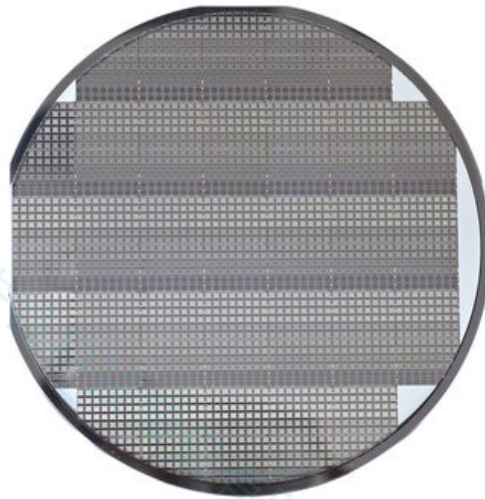


sensL

**Radiation detection
solutions for
miniaturized pager
and handheld markets**

Mission

Working with our customers we identify, design and deliver low light detection solutions which solve customer problems and add value. We aim to be the partner of choice because of our flexibility, capabilities and the desire to meet our customer needs.



Motivation

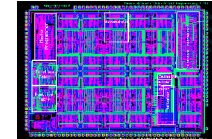
...is to provide a lower cost and technology enabling solid-state alternative to the vacuum tube based photomultiplier tube (PMT)...

Solid State

Vacuum Tube



Plasma TV (Bitzer/Gene Slottow)



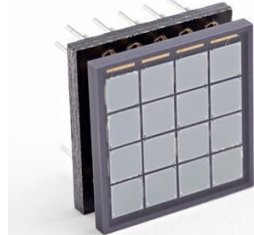
CMOS chip (174,569 transistors)



Silicon Transistor (Texas Inst.)



LED (Holonyak)



sensL SPMArray

1875

1900

1925

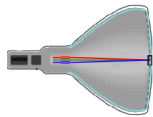
1950

1975

2000



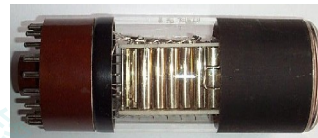
LightBulb (Edison)



CRT (Ferdinand Braun)



Vacuum Tube Diode (Fleming)



Photomultiplier Tube (RCA)

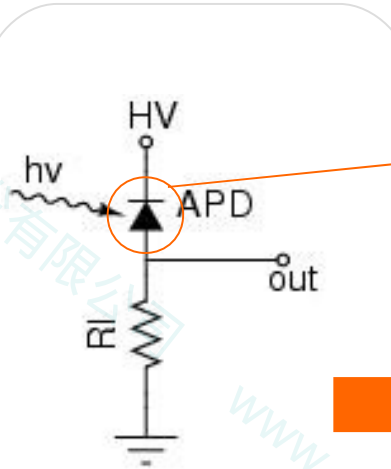


ENIAC (17,468 Tubes)

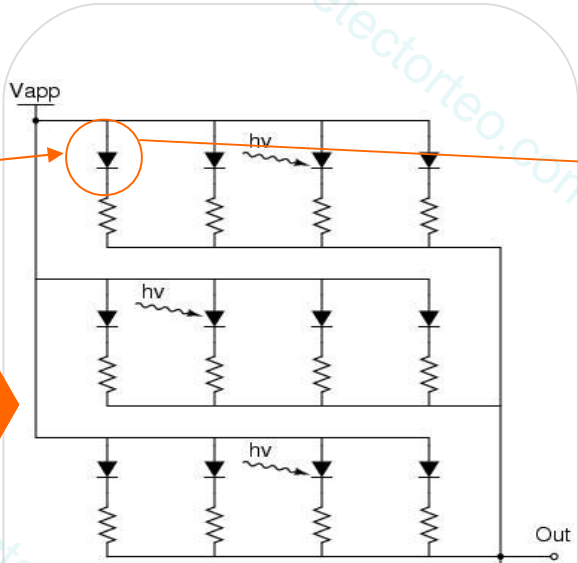
Introduction

- Silicon PhotoMultiplier (SPM) detectors are the next generation detector choice for handheld radiation detection
 - For radiation detection, protection and identification
- sensL offer a fully developed prototype system for radiation detection
- sensL seek partners to take this technology to the marketplace

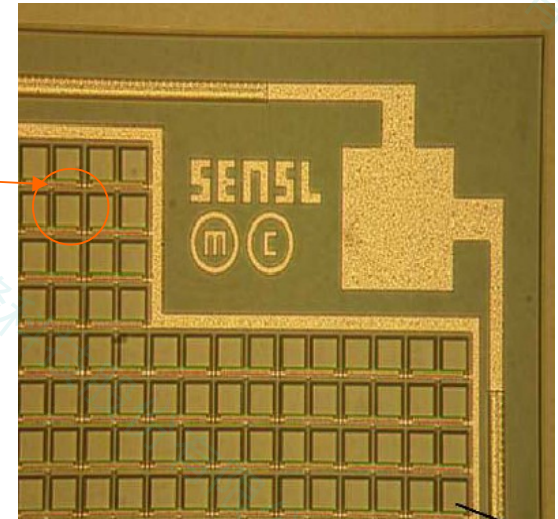
SPM concept



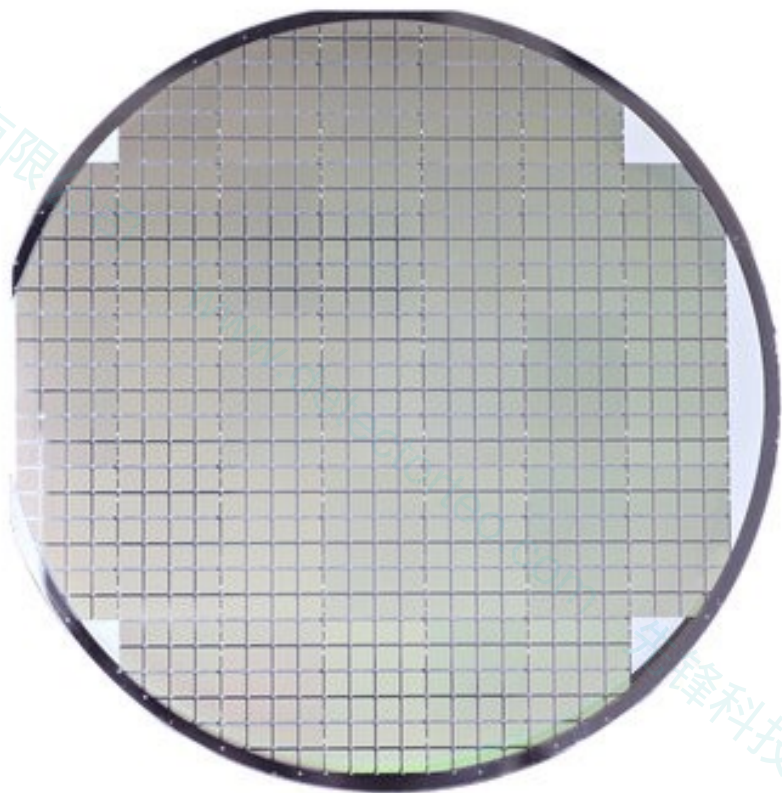
Geiger mode Detector
A photon counting diode detector fabricated in silicon forms the basis for all sensL products



Silicon Photomultiplier (SPM)
By fabricating large arrays of photon counting detectors, sensL create a high gain detector to replace the PMT



Where does an SPM come from?



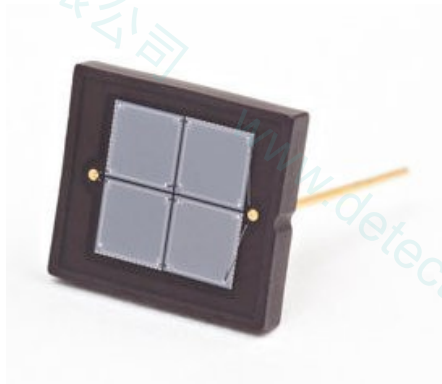
- sensL SPM detectors are bulk manufactured in a ISO9000 controlled semiconductor foundry
- sensL test and package to produce the best SPM products on the market

Why use SPM detectors?

- Compared to PMT detectors
 - Very small form factor
 - Rugged and immune to magnetic fields and vibrations
 - User safe voltages
 - Similar high gain
- Compared to PIN and APD detectors
 - Much higher gain – simpler system design
 - Much lower system cost and power
 - Less sensitive to bias and temperature change
 - Can operate at higher temperatures

SPM for radiation detection

SPM detectors detect light from scintillating crystals



SPM detector in robust ceramic package



Combination of crystal with a sensL SPM

Combining a SPM detector with CsI(Tl) crystals for example, allows radiation to be detected

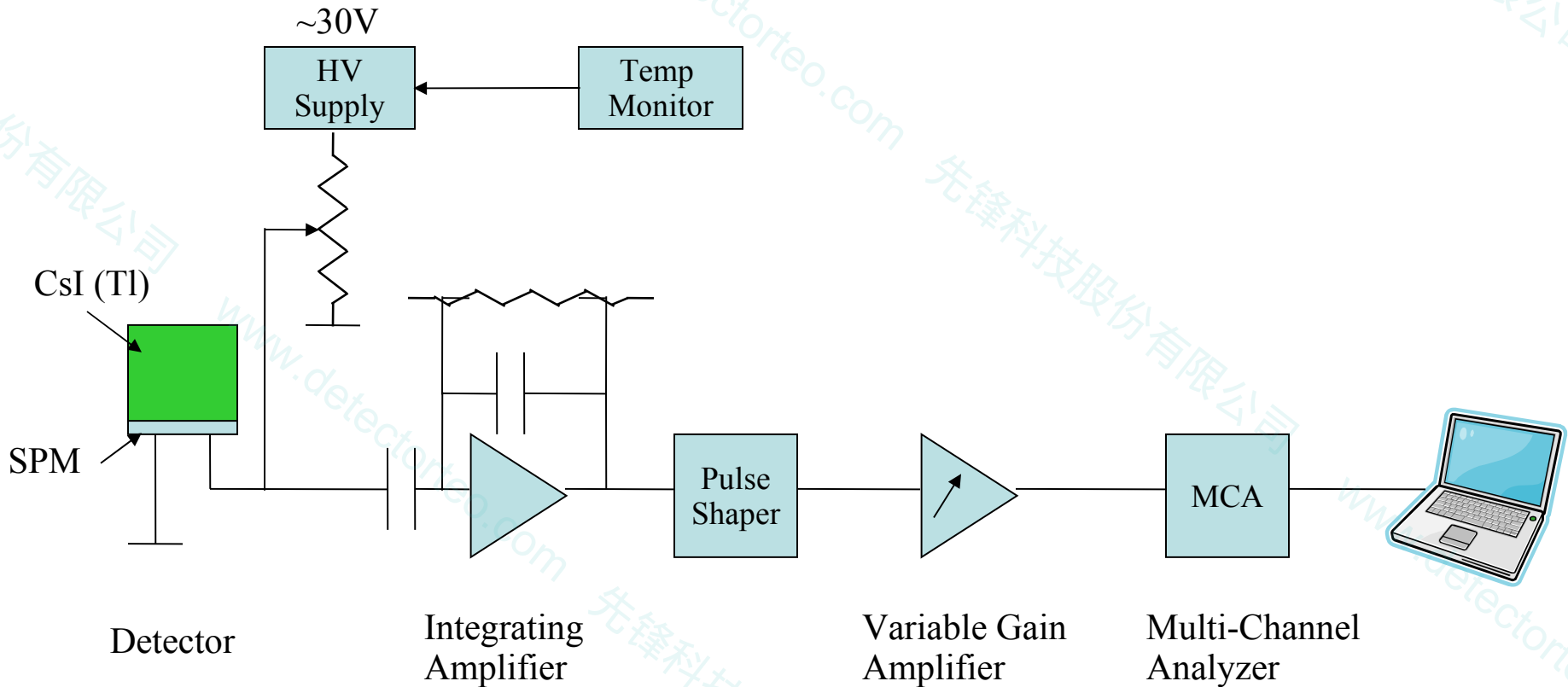
Plastic scintillators can be added for body dose response



Radiation Detection Prototype

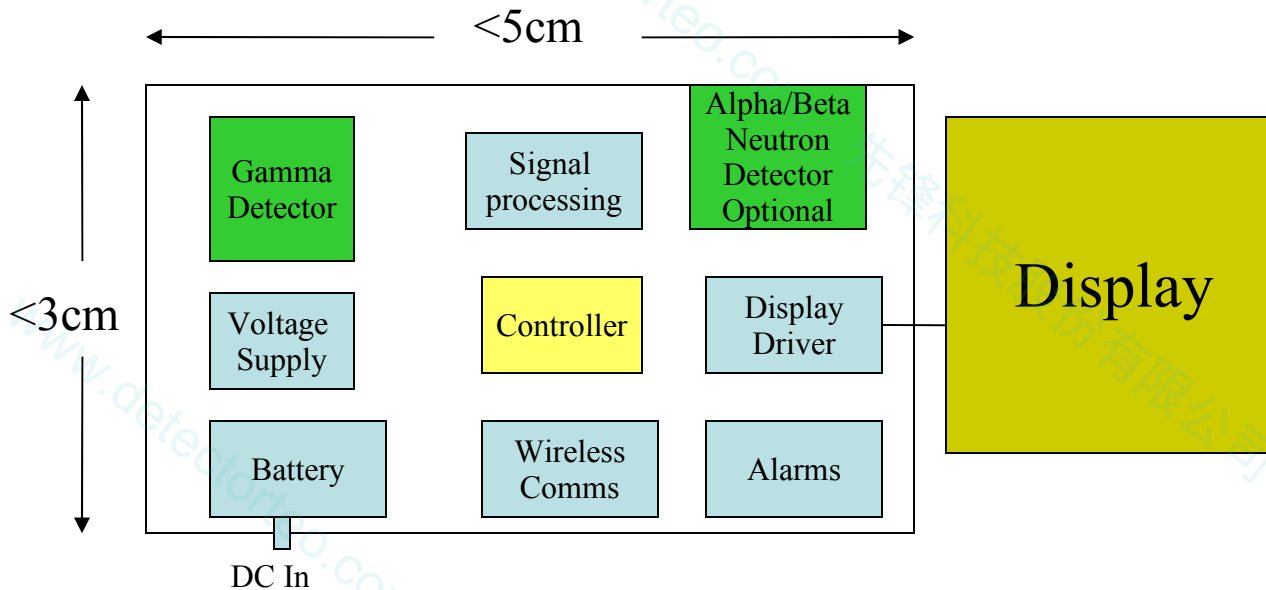
- Portable gamma radiation detector has been built to demonstrate SPM properties and capabilities
 - Ch1: CsI (TI) scintillator used with the sensL SPM detector
 - Ch2: Plastic scintillator for body equivalent dose response possible
 - Pulse shaping, amplification along with the multi-channel analyzer has been integrated on a demonstration board
 - Temperature compensation has been implemented through detector bias control and an on-board temperature monitor
 - Spectra data are stored in on board memory
 - USB connection allows data to be uploaded to the PC for analysis
 - Alarms, LCD display, casing or interface buttons are not included at prototype stage and are added as per customer requirements

System Architecture



Additional channels as required

System Conceptual Design



Simple compact board design. Additional features possible depending on customer sensitivity and power requirements.

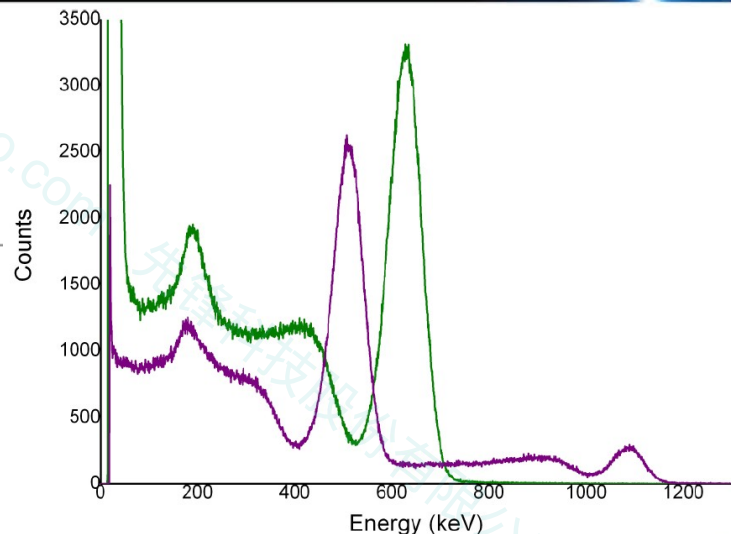
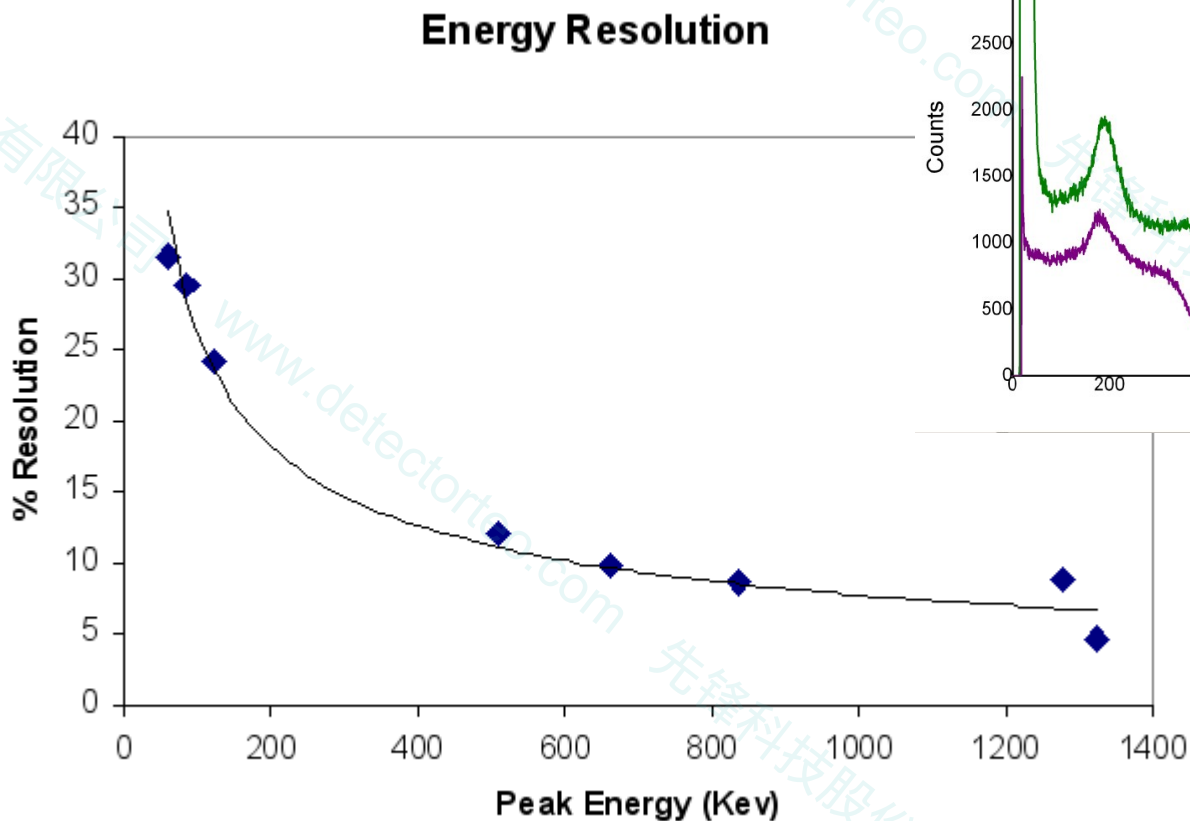
Performance Comparison

| | Personal Dosimeters | Personal Radiation Detectors (PRD) | Isotope Identifier |
|--------------------|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Detector | GM Tube based | PIN Diode with scintillators | PMT with scintillators |
| Description | These pager sized electronic devices track the total radiation dose received by the wearer. | These pager sized electronic devices are used to find low levels of radiation using sensitive crystal scintillators. | These devices are typically larger than PRD's and measure the gamma ray spectra to identify the originating isotope. This information is important in determining the appropriate response actions. |
| Users | Suitable for emergency responders who need to be notified if dangerous levels of radiation are present. | Suitable for law enforcement or inspectors who need to be notified of any unusual radiation in their proximity. | Suitable for HAZMAT teams, inspectors or specialised emergency response teams. |
| Price Range | \$450-\$700 | \$1000-\$3000 | \$8000-\$15000 |

The sensL advantage

| | Personal Dosimeters | Personal Radiation Detectors (PRD) | Isotope Identifier |
|-------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Detector | GM Tube based | PIN Diode with scintillators | PMT with scintillators |
| Description | <p>These pager sized electronic devices track the total radiation</p> <p>sensL SPM price</p> | <p>These pager sized electronic devices are used to find low levels of radiation using sensitive crystal scintillators</p> <p>sensL SPM performance</p> | <p>These devices are typically larger than PRD's and measure the gamma ray spectra to identify the isotope. This is important in the appropriate response actions.</p> |
| Users | <p>Suitable for emergency responders who need to be notified if dangerous levels of radiation are present.</p> | <p>Suitable for law enforcement or inspectors who need to be notified of any unusual radiation in their proximity.</p> | <p>Suitable for HAZMAT teams, inspectors or specialised emergency response teams.</p> |
| Price Range | \$450-\$700 | \$1000-\$3000 | \$8000-\$15000 |

Energy resolution

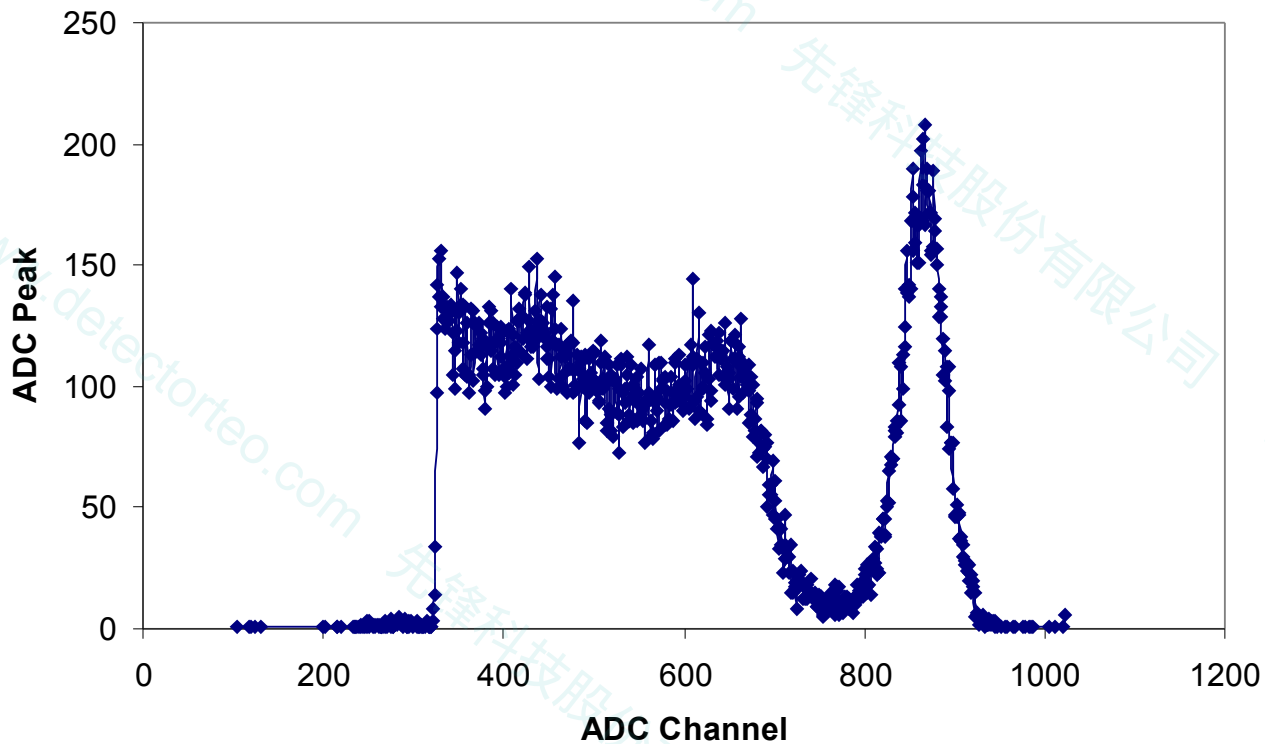


sensL SPM are ideal for detection of common high energy sources and particles



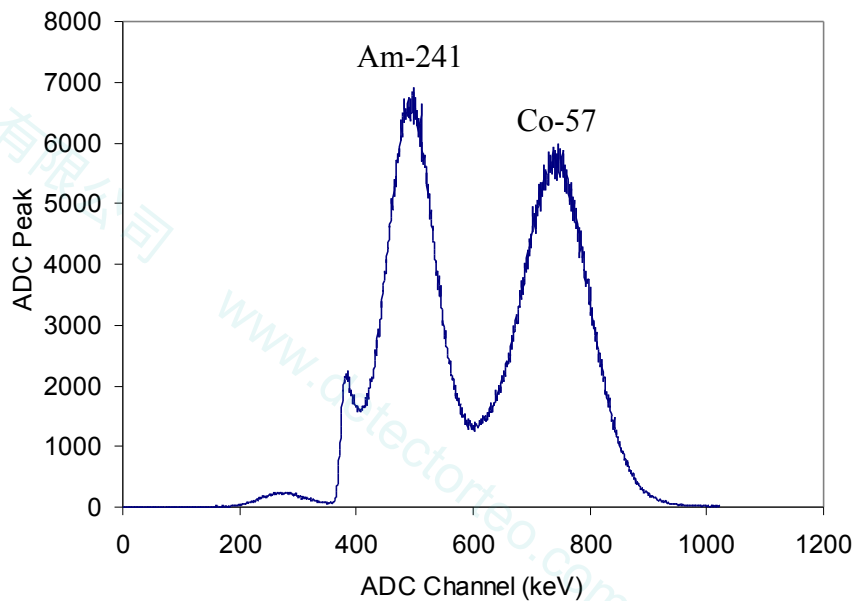
Energy resolution Cs-137

Cs-137 662 keV Peak
(Energy Resolution is 9% at 662keV)

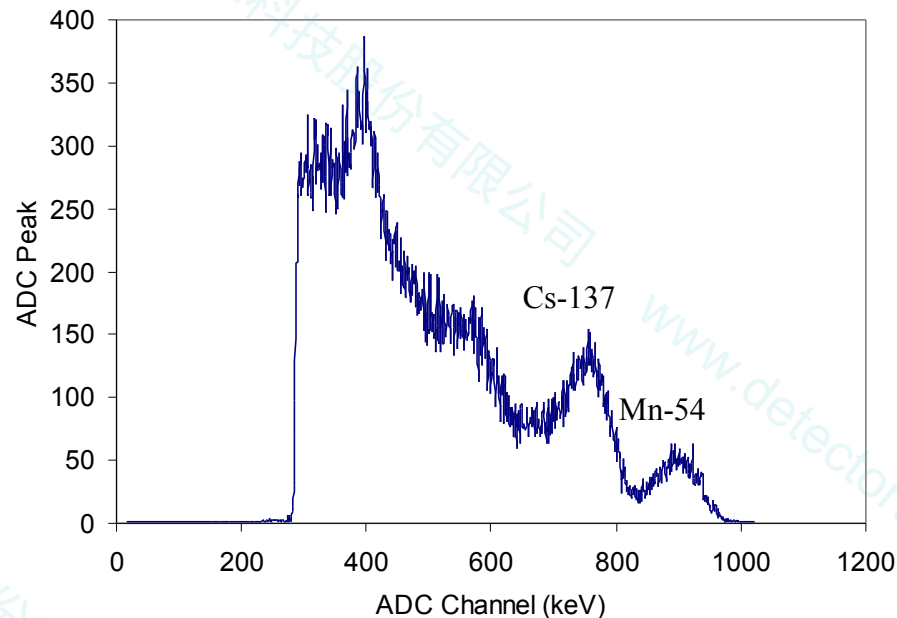


Isotope identification

Low Energy Gamma Spectra



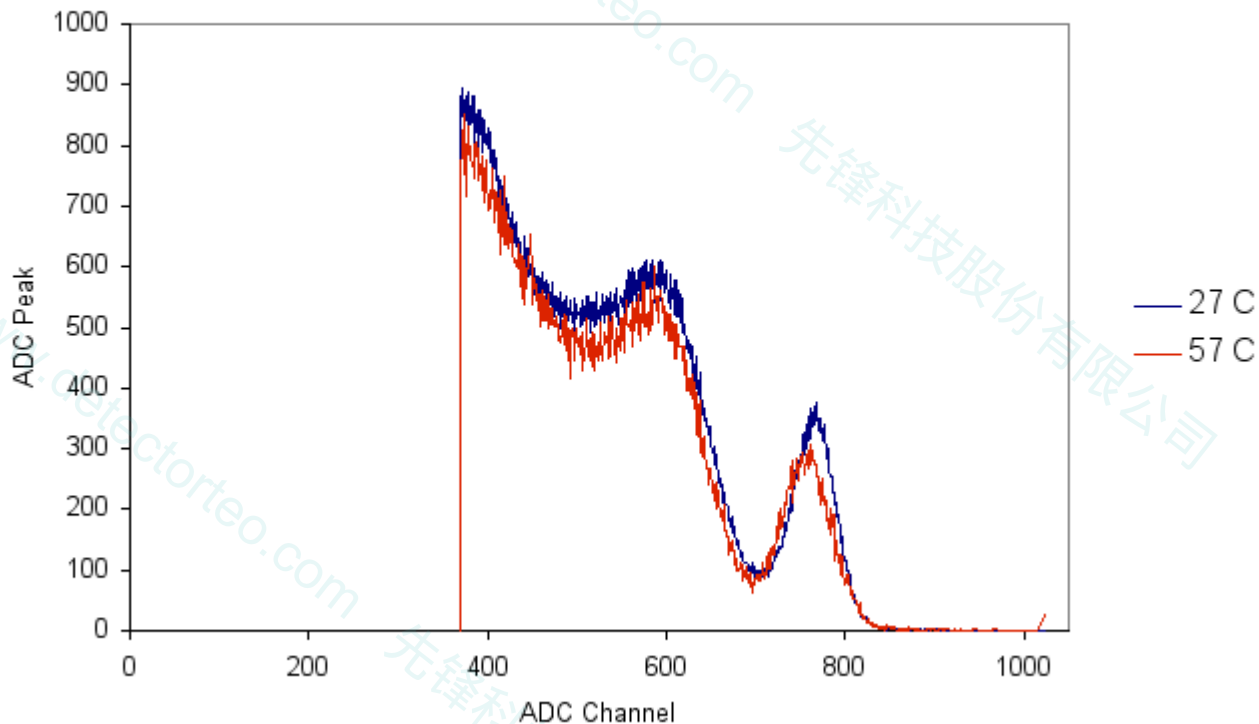
High Energy Gamma Spectra



Measurements for a variety of radiation sources

Temperature stability

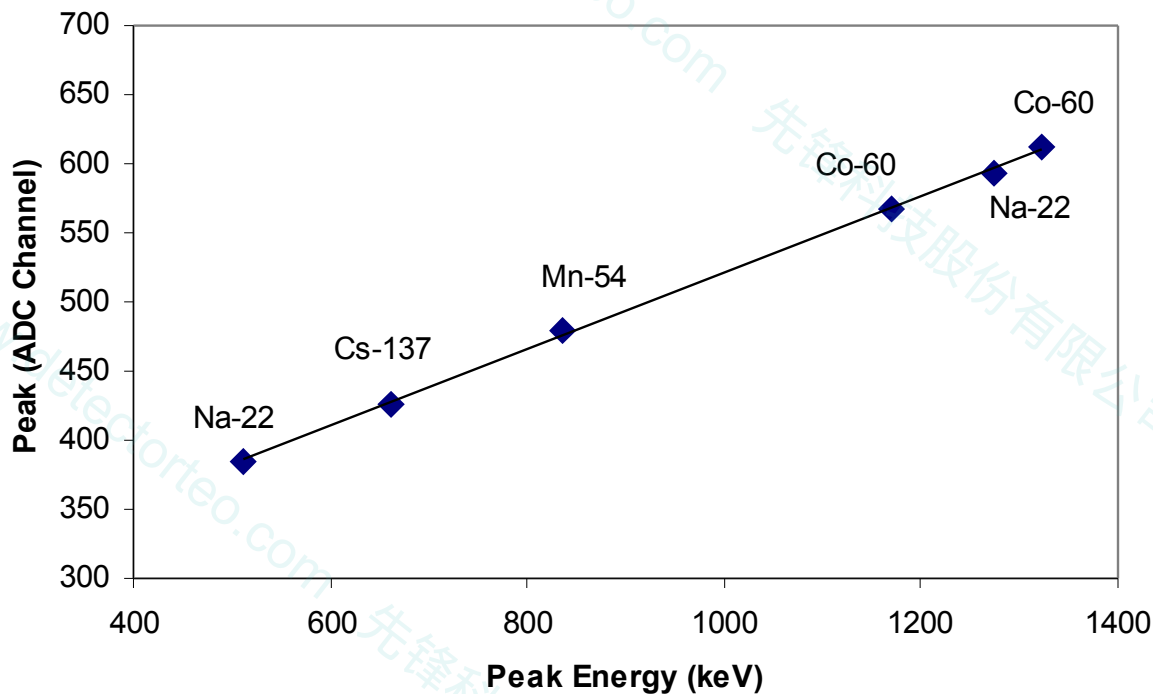
Cs-137 Spectra Taken With Temperature Compensated Bias



Operation is stable over a wide temperature range

Linearity

Detection Linearity



Good linearity up to 3MeV

Conclusions

- sensL have developed the technology required for a compact, portable, pager style radiation detection and identification system
- sensL seeks partners to take this technology to the market
- Benefits to our customers: low system cost, high performance, robustness, reliability, user safe operating voltages, high volume and scalable technology with a rapid time to market