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Scintillation Detector for Muon Imaging System

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Muon scattering tomography has a broad application prospects in homeland security, nuclear reactor and waste imaging, etc. Scintillation detector is a very competitive solution due to its stability and robustness in harsh environment. However, it's a challenge to develop such detectors with both high spatial resolution and large detection area, especially with a limited budget.

We have built 15cm×15cm×1cm prototype detectors with 1cm pitch, composed of scintillators with groove curved on surface, wavelength shift(WLS) fibers and SiPMs. Detectors adopt quadrangular prism, triangular prism and slab structure respectively. Results show that 1-dimensional spatial resolution of these detectors are 3.3 mm, 1.7mm, 6.4mm respectively, proving that triangular prism structure can improve resolution significantly.

A GEANT4 program has been developed to simulate the detector's reaction to incident muons, and to correct systematic deviation of the detector. Simulations give an uncorrected resolution of triangular detector $\sigma =$ 1.5mm, which is close to experimental result. After precise correction, the spatial resolution can reach up to 1mm within the limited 1cm pitch.

Large detection area is necessary for muon imaging in several situations, thus a detector with 45cm×45cm area is under construction. The upgraded detector adopts a new layout and electronic system that designed for reducing readout channels.

Two WLS fibers are placed in one prism slat to reduce false trigger of SiPM, meanwhile, four fibers from different slats make up a cluster and are connected with a 3mm×3mm SiPM so that signals can be encoded and read out by fewer channels. Except from the electrical considerations, the new layout also improve photon collection efficiency and spatial resolution. Several properties of the detector will be tested and reported, e.g. spatial resolution, acceptance, detection efficiency.

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