Science and Technology

New Device Can Accurately Detect Distinct Radiation Types

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Courtesy/Lawrence Berkeley National Laboratory
This portable radiation detection device, known as Cryo3, is able to distinguish between harmful and benign forms of radiation.

Ten years after the dissolution of the Soviet Union, the arms race has been reinvented as a competition between terrorism and vigilance, although the shadow cast by nuclear weapons remains unchanged.

Radiation detection technology under development at Lawrence Berkeley National Laboratory may make the surreptitious transport of nuclear material a much more daunting task, allowing governments to stay one step ahead of atomic terrorism.

A team led by Berkeley lab engineer Lorenzo Fabris has constructed a 10-pound, portable radiation detection device called Cryo3 that uses semiconductor technology to image radioactivity with extraordinary alacrity.

The power of the Cryo3 can distinguish between fissionable material, used to construct nuclear weapons, and harmless isotopes used in medicine.

"The applications of this innovation are much broader now," said Fabris, "You can have lab quality equipment available in the field."

At the heart of the device is a crystal composed of the semiconducting element germanium.

The crystal is cooled to approximately 186 degrees Celsius, limiting its ability to carry charge or maintain a voltage.

Incident X-ray and gamma ray emissions from nuclear material introduce so-called "charge carriers" to the crystal, inducing an easily measured voltage proportional to the radiation density.

This information is read out by the detector as a series of peaks, each of which correspond to a radioactive isotope present in the vicinity.

"The beauty of using germanium is that the uncertainty is very small so you can distinguish peaks that other materials could not," said Fabris, "(Through investigation) you can assign peaks to certain isotopes."

Traditionally, a device known as a Geiger counter was used to detect radiation, but the new Berkeley lab technology offers many advantages over this approach.

The new device can also gauge the amount of nuclear material present, which was not possible in the past.

A major difficulty in moving this technology from the lab to the field was the traditional use of complex liquid nitrogen systems to achieve the low temperatures required.

Berkeley lab scientists eliminated this roadblock by using a compact battery-powered cooling device typically employed to cool low-noise cellular phone antennae.

"(To use the device,) you used to have to have with you liquid nitrogen, which is heavy and bulky," said Fabris, "The innovation is using a mechanical cooler instead."

Increasing the efficiency of the detector by eliminating electronic noise was another major hurdle for researchers.

This was accomplished through the use of a custom-built pre- amplifier that met portability requirements by only needing a small battery.

Development of the detection system began as a way to aid international weapons inspectors in verifying treaty compliance, but the researchers predict the technology will cross over into counterterrorism.

"The next step will be to make bigger and more efficient detectors," said Fabris, "(We will attempt to) make them more portable and with a longer operating life."