

**Abstract:** Aculight proposes to develop a laser source that will enable NIST to perform highly sensitive water vapor detection via cavity ring-down spectroscopy. The source will operate over a wavelength region centered at 1380nm. It will be based upon frequency conversion of a single frequency fiber source using an optical parametric oscillator (OPO).The performance of the source in terms of several critical parameters (linewidth, power output) will substantially exceed that of alternate sources such as external cavity diode lasers (ECDLs). In particular, ECDLs are commercially unavailable at this wavelength. The proposal will take advantage of previous work performed at Aculight for NIST, which demonstrated single frequency operation of an OPO pumped by a low power diode laser. The fiber-pumped device proposed here will display two orders of magnitude greater output power and will allow much greater control of output frequency. In Phase 1, Aculight will demonstrate all the NIST specifications and in Phase II deliver a package source for use in CRDS at NIST. We anticipate that it will be straightforward to extend this technology to other wavelengths between 1 and 4?m, which will make possible detection of other species by the ring-down method.

**Commercial Applications:** The proposed technology will have numerous applications as a light source for gas detection. These include combustion diagnostics, detection of pipeline leaks, industrial process monitoring, and pollution monitoring. The high power, wide tuning and narrow linewidth of the source will enable high sensitivity detection methods to be used for a wide range of important gas species.

**FY 2003 PHASE I AWARD**

**Topic:** 9.14 X-Ray System Technologies

**Subtopic:** 9.14.03 Vacuum Windows for Third Generation Synchrotron Radiation Beamlines

**Title:** Vacuum Windows for Third Generation Synchrotron Radiation Beamlines

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

**Firm:** Advanced Design Consulting, Inc.
126 Ridge Road
P.O. Box 187
Lansing, NY 14882-0187

**Principal Investigator:** Eric Johnson
**Phone #:** (607) 533-3531

**Award Amount:** $74,346.00

**Abstract**: Improving the quality and intensity of the x-ray beam is an important design
goal for every synchrotron installation. Although small, the effects of vacuum windows on x-ray absorption and phase contrast cannot be neglected. Synchrotron x-rays have wavelengths on the order of one Angstrom (1 x 10-10m), the same order of magnitude as inter-atomic distances. These x-rays are used to study many different types of materials. Structural details that are not easy to probe in other ways can often be understood by x-ray diffraction, x-ray spectroscopy, and x-ray fluorescence. The design of vacuum windows has not kept pace with other advances that have been made in the design of third generation synchrotron radiation beamlines. To improve the performance of the windows ADC is proposing new windows that will have improved specifications for surface finish and thicknessuniformity, but will not introduce any other spatial variation in the beam intensity. ADC's proposal outlines a technical approach to achieving a surface roughness of 0.01 ?Micrometer RMS and a peak-to-valley variation of less than0.1 ?Micrometer.

**Commercial Applications:** During the recent years there have been a large number of users from a wide range of scientific such as biology, chemistry, material science are converging to use synchortron to solve complex and demanding applications. Many new beamlines are funded for new drug discovery and applications that need the highest quality X-ray. Developing a cost effective manufacturing process for highly polished Beryllium windows and automating the fabrication will be a key to developing a viable commercial application. ADC with it's solid track record with synchortron community is an ideal candidate to develop this process and commercialize the technology where all scientists will be able to use a cost effective method for obtaining highly polished Beryllium windows.

**FY 2003 PHASE I AWARD**

**Topic:** 9.05 Homeland Security

**Subtopic:** 9.05.02 Development of a Micro-Machined Quadrupole Mass Spectrometer Array for Potential Use in Combination With IMS in "Field:" Detection of Explosives and Chemical Weapons Agents

**Title:** Micro-Scale Quadrupole Mass Spectrometer

NIST OU: 830 Chemical Science and Technology Laboratory

**Firm:** Aerophysics, Inc.
30981 Woodbrush Road
Calumet, MI 49913

**Principal Investigator:** Satwik H. Deshmukh
**Phone #:** (906) 487-2683

**Award Amount:** $75,000

**Abstract:** The proposed research comprises design, analysis, and ultimate fabrication and operation of a microfabricated array of quadrupole mass spectrometers (QMS). The design capitalizes on recent advances in micro-electro-mechanical systems (MEMS) and molecular-beam-epitaxy (MBE) technology so that the device can be mass-produced on a chip. In addition to analyzing a single element QMS in Phase 1, investigators will pursue architectures for multiplexing this geometry to a micromachined array of QMS on a single chip (mAQMS). The analyses of feasibility and expected performance of mAQMS will be guided by the proposing team's demonstrated success in developing similar micro-machined quadrupole ion traps. By implementing the quadrupole element in a massively parallel array, it may be possible to either individually tune filter elements to dedicated mass species allowing real-time sampling and circumventing the need for timely scans, or increase the detection efficiency of the micro-array by simultaneously sampling a given mass with a large number of individual detectors and filters.

**Commercial Applications:** Hazard monitoring of potential or known chemical agents, in-situ monitoring of many industrial processes, integrated sensing of gas quality in medical or pharmaceutical applications, and numerous other arenas. The extremely small size of the proposed device, coupled with its diagnostic capabilities, would allow non-invasive gas quality monitoring within macro-scale apparatus. The potential use by the federal government is, in this proposal, focused on homeland defense and the detection of chemical and biological agents. However, the general physical operating principles of the device would benefit countless endeavors.

**FY 2003 PHASE I AWARD**

**Topic:** 9.11 Optics and Optical Technology

**Subtopic:** 9.11.03 Solid State Radiometric Sources for Remote Sensing

**NIST OU:** 840 Physics Laboratory

**Title:** Monolithic Semiconductor Light Source with Spectral Controllability

**Firm:** Ahura Corporation
46 Jonspin Road
Wilmington, MA 01887-1019

**Principal Investigator:** Kevin J. Knopp
**Phone #:** (978) 657-5555 x102

**Award Amount:** $74,849.00

**Abstract:** Solid-state light sources promise many advantages over traditional technologies. Among these advantages is the ability to construct a source whose relative spectral distribution can be tuned to better match a desired spectrum. We propose addressing this technical and market opportunity through the development of a novel single-chip semiconductor device which delivers high optical output power (>200 mW) into dynamically configurable bands, 5 nm in width, across a wide spectral range (50-100 nm). The light source will be spatially coherent in a single fundamental transverse mode to allow efficient fiber coupling (loss <1dB) or direct free space focusing to a diffraction limited spot. The relative-intensity noise of the source will rival that of the best semiconductor lasers (<-140 dB/Hz). Furthermore, the size and form factor will mimic conventional laser butterfly packages. Our proposed light source is truly revolutionary as it brings together advances in high-power telecommunication lasers and planar-lightwave-circuits with Ahura's broadband source technology for culmination in a solid-state light source with unprecedented performance and reliability.

**Commercial Applications:** Application areas extend from on board radiometric sensor calibration standards, to water and chemical sensors, through to spectroscopy for the biological and pharmaceutical industries. These market segments are looking to replace traditional lamps with solid-state alternatives for increased lifetimes, optical power, and functionality.

**FY 2003 PHASE I AWARD**

**Topic:** 9.02 Analytical Methods

**Subtopic:** 9.02.03 Ultra-Precision Capacitance Bridge

**Title:** Super-Precision Capacitance Bridge

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

**Firm:** Andeen Hagerling, Inc.
31200 Bainbridge Road
Cleveland, OH 44139

**Principal Investigator:** Carl Andeen
**Phone #:** (440) 349-0370

**Award Amount:** $75,000.00

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

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

**FY 2003 PHASE I AWARD**

**Topic:** 9.06 Information Technology

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

**Title:** Service Management Software for Multi-Modal Interactions

**NIST OU:** 890 Information Technology Laboratory

**Firm:** Beyond Access Communications
5050 El Camino Real, Suite 270
Los Altos, CA 94022-1541

**Principal Investigator:** Phong Nguyen
**Phone #:** (650) 694-6800

**Award Amount:** $74,800.00

**Abstract:** Session Control technology, which tracks, controls, and directs all media sessions. Beyond Access proposes to provide feasibility into not only the core Session Control technology, but also an enabling software platform to connect, discover, and manage complex many-to-many multi-modal interaction sessions.

**Commercial Applications:** Multi-modal software platform utilizing Dynamic Session Control can be the next generation in communications services. These services can greatly reduce inefficiencies in corporate service and support organizations, financial institutions where their clients must go to their web site in hope of catching a Non-Sufficient fund on time, or in cases where multi-modal interaction is critical such as military or medical applications.

**FY 2003 PHASE I AWARD**

**Topic:** 9.04 Healthcare and Medical Physics

**Subtopic:** 9.02.01 Accurate Dosimetry for Low-Energy Photon-Emitting Brachytherapy Sources

**Title:** A Photon Counting Fiber Optic Scintillator Dosimeter

**NIST OU:** 840 Physics Laboratory

**Firm:** Boston Science
273 Concord Road
Lincoln, MA 01773-5120

**Principal Investigator:** Alan Sliski
**Phone #:** (781) 259-1543

**Award Amount:** $74,432.95

**Abstract:** A Photon Counting Fiber Optic Scintillator Dosimeter will be constructed to extend the range of useful measurements around low energy photon sources. A micromachined plastic scintillator will be bonded to the end of a fiber optic cable. A photon counting detector package will be constructed to receive the light from the scintillator and record the count rate. Neutral density filters will be employed to limit the count rate near rhte source and optical chopping and detector cooling will extend the lower limit at large distances from weak sources.

**Commercial Applications:** A commercial version of the Photon Counting Fiber Optic Scintillator Dosimeter would enable direct intercomparison with domestic and international standards laboratories and international harmonization of the method used to measure the dose distribution around photon sources in water. Measurements in units of absorbed dose to water would be realized. This detector uses water as a phantom material which eliminates corrections for other phantom materials.

**FY 2003 PHASE I AWARD**

**Topic:** 9.11 Optics and Optical Technology

**Subtopic:** 9.11.02 A Systematic Study of the Growth and Processing of ZnTe and GaP Crystals for THz Detection

**Title:** A Systematic Study of the Growth and Processing of ZnTe and GaP Crystals for THz Detection

**NIST OU:** 840 Physics Laboratory

**Firm:** Brimrose Corporation of America
5025 Campbell Boulevard, Suite E
Baltimore, MD 21236-4968

**Principal Investigator:** Sudhir B. Trivedi
**Phone #:** (410) 668-5800

**Award Amount:** $75,000.00

**Abstract:** Terahertz radiation is an ideal candidate for non-invasive interrogation of concealed objects and substances. As such, there is an increased need for reliable high-quality nonlinear materials for the generation and detection of THz radiation. Zinc telluride (ZnTe) and gallium phosphide (GaP) are the materials of choice for this purpose. However, the performance of these materials varies widely from vendor to vendor, and sometimes, even from a single vendor. We propose to systematically study the growth and processing of ZnTe and the processing of GaP in an effort to determine the necessary procedures to reliably produce high quality crystals. We will fabricate terahertz sensors based on ZnTe and GaP crystals and thin films. We have extensive experience and expertise in producing ZnTe crystals of extremely high purity and crystallographic perfection. Also, Brimrose is one of the very few suppliers in the world capable of producing acousto-optic devices using GaP crystals and thin films. The material that is developed during Phase 1 will be used to fabricate single-element terahertz detectors. Testing will be performed at various frequency bands and the results will be used to optimize the growth and processing of the ZnTe crystals and the processing of the GaP crystals.

**Commercial Applications**: Successful execution of the work plan will lead to the routine fabrication of highly sensitive single-element terahertz sensors and pave the foundation for terahertz sensor arrays ideal for high speed, real-time imaging applications. Applications include: the detection and prevention of concealed weapons, explosives, and incendiary materials; industrial package inspection/quality assurance; food content inspection and control; pharmaceutical manufacturing; and chemical/trace material sensing.

**FY 2003 PHASE I AWARD**

**Topic:** 9.08 Manufacturing System Integration

**Subtopic:** 9.08.04 Next Generation Process Exchange Tools and Applications

**Title**: V-PSL and VISI-PSL: A Visual Language and Interactive Tool for PSL Generation

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Computer Aided Process Improvement, Inc. (DBA CAPI)
830-13 A1A North, Suite 327
Ponte Vedra, Beach FL 32082-3235

**Principal Investigator:** Gregory A. Hansen
**Phone #:** (904) 285-2126

**Award Amount:** $74,905.46

**Abstract:** We propose developing a prototype of a GUI-based wizard that:
· Guides users through the steps that are needed to define their processes using PSL in a visual/textual manner.
· Checks for consistency/correctness according to PSL ontology.
· Generates the PSL description.

We believe that VISI-PSL will facilitate the generation of PSL descriptions to the extent that it will be used by process experts rather than by PSL experts, and it is the process experts that are the key to the successful implementation of process descriptions in any format. Specifically, our research will determine the technologies required to develop a software product that:
1. Allow users to generate PSL process descriptions without having to know PSL.
2. Allow users to express process descriptions in a manner similar to the way they think.
3. Promote the use of PSL by eliminating the technological and non-technological barriers to its use.
Additionally, the end result of the use of our proposed tool will be a graphical representation of a process that is transportable across computer systems.

**Commercial Applications:** In 1998, Jacques Gansler, Under Secretary of Defense (Acquisition and Technology) issued a directive that requires the integration of modeling and simulation in the acquisition process -- across functional disciplines -- and throughout the life-cycle of systems. The basis of any simulation is a model. Process models in and of themselves are not simulations, but rather static descriptions of processes; therefore, it is accurate to state that process models must be developed before process simulations. PSL provides a means of formally defining a model of a process; ultimately, process descriptions developed in PSL may form the basis for simulations of the processes. We believe that our approach is a start in the direction of developing PSL simulations and, based on the support for modeling and simulation in acquisition programs, VISI-PSL will be well-received by the DOD. Because of the relationship between modeling and simulation, and the part that PSL may play in that relationship, we intend to promote PSL to the DOD, and we believe that there is a strong likelihood of finding sponsors in the areas of Simulation Based Acquisition and Simulation Based Manufacturing.

**FY 2003 PHASE I AWARD**

**Topic:** 9.14 X-Ray System Technology

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

**Title:** Large Area Imaging Electron Energy Analyzer

**NIST OU:** 850 Materials Science and Engineering Laboratory
**Firm:** E.L. Principe & Associates, LLC
1 Uccelli Boulevard, Suite NB3
P.O. Box 3742
Redwood City, CA 94064-3742

**Principal Investigator:** Paul E. Larson
**Phone #:** (952) 941-7887

**Award Amount:** $74,823.50

**Abstract:** This project is to assess the feasibility of an instrument to provide energy-filtered electron images of a specimen at least 10mm by 10mm in size, operating over a 50-900eV energy range and suitable for NEXAFS chemical imaging. The applicant proposes to demonstrate feasibility by delivering a suitable electron-optical design along with calculated performance characteristics. Knowledge of the existing journal and patent literaturemakes the applicant confident that a practical design can be discovered. The applicant's key personnel have demonstrated a mastery of the art and science of charged-particle optics simulations and the model is a sufficient demonstration of feasibility. In one likely design approach, the system includes the specimen, a first electrostatic lens system, a spherical electric field energy filter, a second electrostatic lens system, and a two-dimensional imaging detector system. The specimen would be kept grounded and field-free. The first lens system demagnifies, adjusts energy, and transforms the spatial information in preparation for the energy filter. The second lens system provides the inverse operations and directs the electrons onto the detector.

**Commercial Applications:** Several industries should find use for an electron spectrometer that can offer practical large area chemical mapping capabilities. Uniformly mapping is particularly important in the semiconductor industry, where optical techniques have failed to provide necessary precision and sensitivity to chemistry in emerging multi-component systems. Film growth mode studies and chemical distribution studies of biological systems should also benefit significantly.

**FY 2003 PHASE I AWARD**

**Topic:** 9.06 Information Technology

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

**Title:** SMART Life Science Laboratory Solution

**NIST OU:** 890 Information Technology Laboratory

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

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

**Award Amount**: $75,000.00

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

**Commercial Applications:** Commercialization can be gained on many fronts. Lab Automation was once viewed as a maturing business with few companies striving to carve out a stronger presence. But in recent years there has been an explosion of demand and the appearance of a large number of vendors. In 1998, the entire lab automation market generated worldwide revenues of $1.1 billion. Annual growth is forecasted at 14.6% per year for the next five years, bringing estimated revenues to over $2.1 billion by the end of 2003. Further, a report by Frost & Sullivan, leaders in strategic market consulting and training, reveals the bioinformatics industry generated revenues totaling $1.38 billion in 2000; a figure which is expected to reach $6.9 billion in 2007. Frost & Sullivan forecasts revenues from markets for hardware and software for genetic sequence data generation, stand-alone genetic sequence analysis systems, and genetic sequence data management systems will continue to show significant growth through 2007.

**FY 2003 PHASE I AWARD**

**Topic:** 9.09 Microelectronics Manufacturing

**Subtopic:** 9.09.04 Improved Magneto-Optical Indicator Films NCT

**Title:** Liquid Phase Epitaxial Garnet Films for Magneto-Optic Indicators

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

**Firm**: Integrated Photonics, Inc.
132 Stryker Lane
Hillsborough, NJ 08844

**Principal Investigator:** Vincent J. Fratello
**Phone #:** (908) 281-8000 X7#

**Award Amount:** $75,000.00

**Abstract:** Magnetooptic Indicator (MOI) garnet films are an important non-destructive tool for imaging magnetic domains in a wide variety of applications from basic research to quality control. To be effectively used they must be 1) optimized for individual applications using interactive feedback from users, 2) standardized to allow comparison of data, 3) improved in quality and process control and 4) made generally available in large film size. Integrated Photonics will apply its proprietary Liquid Phase Epitaxial (LPE) film growth technology to make planar bismuth-doped, rare-earth iron garnet films suitable for room temperature MOIs with high resolution, good gray-scale contrast and high sensitivity. The films will be coated with suitable mirror and passivation layers to form devices for domain visualization. Feedback from users will be utilized to optimize film properties with respect to applications. Initial investigations will begin on property variations necessary for improved low temperature operation.

**Commercial Applications:** 1) Non-destructive characterization of static and dynamic flux domains in Giant Magnetoresistive (GMR) films and other new multilayer magnetic materials. 2) Data recovery from magnetic tape, Flight Data Recorders, computer hard disks. 3) Recording machine identification of magnetic tape via start and stop signatures. 4) Characterization of static and dynamic flux domains associated with high temperature superconductors. 5) Crack detection in metallic bodies including aircraft fuselages and pipeline components. 6) Visual observation of magnetic card strips and latent markings.

**FY 2003 PHASE I AWARD**

**Topic:** 9.09 Microelectronics Manufacturing

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

**Title:** High Throughput Development of Low-Resistance Contact to p-type GaN by
Combinartorial Screening of Surface Dopants

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

**Firm:** Intematix Corporation
351 Rheem Boulevard
Moraga, CA 94556

**Principal Investigator:** Qizhen Xue
**Phone #:** (925) 631-9005

**Award Amount:** $74,966.00

**Abstract:** Group III-nitrides with their wide bandgap properties are one of most promising materials not only in opto-electronics but also in high power and high temperature electronics. A critical issue in device applications of the nitride materials is the metal ohmic contact, which seriously limits the performance and efficiency of nitride-based devices. Finding suitable low-resistance Ohmic contacts for wide-bandgap materials like GaN is challenging due to high Schottky barrier between wide bandgap semiconductors and metal contacts. Especially in p-type GaN the low carrier concentration and large effective mass increase the contact resistance even higher. With its proprietary high throughput combinatorial approaches, Intematix proposes to modify the surface doping level of p-type GaN by placing group II elements. With the optimized composition and metallization process, at least two orders of improvement in low resistance contacts are targeted.

**Commercial Applications:** The discovery of efficient contact materials and metallization process for p-type GaN will play an important role to improve the performance of nitride-based devices in the fields of optoelectronics and high power high temperature electronics. Its potential benefit to the U.S. semiconductor industry is enormous. The success of Phase 1 program will establish an efficient way to search low-resistance contact to p-type GaN, and will be the key to the extended search of ohmic contacts to other wide bandgap semiconductors in Phase II. The advanced contact technology developed in this program will enable the fabrication of low voltage operation, long life time nitride-based devices, especially in the application of high brightness LED, high power laser diodes, and high power modulation-doped FETs.

**FY 2003 PHASE I AWARD**

**Topic:** 9.14 X-Ray System Technologies

**Subtopic:** 9.14.01 Develop Advanced X-Ray Detection System for Nanoscale Measurements

**Title:** Large Area Silicon X-Ray Spectrometer

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

**Firm:** IntraSpec, Inc.
1008 Alvin Weinberg Drive
P.O. Box 4579
Oak Ridge, TN 37831-4579

**Principal Investigator:** John Walter
**Phone #:** (865) 483-1859 **Award Amount:** $75,000.00

**Abstract:** This project identifies a new approach to silicon x-ray detector technology wherein: (i) the detector geometry is changed to provide a much lower capacitance for a given active area and volume, (ii) the conventional Si(Li) detector is replaced with a stable, oxide-passivated, low leakage-current, deep sensitive-depth, v-type Si element, and (iii) the conventional FET in the preamplifier is replaced with an on-wafer FET with improved high frequency noise. The low capacitance and lower preamplifier noise will allow operation at shorter pulse processing times, which in turn will allow higher operating temperatures and improved count rate capability. This approach, which is compatible with hermetic encapsulation, will provide a rugged, environmentally stable Detector/ASIC amplifier package with improved detection efficiency at both high and low x-ray energies, improved count rate capability, and good energy resolution at higher operating temperatures.

**Commercial Applications:** Conventional Si x-ray energy spectrometers have relatively small active areas which limit their efficiency. Si drift chamber (SDC) x-ray spectrometers also have small active areas unless many are combined in an expensive complex array. Also, SDCs have rather shallow sensitive depths which seriously detract from their efficiency for x-ray energies above 15 keV. Replacement of Si(Li) technology with a temperature-stable, low-capacitance, deep depletion detector combined with an on-wafer preamplifier will have a major impact on this important market.

**FY 2003 PHASE I AWARD**

**Topic:** 9.04 Healthcare and Medical Physics

**Subtopic:** 9.04.03 Sensor Development for Thermal Treatment of Cancer

**Title:** Fiberoptic Sensors for Thermal Therapy

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

**Firm:** IPITEK
2330 Faraday Avenue
Carlsbad, CA 92008-5216

**Principal Investigator:** David Schaafsma
**Phone #:** (760) 436-1010 X3489

**Award Amount:** $69,931.00

**Abstract:** This proposal addresses the need for accurate, self-referencing temperature measurement in cancer treatments such as hyperthermia and RF ablation. In all of these therapies, conventional metallic sensors such as thermocouples are unattractive because they either interact with the heating field (hyperthermia, RF ablation) or have excessive thermal conductivity (cryoablation). Integrated Photonics Technology (IPITEK) is the leader in fiberoptic temperature sensing for cancer treatment, and our unique temperature sensing technology is currently in Phase 2 FDA trials for microwave cancer treatments. In this work, we also propose to investigate the use of nanoparticle colloids for heat dispersion through our numerous collaborations in the thermal therapy field. In addition, we will investigate a novel technique for endpoint detection in cancer treatments of this type. At the end of Phase 1 IPITEK will deliver to NIST a fully-functional (not prototype) multi-sensor unit with probes suitable for thermal therapy use. Due to our advances and experience in this area, IPITEK is uniquely qualified to provide this product and can deliver an instrument with unsurpassed performance and unequalled features.

**Commercial Applications:** In addition to hyperthermia and RF ablation therapies, this technology can be applied to a range of other biomedical applications such as microwave calorimetry, protein synthesis, and neuroscience. Other applications exist in markets such as semiconductor, aerospace, petrochemical, and food processing industries.

**FY 2003 PHASE I AWARD**

**Topic:** 9.11 Optics and Optical Technology

**Subtopic:** 9.11.01 Femtosecond Lasers for Optical Comb Generation

**Title:** Development of Ultrastable Ti:sapphire Lasers for Optical Clock and Spectroscopy Applications

**NIST OU:** 840 Physics Laboratory

**Firm:** Kapteyn-Murnane Laboratories LLC
4699 Nautilus Court South, Suite 205
Boulder, CO 80301-5304

**Principal Investigator:** Kendall Laine Read
**Phone #:** (303) 544-9068

**Award Amount:** $75,000.00

**Abstract:** This Small Business Innovation Research Phase 1 project proposes to develop a femtosecond laser system optimized for optical clocks and other precision metrology applications. In principle, atomic optical transitions have the potential to provide radically higher-accuracy timekeeping, because of the very high frequency of an optical transition. The problem of counting, or down-counting, the oscillations of the optical transition has been solved by self-referenced frequency division of the comb of frequencies generated by a femtosecond laser. This Phase 1 SBIR will work towards passively and actively stabilizing the laser repetition rate, as well as its power and bandwidth, to create a "hands-off" clock source that will run uninterrupted for long periods of time. New approaches to broader bandwidth lasers will also be investigated, both via feasibility study and experiment.

**Commercial Applications:** An extremely quiet, high-repetition-rate laser with feedback control of both frequency offset and repetition rate, that can be synchronized to an external clock with high accuracy, will have applications for both "primary reference" timekeeping standards, as well as for enhanced-accuracy GPS systems, and for synchronization of independent modelocked lasers for metrology and spectroscopy applications.

**FY 2003 PHASE I AWARD**

**Topic:** 9.08 Manufacturing System Integration

**Subtopic:** 9.08.04 Next Generation Process Exchange Tools and Applications

**Title:** PSL-based Process Knowledge Integration and Management Framework

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Knowledge Based Systems, Inc.
1408 University Drive
College Station, TX 77840

**Principal Investigator:** Ronald Fernandes
**Phone #:** (979) 691-2928

**Award Amount:** $74,936.38

**Abstract:** We propose to develop a robust framework, called the Process Knowledge Integration and Management Framework (PKIMF), to support the complete lifecycle of enterprise process knowledge that natively use the Process Specification Language (PSL). PKIMF uses a dashboard approach to design, analyze, integrate, exchange, and manage process knowledge. Its features and capabilities include the use of a process model repository to store, retrieve, modify, and configure process models; process model composition or process "stitching"; process design assistance; process model export, import and automated translator generators; ontology mapping; and process knowledge dissemination with links to external knowledge sources.

Innovations of the proposed effort include the ability to exploit PSL's inherent robustness and simplicity to perform process knowledge reasoning, use of formal ontologies to enable process information management and interchange, and annotation of process models with external knowledge links without modifying source documents. The unified framework that uses PSL natively and brings together a hodge-podge of diverse process design and management tools for process model lifecycle management is a major benefit to any enterprise. We envision that PKIMF will do for PSL what the Mosaic browser has done for http/HTML.

**Commercial Applications:** Our proposed solution will provide an innovative framework and the necessary tools for process-centric information sharing. It has tremendous commercial potential throughout public and private sectors for solving problems relating to agile manufacturing, virtual enterprises, enterprise resource planning and supply-chain management systems. Commercial potential is also increased because the distributed, web-based PKIMF system can be easily integrated into a corporate intranet.

**FY 2003 PHASE I AWARD**

**Topic:** 9.03 Condition-Based Maintenance

**Subtopic:** 9.03.01 Ambient-Powered Wireless Network Smart Sensors for Machine Tools

**Title:** Intelligent Tools with Ambient-Powered Wireless Sensors

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Luna Innovations, Inc.
2851 Commerce Street
P.O. Box 11704
Blacksburg, VA 24062-1704

**Principal Investigator:** Stephen Moore
**Phone #:** (540) 961-4518

**Award Amount:** $74,969.00

**Abstract:** Next-generation smart machine tools are currently under research and development. Critical to the success of these tools will be the inclusion of smart sensors. These sensor suites will need to measure physical parameters such as temperature, vibration, pressure and so on. Luna Innovations has extensive experience in developing solar powered wireless systems to transmit sensor data.

Luna proposes to leverage this design expertise to develop a miniaturized sensor suite customized to a particular machine tool, the exact tool to be decided upon based on consultation with NIST officials. The sensor suite will use miniature sensing technology to measure vibration, temperature and pressure. Also designed into the tool will be the capability to digitize the sensed data, and transmit it via miniaturized wireless radio technology to a remote data collection device. The transmitted data will be formatted according to the IEEE 1451.x TEDS standard. It is expected that this tool is to be used in a lighted environment, such that the electronic circuitry can be powered from the ambient light. Phase 1 deliverables are prototypes of the sensor suite including the miniature digitizer and transmitter, along with a remote receiver.

**Commercial Applications:** With the current generation of machine tools, routine maintenance must be scheduled based on experience. This is inefficient in that maintenance may be performed more often than is necessary, incurring a greater cost in dollars and in lost machine time. If the maintenance is performed less frequently than is needed it is costly in terms of poor quality of the parts machined. With intelligent, standardized sensors built into the machine tools, maintenance can be performed at optimal times, based on feedback from the sensors. This will benefit not only the machine tool users, but the broad market of all customers for the machined parts.

**FY 2003 PHASE I AWARD**

**Topic:** 9.12 Radiation Physics

**Subtopic:** 9.12.01 Two Dimensional Detection of Neutrons with High Spatial Resolution, High Dynamic Range and Low Noise

**Title:** Novel 2-D Digital Imaging Detectors for Thermal Neutrons

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

**Firm:** Radiation Monitoring Devices, Inc.
44 Hunt Street
Watertown, MA 02472-4699

**Principal Investigator:** Sameer V. Tipnis
**Phone #:** (617) 668-6929

**Award Amount:** $75,000.00

**Abstract:** The use of thermal neutrons has been widespread over the past several decades in many investigations such as non-destructive testing (NDT), neutron radiography and macromolecular crystallography. For some applications such as crystallographic diffraction studies, neutrons are scattered over 4o in space and an ideal detector would be able to image the scattered radiation on a spherical surface. Current two-dimensional detectors for neutrons do not provide adequate areal coverage, spatial resolution, sensitivity, and geometry best suited for a given application. To address these issues, we propose to develop a large area digital imaging detector for thermal neutrons, which offers a better combination of areal coverage, spatial resolution, detection efficiency and dynamic range than is currently possible. The detector is based on a novel, large-area scintillator, tailored for imaging thermal neutrons, coupled to a digital readout. This thermal neutron imaging system will advance the state-of-the-art of detectors used in areas such as macromolecular crystallography, neutron radiography, NDT, security inspections, baggage scanning, and other homeland security applications.

**Commercial Applications:** The system is expected to have widespread use in applications requiring high resolution, high dynamic range, rapid, thermal neutron imaging. These include molecular crystallography, medical imaging, nondestructive testing, astronomy, and basic physics research. Many industrial facilities will have substantial interest in such a detector, particularly due to the fact that portable neutron sources are now available for in-house use. As an example, the non-destructive evaluation market, using digital radiography and computed tomography alone, is estimated to be over $200 million. A significant fraction of that market represents applications where the proposed technology could have critical impact. Based on our discussions with the manufacturer of the fiberoptic taper based CCD systems, such a thermal neutron imaging system could be manufactured and profitably sold for the price of ~ $65,000.

 **FY 2003 PHASE I AWARD**

**Topic:** 9.13 Technologies to Enhance Fire Safety

**Subtopic:** 9.13.04 Sensing for Advanced Warning of Structural Collapse

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

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

**Firm:** Sekos, Inc.
12321 Middlebrook Road, Suite 150
Germantown, MD 20874

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

**Award Amount:** $74,912.00

**Abstract:** The focus of this SBIR submission is to develop a system to monitor fire-induced structural vibrations that provide real time data correlating with structural integrity.

The system is designed to bridge an "information void" that would provide firefighters with information that can warn of impending collapse. The system, based on accelerometer technology, will monitor structural integrity through the algorithmic analysis of structural vibrations that have been shown to reliably detect changes in structural integrity. We believe that a careful application of this sensor system would reliably provide timely warnings to fire fighters and would reduce the risk of death and disability following structural collapse.

During Phase 1, Sekos will select the optimal sensor package based on comparison evaluations of performance and build and test the system architecture that will reliably collect data, process the data and transmit the information to remote sites. At the end of Phase 1, a field-ready prototype and documentation will be provided to NIST for evaluation. Follow on phases will focus on methods to optimize fabrication, integrate a robust wireless communication system, integrate environmental protection and test the system in live burn exercises in preparation for the eventual commercialization of the system.

**Commercial Applications:** The US has about 32,000 fire departments, compromising the primary commercial market. This system satisfies an unfulfilled market need. Further testing may also enable us to market the device to search and rescue/disaster, military, mining operations, and general construction.
A variation of the proposed system could be pre-installed into new construction, to provide alarms for fire fighters and the public, much like a smoke detector.

**FY 2003 PHASE I AWARD**

**Topic:** 9.08 Manufacturing System Integration

**Subtopic:** 9.08.03 Manufacturing Data Exchange Standards Interoperability Testing Tools

**Title:** Standards Based Test Cases and Tools for CAE

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** SoftInWay, Inc.
35 Corporate Drive, 4th Floor
Burlington, MA 01803

**Principal Investigator:** Leonid Moroz
**Phone #:** (781) 685-4942

**Award Amount:** $74,770.00

**Abstract:** A new generation of STEP is now coming on line with interfaces between CAD and CAE systems defined by AP 209. The goal of this proposal is to accelerate the deployment of a capability to exchange data between CAD and CAE systems by developing practical test cases for AP 209, as well as developing a software system tools to make the software deployment pilot programs practical. It is proposed to build a software tool that given two STEP files provides the answers to the following questions:

Do these two files describe the same design model or not?
Are these files AP 209 compliant or not?

**Commercial Applications:** Proposed suit of software tools will allow:
- ACE vendors to test new features of their software translators;
- End users to test the coverage and accuracy of a system that they own or plan to purchase
- Users to Validate analysis from different vendors by comparing outputs.

**FY 2003 PHASE I AWARD**

**Topic:** 9.05 Homeland Security

**Subtopic:** 9.05.03 Development of Field Detectors for Radiological Measurements

**Title:** High Sensitivity Directional Hand Held Portable Microelectronic Neutron Detector

**NIST OU**: 840 Physics Laboratory

**Firm:** Structured Materials Ind., Inc.
201 Circle Drive, Unit 103
Piscataway, NJ 08854

**Principal Investigator:** Joseph Cuchiaro
**Phone #:** (732) 885-5909

**Award Amount:** $75,000.00

**Abstract:** The United States faces a broad range of nuclear threats and technologies are needed to prevent or mitigate nuclear incidents. SMI has invented (patent pending) a near 100 volume percent efficient, real-time, microelectronic self calibrating and directional radiation detector. We can increase detector area to increase broad sensitivity and the number of layers to increase directionality. We herein propose to package our detector into a battery powered light weight man-portable instrument that can swiftly detect radioactive materials, identify their location(s), quantify the radioactivity, and display/report the results. Further, the instrument base sensitivity and directionality can easily be augmented by an add-in detector "antenna" array. These capabilities are fully supported with detailed calculations based on known minimum performance of our detector design. In Phase 1 we will demonstrate, by measuring radiation fluxes from known sources, using a bench top proof of concept unit and in Phase II we will package and test instruments and sample them with appropriate organizations. Phase 3 is direct marketing of instruments to civilian and military organizations. Technical Implications of the Approach:
The technical impact of our newly invented detector concept is extremely far reaching into many application areas and is sure to stimulate many additional technical innovations.

**Commercial Applications:**:food industry, personal dosimetry, and the medical industry, among others.

**FY 2003 PHASE I AWARD**

**Topic:** 9.06 Information Technology

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

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

**NIST OU:** 840 Physics Laboratory

**Firm:** Timing Solutions Corporation
5335 Sterling Drive
Boulder, CO 80301-2344

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

**Award Amount:** $54,197.81

**Abstract:** We propose to compare alternative architectures for phase noise measurement by directly sampling the RF waveform. Out of band modulation and cross correlation will reduce noise. The capabilities of each architecture will be determined using analysis and simulation. The results will be used to determine the feasibility of developing a commercially useful measurement instrument. If the results are positive, they will be used to plan a hardware and software development program to realize a prototype device.

**Commercial Applications:** This research could lead to a commercial phase and amplitude noise measurement instrument that
1. Requires much less expertise to use than the presently available equipment.
2. Produces more accurate results.
3. Can be operated in situ because it does not require phase-lock loops to maintain quadrature between the sources.

**FY 2003 PHASE I AWARD**

**Topic:** 9.08 Manufacturing System Integration

**Subtopic:** 9.08.02 Integrated Process Modeling

**Title:** Tool Condition Monitoring and Diagnostics

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Vulcancraft LLC
201 Stable Road
Carrboro, NC 27510-4144

**Principal Investigator:** Donald M. Esterling
**Phone #:** (919) 942-2757

**Award Amount:** $75,000.00

**Abstract:** A smart machine tool must be able to monitor its condition and report problems. Every CNC machine should provide an alarm for tool condition problems, including tool wear, much as every automobile has a low oil indicator. Tool wear is particularly important for unattended machining as a worn tool can ruin a part. All current tool condition systems operate "blind" without direct information on current cutting conditions. Lacking such information, they are not reliable. Normal cutting conditions can cause sensor output to exceed a pre-set threshold, resulting in false alarms. This tool monitoring system will, for the first time, integrate an NC verification system with sensor data to provide a set of "eyes" distinguishing normal changes in sensor output from abnormal events warranting alarm conditions. We will investigate spindle current as an inexpensive and robust indicator of spindle torque and tool forces to compare with nominal (sharp) tool forces predicted by an enhanced NC verification program. That comparison provides a cutting condition-independent discriminator for tool condition monitoring and diagnosis. Extensive experimental validation will test the reliability of spindle current as a force indicator and the comparison of predicted sharp tool forces versus measured forces as a measure of tool wear.

**Commercial Applications:** NIST has declared Smart Machining as important to U.S. competitiveness and national security, committing substantial internal resources to the initiative. Tool condition monitors could greatly improve manufacturing productivity. But, according to a representative for a major producer of tool monitor equipment, current systems are used on only a fraction of a percent of CNC machines worldwide, due to a lack of confidence by end users on the monitoring equipment and pre-set alarm conditions. The same representative traced this defect to a failure by his and competing systems to base the diagnostics on a fundamental process model. As a result, the tool condition report can only be trusted for repetitive machining of simple parts. Even so, the world wide market is between $50M and $80M. The proposed system will "lap the field" in providing accurate and reliable tool conditions based on an industrially hardened process model and may achieve an order of magnitude increase in use and attendant revenue.

**FY 2003 PHASE I AWARD**

**Topic:** 9.05 Homeland Security

**Subtopic:** 9.05.08 MRI, CT, and CAD Input Conversion Software for Virtual MCNP Monte Carlo) Gamma-Ray Calibrations and Measurements

**Title:** CAD Model and CT & MRI Scan Data to MCNP Input Format Conversion Software

**NIST OU:** 840 Physics Laboratory

**Firm:** White Rock Science
P.O. Box 4729
Los Alamos, NM 87544-4729

**Principal Investigator:** Kenneth A. Van Riper
**Phone #:** (505) 672-1105

**Award Amount:** $75,000.00

**Abstract:** We will develop two programs to process data describing a model geometry and convert it to input acceptable to the Monte Carlo transport codes MCNP and MCNPX. One program will read CAD files in the ACIS solid body SAT format. Solid bodies, surfaces, and cells described in the SAT file will be converted to equivalent MCNP objects where available. Where there is no MCNP equivalent, such as for spline surfaces, approximation methods will be developed. The second program will import data from CT and MRI scans. The program will read a sequence of 2D scans in DICOM format. The program will permit the user to select a range of densities in the images and assign a material to that density range. 3D Voxels will be defined from the sequence of 2D scan images. The voxels can be converted to an MCNP lattice or to individual MCNP cells. When individual cells are used, we will develop cell merging algorithms to combine neighboring cells of the same material. The user-friendly software will be designed to require a minimum of user intervention.

**Commercial Applications:** With thousands of users world wide, MCNP and MCNPX are popular transport codes throughout the nuclear engineering and radiation physics communities. The usefulness of the codes is hampered by the difficult manual description of the 3D geometries. Codes to quickly translate CAD files to MCNP format and to import scan data would greatly extend the usefulness of the code and would be commercially viable. White Rock Science has encountered considerable demand for such tools among its customers. Support for additional transport codes will extend the commercial appeal of the conversion programs.

**FY 2003 PHASE I AWARD**

**Topic:** 9.13 Technologies to Enhance Fire Safety

**Subtopic:** 9.13.02 Distributed Multi-Nodal Voice/Data Communication

**Title:** Automated Reconfigurable Intelligent Radio (ARIR)

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

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

**Principal Investigator:** Kartik Moorthy
**Phone #:** (817) 872-1500

**Award Amount:** $75,000.00

**Abstract:** Williams-Pyro, Inc. proposes to develop an Automated Reconfigurable Intelligent Radio (ARIR), which consists of a series of distributed nodes that will relay voice and data to Intelligent Access Points (IAP) located within the building. This system will allow faster, more accurate information transmission, resulting in timely fire detection and safer firefighting. The main goal of ARIR is to identify how a real-time channel within the distributed system can be enhanced at a moderate cost to be immune to any single component failure within the channel. The basic structure of the ARIR consists of neural networks for failure diagnosis and fault prognosis, as well as a new Discrete Event Controller based on matrices (U.S. patent) for dynamic real-time network reconfiguration and resource assignment. This failure analysis/network reconfiguration supervisor will be distributed in nature, consisting of multiple redundant subsystems. The proposed innovation will allow the creation of self-forming nodes that can expand and contract on demand, extend into damaged areas with unknown infrastructures, support firefighters with no/short notice, and communicate between ad-hoc elements of the platform as needed.

**Commercial Applications:** Our initial application for the proposed system is firefighting teams. However, WPI's proposed system has numerous commercial applications. For example, the U.S. Air Force has expressed interest in a fire detection system for use in aircraft hangars. A variation of this proposed building control system may have application for the government in buildings and military aircraft hangars. Another possible application of this system is fire detection in commercial buildings.

**FY 2003 PHASE I AWARD**

**Topic:** 9.03 Condition-Based Maintenance

**Subtopic:** 9.03.02 Software Tools for IEEE 1451-Based Smart Sensor Networks

**Title:** Development of Multifunctional Open-system Sensor Integration Tool (MOSIT)

**NIST OU:** 820 Manufacturing Engineering Laboratory

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

**Principal Investigator:** Matthew Scarpino
**Phone #:** (817) 872-1500

**Award Amount:** $75,000.00

**Abstract:** Williams-Pyro, Inc. proposes to model and develop software to provide an interface allowing a common method of incorporating sensing components within different systems. The proposed software package, called the Multifunctional Open-system Sensor Integration Tool (MOSIT), will provide the circuit designer with a complete sensor interface solution. MOSIT will provide not only the Network Capable Application Processor (NCAP) functionality specified within the IEEE 1451.1-1999 standard, but also application software for use by the circuit designer. It will incorporate a user interface to allow designers to view parameters of the Smart Transducer Interface Modules (STIM) and incorporate them within an application framework. MOSIT will provide a simple interface for network connectivity, allowing the STIMs to be recognizable from any device connected to the network. Given the many NCAP functions specified within IEEE 1451, a modeling language should be used to provide insight into object structure and relationships between software components. The Unified Modeling Language provides a standardized set of tools and techniques for mapping these relationships. In this manner, programmers in any language can grasp the structure and functionality of the MOSIT design, allowing for easy upgrading and porting to other computing platforms.

**Commercial Applications:** The potential use of the MOSIT software by the government is extensive. Already, several branches have expressed interest in applications of 1451-compliant sensors, which opens the opportunity for our software to provide plug-and-play capabilities. For example, the U.S. Navy wants sensors for applications ranging from detecting oil leaks to finding hidden corrosion. The Defense Advanced Research Projects Agency is funding development of a "laboratory on a chip," a button-sized device that will warn soldiers of hazardous gases or bioweapons. The Department of Agriculture wants to detect the moisture content of crops as they tumble through delivery chutes. The Bureau of Prisons is helping to develop and road-test sensors used for security and drug detection. Commercial applications are also extensive. For example, Boeing plans to use 1451-based systems for flight-test applications on Boeing 777 aircraft. By using the new technology on so-called pressure belts, Boeing engineers can measure the forces on top and bottom surfaces of the 777's wings. The pressure belts, designed in conjunction with Endevco (which has joined the Plug & Play Sensors Program), use transducers at intervals of every 2 inches along their length.

**FY 2003 PHASE I AWARD**

**Topic:** 9.09 Microelectronics Manufacturing

**Subtopic:** 9.09.01 Calibration Methods to Remove Probe Shape Effects from Scanned Probe Microscope Measurements of Semiconductor Linewidth

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

**NIST OU:** 820 Manufacturing Engineering Laboratory

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

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

**Award Amount:** $75,000.00

**Abstract:** Xidex proposes to demonstrate the feasibility of calibrating a critical-dimension atomic force microscope (CD-AFM) without the use of a reference artifact in such a way that high-precision critical dimensions can be generated independently of changes in probe tip shape (including the effects of tip wear), presence of the surface force uncertainties, and the stage uncertainties. The proposed calibration method relies on a tip-to-tip based calibration with a dual-probe CD-AFM architecture. The proposed calibration method adopts an alternative approach that rejects model-dependence in favor of an entirely new dual-scanning-probe NanoCaliperTM architecture that is virtually model-independent. The prospect of removing the major sources of uncertainty in scanning probe tools provides an exciting opportunity to demonstrate a revolutionary new breed of CD-AFM tool that paves the way for scanning probe measurements that are both precise (i.e., highly repeatable) and accurate (i.e., traceable to reference artifacts). Results of the proposed Phase 1 SBIR research will enable us to quantify the achievable repeatability of a tip-to-tip calibration procedure. Once fully demonstrated, this calibration procedure will be used with the NanoCaliperTM CD-AFM commercial tool we are currently developing.

**Commercial Applications:** The commercial CD-metrology tool being developed by Xidex, the NanoCaliperTM CD-AFM, which will provide semiconductor manufacturers with better process control, enabling accelerated yield learning and increased production yield. The NanoCaliperTM CD-AFM is also well positioned to take advantage of the future market for advanced CD metrology tools that will be required for large-scale manufacturing of microelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS).

**FY 2003 PHASE II AWARD**

**Topic:** 7.0 Advanced Biological and Chemical Sensing Technologies

**Subtopic:** 7.01 Advanced Microplatforms for Chemical and Biochemical Sensing

**Title:** Quantum Cascade Laser Monitor for NO NO2 and O3

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

**Firm:** Aerodyne Research, Inc.
45 Manning Road
Billerica, MA 01821-3976

**Principal Investigator:** David Nelson
**Phone #:** (978) 663-9500 x231

**Award Amount:** $300,000.00

**Abstract:** This project will design and deliver a high accuracy monitor for the photo-chemically coupled pollutants nitric oxide, nitrogen dioxide and ozone using infrared absorption spectroscopy with quantum cascade (QC) lasers. The target molecules are monitored at air quality stations worldwide using instruments which require frequent calibration and are subject to significant chemical interferences (in the cases of NO2 and O3). This QC monitor will initially provide a portable measurement standard to calibrate the existing network and could eventually replace existing instruments. QC lasers are spectroscopically stable and can be operated near room temperature when in pulsed mode. This allows the design of compact, rugged, monitors which are also highly accurate. The main Phase II objectives are to complete the detailed design and construction of an instrument which can simultaneously measure all three species with high time resolution and high accuracy. This instrument will be delivered to NIST scientists upon project completion and after a period of collaborative testing and training.

**Commercial Applications:** There are several large markets which will be serviced by the instrument resulting from this research. These include 1) the market to calibrate or replace the existing instruments deployed worldwide to monitor NO, NO2 and O3, 2) the research market attempting to quantify the sources and sinks of these species and their ambient concentrations, 3) the market for trading credits for pollutant emission reductions which requires quantitative documentation of these reductions, and 4) various research markets needing to quantify NOx or ozone concentrations or emissions in both laboratory and field settings.

**FY 2003 PHASE II AWARD**

**Topic**: 7.05 Condition-Based Maintenance

**Subtopic:** 7.05.02 Development of a MEMS Viscosity Meter for Refrigerant/Lubricant Systems

**Title:** Robust MEMS Viscosity Meter for Condition-based Maintenance

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

**Firm:** Boston Microsystem
30-H Sixth Road
Woburn, MA 01801-1758

**Principal Investigator:** Jeffrey Chan
**Phone #:** (781) 933-5100

**Award Amount:** $300,000.00

**Abstract:** In this NIST SBIR program Boston MicroSystems develops MEMS-based fluid viscosity-density sensors which can be installed in refrigerant system compressors to monitor, in real time, refrigerant system health. Such sensors will provide early detection of water contamination, lubricant degradation and other problems which can lead to catastrophic refrigerant system failure if left uncorrected. Such sensors will also allow scheduling of system maintenance on an as-needed basis, and will reduce system downtime, lower operating costs, and improve system reliability. Boston MicroSystems' proprietary technologies for micromachining harsh environment compatible SiC and AlN materials now allow, for the first time, fabrication of small and inexpensive fluid viscosity and density sensors that can operate in the harsh environments inside refrigeration systems and other machinery. In Phase 1, Boston MicroSystems tested the suitability of three of its already developed SiC-AlN MEMS sensors (microresonators, SAWs and FPWs) for this application, and demonstrated that FPW (flexural plate wave) sensors meet the required performance specifications. In Phase II, we will develop, characterize and deliver to NIST fully functional prototype refrigerant system health monitors based on our FPW sensors, including packaging for installation into refrigerant system compressors and electronics and software to convert sensor response into system health data.

**Commercial Applications**: Condition-based maintenance and health monitoring of refrigerant compressors, engines, and other machinery, and fluid viscosity sensors for industrial process control and quality control.

**FY 2003 PHASE II AWARD**

**Topic:** 7.17 X-ray System Technologies

**Subtopic:** 7.17.03 High Efficiency Circular Array Secondary Electron Yield Detectors

**Title:** Improved Manufacturing Processes for Circular Array Detectors

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

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

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

**Award Amount:** $293,453.00

**Abstract:** The goal of Phase I was to create a channel electron multiplier that could be used in an array for configuration in the synchrotron beam application. In order to have little variance in first strike statistics contamination needed to be eliminated from the surface. This was accomplished with Phase I research. During Phase II the primary objective is to manufacture a circular array of multipliers that operate with consistent electrical characteristics from unit to unit. Three areas in the process will be focused on in order to obtain this consistency. One important process to be investigated is the hydrogen reduction process, which is needed to maximize the amount of semi-conducting lead on the glass surface. Another process that needs to be addressed is the wet chemistry performed both before and after the hydrogen reduction process so that the proper formation of silica occurs on the surface. The third process that will be examined is vacuum bake, which is important in removing loosely bonded gases on the surface. Finally, 32 multipliers will be mounted on a flange suitable for the NIST synchrotron beam application. This flange will be delivered to NIST along with appropriate power supplies and 32 individual preamps.

**Commercial Applications:** Time of flight; Hemispherical analyzers; Magnetic sectors; Mass spectrometers; and Residual gas analyzers.

**FY 2003 PHASE II AWARD**

**Topic:** 7.11 General

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

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

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

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

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

**Award Amount:** $299,989

**Abstract:** Thermal neutrons are among the most useful probes for investigation of the structural, magnetic, and acoustic properties of materials. To construct a large-area, lightweight, high-resolution, and very fast position sensitive thermal neutron detector, EIC has proposed a new solid-state neutron detector based on boron-doped a-Se (As, Cl) alloy semiconductor. In Phase 1 program, high quality boron-doped (up to 32.4 atomic%) a-Se (As, Cl) alloys were synthesized in large quantities, and various detectors have been fabricated on alloy mold plates/wafers with 6.25 cm2 area and 1200 m thickness. The feasibility of this material as a ‘direct read-out’ solid-state neutron detector has been tested at ORNL and at Fisk University. Extension of this work in Phase II should lead to a new low-cost, large-area, and high performance solid-state neutron detector. Phase II effort will be directed at improvements in zone refining method, alloy synthesis, detector structure, and development of good surface encapsulation technique. These detectors would offer high detection efficiency over existing instruments, and would find widespread use in neutron scattering science, structural characterization in materials research, biomedical research, homeland security, nuclear non-proliferation, radiation safety, and non-destructive testing.

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

**FY 2003 PHASE II AWARD**

**Topic:** 7.08 Information Technology

**Subtopic:** 7.08.03 Pervasive Computing, Accessible Computing Technology Integration and Demonstration

**Title:** Selective Speaker Interface to Support Smart Space Accessible Computing

**NIST OU:** 890 Information Technology Laboratory

**Firm:** Intelligent Automation, Inc.
7519 Standish Place, Suite 200
Rockville, MD 20855-2785

**Principal Investigator:** Dr. Chiman Kwan
**Phone #:** (301) 294-5238

**Award Amount:** $300,000.00

**Abstract:** The Smart Flow system developed by NIST provides a platform to develop standards that promote the interoperability of devices produced by different manufacturers. The NIST system can acquire and process multiple sensor data such as voice and image in real-time. Many applications such as speaker verification, head trackers, etc. can be implemented under the framework. In Phase 1, we have demonstrated that a speaker can be correctly identified in real-time from speech acquired through a microphone array. In Phase II, we propose further enhancements to the speaker interface with the aim of achieving robust and accurate speaker verification and speech recognition for speakers with special needs in noisy environment. In particular, we will: (i) acquire speech continuously by establishing plausible voice tracks; (ii) perform adaptive beam forming along voice tracks; (iii) perform speech segmentation based on speech utterances; (iv) further improve speech verification by using utterances rather than a fixed number of speech frames; (v) establish good communication interface between PDA and Smart Flow system; (vi) carry out two real-time demonstrations to illustrate the improved speaker interface; (vii) transfer some of the technology in the Smart Flow system to bird monitoring and classification.

**Commercial Applications:** The Smart Space concept will have great impact in many applications such as hospitals, conference and meetings, border control, workspace, customs, airport, etc. The ability to acquire voice and facial information and track a person around a space is very important in airport or workspace security. After September 11, homeland security becomes an urgent task, which is extremely difficult as America is a free country. We anticipate the market of Smart Space in security will be huge (billions of dollar market).

**FY 2003 PHASE II AWARD**

**Topic:** 7.11 Manufacturing Systems Integration

**Subtopic:** 7.11.04 Next Generation Process Exchange Tools and Applications

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Title:** Advanced Tools for Process Specification Language

**Firm:** Knowledge Based Systems, Inc.
1408 University Drive, East
College Station, TX 77840-2335

**Principal Investigator:** Ronald Fernandes, Ph.D
**Phone #:** (979) 260-5274

**Award Amount:** $299,403.63

**Abstract:** This project will (i) extend and harden the PSL Editor and the Ontology-Driven XSLT Generator (ODXG) tools and (ii) extend the process description syntax (PDS) derived from the PSL for both KIF and XML/RDF formats. In addition, we will extend the PSL metatheoretical framework to support the PDS and the PSL tools by providing PSL extensions to support calendars and activity specialization, and by developing the PDS-to-PSL compilation. The PSL Editor and the ODXG provide numerous application scenarios that will further the role of PSL as the ultimate interlingua among various process-centric languages and formats, including automation of software development for process-centric translators. One of today's greatest challenges to successful Inter-enterprise Process Engineering implementations is the lack of technology for enabling processes to be exchanged, analyzed, modified and executed as if processes were considered as core business transaction data. This necessitates (a) technology and standards for process information, and (b) software tools that can interchange, extract, merge, and transform process data. Our proposed solution will solve these problems by extending the process description syntaxes and developing the PSL tools that are maintainable, scalable and extensible, as a means for increasing the adoption of PSL in industry.

**Commercial Applications:** The proposed solution will provide an innovative framework and advanced enabling tools for process-centric information sharing. The results of this initiative have significant commercial potential in both public and private sectors for solving problems relating to agile manufacturing, virtual enterprises, enterprise resource planning, supply-chain management, business activity modeling, and enterprise knowledge management systems

 **FY 2003 PHASE II AWARD**

**Topic:** 7.09 Microelectronics Manufacturing Infrastructure

**Subtopic:** 7.09.07 Precision Optical Current Sensor

**Title:** Precision Optical Current Sensor

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

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

**Principal Investigator:** James Blake
**Phone #:** (602) 331-8000 x101

**Award Amount:** $300,000.00

**Abstract:** The focus of this Phase II SBIR is to develop three new optically based electric current measurement standards for NIST. These standards comprise methods for very accurately calibrating current transformers that have digital outputs, are DC coupled, and have noise riding on the output. The development of these standards is a part of our larger business strategy of embarking on a new venture focused on providing high quality metering services to the electric power transmission grid operators. Precision Lightwave Instruments is teaming with NxtPhase, Inc. in Phoenix, AZ and others to create this business. Achieving unprecedented accuracies in the measurement of electric current at high voltage is one of several key technology development programs necessary for the success of this venture.

**Commercial Applications:** High voltage power systems metering, protection, health monitoring and calibration services.

**FY 2003 PHASE II AWARD**

**Topic:** 7.04 Chiral Chemistry

**Subtopic:** 7.04.01 Chiral Surface Diagnostic Instrumentation

**Title:** Surface Selective Chiral Detection: A New Metrology Technique

**NIST OU:** 840 Physics Laboratory

**Firm:** Vescent Photonics
2927 Welton Street
Denver, CO 80205

**Principal Investigator:** Scott Davis
**Phone #:** (303) 296-6766

**Award Amount**: $300,000.00

**Abstract:** The near chiral purity of the biosphere leads to a vast array of chiro-specific physiological responses. This chiro-specificity, in turn, gives rise to the need for the manufacturing of enantiomerically pure chiral chemicals, such as pesticides, pharmaceuticals, food additives, pigments, etc. Critical to the efficacy of both chiro-specific biology and chiro-synthesis/separation are the interfacial regions of chiral surface layers. Vescent Photonics proposes to develop an entirely new metrology technique designed to investigate chiral surface layers. The technique combines the established fields of optical activity (circular dichroism and optical rotary dispersion) for chiro-specificity with evanescent wave sensing for surface selectivity. The device employs a new polarization modulator, with demonstrated speeds of greater than 200 kHz and great potential for compact, and economic construction.

**Commercial Applications:** An immediate application of this technology will be as a research tool for scientists in the areas of chromatographic chiral stationary phases, chiral drug development, and fundamental chiral research. Further applications exist as a monitoring device for enantiomeric excess, concentrations of chiral compounds (such as glucose), and potentially as probe of extraterrestrial life. The polarization modulator also has market applications in optical switching, telecommunications, and linear dichroism applications.

**FY 2003 PHASE II AWARD**

**Topic:** 7.12 Microelectronics Manufacturing

**Subtopic:** 7.12.05 Semiconductor Diode Lasers for Water-Vapor Spectroscopy

**Title:** Compact Tunable Diode Laser for Water Vapor Spectroscopy

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

**Firm:** Vescent Photonics
2927 Welton Street
Denver, CO 80205

**Principal Investigator:** Mike Anderson
**Phone #:** (303) 823-9229

**Award Amount:** $300,000.00

**Abstract:** We will develop a compact external cavity stabilization system, which will employ independent electro-optic control over the optical path length of the cavity and a wavelength-selective element. The system should be able to cover a 30 nm range and give mode-hop-free tuning over 20 nm intervals. The design of the feedback system will be compatible with any commercially available laser diode from 630 nm to 2 ?m including emerging 400 nm lasers. The feedback element is entirely electro-optic, compact and robust. In Phase II we will combine a commercially available laser diode at 1400 nm with our external cavity to produce a compact laser for water vapor spectroscopy.

**Commercial Applications:** This laser can be incorporated into existing or developing commercial spectrometers for monitoring water vapor in phosphine gas used by the semiconductor industry. Diode laser systems optimized for spectroscopy are not generally available or are complex mechanical systems whose price and sensitivity to vibrations discourage wide market development. Low cost, compact tunable lasers are needed to develop trace-gas spectrometers for semiconductor process control, combustion control, environmental monitoring, chemical detection and medical diagnostics on human breath.

**FY 2003 PHASE II AWARD**

**Topic:** 7.16 Technologies to Enhance Fire Safety

**Subtopic:** 7.16.01 Advanced Building Sensors and Information Systems

**Title:** Development of the Smart Environmental Monitoring Systems (SEMS)

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

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

**Principal Investigator:** Matthew Scarpino
**Phone #:** (817) 872-1500 ext 117

**Award Amount:** $300,000.00

**Abstract:** Firefighters have expressed the need for both increased accuracy in fire detection systems and greater access to environmental information in the event of a fire. To accomplish both tasks, Williams-Pyro, Inc. proposes to develop the Smart Environmental Monitoring System (SEMS). This system comprises both an advanced fire detection system and the networking capability necessary to provide real-time data to emergency personnel. This device will utilize a multi-sensor suite to measure optical radiation, temperature, gases, and smoke produced by a fire. These sensors send their results to an embedded microcontroller that determines the presence of flame through use of an artificial neural network (ANN) algorithm. The ANN sends its response to a network switch that connects it to the building's network. From there, the response can be viewed on a display system, called the fire console, located outside the building or within its common entrance. Along with the location of the fire, the SEMS will show the direction of the fire, the building's temperature, and the presence of harmful gases.

**Commercial Applications:** SEMS will provide building and occupants with fast, accurate, and economical fire detection. It will also provide firefighters with real-time advance information concerning the building environment, enabling them to battle the fire more efficiently. Ease of installation makes the SEMS ideal for both new and existing buildings. Insurance companies will appreciate early fire detection that can reduce the loss of life and property as well as financial liability. By reducing the false alarm rate and increasing firefighter efficiency, SEMS will; generate demand among building owners, firefighters and insurance providers.