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Tracking and Timing Performance of a Muon Hodoscope for Transmission Muography

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We present the tracking and timing performance characterization of a plastic scintillator muon hodoscope developed at Universidad de los Andes for transmission and scattering muography. In this work, we focus on the performance relevant to transmission muography. The hodoscope comprises four tracking matrices with an active area of 57×57 cm^2, using triangular scintillator bars coupled to wavelength shifting fibers and silicon photomultipliers, together with two external scintillator plates read out by photomultiplier tubes. The two plates define the event trigger through a coincidence implemented with NIM electronics, while CAMAC TDC and QDC modules provide independent timing and charge measurements. The four CAEN FERS 5200 boards provide synchronized spectroscopic and timing information from the tracking matrices. Charge centroid reconstruction using the four matrices yields spatial resolution estimators of approximately 2.6-3.0 mm and angular resolution estimators of 0.12-0.14°. In a configuration with the detector axis horizontal, the external plates were separated by 1.91 m and the timing difference between the plates resolves two populations associated with opposite muon propagation directions, with a separation of 13.07 ns. After excluding a background component, the two directional populations exhibit Gaussian widths of 1.81 ns and 2.01 ns. Complementary measurements with the CAEN system in the vertical detector configuration yield a plate timing difference width of approximately 1.89 ns and pairwise matrix timing widths of 1.34-2.29 ns. This directional sensitivity is particularly relevant for the proposed transmission measurements, where the detector will operate approximately horizontally so that its angular acceptance simultaneously covers open sky and a geological structure. This configuration allows the open sky reference and transmitted muon populations to be recorded during the same acquisition, while timing information determines the propagation direction of reconstructed tracks and contributes to background discrimination.

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