

## Low-Temperature Detectors for High Precision Measurements

Mark Croce, Nuclear Engineering and Nonproliferation Division, Los Alamos National Laboratory

Low-temperature microcalorimeter detectors are creating transformative new capabilities in nuclear material analysis, nuclear data measurements, and nuclear science. With 10-50 times better energy resolution than semiconductor detectors, the development of microcalorimeters is intended to allow better observation of spectral signatures in a variety of applications. Extensive technology development over the past several years is now enabling the first deployed microcalorimeter instruments and quantitative performance evaluation with real-world nuclear material samples. We will present an overview of the LANL Low Temperature Detector program which focuses on three categories of microcalorimeter technology: X-ray, gamma-ray, and decay energy spectroscopy. The X1 X-ray fluorescence microcalorimeter spectrometer and the SEM-coupled Hyperspectral X-ray Imaging instrument bring capabilities to the regular laboratory that were previously only available at synchrotrons. Ultra-high resolution enables chemical speciation through subtle features in the X-ray emission spectrum resulting from chemical bonding. The SOFIA (Spectrometer Optimized for Facility Integrated Applications) compact gamma spectrometer and a larger instrument being built for an analytical laboratory will be the first two microcalorimeter instruments deployed to nuclear facilities, with on-location measurement campaigns beginning this year including at Oak Ridge National Laboratory. The SOFIA instrument is already being used to improve nuclear data and plutonium isotopic analysis, evaluate direct U-238 and Np-237 quantification, and quantify actinide signatures in spent fuel materials. Decay energy spectroscopy, as a new radiometric method with sensitivity and precision to complement mass spectrometry, is being evaluated for applications spanning safeguards to basic science: uranium, plutonium, actinide-containing waste, medical isotopes, electron capture spectroscopy for neutrino mass determination. We look forward to the opportunity to present our program, and discuss how low-temperature detector technologies may contribute to new applications.