Transforming Inorganic Scintillators Into Neutron Spectrometers

Joseph O'Neill[1,2]
[1]University of Birmingham, UK, [2]University of Surrey, UK

Scintillator materials capable of dual-mode gamma-neutron detection are of vital importance to the nuclear energy and national security sectors, as well as to fundamental scientific research. Inorganic scintillators such as $LaCl_3$(Ce), $LaBr_3$(Ce), and $CeBr_3$ offer high light yields, fast emission times, and exhibit intrinsic fast-neutron sensitivity via (n,p) and (n,α) reactions.

$LaCl_3$(Ce) and $LaBr_3$(Ce) scintillators can typically distinguish neutron and gamma scintillation signals using pulse shape discrimination (PSD); however, their performance varies significantly between samples and depends strongly on dopant concentration and material purity. Recent work has explored advanced waveform analysis techniques to greatly improve discrimination performance, by up to 300%. In this work, we demonstrate the use of fast Fourier transform-based analysis to perform neutron spectroscopy measurements with $LaCl_3$(Ce) and $LaBr_3$(Ce) detectors.

Furthermore, while $CeBr_3$ exhibits negligible conventional PSD capability, we show clear separation of neutron-induced gamma, proton, and alpha particle signals arising from fast-neutron interactions using this analysis method. This presents benfits from both neuton spectrometry and from greatly improved neutron signal suppression in mixed-field environments.