On the Efficiency of a Lidar-Type Single-Sided Gamma-Ray Tomography Approach

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Abstract. The efficiency is investigated by computer simulations of a LIDAR-type approach for non-destructive single-sided gamma-ray probing and tomography of dense optically-opaque media. The approach is based on time-to-range resolved detection of the backscattering returns from the probed object (irradiated by pulsed gamma-photon beams) and determination of the internal distribution of the attenuation and Compton-backscattering coefficients. The image-reconstruction accuracy of sensing homogeneous and multifragment objects is investigated as a function of the depth of sensing. The results obtained show that this approach allows one to reliably establish the presence, the material content, and the disposition of different ingredients and flaws without noticeable influence of masking effects.

Keywords: Gamma-ray, Compton scattering, Tomography, Nondestructive testing
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The purpose of the present work is to investigate by simulations the potentialities of a novel approach we developed recently [1] for single-sided gamma-ray probing and tomography of dense optically-opaque media. The approach is based on LIDAR principle, that is, time-to-range resolved detection of the back-scattering returns from the object irradiated by pulsed gamma-photon beams. It allows one to determine the internal distribution of the linear extinction and Compton-backscattering coefficients and as a final result - the internal distribution, the kind, and the mass density of different homogeneous ingredients.

Correspondingly, we have simulated the sensing of an aluminum bar, as a test target, containing (like flaws) a Fe enclosure and air cavities. The results obtained, illustrating the ability of detecting a multitude of flaws, are represented in Fig.1. It is seen that all the flaws are well distinguishable and there is no masking of cavities caused by the Fe enclosure.

In general, the results from the simulations confirm that one could successfully sound dense opaque media by gamma-photon beams and establish the presence, the disposition, and the density of different ingredients and cavities within the investigated objects. The presence of more than one flaw along one LOS was shown to not lead to any noticeable masking effect.

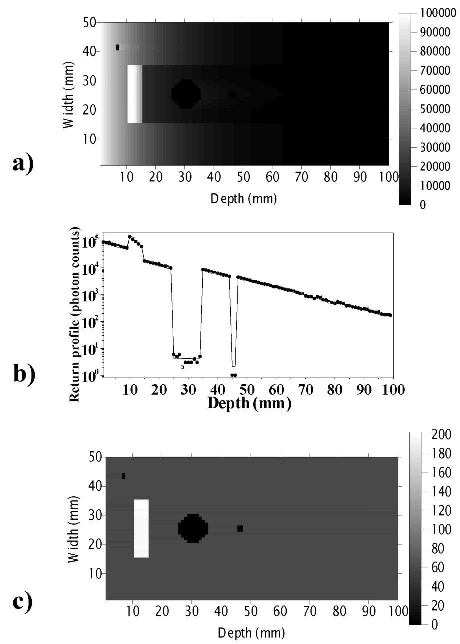

FIGURE 1. The 2D return signal image (a), one LOS return signal profile, involving Fe enclosure and air cavities (b), and recovered 2D distribution of the extinction coefficient (c). The grey level bar is in photon counts (a) and m^{-1} (c).

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REFERENCES

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