MCNP simulations of a new time-resolved Compton scattering imaging technique

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Medical images of human tissue can be produced using Computed Tomography (CT), Positron Emission Tomography (PET), Ultrasound or Magnetic Resonance Imaging (MRI). In all of the above techniques, in order to get a three-dimensional (3D) image, one has to rotate or move the source, the detectors or the scanned target. This procedure is complicated, time consuming and increases the cost and weight of the scanning equipment.

Time resolved optical tomography [1] has been suggested as an alternative to the above conventional methods. This technique implies near infrared light (NIR) and fast time-resolved detectors to obtain a 3D image of the scanned target. However, due to the limited penetration of the NIR light in the tissue, the application of this technique is limited to soft tissue like a female breast [2] or a premature infant brain [3].

In this work, a new concept for a time-resolved Compton scattering imaging (TR-CSI) technique is proposed and its feasibility is examined by MCNP simulations [4]. The concept design is based on a standard Compton scattering imaging (CSI) system [5], with the above modifications:

- The collimated continues x-ray beam that scans the target from one side, has been replaced with a non-movable pulsed x-ray cone beam with 0.1 ns duration.
- The integrated detectors response was recorded in time intervals of 0.1 ns.

These modifications are now feasible with a combination of fast detectors and Multi Channel analyzer (MCA) card. The examined system combines the advantages of the non-movable time resolved optical tomography technique with the penetration depth of x-ray radiation.

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