Optimization of Solid-state Detector in Cargo Container Inspection System

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Abstract

Energetic x-ray is used for nonintrusive inspection of large cargo containers at seaport or airport, nondestructive inspection of machine engines or pipesin industry, and quantification of free water in radioactive waste drums in nuclear industry. Such inspection systems have employed a photodiode-based solid state detector consisting of a single crystal and a photo sensor. In x-ray inspection systems using low energy x-ray known well, there is no interrelation between the increase in the crystal thickness for improving signal amplitude and the expansion of an active area of a photodiode. On the other hands, due to different detector arrangement, the increase of detector depth for improving signal in imaging system using high energy x-ray gives rise to the increase of signal as well as noise. In addition, the noise in a large detector has a significant effect on detector SNR. However, no studies on how to design a high energy x-ray detector in consideration of electronic noise in detector system have reported in the literature. To address this problem, new generalized design model using SNR (Signal-to-Noise ratio) of x-ray detector is proposed in this paper. The design model of this paper is also applied to realize the actual x-ray detector for 0.45 MeV cargo container inspection system and the test results obtained by the inspection system are discusse.

Key words : nonintrusive inspection, x-ray, CWO, solid state detector, signal-to-noise ratio