DISCOVERY IN ACTION

Scientists at PNNL's Shallow Underground Laboratory utilize an electroforming process to produce high purity copper used in ultra-low background detector research and development for environmental, national security and fundamental physics applications. This research supports activities including international treaty verification to prevent and counter acts of terrorism.

PNNL innovations protecting the nation

This is the 11th of a 12-part series that features some of the scientific challenges PNNL has tackled over its 50-year history and highlights its vision for the future. PNNL is one of 10 national laboratories overseen by the U.S. Department of Energy's Office of Science and has been managed by Battelle since its inception in 1965. Through this enduring partnership—and by working closely with sponsors and collaborators—PNNL builds upon its legacy to advance science and solutions that improve the lives of Tri-Citians and people around the world. This edition focuses on how PNNL draws upon its broad scientific capabilities to develop technologies and tools to protect the nation from threats of weapons of mass destruction, terrorists and cyber-attacks.

PACIFIC NORTHWEST NATIONAL LABORATORY

The tragic events of Sept. 11, 2001 made clear the critical need to develop and deploy new and different ways to protect the nation. And the Department of Energy's Pacific Northwest National Laboratory draws upon its nuclear heritage, broad scientific capabilities and national security expertise to do just that.

"In October 2002—13 months after Sept. 11—we powered on the first radiation detector designed to detect potential threats by scanning international cargo for radiation sources at U.S. borders," said Tony Peurrung, associate laboratory director for national security. "Before 9/11, there wasn't a single radiation portal monitor (RPM) deployed at our country's borders. Today, U.S. Customs and Border Protection uses the nearly 1,400 RPMs installed in the last 10 years to scan 100 percent of privately owned vehicles and cargo at U.S. land border crossings and 99 percent of all cargo arriving in the U.S. by sea," he said.

PNNL supports the Department of Homeland Security's effort to deploy these systems, which are capable of detecting radiation emanating from nuclear devices, dirty bombs, special nuclear materials, natural sources, and isotopes commonly used in medicine and industry.

"This is an example of how we embrace our mission to lessen the threat of weapons of mass destruction or mass effect—which include terrorism or cyber-attacks that could severely impact the health and welfare of our society and the economy," Peurrung said.

While PNNL's national security work intensified in response to 9/11, it started five decades ago with strong roots in radiological and nuclear work and has grown in breadth and impact ever since.

Detection and protection

PNNL builds upon its radiological detection expertise to support detection of trace amounts of radioactivity that could be evidence of nuclear explosions around the world, including underground tests of nuclear weapons.

For example, one technology developed in the late 1990s analyzes air samples for radioactive xenon. Another detects fission products in the form of particulate debris from atmospheric nuclear explosions. Both technologies were transferred to a commercial partner that manufactures safety and diagnostic equipment and were recognized with a Federal Laboratory Consortium award for technology transfer in 2000.

One novel approach to detecting conventional explosives "sniffs" the air similar to the way bomb-sniffing dogs can detect trace amounts of explosives. This direct, real-time vapor detection technology samples the air and converts the small number of explosives molecules to ions that can then be detected and identified almost instantaneously. While this technology is only in the prototype stage, it has the potential to revolutionize security operations including airport screening, port security and military applications.

On the chemical and biological weapons front, PNNL scientists solve research and development challenges related to chemical and biological detection and forensics. Their work focuses on identifying appropriate "signatures" for these agents, collecting and preparing samples, and developing detection and analysis technologies.

Aiding first responders

Being the first to respond to major events—whether natural or manmade—comes with its own challenges. Over the years, PNNL has helped develop tools for first responders that lighten their load as well as provide tools to help them understand and address the situation more quickly.

PNNL researchers devised a small, inexpensive microscopic lens that can be printed with a 3-D printer and attached to a smart phone camera to produce up to 1000x magnification, which makes it possible to see tiny anthrax spores and plague cells.

Back in 1996, a PNNL-developed, three-dimensional ultrasound medical imaging device for Army MASH units was tested by the Army in Bosnia. The system allowed medics in the field to share images electronically with other doctors and specialists who could then help with diagnoses and treatment.

On a global scale

As early as 1997, PNNL was helping equip and train the law enforcement officials whose job is to thwart the trafficking of chemical, biological or nuclear materials across international borders. PNNL staff members have assisted officials from more than 60 countries in the interdiction of weapons of mass destruction through training at the Volpentest Hazardous Materials Management and Emergency Response Federal Training Center, or HAMMER, which is located on the Hanford Site.

PNNL global security experts also engage with foreign nationals from as many as 100 countries a year to enhance global security through a variety of means including technology assessments, energy security, and remote monitoring and response.

Just last December, PNNL staff members participated in an integrated field exercise in Jordan to simulate an on-site inspection. Those participating in the fictional exercise, which was organized by the Preparatory Commission for the Comprehensive Nuclear Test Ban Treaty Organization, had to determine whether a nuclear explosion had been conducted.

Airport security

It's hard to travel through a major U.S. airport without walking through a scanner developed by PNNL and licensed for commercial use. Unlike metal detectors, the millimeter-wave holographic scanning technology can detect nonmetallic weapons or explosives, even if they are concealed under clothing. This technology's roots date back to the 1970s when PNNL was a pioneer in developing 3-D holograph imagery for nondestructive evaluation of nuclear reactors. The whole-body scanner was first patented in 1995 and licensed in 2003 for security applications. Just five years later, the first scanner was deployed at the Los Angeles International Airport. Today, there are more than 1,300 systems in 250 airports across the country and around the world.

Expanding on this approach, PNNL is developing a technology that could bring an end to having to remove your shoes as part of airport security measures. Researchers are exploring the use of low-profile millimeter-wave arrays that could be integrated into the floor of the body scanners to also scan the soles of passengers' shoes as they pass through.

Safety on the cyber front

Cybersecurity is a hot topic these days. PNNL is developing tools and approaches, some made possible by recent advances in science, to discover and analyze evolving threats so that quick action can be taken both to stop the attack and determine its source.

One such tool is called MLSTONES, which stands for Machine Learning String Tools for Operational and Network Security. It allows analysts to share signatures of threats with others, without sharing sensitive data. By leveraging technologies and methods from biology and DNA research, PNNL researchers have translated biology and bioinformatics concepts onto cyber defense data. For example, one process creates cyber "proteins." Analysts can learn the function of a cyber protein by its relationship to those that are similar—much like the process biologists use to discover similar proteins. Analysts can look for the defining characteristics of a "family of behaviors" that could be used to identify and attribute new threats based on similarities to events they have seen before.

Looking ahead

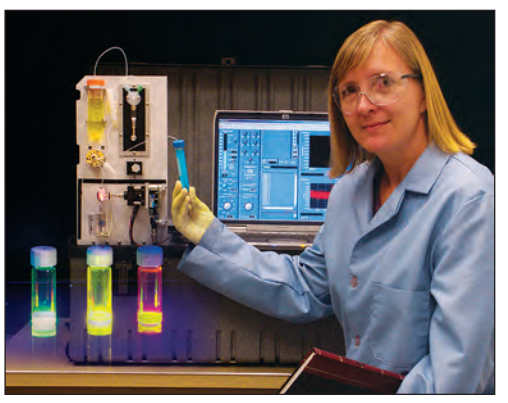
PNNL will continue advancing national security solutions, whether that means coming up with entirely new tools or improving existing technologies with new capabilities, in support of DOE's National Nuclear Security Administration, the Department of Homeland Security and other sponsors. These methods and solutions have to evolve just as the threats evolve, especially in areas such as chemical and biological warfare and cybersecurity.

"Our national security work is thriving because we have a whole national laboratory behind us," Peurrung said. "We leverage the breadth and depth of PNNL's science and technology to deliver innovations to protect the nation."

Owned by the U.S. Department of Energy; operated by Battelle; and supported by academic, industrial and governmental collaborators, Pacific Northwest National Laboratory is celebrating 50 years of inspiring and enabling the world to live prosperously, safely and securely. Interdisciplinary teams at PNNL address many of America's most pressing issues in energy, the environment and national security through advances in basic and applied science. With an annual budget of about $1 billion and nearly 4,300 staff members, Battelle is the largest employer in the Tri-Cities.

Learn more about PNNL at **www.pnnl.gov** and through stories to commemorate 50 years of scientific discovery contributed by employees, retirees and the community at **www.celebrate.pnnl.gov**.

In 1998, Vice-president Al Gore learned about PNNL's Scene Pro technology—an interactive system that could enable law enforcement personnel to quickly capture, store and relay vast amounts of information at crime scenes and other field scenarios.



The Biodetection Enabling Analyte Delivery System, or BEADS, developed by PNNL could be used to detect protein signatures including E. coli, salmonella, ricin and other toxins or biological weapons with high specificity and high sensitivity in dirty environments.

Researchers at PNNL's Radiochemical Processing Laboratory advance radiological material processes and solutions for environmental, nuclear and national security initiatives. Specialized capabilities, along with the ability to receive and prepare highly active and dispersible materials, enable research not available elsewhere.

PNNL developed the Acoustic Inspection Device to help identify the contents of sealed containers. For nearly 20 years, PNNL has trained officials from around the world to use this technology and others to help detect materials or components of weapons of mass destruction being shipped across borders.