

Homeland Security & Threat Detection

Radiation identification at borders, transit hubs, and in the field demands both high gamma resolution and confirmed neutron sensitivity. ScintIQ detectors built on CLYC, CLLBC, NaI(Tl), and LaBr₃(Ce) crystals cover the full range: from wide-area search to single-isotope confirmation in a RIID.



ScintIQ scintillation detector assemblies with integrated photomultiplier tubes.

APPLICATION BRIEF · SCINTIQ CUSTOM SCINTILLATION DETECTORS · dc-62023201

The Detection Challenge

Threats at a port of entry do not announce themselves. Shielded special nuclear material (SNM), improvised radiological devices, and smuggled medical isotopes all present weak, sometimes heavily scattered signatures. A detector that misidentifies a naturally occurring radioactive material (NORM) as a threat triggers costly false alarms. One that fails to flag a genuine weapon-grade source is a catastrophic gap.

Three capabilities define a credible homeland security detector. First, energy resolution: the sharper the gamma spectrum, the more confidently the algorithm separates Cs-134 from Cs-137 at 605 and 662 keV, or uranium from radium by the pattern of their lines. Second, neutron sensitivity: plutonium emits neutrons by spontaneous fission and highly enriched uranium emits few, so a neutron channel flags the plutonium case and neutron sources, and a crystal that responds to both gammas and neutrons carries both channels in one instrument. Third, speed: a RIID carried by a first responder or mounted in a portal must reach an identification in seconds, not minutes.

No single material is optimal for every scenario. Berkeley Nucleonics ScintIQ detectors are configured to match the mission: RIID hand-holds, walk-through portal monitors, vehicle search, backpack search systems, and fixed-site monitoring all place different demands on crystal size, resolution and ruggedness.

Why Resolution and Neutron Capability Matter for Isotope ID

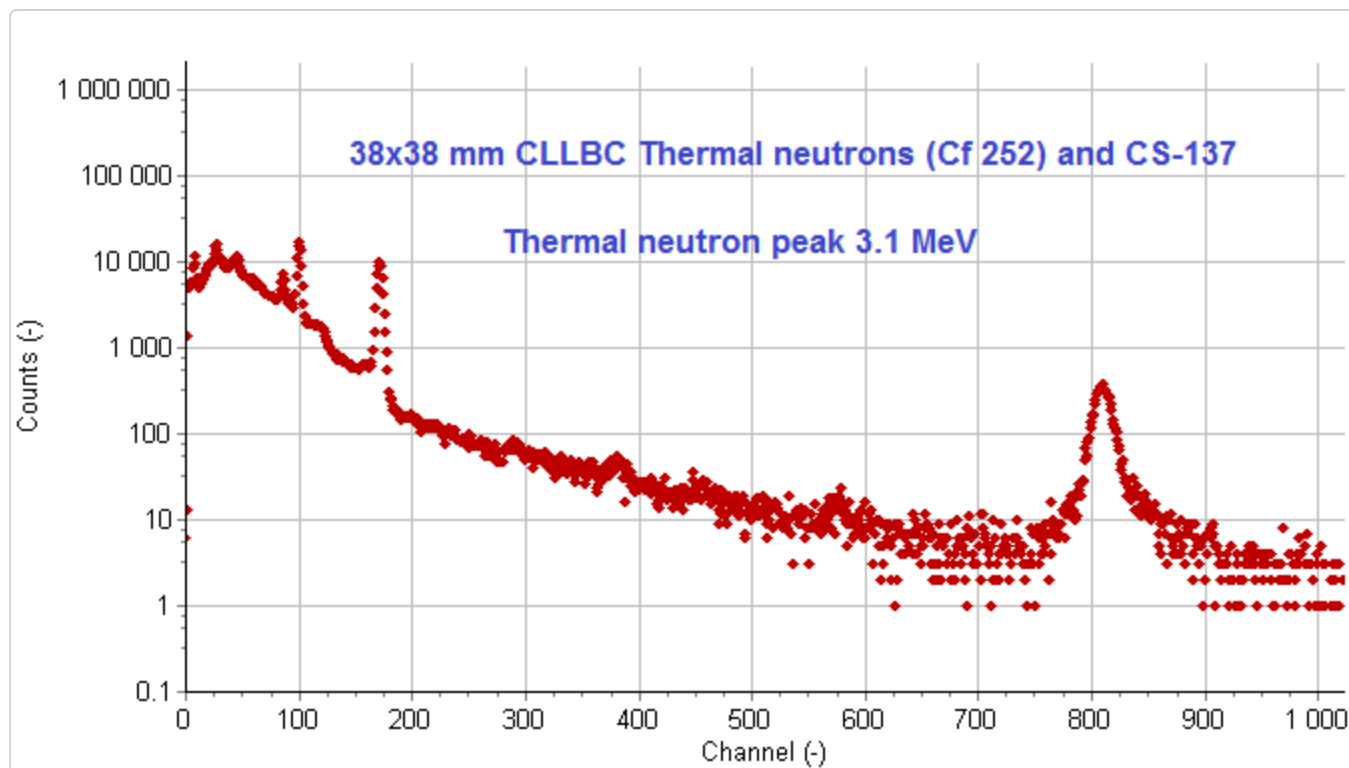
Gamma energy resolution is expressed as the full-width at half-maximum (FWHM) of a photopeak, given as a percentage of peak energy. NaI(Tl), the longstanding workhorse of radiation search, delivers roughly 7% resolution at 662 keV. That is adequate for broad categorization. But separating Cs-134 from Cs-137, or the Eu-152 lines from a mixed industrial source, requires better performance; the U-235 and Ra-226 lines at 185.7 and 186.2 keV are beyond any scintillator, and an identifier separates those two by the rest of each pattern.

LaBr₃(Ce) narrows that window to 3.0% at 662 keV, about 2.3 times sharper than NaI(Tl). The gain is most significant at lower energies, where isotope-specific photopeaks cluster and overlap. A higher-resolution spectrum means the identification algorithm can run with higher confidence and lower false-positive rates, directly reducing alarm fatigue for operators.

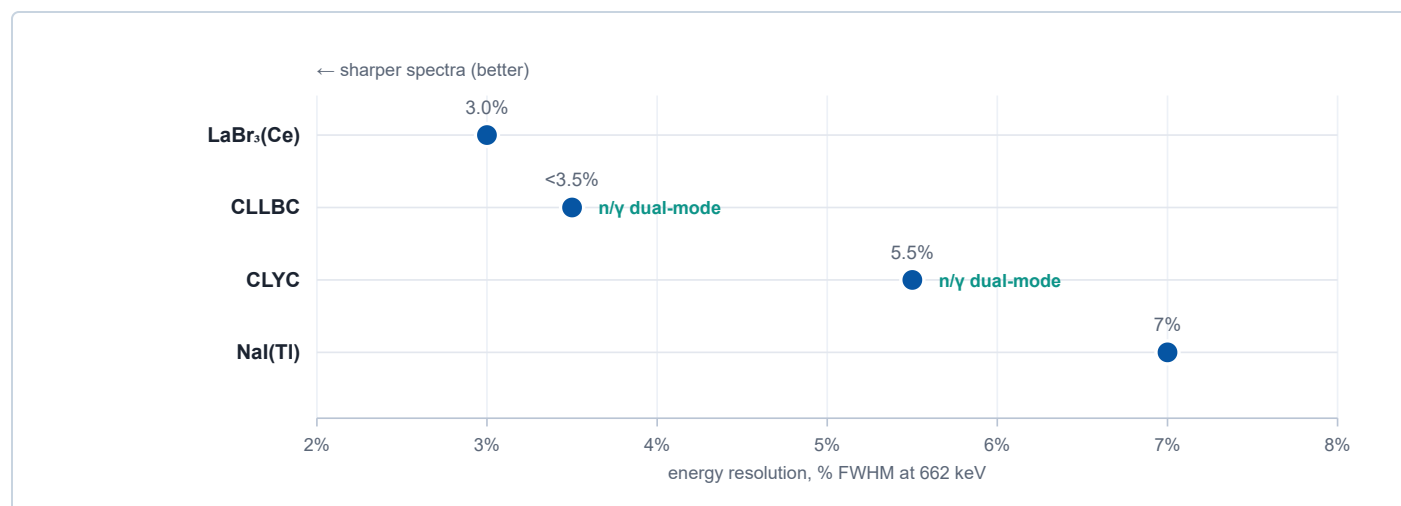
Neutron detection is the other critical axis. Plutonium isotopes emit spontaneous fission neutrons, and neutron sources such as AmBe and Cf-252 are neutron emitters in their own right. A detector sensitive only to gamma radiation does not see that channel at all. **CLYC** (Cs₂LiYCl₆:Ce) and **CLLBC** (Cs₂LiLaBr_{4.8}Cl_{1.2}:Ce) are dual-mode crystals: the Li-6 content captures

thermal neutrons, while the same crystal simultaneously records the gamma spectrum. Pulse-shape discrimination (PSD) cleanly separates neutron events from gamma events in the signal processing chain, with no need for a separate neutron detector module.

This matters operationally. A single compact CLYC or CLLBC detector replaces a gamma crystal plus He-3 tube (increasingly supply-constrained and expensive), reduces instrument size and weight, and simplifies the electronics chain. The neutron channel adds an independent signature: a neutron count above background means a neutron emitter is present, which separates plutonium and neutron sources from a gamma emitter with a similar spectrum. The reachback analyst adjudicates what that emitter is.



■ **MEASURED** Figure 1. A 38 x 38 mm CLLBC crystal exposed to a Cf-252 neutron source and Cs-137 (CLLBC datasheet). The thermal neutron capture peak at 3.1 MeV electron-equivalent is separated from the gamma spectrum, which is what lets one crystal carry both channels.



■ **DERIVED** Figure 2. From the ScintIQ datasheets: energy resolution at 662 keV. CLYC and CLLBC add confirmed neutron response to gamma spectroscopy, which is what lets one instrument carry the full threat signature.

ScintIQ Materials for Homeland Security

Four crystal families address the range of homeland security use cases. Each has a distinct performance profile.

CLYC

CLLBC

Nal(Tl)

LaBr₃ (Ce)

Table 1.

Material	Density (g/cm³)	Energy Resolution @ 662 keV	Neutron Detection	Primary Role
CLYC	3.31	4.5–5.5%	Yes (Li-6, PSD)	RIID, SNM confirmation, dual-mode search
CLLBC	4.08	<3.5%	Yes (Li-6, PSD)	High-resolution RIID, upgraded dual-mode
Nal(Tl)	3.67	~7%	No	Portal monitors, wide-area search, vehicle scan
LaBr ₃ (Ce)	5.07	3.0%	No	Precision RIID, isotope library confirmation

CLYC: The Dual-Mode RIID Crystal

CLYC delivers a moderate gamma resolution of 4.5 to 5.5 percent at 662 keV alongside confirmed thermal neutron sensitivity through its 96 percent enriched Li-6 (light output about 20,000 photons per MeV, roughly half of Nal(Tl)). Its tri-component decay time (1 ns, 50 ns, and 1 microsecond components) enables the pulse-shape discrimination that separates neutron events from gamma events in software. The result is a single crystal that satisfies both the gamma-ID and neutron-alarm requirements of modern RIID standards. CLYC is hygroscopic and requires hermetic packaging, standard for field-deployed detectors.

CLLBC: Higher Resolution, Same Dual-Mode Capability

CLLBC pushes the dual-mode concept further. By substituting lanthanum and bromine into the lattice (Cs₂LiLaBr_{4.8}Cl_{1.2}:Ce), the crystal achieves a photoelectron yield of 70 percent of Nal(Tl) and a gamma resolution under 3.5 percent at 662 keV, half the Nal(Tl) figure. This makes CLLBC the preferred choice when a RIID must resolve closely spaced isotope lines while still confirming neutron presence. The density of 4.08 g/cm³ also improves stopping power relative to CLYC. CLLBC is hygroscopic; appropriate detector housings are required.

Nal(Tl): Large-Format Search and Portal Monitoring

Nal(Tl) remains the dominant crystal for systems where detection efficiency matters more than resolution. Its light yield of 100 (the reference standard), low cost per volume, and mature production base make it practical in large-area panel configurations, vehicle portal monitors, and hand-held search instruments. A 7% resolution at 662 keV is sufficient for the gross isotope categorization (NORM vs. SNM vs. medical) that portal algorithms require. Nal(Tl) is hygroscopic; all ScintIQ Nal assemblies ship in sealed aluminum or stainless housings with hermetic optical coupling.

LaBr₃(Ce): Precision Spectroscopy in the Field

Lanthanum bromide brings laboratory-grade resolution to field instruments. At 3.0% FWHM at 662 keV (versus 7% for Nal), LaBr₃ produces spectra tight enough to resolve isotope doublets that would otherwise merge. Its fast decay time (16 to 20 ns) allows high count-rate operation without pile-up, useful at checkpoints with high cargo throughput. The intrinsic La-138 background emission (at 1436 keV and 789 keV) is a known artifact, well-characterized and easily accounted for in isotope ID libraries. LaBr₃ is hygroscopic and is supplied in sealed detector assemblies.

Mission Profiles and Detector Matching

Homeland security detection spans several distinct operational contexts. The crystal choice follows from the mission.

Radiation Isotope Identification Devices (RIIDs)

A RIID is a hand-held instrument carried by CBP officers, first responders, and military EOD teams. It must identify an isotope in seconds while the user is moving. The highest-value configurations pair CLLBC (for dual-mode, high-resolution spectroscopy) or LaBr₃ (for maximum gamma resolution) with compact SiPM readout electronics. CLYC is the established alternative when the neutron channel matters more than the last point of resolution.

Portal Monitors and Fixed-Site Systems

Vehicle portals and pedestrian walk-throughs require large sensitive volumes and fast throughput. NaI(Tl) panel arrays are the standard configuration. Typical panels range from 2 to 4 liters of crystal volume per side. ScintIQ NaI(Tl) detectors are available in custom rectangular and cylindrical geometries, with large volumes quoted to the frame design. For upgraded portals where isotope identification is required beyond simple alarm triggering, LaBr₃ modules can supplement NaI panels as secondary confirmation detectors.

Backpack and Standoff Search

Mobile search teams at large events or wide-area surveys use backpack-form detectors that must balance sensitivity with wearable weight. NaI(Tl) in 2-inch cylindrical or 3x3 inch geometries is typical here. For missions where neutron detection is specifically needed (SNM interdiction sweeps), CLYC in a compact housing provides simultaneous gamma and neutron mapping without requiring a separate He-3 instrument.

Radiological Emergency Response

First-responder teams assessing a suspected radiological dispersal device need to characterize the source quickly and from a safe standoff. LaBr₃ detectors, with their fast decay and sharp resolution, allow shorter integration times at distance. CLYC or CLLBC adds the neutron channel that flags a neutron emitter; the incident commander sets the initial protective action on the dose rate, and the reachback analyst adjudicates the identification.

Configure a ScintIQ Detector for Your Mission

Berkeley Nucleonics engineers work with program managers and system integrators to specify crystal geometry, readout, housing, and electronics for each application. Contact us to discuss RIID-grade CLYC or CLLBC assemblies, large-format NaI portal configurations, or LaBr₃ precision ID modules.

Email: info@berkeleynucleonics.com · **Phone:** 800-234-7858

Berkeley Nucleonics Corp.

Test, Measurement and Nuclear Instrumentation since 1963
For details: info@berkeleynucleonics.com or 800-234-7858

Application Brief

ScintIQ Custom Scintillation Detectors | dc-62023201