A compact electronic system for a photodiode neutron detector

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The demand for portable neutron detectors is on the rise, and for that purpose, low cost boron-10 has been frequently used instead of helium-3, which is usually employed in large and expensive detectors. Portable detectors are of interest in some applications, such as neutron dosimeters or inspection systems targeted in the detection of fissile material and drugs in airports. In this work a portable thermal neutron detection system was developed which is based on a commercial silicon photodiode coupled to a boron converter; this prototype is then plugged into a portable electronic system. The boron layer was produced by pulsed laser deposition, either on a thin glass slide or on the photodiode itself. The boron deposition in the photodiode was made directly in the active area of the detector, so before and after the deposition process a characterization of the device regarding both the dark current and the operation voltage was performed using an americium source. Finally, both configurations were tested. The neutron detection process occurs by detecting the alpha and lithium particles produced by the interaction of the incoming neutron with the boron-10 nuclides. These heavy ions then interact with the active area of the reverse-biased photodiode, producing an electric signal that has to be preamplified and then properly amplified by the portable electronic system, which in turn produces an output that can either be sent to a multichannel analyzer or to a digital counter. The integrated circuit of the low noise preamplifier transforms the detector's current pulse into a voltage pulse with amplitude proportional to the charge carried by the current pulse. The shaper-driver consists of a differentiator and an integrator and is responsible for filtering and further amplifying the preamplifier signal, generating a NIM-compatible energy output pulse. The performance of the photodiode-amplifier set for alpha particles was successively tested using a ^{243}Am radioactive source. Initial tests were made using the boron-deposited glass, and the electronic signal was properly read. However, when the same system was tested using the boron deposited directly in the photodiode, the output signal couldn't be read, due to the fact that during the deposition process there was an increase in the dark current and a decrease in the operation bias. In this way, a new portable electronic system was developed using a hybrid integrated amplifier circuit. This new electronic setup allowed the use of both configurations, and was tested both with alpha-emitting Americium and neutron-emitting AmBe sources. In conclusion, both portable electronic systems have proven suitable for the thermal neutron detector developed.