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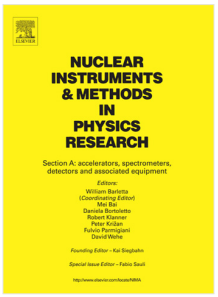

Large-scale MV CT for cargo imaging: A feasibility study

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Large-scale MV CT for cargo imaging: a feasibility study

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A B S T R A C T

Computed tomography (CT) has a major advantage over radiography in that it provides 3D imaging and resolves the structural overlap problem inherent to radiography. Since the early 1970s, CT evolved in parallel with radiography in many areas. As megavoltage (MV) cargo radiography is now in use, it is of interest to evaluate the feasibility of corresponding MV cargo CT. A feasibility study of MV cargo CT has been performed in this work. The MV cargo CT system has an imaging field of view of 3.25m in diameter. The system design includes a compact x-ray source and detectors that are already used in existing MV cargo radiography systems. Although compact x-ray sources provide limited x-ray output, it is shown that this output is sufficient to perform CT imaging of large cluttered cargo contents for which MV radiography may be inconclusive. The scan time is 60sec. at the x-ray dose levels lower than the permitted limit of 5mGy. A steel tank phantom with 2m diameter including different materials was used. The MV CT images were generated at 3.5MV, 6MV, and 9MV beam energies. The materials were separated based on their CT numbers as well as using dual energy subtraction method. The materials with close densities and x-ray attenuations such as W and U were reliably separated and quantified based on their measured CT numbers. The boundary conditions for the system design were determined, including scan time, radiation dose, maximum object thicknesses, and spatial resolution. Based on the findings of this feasibility study, it is concluded that the MV cargo CT system with large field of view can be developed based on existing technology already used in MV cargo radiography. Such a CT system can be extremely useful when used adjunct to existing MV radiography on resolving the special cases that cannot be resolved conclusively with radiography alone.

Key words: cargo imaging, computed tomography, dual energy, material decomposition

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1. Introduction

Hundreds of millions of large cargo transactions are performed annually worldwide. These cargos can potentially be used for smuggling illicit materials including explosives, narcotics, nuclear materials, shielded radiation sources, etc. These large cargos may have sizes of up to a few meters in cross sections and average densities of about thousand kilograms per cubic meter. They may have cluttered arrangements of contents which can serve suitable environment for concealing illicit materials. Routine inspections and security screenings are necessary to detect these illicit activities, and x-ray imaging is one of the widely used non-intrusive screening methods for doing so. High-energy x-ray beams with high penetration capabilities are required for imaging large cargos. X-rays with energies in the mega-electronvolt (MeV) range are appropriate for this purpose and corresponding mega-voltage (MV) cargo radiography systems have been developed, investigated [1-11] and are commercially available from several companies [12-16].