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MONTE CARLO SIMULATION OF ELECTRON SWARMS IN PULSED TOWNSEND EXPERIMENT AND VALIDATION OF THE SWARM DATA DERIVED FROM WAVEFORM ANALYSIS

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Abstract. The pulsed Townsend experiment (PT) is one of the swarm methods in active use to determine transport coefficients for fluid model. A shared characteristic of the PT experimental techniques is their initial recording of electron current waveform, followed by the fitting of electron swarm parameters using a theoretically derived electron current expression. However, the theoretically derived expressions are based on the hydrodynamic regime and involve truncation approximations of higher-order terms in the original diffusion equation. Therefore, it is necessary to investigate whether idealized analytical tools are applicable for analyzing measurements (usually in non-hydrodynamic conditions). In this work, Monte Carlo simulations with cross section set of Ar as input are used to describe electron transport at the kinetic theory level, fully accounting for the behavior of the electron swarm in the PT experiment. The simulation in this work is set within a finite boundary equivalent to the experimental setup, and it is capable of describing the behavior of electron swarm under non-equilibrium conditions. Additionally, the ideal "simulated experimental waveforms", regarding as computer-based representations of actual experiments, are used to fit electron swarm parameters using previously established electron current expressions. By comparing the fitted electron swarm parameters with standard data from MCIG, a software for calculating transport coefficients based on the Monte Carlo method (In MCIG, the electron swarm evolves endlessly under boundless space and within the hydrodynamic regime, so the obtained transport coefficients are considered standard), we can gain a better understanding of the quality of these fitted data, as well as identify the circumstances under which the employed electron current expressions are inadequate for describing actual PT discharge.

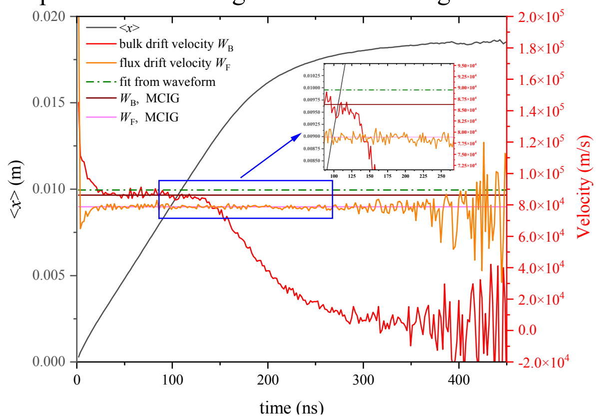

Fig.1 The evolution of the mean position for electrons and drift velocities, with the left axis representing position and the right axis representing velocity, for pressure $p = 500$ Pa, $E/N = 100$ Td in Ar.