CARGO SECURITY SYSTEMS

In order to make critical decisions in security applications, you need to produce clear, noise-free images. BIR designs and manufactures x-ray detectors for high-energy cargo screening applications. BIR detectors are modular and therefore scalable to the application. Usually there are 32 detector channels per module. This improves reliability because the entire array is not susceptible to failure and modules can be easily replaced in the field. Here are just a few of the key elements of detector design that dramatically improve image quality in BIR High-Energy Inspection Systems:

Dynamic range of the x-ray detection system: The detection system should respond to a wide range of input signal strength, to match a wide range of attenuation paths encountered by the x-ray beam. For instance, a container of food products provides a uniform, high-attenuation x-ray path. A container that is almost empty, loosely packed, or containing irregular objects, will have some very low-attenuation paths through empty spaces. The detection system should handle this wide range of paths whose attenuation properties may differ by over 100,000 to one.

Sensitivity of the x-ray detection system: The detectors' collection efficiency contributes directly to image quality because x-ray photons arrive randomly in time. The detection system must also maintain incremental sensitivity to attenuation differences throughout the wide range mentioned above. In regions with low attenuation it should be possible to distinguish between empty space and other thin, slightly more attenuating paths, say through layers of clothing. The ability to see thin objects is even more important in regions where highly attenuating material may, accidentally or deliberately, mask something that should otherwise be visible.

Physical size of x-ray detector elements: The physical size of detector elements defines another important determinant of system performance-spatial resolution. The narrower the detector elements, the closer the "sampling" of the x-ray signal and the finer the resulting image details. With wider detector elements, small details will not be visible and object recognition will be poorer.

Signal-to-noise performance after x-ray detection: The detection system processes the input signal at various stages, starting from conversion of input x-ray photons into light, conversion of light into electrical signals and finally, conversion of electrical signal strength into digital form. At each stage, electronic "noise" may be introduced, via x-ray crosstalk, optical crosstalk, optical scatter, etc. This noise will corrupt the signal and affect image quality.

Scatter Rejection: The noise discussed above is introduced after the signals have been received at the face of the x-ray detectors. There are other external sources of noise that can corrupt the signals even before they reach the detector. The worst is x-ray scatter—photons that do not come from the straight-line path from the x-ray source through the object. Photons scatter by bouncing off other parts of the object, the walls of the container, etc. The effect of scatter can be worse than other sources of noise in the signal because it creates a background level (like "fog" in film) that can obscure faint features. Scatter is the main reason why the dynamic range of a cargo inspection system can be below 1,000-to-one, even if its detectors individually measure much higher dynamic ranges.

Artifacts: The chief causes of artifacts—streaks and spots—are hardware-based unwanted signal variations. One cause is that accelerators emit x rays in pulses, and one may occasionally be missed. This can be corrected for by sensing the number of pulses synchronized with each step of the container's motion, and brightening the displayed signal for any steps that have fewer than normal. Another cause is that detector and amplifier performance can drift with time, temperature, and radiation exposure. These variations, which alter the output value at zero, full scale, or the linearity, are extremely slight. But even a few parts-per-million can mask or distort true image details.

In summary, once the source energy has been selected for adequate penetration, it can be said that detectors are the most important element of an x-ray inspection system. No other part of the inspection system can compensate for poor detectors.

Learn More:

Image Analysis Tools
Image Display Terminal
Penetration Capability
System Architecture
Permanent Facilities Description
Permanent Facilities Specifications
Movable Facilities Description
Movable Facilities Specifications

BIR, Inc., 425 Barclay Boulevard, Lincolnshire, IL 60069 TEL: 847.279.5100 FAX: 847.279.4900 EML: marketing@birinc.com WEB: www.birinc.com