and directions of the muons passing from the detection region through the second array; support structures to position the first housing structure at the fixed height; and a processing unit to receive data of the measured positions and directions from the first and second arrays of muon detection sensors and analyze scattering behaviors of the muons caused by scattering of the muons in materials of the target object within the detection region to obtain a tomographic profile or spatial distribution of scattering centers within the detection region. In some implementations, other exemplary detector configurations may be used, including, but not limited to, having a pair of detector arrays on either side of the target object, e.g., such as above and below the object and/or multiple opposing sides of the target object, e.g., such as having a side pair in addition to a pair above and below the object.

In another aspect, a vehicle inspection station having a built-in muon tomography inspection capability, comprising: a housing structure structured to at least partially enclose a vehicle and allow the vehicle to move in and out of the housing structure, the housing structure including a detection region to contain the vehicle; a first detection unit including a first array of one or more muon detection sensors, the first detection unit positioned along a first side of the housing structure adjacent to the detection region, wherein the one or more muon detection sensors of the first array measure positions and directions of muons passing through the first array to the detection region; a second detection unit including a second array of one or more muon detection sensors, the second detection unit positioned along a second side of the housing structure opposite the first side and adjacent to the detection region and at a fixed distance from the first detection unit, wherein the one or more muon detection sensors of the second array measure positions and directions of the muons passing from the detection region through the second array; a platform located in the detection region between the first and second detection units and configured to include a surface to receive and support a vehicle to be inspected, the platform including tracks or alignment marks for guiding the vehicle to a desired position on the platform to be inspected; and a processing unit to receive data of the measured positions and directions from the first and second arrays of one or more muon detection sensors, the processing unit configured to analyze scattering behaviors of the muons caused by scattering of the muons in materials of the vehicle within the detection region to obtain a tomographic profile or spatial distribution of scattering centers within the detection region.

In another aspect, a warehouse having a built-in muon tomography container inspection capability, comprising: a warehouse housing structure structured to include a roof over a storage area for placing storage containers, the warehouse housing structure including a detection region encompassing at least some of the storage containers; a first detection unit including a first array of one or more muon detection sensors, the first detection unit positioned along a first side of the housing structure adjacent to the detection region, wherein the one or more muon detection sensors of the first array measure positions and directions of muons passing through the first array to the detection region; a second detection unit including a second array of one or more muon detection sensors, the second detection unit positioned along a second side of the housing structure opposite the first side and adjacent to the detection region and at a fixed distance from the first detection unit, wherein the one or more muon detection sensors of the second array measure positions and directions of the muons passing from the detection region through the second array; and a processing unit to receive data of the measured positions and directions from the first and second arrays of one or more muon detection sensors, the processing unit configured to analyze scattering behaviors of the muons caused by scattering of the muons in materials of the storage containers within the detection region to obtain a tomographic profile or spatial distribution of scattering centers within the detection region.

In another aspect, a method of materials inspection in a storage facility using muon tomography, comprising: scanning a storage container stored in a storage facility using muon sensors to obtain muon tomography imaging data, the storage facility including housing structure having a first detection unit and a second detection unit positioned in a fixed alignment with respect to each other; moving the first detection unit and the second detection unit from a first position to a second position in the housing structure while maintain the fixed alignment between the first detection unit and the second detection unit; scanning a calibration marker of a known material located in the storage facility using muon sensors to obtain muon tomography imaging data; and determining, using a processing unit, the presence or lack of presence of a target material in the storage container based on the obtained muon tomography imaging data of the scanned storage container and the scanned calibration marker, wherein the first detection unit includes a first array of the muon sensors configured in a first plane and the second detection unit includes a second array of the muon sensors configured in a second plane parallel to the first plane, such that the muon sensors of the first array measure positions and directions of muons

passing through the first array and the muon sensors of the second array measure positions and directions of the muons passing from the detection region through the second array, and wherein the processing unit receives data of the measured positions and directions from the muon sensors and analyzes muon scattering behaviors caused by scattering of the muons in materials of the storage container.

[0006] These and other features are described in greater detail in the drawings, the description and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1A shows an illustrative diagram of an exemplary muon tomography materials inspection station for automotive vehicles.

[0008] FIG. 1B shows an illustrative diagram of a lower detection unit of the exemplary muon tomography materials inspection station.

[0009] FIG. 2 shows an illustrative diagram of an exemplary muon tomography materials inspection station for aircraft.

[0010] FIG. 3A shows an illustrative diagram of an exemplary muon tomography materials inspection station for a warehouse or storage facility.

[0011] FIG. 3B shows an illustrative diagram of another exemplary muon tomography materials inspection station for a warehouse or storage facility.

[0012] FIG. 3C shows an illustrative diagram of another exemplary muon tomography materials inspection station for a warehouse or storage facility.

[0013] Like reference symbols and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0014] Cosmic ray tomography is a technique which exploits the multiple Coulomb