

Sandia's

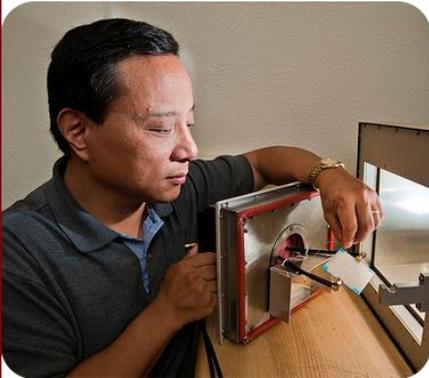


Sandia
National
Laboratories

Innovation Marketplace

A Quarterly Update of
Available Technologies
for Industry

*Exceptional service
in the national interest*



January 2014

Introduction 1

- Overview
- Contact Information

Medical Applications & Bioscience 3

- Rapid, Automated Point-of-Care System RapiDx
- The μ ChemLab™: Bio Detector
- SpinDx™
- CleanBurst Rapid Acoustic Lysis for Point-of-Care Diagnostics
- Neustristor
- Atomic Magnetometer

Engineering & Manufacturing 6

- Stress-Induced Nanofabrication
- The Multiple Environment Mobile Robot (Volant)
- PC Board Mountable Corrosion Sensors
- Sandia Cooler
- Membrane Projection Lithography (MPL)
- Age and Temperature Sensor System
- Technology Refreshment Assessment Model (TRAM)
- Umbra™
- Micromachined Dimensional Calibration Artifact for Mesoscale Measurement Machines

Security & Asset Management 10

- Ultra-Thin Laser Warning Receiver
- NEW Class of Radiation Detection Materials
- Security Risk Assessment Methodologies (RAM)
- TacNet Tracker
- 3D Structured Lighting Sensor

Energy & Natural Resource Management 13

- Optimized Alumina Coagulants
- Single Well Injection Withdrawal Tracer Tests
- Microsystems Enabled Photovoltaics (MEPV)

Featured at Sandia: Cutting Edge Open Source Software .. 15

- SGHAT
- Xyce
- Mantevo Suite 1.0
- Megadroid
- CANARY



Licensing Sandia's Intellectual Property

Welcome to Sandia National Laboratories' Intellectual Property Licensing showcase. This booklet highlights exceptional opportunities for licensing Sandia's intellectual property, including patents, copyrights (generally software), trademarks, and maskworks.

Listings within should not be construed as an offer to license technology. All licenses are subject to negotiation and availability of the intellectual property for licensing. This booklet is intended for indications of interest only.

Why Work with Sandia?

Leverage World-Class Technology and Research

For more than 60 years, Sandia has delivered essential science and technology to resolve the nation's most challenging security issues.

A strong science, technology, and engineering foundation enables Sandia's mission through a capable research staff working at the forefront of innovation, collaborative research with universities and companies, and discretionary research projects with significant potential impact.



The Best and Brightest

In keeping with our vision to be the nation's premier science and engineering laboratory for national security and technology innovation, we recruit the best and the brightest, equip them with world-class research tools and facilities, and provide opportunities to collaborate with technical experts from many different scientific disciplines.

The excitement and importance of our work, an exemplary work environment, partnerships with academia, industry, and government, and our record of historic contributions help us attract exceptional staff. Our employees are recognized by their professional peers for their outstanding contributions.

Contact Information

To discuss licensing opportunities, please send inquiries to ip@sandia.gov
Or for more information, visit our website: <https://ip.sandia.gov>

Business Development & Intellectual Property Management

Sandia National Laboratories

P.O. Box 5800

Mail Stop 0114

Albuquerque, NM 87185-0114

Fax: (505) 844-8011

Medical Applications & Bioscience

Rapid, Automated Point-of-Care System (RapiDx)

conducts point-of-care diagnosis and treatment of patient ailments



RapiDx is a portable diagnostic instrument that quickly measures--with high sensitivity--disease and toxin biomarkers in human biological samples (e.g., blood, saliva, urine) so that patient ailments can be quickly diagnosed and treated. *RapiDx* is an ideal instrument for point-of-care diagnostics of disease and toxin detection in health clinics and in the field.

Built on Sandia's advancements in lab-on-a-chip technologies, *RapiDx* is a miniaturized device that requires mere microliters of a sample to measure protein signatures. With *RapiDx*, drawing tubes of blood is no longer required. Instead, drops of blood or saliva can be collected and analyzed at the point-of-care (e.g., in a doctor's or dentist's office), thereby enabling low-cost, rapid diagnoses during an office visit. *RapiDx* can also be used to address bioterrorism threats. If a crowd is exposed to dangerous biotoxins, potentially exposed persons can be triaged rapidly with *RapiDx*. Timely treatment--critical in such an event--also conserves valuable health resources (e.g., hospital beds, prophylactic supplies).

Applications and Industries:

- * Disease detection
- * Ultrasensitive research tools
- * National defense

Hand-held μ ChemLab™ rapidly detects and analyzes toxic agents



SNL has developed a compact, hand-held detection system that places the capability of a fully functional chemistry laboratory at the fingertips of a trained field operator. Sandia's chemical analysis system can rapidly detect and analyze toxic agents such as bacteria, viruses, and protozoa. A variety of applications and near-term commercialization opportunities now exist in markets

such as air and water quality, medical diagnostics, biotechnology, and industrial process control.

Designed for the rapid detection of proteins, the μ ChemLab™ has been used to identify biotoxins such as ricin, staphylococcal enterotoxin B, and botulinum toxin; its capability has been extended in combination with innovative, automated sample preparation technology to enable the identification of viruses and bacteria. Parallel analysis channels provide highly accurate detection at nanomolar sensitivities with a low false alarm probability.

Applications and Industries:

- * Identification of biotoxins such as ricin, staphylococcal enterotoxin B, and botulinum toxin
- * Identification of viruses and bacteria
- * Air and water quality testing, medical diagnostics, biotechnology, and industrial process control
- * Full amenability to DNA-based separations for sizing or fragment detection

The μ ChemLab™ was used for bioagent detection in the BioBriefcase program. [Click here](#) more information.

*Faster, less expensive **SpinDx™** point-of-care diagnostics prototype detects heart attacks, strokes, infections, certain cancers and other afflictions days or weeks sooner than they are today*



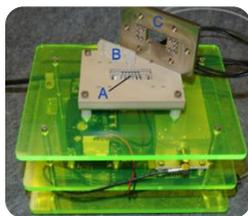
Sandia researchers have developed a break-through technology which can test and diagnose up to 64 assays on a single disc within 15 minutes of sample collection. It requires significantly less blood (less than a pin-prick) than the current laboratory blood draw. Detection is achieved with a novel bead sedimentation immunoassay scheme. The sample is mixed on-disk with a detection cocktail consisting of a) capture beads coated with antibodies specific for the target(s) of interest, and b) detection antibodies labeled with a fluorescent tag, which will be bound to the capture bead in the presence of the corresponding antigen. Following incubation, the beads are removed from the sample via sedimentation by washing the beads to remove any interferences as the beads stack at the end of the channel. The fluorescent signal of the resulting bead pellet is used to quantify the analyte present. Single channel multiplexing is achieved using beads of different size/density for individual targets.

SpinDx™ can revolutionize the way we get test results from doctors' offices and hospitals alike. Besides the inherent portability of the testing device, the assay discs can be manufactured for pennies, making this an affordable option for both small and large practices with the potential to drive down the cost of testing, visits, and to shorten time-to-treatment. This technology has broad application beyond medical diagnostics. It can be broadly applied across food safety, over bio-terrorism detection, and commercial drug testing markets.

Applications and Industries:

- * Point-of-care diagnostics (human and animal)
- * Food & environmental monitoring
- * Bio-defense

***CleanBurst** biosensor overcomes limitations of current extraction methods to enable high-speed sample preparation techniques for clinical point-of-care medical diagnostics*



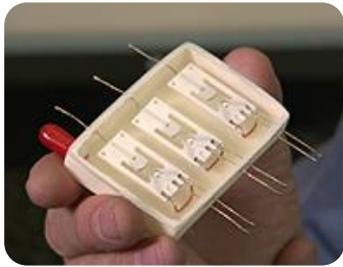
Most biosensors in today's market require a critical sample preparation procedure prior to analysis of cellular contents such as nucleic acids and proteins. Technology is needed to release the cellular contents in a format compatible with nano/microfluidic and point-of-care devices.

Sandia National Laboratories has developed *CleanBurst Rapid Acoustic Lysis For Point-Of-Care Diagnostics*, a miniature cell lysis system to overcome the limitations of current extraction methods. This system utilizes high-frequency compression waves with a wavelength similar to the size of cells, resulting in more efficient energy transfer. Unlike commercial acoustic transducers, our technology does not generate significant amounts of heat, making it compatible with protein assays. This technology releases viable DNA, RNA, and proteins from human or bacterial cells, without chemicals or additional processing, to enable high-speed sample preparation for clinical point-of-care medical diagnostics and use with nano/microfluidic devices.

Applications and Industries:

- * Same-day pathogen diagnosis
- * Lysing of resilient cells
- * Rapid DNA testing
- * Species-specific drug prescriptions
- * Bio-agent identification

*Compact, simple and inexpensive **Neutristor** may allow cancer patients to receive treatment at home*



Sandia has demonstrated the basic technology necessary for a tiny, mass-produced neutron generator that can be adapted to medical and industrial applications.

Traditional neutron generators operated on cylinders limit size, beam current and neutron output. Rather than using these traditional cylindrical tubes found in most neutron generators today, the *Neutristor* technology is based on a computer chip-shaped neutron source. The chip configuration allows varying numbers of layers in a stack and can increase the number of neutrons by one or two orders of magnitude. This opens the door for a variety of applications, including cancer treatment. The tiny medical neutron source could be implanted near a tumor and provide a low neutron dose to cancer patients in the comfort of their own home instead of having to be treated in a hospital.

Applications and Industries:

- * Neutron generators
- * Cancer treatment

- 2012 R&D100 Award Winner -

*Highly sensitive, cryogen-free **Atomic Magnetometer** magnetic field sensor substantially reduces costs of acquiring and operating magnetoencephalography (MEG) systems*



The *Atomic Magnetometer* MEG system uses a novel sensor design that allows it to be compact, highly sensitive, and versatile enough to be readily arrayed around the human skull. In the system, the pump and probe laser light are delivered via a single polarization-maintaining optical fiber, leaving the magnetometer with a single optical axis. The use of an optical fiber instead of beams propagating through free space allows the device to be oriented at any angle necessary for arraying the sensors properly around the head. The single optical axis allows the sensor to be long in one dimension but short in the other two dimensions so that the sensor has only a 4 cm by 4 cm footprint on the subject's head. The device has four spatially separated magnetometer channels to measure the magnetic field gradients.

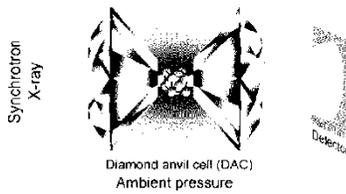
The *Atomic Magnetometer* has the potential to substantially reduce the cost of MEG. With reduced cost, MEG would be available to a much broader user community. In addition, the technology could provide the essential sensor technology that would enable the combination of MEG and low-field MRI in the same device. The technology is also ideally suited for use in the detection of cancer cells by using functionalized magnetic nanoparticles. Such detection techniques could reduce the duration of chemotherapy treatments and provide for earlier detection of cancer.

Applications and Industries:

- * Magnetoencephalography (MEG) systems
- * Cancer detection with magnetic nanoparticles
- * Low-field MRI
- * Baggage screening



Stress-Induced Nanofabrication *technique synthesizes uniform semiconductor nanostructures*



Stress-Induced Nanofabrication is a mechanical compression method for the synthesis of uniform semiconductor nanostructures including nanorods, nanowires, nanosheets. Due to the size- and shape-dependent properties, nanoparticles have been successfully used as functional building blocks to fabricate multi-dimensional ordered assemblies for the development of 'artificial solids' (e.g.,

metamaterials) with potential applications in nanoelectronic and optic devices. To date, fabrications of ordered nanoparticle assemblies have relied on specific interparticle chemical or physical interactions such as van der Waals interactions, dipole-dipole interaction, chemical reactions, and DNA-templating. The consequent self-assembly scenario is the formation of higher dimensional nanoparticle architectures from single nanoparticles.

Stress-Induced Nanofabrication is a technique used to make nanostructures by preparing a face centered cubic-ordered metal nanoparticle film from metal nanoparticles, such as gold and silver nanoparticles, exerting a hydrostatic pressure upon the film at pressures of several gigapascals, followed by applying a non-hydrostatic stress perpendicularly at a pressure greater than approximately 10 GPa to form an array of nanowires with individual nanowires having a relatively uniform length, average diameter and density.

Applications and Industries:

- * Nanostructure fabrication
- * Semiconductor nanostructures
- * Optic devices
- * Nanoelectronics

- 2014 R&D100 Entry -

The Multiple Environment Mobile Robot (Volant)

pushes boundaries of mobility for robotic and unmanned systems



Volant, a multi-modal vehicle concept, is a design created by Sandia that would enable a single unmanned system to fly, swim, drive, and hop across a variety of terrains and obstacles.

Volant was developed to address the need for mobile robotic vehicles to traverse through more than a single type of environment. The *Volant* vehicle is able to navigate aerial, aquatic, and terrestrial environments through the use of different mission mobility attachments. These attachments allow the *Volant* vehicle to be deployed from greater distances either from the air or through the water prior to any terrestrial navigation that would be done by the base *Volant* system.

Applications and Industries:

- * Unmanned systems
- * Robotics

Sandia is seeking partnership opportunities to advance this concept and develop additional applications.

PC Board Mountable Corrosion Sensors *reduce damage and expense by identifying and assessing corrosion in microelectronics*



SNL has created sensors to identify and assess the pervasive and expensive problem of corrosion in applications ranging from construction to microelectronics. The *PC Board Mountable Corrosion Sensors* are designed and fabricated in the style of standard surface mount components (such as resistors and capacitors), which can be soldered directly onto networks such as printed circuit boards (PCBs). This allows easy integration with support electronics via standard assembly processes in a very small footprint. Sensors can be packaged with a high density for redundancy, designed for a wide range of sensitivity, and strategically located for multiple sensing tasks. The sensors are produced by the hundreds per wafer using standard industry methods resulting in low per unit costs. To date, sensors have been designed for corrosion assessment of copper, aluminum and wire bonded chips. Many other interrogation systems are possible.

Applications and Industries:

- * Building ventilation systems
- * First responder respirators
- * Household electronics
- * High consequence systems
- * Water monitoring systems
- * Architectural structures
- * Automotive systems
- * Space systems
- * Environmental change indicators
- * Remote-based systems

Sandia Cooler *provides dramatic increase in cooling performance without resorting to exotic methods*



Sandia researchers have developed a radically new architecture for air-cooled heat exchangers. In conventional “fan-plus-finned-heat-sink” air-cooled heat exchangers, the primary physical limitation to performance (i.e. achieving low thermal resistance) is the boundary layer of motionless air that adheres to and envelops all surfaces of the heat exchanger. Within this boundary layer region of “dead air”, diffusive transport is the dominant mechanism for heat transfer. The resulting thermal bottleneck largely determines the thermal resistance of the heat exchanger. Another longstanding problem is inevitable fouling of the heat exchanger surface over time by particulate matter and other airborne contaminants. Heat sink fouling is especially important in applications where little or no preventative maintenance is typically practiced. The third major obstacle concerns inadequate airflow to heat exchanger resulting from restrictions on fan noise. Small and medium-sized fans have relatively poor mechanical efficiency; unproductive expenditure of mechanical work on the surrounding air results in high noise levels.

The *Sandia Cooler* architecture simultaneously eliminates all three of the drawbacks of conventional air-cooled heat exchanger technology. The *Sandia Cooler* provides a several-fold reduction in boundary layer thickness, intrinsic immunity to heat sink fouling, and drastic reductions in noise. It is also expected to be very practical from the standpoint of cost, complexity, ruggedness, etc.

- 2012 R&D100 Award Winner -

Applications and Industries:

- * Laptops
- * High performance "gaming" PCs
- * Various other electronic devices
- * Automotive
- * Home video game boxes
- * LED Lighting
- * HVAC
- * Large appliances
- * Any device comprising one or more forced-air exchangers

Membrane Projection Lithography (MPL) creates 3D micrometer scale structures which are impossible to create using traditional 2D micro-fabrication techniques



Although metal metamaterials have been constructed with resonances to radio waves and microwaves, designers and engineers have been unsuccessful in the higher-frequency infrared and visible regions of the EM spectrum because metals show high losses at these frequencies. *MPL* is a novel nanofabrication technique capable of producing 3D resonator metamaterials with dimensions 100-times smaller than prior fabrication methods.

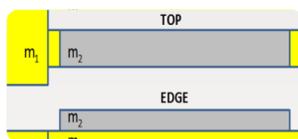
MPL enables the creation of a diverse array of microscopic 3D structures with macroscopic impact. For instance, the technique can be used to create 3D integrated circuits, the next step in the evolution of 2D microprocessors. It is also capable of creating structured electromagnetic materials. Currently, the technique is being used to make thermal antennas which can control the direction of heat emitted from an object, potentially easing cooling and heating needs for satellites or perhaps even buildings and cars.

- 2013 R&D100 Award Winner -

Applications and Industries:

- * 3D integrated circuits
- * Structured electromagnetic materials
- * Thermal antennas

Age and Temperature Sensor System records absolute age and/or temperature history for commercial and military applications



Various commercial and military applications require knowing the absolute age and/or temperature history of a device or system starting from the time it is assembled or commissioned. Ideally this information could be obtained simply and without power. The Sandia-developed *Two-Sensor System for Absolute Age and Temperature History* is a physical materials system solution to address this need.

Sandia's passive sensor is based on diffusion of one metal into another, or into a semiconductor, as a function of time and temperature. This new technology leverages two similar sensors with different activation energies. Sensors can be conductive, capacitive, optical, visual or crystalline. Devices can be created using standard metal deposition techniques on common semiconductor and micro-device substrates, including sputter coating, chemical vapor deposition and electrochemical methods.

Applications and Industries:

- * Removal/replacement of systems exposed to extreme environments
- * Verification/invalidation of warranty claims

Technology Refreshment Assessment Model (TRAM)

assists in development of optimal technology management strategies

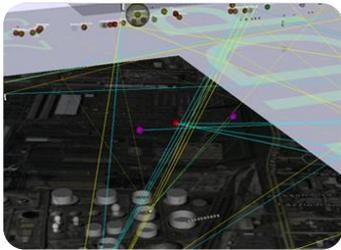


TRAM is a computer software application that provides analysts and executives with the ability to perform optimal technology management decision making over the life-cycle of a technologically sophisticated, high value system or system-of-systems. The tool allows for the development of optimal technology management strategies and technology roadmaps over long-term time horizons, factoring in performance, cost, schedule, risk and obsolescence.

Applications and Industries:

- * Technology management
- * Manufacturing
- * Energy optimization
- * Military and non-military systems

UmbrTM rapidly simulates environments and models complex systems for real-time interactions



UmbrTM is a flexible tactical hybrid simulation engine and framework that can integrate physical, cyber, and behavioral elements at variable fidelity in a 3D environment. It regularly works the range of LVC (Live-Virtual- Constructive) environments including faster than real time simulation calculations for generative analysis and real-time interactions that incorporate live external data feeds or human interaction.

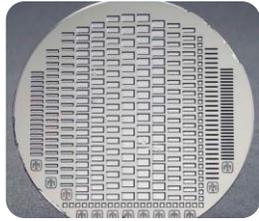
UmbrTM utilizes a formal “Worlds abstraction” to support modularization of any world model (US Patent No. 7,085,694). This is in contrast to many simulation environments which rely upon a fixed set of data structures or a global variable space. Agents operate in various heterogeneous scenarios that include environment (terrains, weather, plumes, communications, etc.), objects (vehicles, devices, cyber-systems, etc.), sensed phenomena (magnetic, acoustic, seismic, radiation, etc.), behavior (state based, cognitive, etc.), or external simulations. These environments can co-exist in the same simulation environment and share data in a loosely coupled relationship.

Applications and Industries:

- * Human behavior
- * Augmented reality
- * Physical-cyber operations
- * Robotics applications
- * Visualization



Micromachined Dimensional Calibration Artifact for Mesoscale Measurement Machines *improves measurement accuracy while reducing manufacturing costs*



With increasing miniaturization in manufacturing (such as nozzles in fuel injectors, watch parts, inkjet printer parts, or other small scale parts), it is necessary to improve inspection accuracy while maintaining the ability for high-volume manufacturers to inspect at high speeds. The accuracy of vision metrology systems used to inspect these small-scale parts is limited by the accuracy of the calibration artifact.

The *Micromachined Dimensional Calibration Artifact for Mesoscale Measurement Machines* has both lower cost and up to ten times better accuracy than other vision calibration artifacts. Purchasing, installing, and qualifying new equipment is expensive. With Sandia’s artifact, a user can improve their accuracy by simply recalibrating their equipment, using the Silicon Micromachined Dimensional Calibration Artifact as the calibration standard. The user would operate and calibrate their equipment in the same fashion as before, and potentially improve inspection accuracy by a factor of ten.

Finally, because the Silicon Micromachined Dimensional Calibration Artifact is three-dimensional in nature, it provides a new capability for multisensor system calibration.

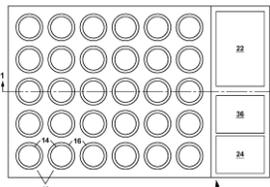
Applications and Industries:

- * Calibration of vision-based inspection equipment
- * Calibration of hybrid/multisensor inspection systems
- * Calibration of micro-coordinate measuring machines

- 2008 R&D100 Award Winner -

Security & Asset Management

Ultra-Thin Laser Warning Receiver *reduces risk of temporary flash blindness or permanent blindness to pilots, soldiers, and others exposed to laser sources*



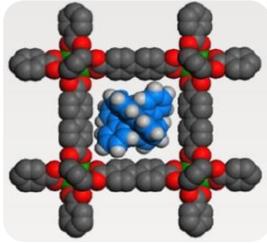
Laser sources pose a risk to people either on the ground or piloting an aircraft since they can produce temporary flash blindness or even permanent blindness. Laser sources can also be used to direct munitions and laser-guided missiles; and they can also disable satellite borne imaging systems. To protect against the various threats posed by laser sources, laser warning receivers are needed.

The *Laser Warning Receiver* is compact, and can be used to determine both the angle of arrival and wavelength of an incident laser beam so that counter measures can be taken against the laser threat. This credit card-sized detector package can sense laser illumination that might be hazardous to pilots, soldiers, and others. The detector is similar to a standard dielectric multilayer coating with very thin detector layers within the layers. Each detection layer only absorbs a small fraction of the light so all layers are illuminated. Colors are discriminated because the coherent peaks for different colors will occur at different depths within the ML. The optical architecture allowing the very thin package has many channels that accept light from different angles in the field of regard.

Applications and Industries:

- * Laser threat warning systems
- * Directional aids
- * Position determining systems
- * Vehicle guidance

NEW Class of Radiation Detection Materials *enables radiation-specific scintillators for detection applications*



Sandia's new class of scintillators possess novel properties enabling use in a wide range of particle detection schemes, including pulse-shape discrimination methods for detecting fast neutrons. Known as Metal-Organic Frameworks (MOFs), they are crystalline nanoporous structures in which a luminescent organic component is chemically linked to a heavy metal ion such as zinc. The light output and timing of MOFs is highly tunable because their structure is governed by well-

known chemistry, allowing the chemical nature of the organic fluor and its local environment to be tuned.

A wide variety of luminescent organic components can be incorporated. In addition, the nanopores in their structure can be infiltrated with species such as wavelength shifters, elements that facilitate detection of thermal neutrons, or additional hydrogen to increase the overall cross section for neutron detection. Infiltration with triplet exciton harvesters enables spectral shape discrimination (SSD), in which particle type is determined by the shape of the luminescence spectrum. MOFs therefore offer an unprecedented level of flexibility to design a scintillator for a specific radiation detection application. Because they are solids, the hazards associated with liquid organic scintillators are absent.

Applications and Industries:

- * Radiation detection
- * Public safety
- * National security

Security Risk Assessment Methodologies (RAM) *reveal security issues and solution options for various critical infrastructures*



The Department of Energy (DOE) designated Sandia as the Lead Laboratory for development of physical security technology and funded Sandia to develop a technical capability in security modeling and systems analysis, security equipment and components, and security systems engineering, integration and implementation.

For more than 30 years, Sandia has applied performance-based methods for designing and evaluating physical protection systems (PPS). This approach has been applied for many years to high-consequence government facilities, and in the last several years this approach has been modified, tested, and applied to various critical infrastructures such as federal dams, power utilities, water utilities, etc. Using a Sandia-developed algorithm to assess a facility's risk, the RAM series provides an in-depth analysis of risk management and reduction procedures.

RAMs available for licensing:

- | | |
|--|---------------------------------------|
| * RAM BioRAM for biological facilities | * RAM-C™ for communities |
| * RAM-CF™ for chemical facilities | * RAM-CI for critical infrastructures |
| * RAM-DSM for dams | * RAM-E for energy infrastructures |
| * RAM-PSM for prisons | * RAM-W™ for water utilities |
| * RAM-TSM for transmissions | |

TacNet Tracker handheld device provides users with real-time location tracking and secure information transfer



The *TacNet Tracker* is designed to transport information securely via portable handheld units without the need for fixed infrastructure. The low profile device is easily worn to provide users with real-time location tracking, communication with other users, and shared information along a secure encrypted self-forming and self-healing network. This line-of-sight network is essentially a custom, privately owned Internet with the capability to self-form on a second-to-second basis. If a unit becomes separated (e.g., line-of-sight is lost), the remaining components “self-heal” the network by forming another path. Because of the mesh network’s multi-hopping capabilities, the *TacNet Tracker* can create secure paths around obstructions that might hinder a regular radio.

The device has similar communication and data-sharing capabilities as a laptop computer, but in a much more compact, lightweight format—approximately the size of a smartphone. The *TacNet Tracker* also provides additional functionalities—including Bluetooth communications, USB ports, and tracking with GPS or mesh positioning.

Applications and Industries:

- * Corrections - jails/prisons
- * Military
- * Law enforcement & first responders
- * Mining industry
- * Secured access facilities

Low cost, eye-safe, robust, lightweight 3D Structured Lighting Sensor reduces background clutter in a camera image



Sandia has developed an eye-safe, robust, lightweight, and low-cost 3D structured lighting sensor for use in broad daylight outdoor applications. This newly developed sensor overcomes the current limitations of laser-based 3D sensors and can help with threat assessment for first responders, crime scene investigation, and any other scenario which requires accurate 3D mapping.

Structured lighting systems provide a way of mapping and modeling the environment in three-dimensions using a camera, laser, and a compute to process the data. Structured lighting requires image processing to isolate, or segment, a laser signal from background clutter in a camera image. Segmenting the laser signal is easy if the reflected laser light is significantly brighter than the background clutter due to reflected ambient light. Under most outdoor conditions and some indoor conditions, however, reflected energy from background clutter is often significantly greater than the reflected laser energy. Problems also occur when the reflective surface is highly absorptive, such as asphalt. The geometry of the *3D Structured Lighting Sensor* allows one to calculate the position of a point using triangulation. In addition, the laser light is projected in a precise pattern (grid, line, ellipse etc.), which allows surface shapes to be deduced from the distortion of the pattern on an object's surface. Currently available laser scanners are slow, bulky and heavy, expensive, fragile, short-range, sensitive to vibration, and unreliable for outdoor use in bright sunlight conditions. The technology developed by Sandia overcomes these limitations and contributes to the realization of intelligent machine systems reducing manpower.

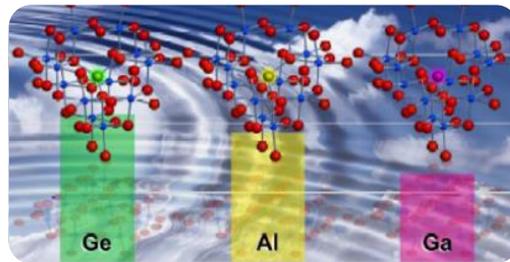
Applications and Industries:

- * Outdoor 3D mapping
- * First responder threat assessment
- * Surveillance reconnaissance
- * Crime scene investigation

Energy & Natural Resource Management

Innovative and efficient water purification technique uses

Optimized Alumina Coagulants *to reduce chlorinated by-products*



This innovative technology uses a water treatment coagulant, or reagent, to facilitate the process of water purification. By inserting a single gallium atom in the center of an aluminum oxide cluster, the stability and efficacy of the reagent is greatly improved. This stability also provides a longer shelf life, increased effectiveness in various environments, and outperforms other current commercially

available coagulants for water clarification and pathogen removal. The key benefit to this technology is the efficiency of the coagulation process as a front-end treatment means less chlorinated by-products in the potable water.

Applications and Industries:

- * Water supply
- * Sewage treatment
- * Emergency usage

Single Well Injection Withdrawal Tracer Tests *detect and track proppant movement without new drilling and use of hazardous chemicals*



A large question preventing optimal natural gas production from "hydrofracked" shales is how far proppants, injected to keep shale fractures open, move into the gas-bearing shales. Knowing precisely where injected proppants go in the subsurface is the first step to optimizing the spacing of hydrofrack jobs. Sandia researchers propose that subsurface proppant distribution can be imaged using single-well tracer techniques. By analyzing the lag time in appearance between interacting and inert tracers in hydrofrack flowback waters appearing at the wellhead, the extent of proppant

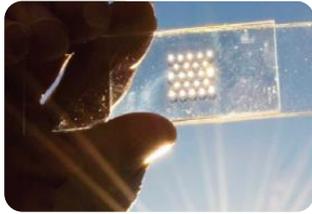
movement can be estimated. The approach requires no new drilling and involves no hazardous chemicals.

Applications and Industries:

- * Oil & gas production
- * Geothermal energy



Microsystems Enabled Photovoltaics (MEPV) revolutionize solar energy collection



Sandia's *microsystems-enabled photovoltaics (MEPV)* uses microdesign and microfabrication techniques to produce solar cells as small as 3-20 microns thick and 100-1000 microns wide. These PV cells are then placed or 'printed' onto a low-cost substrate with embedded contacts and microlenses for focusing sunlight onto the cells. Moving to micro-scale PV cell sizes results in distinct benefits at cell, module, and system levels, including reducing the amount of expensive semiconductors by 30 times while still achieving high efficiencies.

MEPV solar power systems can have impact in both mobile and stationary power applications. At the system level, the large number of individual micro-PV cells can be interconnected to tailor voltage and current output to meet system requirements. The flat panel profile with micro-optical focusing further simplifies sun tracking, reducing both the cost and complexity of the solar concentrating design.

Put together, glitter-sized photovoltaic cells become the building blocks for generating electricity in a new, efficient, versatile, and inexpensive way—the powering of anything could become as simple as exposing it to light.

- 2012 R&D100 Award Winner -

SGHAT *determines when and where solar glare can occur throughout the year*



The *Solar Glare Hazard Analysis Tool (SGHAT)* is a web-based tool that predicts energy production and the potential for solar glare and ocular impacts from an array of photovoltaic panels. SGHAT uses an interactive Google Maps interface together with a few user-specified parameters such as orientation and tilt of the panels to quickly locate a site, outline the proposed array, and calculate the occurrence, intensity, and size of the potential glare throughout the year. The tool also predicts the annual energy production of proposed arrays so that alternative designs, layouts, and locations can be optimized to maximize energy production while mitigating glare. The use of this tool is required by the Federal Aviation Administration for solar energy installations proposed at federally obligated airports in the United States.

- 2013 R&D100 Award Winner -

SGHAT is free and available to the public at www.sandia.gov/glare.

Xyce *simulator provides tool for the design and analysis of electronic circuits*



Xyce is an open source, SPICE-compatible, high-performance analog circuit simulator, capable of solving extremely large circuit problems by supporting large-scale parallel computing platforms. It also supports serial execution on all common desktop platforms, and small-scale parallel runs on Unix-like systems. In addition to analog electronic simulation, Xyce has also been used to investigate more general network systems, such as neural networks and power grids.

- 2008 R&D100 Award Winner -

Xyce is free and available to the public at <https://xyce.sandia.gov/>.

Mantevo Suite 1.0 *pioneers miniapp concept*



Mantevo Suite 1.0 is an integrated collection of small software programs (miniapps) that model the performance of full-scale applications, yet require code only a fraction of the size of the full application. The Mantevo project pioneered the miniapp concept, and Mantevo Suite 1.0 is the first integrated collection of full-featured miniapps. Miniapps have emerged as central components of computer system co-design in an era of rapid architectural changes. Major companies like Intel, IBM, NVIDIA, AMD, Cray, along with universities and national laboratories, use miniapps for rapid design-space exploration in the development of the next generation of high-performance computers.

- 2013 R&D100 Award Winner -

Mantevo is free and available to the public at <http://mantevo.org/>.

MegaDroid *helps protect smartphones from hackers*



The Android project, dubbed *MegaDroid*, is expected to help researchers at Sandia and elsewhere who struggle to understand large scale networks. Sandia cyber researchers linked together 300,000 virtual hand-held computing devices running the Android operating system so they can study large networks of smartphones and find ways to make them more reliable and secure. Android dominates the smartphone industry and runs on a range of computing gadgets.

The work is expected to result in a software tool that will allow others in the cyber research community to model similar environments and study the behaviors of smartphone networks. Ultimately, the tool will enable the computing industry to better protect hand-held devices from malicious intent.

Read more about the MegaDroid project [here](#).

Sandia expects to complete a sophisticated demonstration of the MegaDroid project that could be presented to potential industry or government collaborators.

CANARY *enhances day-to-day water quality management with immediate contaminant detection*



How does a country whose water supply is as dispersed as the U.S. rapidly and accurately detect contamination of any of it, whether due to natural causes or terrorist activities? Sandia researchers have developed software that enables immediate contaminant detection by continuously analyzing signals from networked sensors for unusual

responses. *CANARY: Event Detection Software* is designed to be compatible with sensor technologies and information technology programs existing at most water utilities, and it can be easily modified by the end-user for specific applications and for utility-specific customization. But this isn't just a war-and-disease prevention program. Several utilities have reported that using the software has enhanced the day-to-day water quality management within their distribution networks.

- 2012 R&D100 Award Winner -

CANARY is free and available to the public at <https://software.sandia.gov/trac/canary>.



intellectualproperty



Sandia
National
Laboratories



U.S. DEPARTMENT OF
ENERGY

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND No. 2013-10667P