

# HAZARD AND THREAT DETECTION

APPLICATION NOTE

**sensL**  
SENSE LIGHT

## BENEFITS OF USING AN SPM

### COMPACT AND RUGGED

The SPM is a solid state detector that requires minimal packaging resulting in a very compact form factor and making it ideal for miniaturization and portability.

### LOW OPERATING VOLTAGE

Requiring just ~30V bias omits the need for bulky, heavy and costly HV supplies providing further benefit to portable applications. They can even be battery powered.

### LOW COST

SensL SPM detectors are bulk manufactured in an ISO9000 controlled semiconductor foundry, resulting in a low cost alternative to the PMT.

### PROVEN PERFORMANCE

SensL's prototype hand held personal detector has shown excellent energy resolution across a wide range of energies.

## MARKETPLACE APPLICATIONS

### X-RAY SCANNING

X-ray scanning of cargo, vehicles, baggage and personnel via portal monitor at borders and ports to look for contraband

### RADIATION SPECTROSCOPY

Radiation Spectroscopy portal monitors for detection and identification of illicit radioactive sources at borders and ports, distinguishing them from background and permitted sources.

### AREA MONITORS

Area Monitors at critical locations to give a prior warning of threats and ensure a rapid response

### ISOTOPE IDENTIFIERS

Isotope Identifiers to form part of the rapid first response to any detected threat that will allow the type of radioactive substance to be identified and appropriate action taken.

### DOSE METERS

Dose Meters for continual monitoring of radiation levels

### PERSONAL MONITORS

Personal Monitors to be worn by workers in certain industries or at strategic locations at risk of threats or hazards, to warn any of unexpected levels of radiation present.



## Market Overview

Hazard and threat detection refers to a broad range of applications that aim to secure national infrastructure against nuclear incidents and contraband trafficking. Screening of cargo, vehicles, baggage and personnel via portal monitors at key entry/exit point can be used to prevent the transport of illicit goods. A more distributed monitoring system of strategic facilities and critical infrastructure can provide a rapid first response to any radiological threat or incident, as well as the day-to-day safeguarding of the nuclear industry.

The specifications demanded of each of these applications are challenging. For example, to identify the trafficking of radioactive materials and contraband at busy ports and border crossings, one must provide an effective means of detection without disrupting the flow of traffic or goods. This is further complicated by the fact that any illicit nuclear materials must be identified against a background of naturally occurring or legally transported radioactive material, such as medical isotopes. Therefore, high performance detectors are required to ensure the necessary sensitivity and specificity in a short time frame.

## Application: Portable Detectors

In order to minimize personal injury, infrastructure damage and disruption to services, an early warning and rapid response to a nuclear threat or accident is required. Early warning systems at strategic locations can be in the form of area monitors (a widely distributed network of low cost detectors combined with a smaller number of isotope identifiers) or as small, portable detectors worn by key workers such as law enforcement and first responders.

These portable detectors are technically some of the most challenging to produce as they should be compact and lightweight, rugged and unaffected by vibration and stray magnetic fields and low cost to allow for a high proliferation. The bulky and delicate PMT (Photomultiplier Tube) and the PIN and APD (Avalanche Photodiode) detectors that require more complicated support electronics have proved problematic. The SPM (Silicon Photomultiplier) has been shown to overcome these limitations.

There are three types of portable detector; personal dosimeters, personal radiation detectors and isotope identifiers;

**Personal Dosimeter:** These pager sized electronic devices track the total radiation dose received by the wearer. They are suitable for emergency responders who need to be notified if dangerous levels of radiation are present.

**Personal Radiation Detectors (PRD):** These pager sized electronic devices are used to find low levels of radiation using sensitive crystal scintillators. They are suitable for law enforcement or inspectors who need to be notified of any unusual levels of radiation in their proximity.

**Isotope Identifier:** These devices are typically larger than PRDs and measure the gamma-ray spectra to identify the originating isotope. This information is important in determining the appropriate response actions. They are suitable for HAZMAT teams, inspectors or specialized emergency response teams.

SPMs are ideally suited to provide a high performance solution to all three of these portable applications. When coupled to an appropriate scintillator, the SPM detector forms a sensitive and high resolution X- and gamma-ray detector.

## Benefits of a Silicon Photomultiplier

The Silicon Photomultiplier (SPM) is a technological breakthrough that finally provides a solid state substitute for the legacy vacuum photomultiplier tube (PMT). The PMT has remained in widespread use due to its high gain and stability coupled with a moderate QE (quantum efficiency). However, the SPM matches these characteristics while having the additional benefits of compactness, ruggedness, magnetic insensitivity, low power requirements and low cost, all of which provide huge benefits for use as the basis for X- and gamma-ray detectors in the hazard and threat detection field.

The SensL Silicon Photomultiplier is a single-photon sensitive, solid state detector, useful in the range of 380nm to 1000nm. Its novel structure results in a high gain ( $\sim 10^6$ ) that is achieved at low bias voltage ( $\sim 30V$ ). The output signal is a fast rise-time (of the order of 1ns) charge pulse, proportional to the number of photons incident on its surface. The technology has been developed using modern commercial semiconductor manufacturing which makes it highly scalable, exceptionally cost effective and with a rapid time to market.



### SensL Array4 - Large Area SPM Detector

SensL's Array4 is a large area SPM detector mounted in a low profile ceramic package. The detector is over-molded with epoxy to completely encapsulate the pixels, bondwires and substrate bondpads making it ideal for close-coupling to scintillators. The Array4 is designed to be used as either a pixellated 'position sensitive' detector or as a summed-output, single channel detector. In this latter mode, the Array4 has a total detection area of 13.4x13.4mm<sup>2</sup>. This is ideal for many of the portable radiation detector applications. In addition, the package has been designed so that an external TEC controller can be placed under the package for moderate cooling applications and/or temperature stabilization, which may be beneficial for applications in the field.

SensL has used an SPM to develop a prototype of a compact, pager-style radiation detection and identification system, using a SensL Array4 and cubic (12.5mm on side) CsI(Tl) scintillation crystal. Excellent sensitivity and stability were demonstrated. Data can be seen in Figure 2. The prototype is based on the block diagram shown below, which illustrates just how simple a system based on the SPM can be.

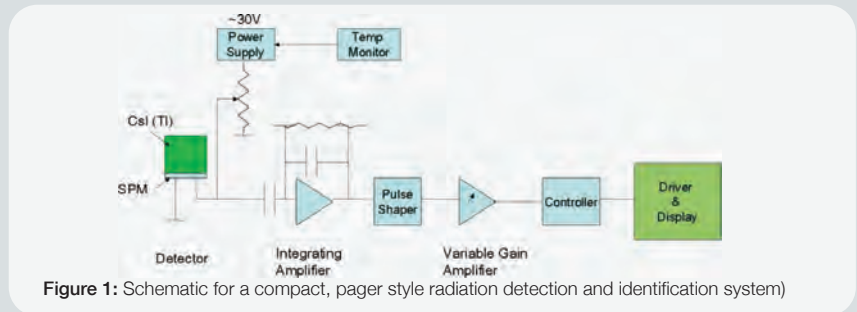


Figure 1: Schematic for a compact, pager style radiation detection and identification system)

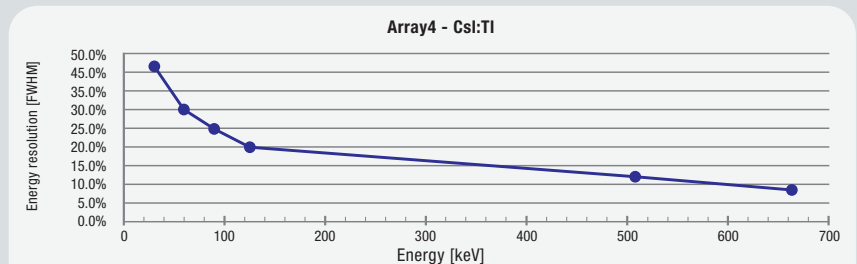


Figure 2: FWHM energy resolution obtained for different sources reading out a 12.5mm cube of CsI(Tl) coupled with optical grease to a SensL SPMArray4