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Study of Negative-Ion TPC using μ -PIC for Directional Dark Matter search

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Negative-ion TPCs have been studied for low-rate and high-resolution applications. Lately, the discovery of “minority carriers” in CS₂ gas, broadened its potential and the measurement of absolute Z-position in a self-triggering TPC became possible (J.B.R. Battat et al., (2014) arXiv:1410.7821). The minority carriers appeared after adding a few percent O₂ to the original gas. They each drift with slightly different velocities. Recently, a GEM-TPC with SF₆ negative ion drift gas was reported (Nguyen Phan, Eric Lee in: Cygnus 2015 Conference in Los Angeles). They also observed minority carriers without any additional gas. SF₆ is non-toxic, it can be handled easily while keeping the same advantages as CS₂ gas.

NEWAGE has been using a μ -PIC-based TPC for direction-sensitive dark matter search using CF₄ gas (Nakamura et.al, PTEP(2015)043F01s). In order to increase the angular resolution and decrease the radioactive background, we started a new study using a μ -PIC-based TPC with negative ion gas. A test performed at Occidental College showed that a μ -PIC system with pure CS₂ gas can have a gain as high as with pure CF₄ gas. This was the first test of negative ion gas with a μ -PIC. We plan to test a μ -PIC-based TPC with SF₆ gas. We will optimize the SF₆ gas mixture and pressure for dark matter detection. Minority peaks in SF₆ will be used to achieve full volume fiducialization without an external start pulse and should be a valuable tool for rare-event detection such as in Dark Matter Experiments.

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