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Muon Scattering Tomography Using Drift Chamber Technology

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Muon Scattering Tomography offers a powerful method to image the contents of cargo containers. Muons are highly penetrating, natural particles originating in Earth's upper atmosphere. At sea level muons have a flux of about 10 000 per square metre per minute. Most cosmic muons have sufficient energy to penetrate several metres of dense cargo, making them suitable for scanning cargo for shielded nuclear materials.

Muons scatter as they pass through materials via Coulomb Scattering. The degree of scattering is dependent on the density of the material. Nuclear materials have high densities and can be distinguished from normal cargo by measurement of muon scatter angles.

Two sets of muon detectors are positioned above and below the volume to be scanned. Each set takes a measurement of the trajectory of a muon as it passes through. AWE is currently researching the use of drift chamber technology for use in a detector system. A drift chamber contains gas which is ionised as a muon transverses the detector volume. Electrons are created in the ionisation and are accelerated to a central wire carrying a high voltage. As they drift towards the wire they gain enough energy to ionise further gas molecules. This creates an avalanche of electrons on the wire which is an amplification of the original signal. By timing this signal and measuring its strength it is possible to locate where the muon passed through. Then, by reconstructing the trajectories of the muon through the cargo and calculating its scatter angle it is possible, after a sufficient number of muons, to accurately determine the density and location of objects within the cargo container.

Muon technology is particularly powerful in the fact that nuclear materials shielded by lead stand out more than those without shielding due to the lead causing a high degree of scatter. The low-cost of the detector combined with its ability to construct a 3D image of any cargo in a short space of time (on the order of 1-2 minutes) makes it a very powerful tool for cargo screening purposes.

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