Muon Vision for U.S. National Security

Muon vision could help ensure that shipping containers do not contain dangerous radioactive materials or other contraband. (Photo: DSIC)

Every year, more than 16 million vehicles and shipping containers enter the United States through its ports of entry. Suppose a nuclear bomb, a dirty bomb, or enough radioactive material to make a bomb is hidden in one them—how do we prevent nuclear terrorism?

Scientists at Los Alamos have responded to what President Barack Obama calls "the single biggest threat to national security" by proposing a new technology—muon vision—that is specifically designed to detect nuclear materials hidden inside vehicles and containers (see "What is Muon Vision?" page 39). In 2006, Los Alamos partnered with Decision Sciences International Corporation (DSIC) and granted DSIC an exclusive contract to develop and commercialize the Lab's muon vision system.

Currently, passive radiation monitors, much like giant Geiger counters, are the main screening tools looking for nuclear contraband. These monitors detect the gamma-ray and neutron radiation given off by uranium, plutonium, or other nuclear materials.

However, not all ports have these monitors, and those that do can experience false positives from unexpected sources. For example, crates of bananas or sacks of water-softening chemicals can set off these monitors because both contain trace amounts of potassium-40, a radioactive isotope of potassium. The glazes of certain ceramics contain radioactive uranium isotopes that also set off the monitors. Tracking down those false positives wastes valuable time and resources.

Furthermore, these radiation monitors are not capable of finding radioactive materials that are shielded—for example, hidden inside lead containers. The walls of a thick lead box, for instance, will stop (absorb) uranium's gamma rays before they escape, thereby removing the telltale radiation signal that the current radiation monitors need for effective detection. A 50-pound "cube of terror" (about the size of a half-loaf of bread) of highly enriched uranium, which is enough to make a nuclear weapon, can pass through a port without detection.

One defense is to use a very powerful x-ray machine, which would definitely "see" the lead box but could not look inside or identify the contents as nuclear material. In addition, powerful x-ray machines are massive and need lots of electrical power, which means they are very expensive to build and operate. The high voltage and lethal x-rays these machines produce also make them dangerous for

port-of-entry security staff to operate. And what if an interrogated truck is smuggling human cargo?

Muon vision offers a different approach that is potentially less expensive to build and operate and uses no dangerous radiation. DSIC's Multi-Mode Passive Detection System (MMPDS), which has been operating in Freeport, Bahamas, since 2012, safely scans cargo containers, often in about a minute or less.

In April 2015, the Department of Homeland Security's Domestic Nuclear Detection Office successfully completed the final testing phase of its five-part system characterization of the MMPDS at Freeport, bringing muon vision much closer to possible widespread deployment in U.S. border security.

Treaty verification

Muon vision has great potential for solving other challenges to U.S. national security. For example, the State and Defense Departments are partnering with Los Alamos to develop a variation of muon vision that could be a game changer in solving challenges in nuclear weapons treaty verification.

The New Strategic Arms Reduction Treaty limits the number of nuclear warheads deployed on intercontinental ballistic missiles and on submarine-launched ballistic missiles. Inspections are needed to verify compliance, but the treaty proscribes current detection and monitoring methods.

So, how can inspectors see under a missile's nose cone to verify the number of warheads inside? In some cases, a missile might even be loaded with decoy warheads to fool ballistic-missile-defense systems. Verification of the number of warheads would require taking the nose cone off the missile and opening the warheads. The major problem is that militaries refuse to show one another what the insides of their nuclear missiles look like. But even if they did, imagine the labor, cost, and risk involved in removing nuclear missiles from submarine launch tubes or missile silos, disassembling the nose cones and warheads, verifying the number of warheads, reassembling everything, and then returning the missiles to their launch tubes or silos.

But muon vision could solve these challenges. Setting up muon detectors on either side of a submarine, for example, could, in principle, safely, quickly, and inexpensively verify the number of warheads and potentially do so without revealing military secrets.

Interrogating nuclear fuel storage containers

The National Nuclear Security Administration's Office of Global Material Security is investing in muon vision as a potential tool for the International Atomic Energy Agency's nuclear inspectors to monitor spent nuclear fuel inside storage containers. The Laboratory's muon team is currently testing the feasibility of this capability at Idaho National Laboratory.

Beyond nuclear screening

Recently, DSIC demonstrated that its MMPDS can combine muon vision with an electron detection technology that is more sensitive to "seeing" less-dense materials. When used together, these technologies might identify items such as conventional explosives, precursor chemicals to make explosives, narcotics, tobacco, and alcohol. So security staff can not only "see" heavily shielded radiological threats, but they can also locate less-dense contraband being smuggled into the country—a step in the right direction for improving national security.

~Necia Grant Cooper

A truck passes through a pair of muon vision detectors—one in the ceiling and one in the floor—of the MMPDS muon scanner at Freeport, Bahamas. (Photo: DSIC)