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Study of Low-Energy Electron Transport at Extraction Region in Hydrogen Negative Ion Source with an Additional Electrons Source

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Tandem type hydrogen negative ion (H^-) sources are generally designed to have two plasma regions of different average electron energies. The higher and lower electron energy regions are called "driver region"and "extraction region", respectively [1]. The driver region should contain electrons with energy high enough to produce excited hydrogen molecules for H^- production. On the other hand, the extraction region is generally located in the vicinity of a beam extraction hole in order to enhance H^- beam current, while avoiding the H^- destruction due to the higher energy electrons over 1 eV. The separation of the two plasma regions is realized with the filter magnetic field which is introduced to the extraction region. Therefore, the low-energy electron transport in the filter field determines the plasma parameters at the extraction region which decides the performance of H^- sources.
In this study, we aim to understand mechanism of the low-energy electron transport at the extraction region through experiments, especially transport across the filter magnetic field, using numerical simulations in order to obtain basic knowledge for development of more efficient H^- sources.

In the experiment, we use a test stand with a small cylindrical-shape ion source whose diameter and length are 9 cm and 11 cm, respectively [2]. The ion source generates a DC hydrogen plasma with a pair of tungsten filament installed at the driver region. Here, to study the low-energy electron transport, we introduced another filament system [3] inside the extraction region. The additional filament system enhances density of low-energy electrons in the extraction region. The injected electrons diffuse around the filament and the electron density increases locally. The transport of these low-energy electrons in the extraction region can be studied through an analysis of the local change on the density profile. Thus, we measured the spatial distribution of electron density with a Langmuir probe under different experimental conditions. The experimental results were analyzed with two-dimensional position and three-dimensional velocity Particle-In-Cell (2D3V PIC) simulations to understand the low-energy electron transport.
In our early experiments, we have already confirmed the local-density enhancement in electron density profiles. In a poster, we will report the results of experiment and analysis with the PIC simulation.

References

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