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Simulation of a cosmic ray tomography scanner for trucks and sea containers.

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The SilentBorder project aims to develop and construct a new high-technology cosmic ray tomography (CRT) scanner for identification of hazardous and illegal goods hidden in trucks and sea containers. The scanner is based on natural cosmic ray tomography technology that is inherently safe for people and will enable scanning of shipping containers or cargo. We report on the development of the simulation and reconstruction framework aimed at optimizing the geometry of the detector and exploring feasibility of CRT in real smuggling scenarios using simulated data. The framework includes GEANT4 modeling of light transport in a scintillating-fiber tracker to optimize the geometry and materials used to produce fiber mats, as well as to convert raw Geant4 hits in scintillating fibers into clusters through a digitization process to develop track reconstruction algorithms. A systematic comparison was made of particle generators such as CRY, MUSIBO and EcoMug interfaced to the GEANT4 toolkit to find the most effective one for modelling real smuggling scenarios. The Point of Closest Approach reconstruction algorithm was used to create 3D images of sea containers or trucks to perform accurate analysis of the constraints on sensitivity of CRT using simulated synthetic data generated for different smuggling scenarios of low-Z organic materials and high-Z inorganic materials contraband. Results of our research indicate that by using cosmic-ray tomography, it would be possible to improve the performance and sensitivity of sea container and cargo screening systems to overcome limitations of traditional screening methods, such as X-ray scanners, when it comes to detecting illicit materials that may be well-concealed. Cosmic-ray tomography can provide a complementary imaging technique that could enhance the detection capabilities of existing systems.

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