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Experimental comparison of strip micromegas readouts in gaseous TPCs for directional recoil detection

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Imaging the detailed 3D topology of ionization in detectors is broadly desirable in nuclear and particle physics. Of particular interest is the directional detection of nuclear recoils from neutrinos or dark matter, which may prove critical for probing dark matter beneath the neutrino fog and affirming its galactic origin. Gaseous time projection chambers (TPCs) can provide the required low-energy directionality and in this context high-resolution x/y strip readouts are identified as the optimal balance between cost-efficiency and performance. We present an experimental comparative analysis of nine distinct x/y strip configurations with a Micromegas amplification stage. The VMM3a ASIC within the RD51 Scalable readout system (SRS) is used to read out individual strips, while the Micromegas avalanche charge is recorded with a pulse height analyzer system. These two complementary charge readout techniques are used with radioactive sources to characterize the gain, gain resolution, x/y charge sharing, and point resolution of each setup, in order to identify the optimal charge readout configuration. Additionally, we discuss how these results have informed the design of a 40L strip Micromegas TPC currently under development.

Author: MAJD, Ghrear (University of Hawaii)

Presenter: MAJD, Ghrear (University of Hawaii)

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