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Development of a simulation and analysis framework for NνDEx experiment

In this work, a simulation and analysyis framework for the NνDEx experiment is presented.
NνDEx aims to search for the neutrinoless double beta decay in ^{82}Se using a high pressure $^{82}SeF_6$ gas time projection chamber (TPC). Direct charge collection for the drifting ion charge carriers using low-noise CMOS charge sensors is the main feature of the experiment.

Using density functional theory and two-temperature theory, the reduced mobilities of SeF_5^- and SeF_6^- ions in SeF_6 were calculated, obtaining values of 0.444 ± 0.133 and 0.430 ± 0.129 $cm^2V^{-1}s^{-1}$, respectively.

The TPC geometry, featuring a cathode–focusing plane–anode structure and a 10,000-pixel readout array, was modeled in COMSOL to compute electric fields. Signal and background events were generated with BxDecay0 and Geant4, while Garfield++ was used to simulate charge transport and signal induction. Three-dimensional tracks were reconstructed from drift-time differences using a breadth-first search algorithm.

To enhance signal–background separation, six topological variables were extracted from reconstructed tracks and used to define selection criteria. A boosted decision tree was applied for a preliminary analysis. The simulation framework thus provides a comprehensive tool for detector design and sensitivity studies in the NνDEx experiment.

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