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X-ray Imaging Based on Compton Scattering

Most of us are familiar with transmission x-ray systems that are used to inspect luggage and briefcases at airports, and entrances to courthouses and other sensitive government buildings. Much more powerful x-ray systems are also used by customs agencies around the world to inspect cargo containers in order to find illegal or untaxed materials entering their countries. But there are many situations where conventional transmission x-ray imaging is impractical. This could be due to difficulties in deploying an x-ray source and detectors on opposite sides of the object being scanned, difficulties in detecting certain threats in a cluttered environment, or the x-ray intensities that might be required to fully penetrate — and discern a threat in — an occupied vehicle.

Compton back-scattered x-rays permit screening of sea containers, as well as inspection of a wide variety of vehicles, luggage, and even people. In contrast to more commonly used transmission systems, backscatter imaging involves positioning both source and detector on the same side of a target object. The backscatter image is somewhat akin to a photograph of the contents of a closed container, taken through the container walls. In a backscatter image, objects composed of low atomic number materials, including explosives and drugs, appear particularly bright and are often easily detectable.

This presentation will highlight a number of applications where rapid, low-dose, one-sided Compton imaging is especially desirable and describe typical methods for creating these images. Some of these systems are also capable of scanning an object by simultaneously forming multiple backscatter images of vehicles from different perspectives, such as left, right, and top-down. While each view has limited penetration ability, the combination of views provides a powerful inspection tool that often permits threat objects to be easily discerned, even in a cluttered environment

Joseph Callerame joined American Science & Engineering, Inc. (AS&E) in June 1998 as Vice President, Technology, and Chief Technology Officer. AS&E develops and manufactures sophisticated x-ray inspection products for critical detection and security applications. Prior to joining AS&E, Callerame spent over 20 years at Raytheon, most recently as Manager, Engineering and Technology Development. Prior to that appointment, he was Deputy General Manager of Raytheon's Corporate Research Division, where he was charged with overseeing development of a wide variety of research activities in areas as diverse as surface acoustic wave oscillators as ultra-stable frequency sources for advanced radars, sonar transducers for ship and submarine detection, as well as medical ultrasound, high-durability infrared materials and infrared detector arrays, laser-based systems for both communication and target identification, and high-speed gallium arsenide-based circuitry for both microwave and millimeter wave applications. Callerame received a B.A. in Physics from Columbia College in 1970, and an M.A. and Ph.D., also in Physics, from Harvard University in 1971 and 1975, respectively. After receiving his Ph.D. and prior to his employment at Raytheon, he served as a Post-Doctoral Fellow in Nuclear Physics at MIT., where he worked on neutron interferometry.

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