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Quantum Calorimeter Gamma-ray Detectors: New Tools for Non-proliferation[1]

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High resolution γ-ray spectroscopy is an important tool for non-destructive analysis of nuclear materials and is often used by safeguards inspectors to help verify the inventories of nuclear materials held around the world. The energy spectrum of photons emitted from isotopes of uranium or plutonium in the $40 - 1000$ keV energy range give unique signatures that, if accurately measured, give inspectors important information about the age and enrichment of the material and therefore its intended purpose. In this talk I will describe recent work by a team of researchers from the Unversity of Denver, the National Institute of Standards and Technology, and Los Alamos National Laboratory on γ-ray spectrometers with more than an order of magnitude improvement in energy resolution over standard techniques. The heart of this improved tool for non-proliferation is a microcalorimeter γ-ray detector that combines a micromachined thermal isolation structure with a bulk absorber and a highly sensitive superconducting transition-edge thermometer optimized for operation well below 1 K. In the last several months, we have assembled and tested arrays of these microcalorimeters, with many detector pixels on a single chip. When read out with SQUID multiplexers, these arrays dramatically increase the speed of data collection, allowing ultra-high resolution γ-ray spectra to be acquired in roughly the same time needed for traditional detector technologies. In addition to presenting high-resolution γ-ray spectra of nuclear materials such as plutonium, I will describe the physics of the microcalorimeter, which ranges from the lifetime of quasiparticles in bulk superconductors to the thermal properties of glue.

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