

MEDICAL IMAGING

APPLICATION NOTE

sensL
SENSE LIGHT

BENEFITS OF USING AN SPM

PERFORMANCE

Silicon Photomultipliers from SensL have proven performance for readout of typical scintillating crystals (LYSO, LSO, BGO) found in today's PET systems.

UNIFORMITY

Semiconductor processing provides superior uniformity over vacuum tube technology simplifying readout electronics and improving images. Readout architectures are simplified and less image correction and calibration is required to produce high quality images.

MAGNETIC FIELD IMMUNITY

SensL SPM are immune to electromagnetic interference. PET/MRI is made possible by use of SensL SPM while, for other modalities, the reduction in electromagnetic interference yields better images and more stable system performance.

SMALL SIZE & WEIGHT

SensL SPMs provide the small size and low weight required for handheld probes and intraoperative probes. They are uniquely positioned as the leading technology for emerging catheter based probes for minimally invasive surgical procedures.

LOW COST

SensL SPMs are produced using semiconductor processing technology that provides a cost advantage over existing vacuum tube PMT technology. This is increasingly important for customers looking to enter cost sensitive emerging markets.

MEDICAL IMAGING APPLICATIONS

PET/CT WHOLE BODY

Positron Emission Tomography (PET) combined with Computed Tomography (CT) is the mainstream imaging tool for oncological assessment. PET/CT is used in hospitals worldwide to image metastatic disease better than non-functional imaging techniques

PET ORGAN SPECIFIC

Systems designed to target specific portions of the human anatomy for high resolution imaging. Organ specific imaging can provide the oncologist with precise information relating to tumor formation

PET PRE-CLINICAL

Systems used by medical research institutes and the pharmaceutical industry to understand and develop new drugs. Pre-clinical systems are dedicated for use with animal subjects and offer extremely high resolution images

PET TIME OF FLIGHT

High performance PET scanning for precise disease location and decreased scanning times. PET Time of Flight is driving the performance of PET systems to improved image resolution

PET/MRI

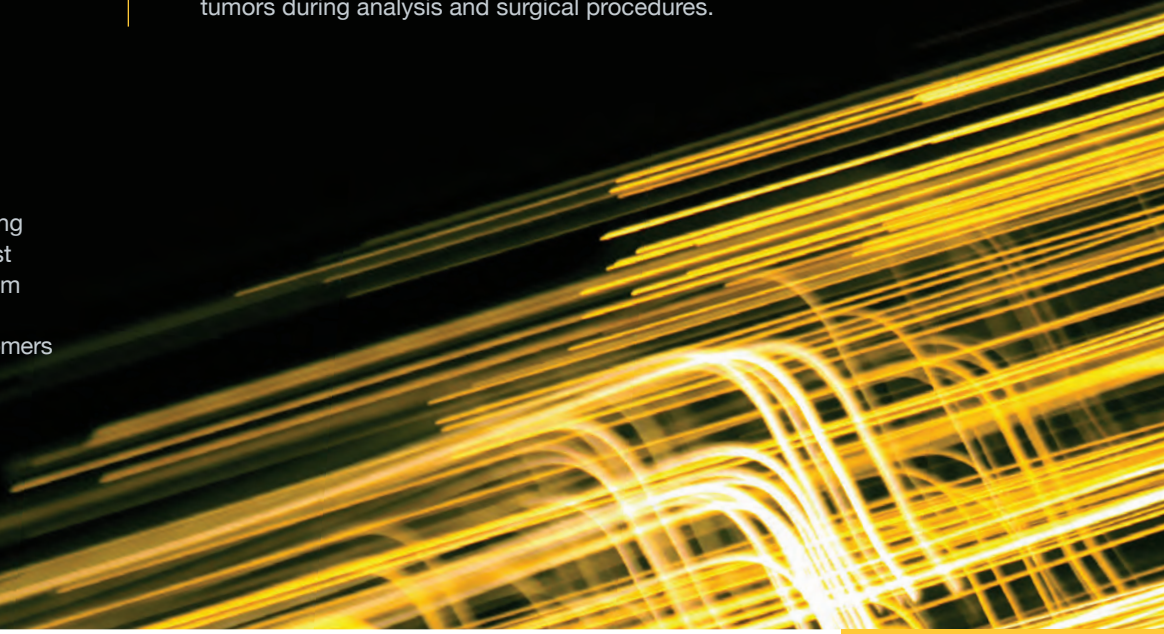
PET combine with Magnetic Resonance Imaging (MRI) is an emerging imaging modality that combines the proven soft tissue contrast of MRI with the functional imaging of PET

SPECT

Single Photon Emission Computed Tomography (SPECT) is a key imaging tool in myocardial perfusion imaging, brain and breast imaging

INTRAOPERATIVE PROBES

Intraoperative probes are small handheld instruments for localization of tumors during analysis and surgical procedures.



Market Overview

There is an increasing demand on the health care systems of the world to provide high performance medical screening for cancer, Alzheimer's and cardiac disease detection and staging at lower cost than is possible today. This increases the demand on system providers to develop and market products that can provide better functional imaging at a reduced cost of ownership. What was previously a high end imaging technique, and only available at the largest medical centers, is now a routine procedure today. SPMs enable the replacement of aging vacuum tubes allowing increased performance and enabling new systems not possible in the past.

New applications for PET imaging techniques are emerging. These procedures benefit significantly from the small size and safe low voltage operation voltage of SPM. Systems can now be designed that are smaller, portable and not susceptible to vibration damage.

Additionally there is pressure on manufacturers to bring to market new imaging systems that meet the unique needs of the large emerging markets. These emerging markets need to provide a high quality health care but cannot afford the high capital equipment cost of current PET systems. The use of solid-state SPMs makes it possible for system manufacturers to meet these demanding cost and performance requirements.

Application Examples

Vacuum tube technology has historically been the preferred detector of choice for these types of systems due to the high gain and low cost in large area systems. With the advent of high volume manufacturing of SPM by SensL, the same high gain can be achieved with low cost solid state technology. Large area coverage is accomplished through the high uniformity of the SensL SPM, enabling large area to be covered with continuous active detector area. This advancement brought by SensL SPM sees the aging vacuum tube PMT being replaced in all PET modalities, SPECT and in intraoperative probes.

Positron Emission Tomography (PET): The high performance functional imaging resolution of PET is now the industry standard for cancer staging. Additionally, the clinical use of PET is increasing at double digit rates per year and new applications for PET are becoming mainstream and authorized by the world's health care providers. SensL provides a flexible silicon photomultiplier architecture that replaces vacuum tube PMT today and enables new system designs in the future.

Single Photon Emission Computer Tomography (SPECT): The SensL SPM is the world's first silicon photomultiplier to be produced in volume with a uniformity that allows replacement of the PMT used in today's SPECT systems. SensL's SPM is extremely compact enabling smaller, more portable and, ultimately, more sensitive SPECT medical imaging equipment to be brought to the market.

Intraoperative Probes: Small size, low weight, robustness, low voltage and uniformity enable a new generation of handheld and intraoperative detection and imaging probes. Using the SensL SPM in a handheld probe solves the problems with size, weight, power and uniformity problems inherent with vacuum tube technology. Additionally, the SensL SPM is robust and can withstand the shocks and vibrations that handheld equipment is subjected to during use in clinician and operation theatres.

Benefits of a Silicon Photomultiplier

SPM from SensL provide a solid state alternative to the vacuum tube photomultiplier (PMT) used in PET and SPECT and PIN photodiodes used in CT systems. The SensL SPM combines the high gain of the (PMT) with the advantages of PIN photodiodes.

Uniformity, reliability, low power, and small size are inherent in SensL's SPMs. SensL SPM is used to replace the PMT in all modalities found in current and emerging medical imaging systems. The low voltage of the SensL SPM reduces the power supply requirements and simplifies construction of modern medical imaging equipment. PMT technology operates at up to 1000 Volts while a SensL SPM operates at 30 Volts. This low voltage operation greatly simplifies system design and increases patient safety where close contact with the human body is a requirement.

The small and compact size of the SensL SPM allows the detector head to be in closer proximity to the patient in imaging applications. In brain, cardiac and breast systems, smaller more compact and portable systems can be created. Specifically, in the case of breast imaging, a SensL SPM (which is only 0.5mm in thickness) allows smaller detector heads to provide access to the chest wall which is critical for metastatic disease identification.

Sensitivity to the emission of light from the various scintillating crystals used in medical imaging is critical and SensL provides a range of SPMs optimized for the emission properties of different crystals, including spectral sensitivity tuning and fast timing required for the highest sensitivity systems.

The uniformity of a SensL SPM means that systems can be designed to operate from a single supply voltage eliminating the necessity to adjust the detector pixel to pixel. The SPM uniformity also allows single low gain pre-amplifiers to be used in the analog readout chain enabling the system to be designed in a modular fashion where all system components are identical thus reducing the cost and complexity of the system.



About the Matrix9 in Medical Imaging

Replacing the position sensitive PMT has never been easier. As SPM has moved from early technology investigation to full system production, SensL has developed full readout solutions for our customers. The Matrix9 provides the user with the ability to incorporate SPM technology in medical imaging systems with a full readout and digitization architecture. This sub-system reads out 144 channel pixels, localizes the crystal pixel and provides digital energy and timing information. This compact and full featured unit simplifies and reduces system design time and ultimately this reduces time to market.

Through collaboration with a number of leading research groups, SensL SPM have been incorporated into many leading edge system designs. To aid researchers in developing new applications for SPM and medical imaging, SensL founded the openPET program with the Lawrence Berkeley National Labs. This initiative specifies a PET system architecture for rapid development of SPM based PET systems. Additionally, openPET establishes a baseline system from which further improvements to system design and technology may be measured. The openPET system provides readout of the many channels of SPM required - typically 55,000 channels of 3mmX3mm SPM - for a whole body system.

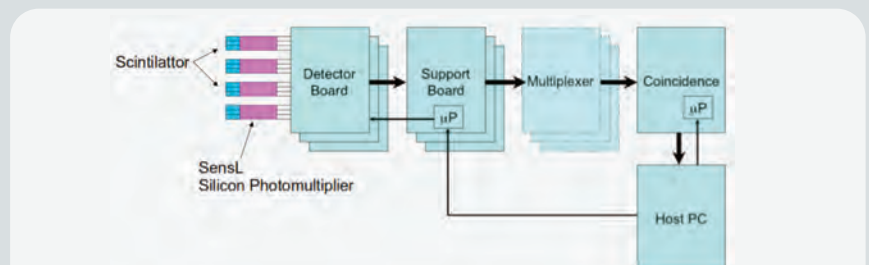


Figure 1: SensL Silicon Photomultiplier provides the readout of scintillating crystals in a PET ring, the signal which can be processed for example in an openPET readout system