High-Energy System Penetration

Cargo containers and trucks carry a wide range of materials, including liquids, that can be difficult to see through. Locating contraband materials or weapons of mass destruction requires high-energy x rays generated from linear accelerator x-ray sources. While two other techniques are in use, their performance is limited.

Some systems already in the field use isotopic gamma-ray sources, such as cobalt-60 at an average of 1.25 MeV. Cobalt can penetrate lightly loaded containers; however, even then, cobalt systems do not provide the superior spatial resolution that is obtainable with accelerator-based systems.

Another existing approach is backscatter. Its penetration does not depend on the energy of the primary beam, as the backscattered energy is lower. Even with megavolt primaries, the backscattered radiation is less than 250 kV, so it is only good near the surface, except for mostly empty containers.

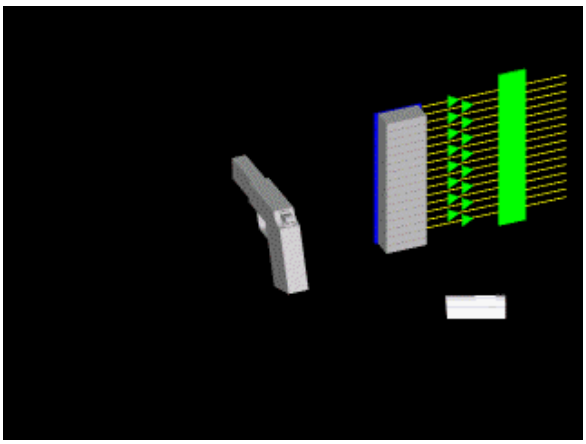
No matter what energy is used, image quality depends on detector quality. BIR manufactures its own detectors in many different standard configurations; four of these are designed to be super-sensitive at high voltages, and offer a choice of width, or pitch. The combination of pitch and voltage can be optimized for the individual applications, as each application needs its own combination of scanning speed, image detail (spatial resolution), and penetration.

The following table shows the penetration BIR can achieve with typical operating conditions, except for the first column, which is another company's quoted result with a cobalt-60 source.

Energy	1.25 MeV	2 MV	3 MV	4 MV	6 MV	9MV
Steel	133 mm 5.2 inches	205 mm 8.1 inches	297 mm 11.7 inches	352 mm 13.9 inches	406 mm 16.0 inches	430 mm 16.9 inches
Water	88 cm 35 inches	137 cm 54 inches	205 cm 81 inches	253 cm 100 inches	316 cm 124 inches	364 cm 143 inches
Ratio	6.6	6.7	6.9	7.2	7.8	8.4

Note that the ratio between water and steel is not constant, but increases with energy. Except near 6 MV, it is not the generally assumed eight-to-one ratio.

A narrow fan beam of x rays is projected, or pulsed, through the object. The beam strikes a narrow line of detector elements. The resulting lines of attenuated x-ray data are collected at predetermined intervals. The x-ray measurements are then digitized and an image is reconstructed and displayed as a 2D image on the systems computer screens.



In order to penetrate cluttered ISO cargo containers or large vehicles, high-energy 6 MV to 9 MV (6 to 9 million volts) is required. BIR high-energy screening systems utilize a linear accelerator (LINAC) which generates megavolt pulses. In the example above, 6 MV-three-pulse integration is illustrated. The object being scanned moves a predetermined distance in synchronization with the pulsing of the accelerator. Each three-pulse sequence is integrated into data thatcreates a line of the developing DR image (the gun below).

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