electronics and instrumentation

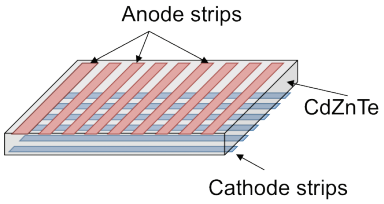
Compact, High-Resolution, Multi-Layer Semiconductor PET Detector Module

Summary

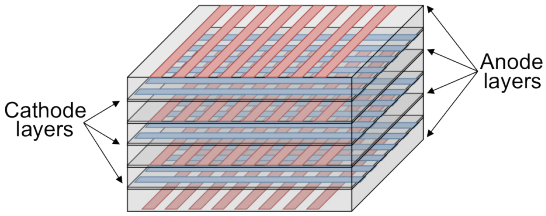
Multi-layer semiconductor detectors can enhance image resolution, contrast, and position sensitivity in positron emission tomography (PET) systems, but the conventional electrodes used require a prohibitive number of readout channels. Now, a breakthrough compact PET detector offers a specialized configuration of cross strip electrodes in its detector stack to reduce readout channels by half and efficiently generate ultra-high resolution images in PET scan and other gamma radiation detection systems.

Description

The Reduced Readout Channel Semiconductor Detector Module (RRCSDM) is configured to reduce readout channels and inactive volume between detector elements by interposing only anode(s) or cathode(s) between adjacent elements of the detector stack, providing better interconnect density, better thermal management, and a more compact design than conventional multi-pixel and cross-strip detectors. The RRCSDM can include a plurality of cross-strip electrode layers, consisting of sets of linear array electrodes oriented perpendicularly to each other on opposing sides of each element, with any two adjacent semiconductor elements sharing readout channels (and potentially the electrodes themselves). In this configuration, signals are read out from both sides of each element and the coincidence of signals indicates the interaction position of the gamma-ray photon inside the detector, providing desired spatial information while using fewer readout channels as compared to both standard square pixel array designs, e.g., (n electrode strips)*(m detector stack elements +1) vs. (m detector stack elements)*(1 + (n pixels)^2), and conventional cross-strip electrode multi-layer detector stacks, e.g. (n electrode strips)*(m detector stack elements +1) vs. 2*(n electrode strips)*(m detector stack elements).



Conventional multi-layer semiconductor detector stack element, usually stacked vertically one on top of another with the same electrode orientations to create a multi-layer detector stack module.



RRCSDM configuration, including adjacent detector elements with inverted vertical orientations and shared anode and cathode readouts between adjacent detector elements.

Benefits

Compared to conventional scintillator-based PET detectors, semiconductor detector modules confer several advantages: greatly enhanced image quality (intratumoral contrast improved by almost 30% for CdTe detectors), higher energy and spatial resolution, and easier reconfiguration of the detector modules. In addition to these advantages, the RRCSDM resolves the problems associated with the proliferation of readout channels, and it is also easier to fabricate compared to scintillator-based detectors.

Applications and Industries

The primary intended use of the RRCSDM is in PET systems and medical imaging. However, semiconductor radiation detectors are now used in a large variety of fields, including homeland security, nuclear nonproliferation, non-destructive detection, radiation imaging, nuclear physics, X-ray and gamma ray astronomy, and nuclear medicine.

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