§23. High Resolution Measurements of Time Evolutions and Spatial Profiles of Electric Fields in a Fusion Plasma Neutron Source

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An IECF (see Fig. 1) is a device injecting ions and electrons towards the spherical center through the hollow cathode, trapping both species in the electrostatic self-field and making fusion reactions in the dense core. An IECF device can be promising for a portable neutron generator as intermediate products along the path to fusion power source. At present, D-D fusion neutrons of about several millions/sec are successfully produced continuously at our research group, and at several institutions, as well 1).

The most essential objective of our study is to make clear the mechanism of the beam-beam colliding fusion occurring in the IECF device aiming at a further significant enhancement of the fusion reaction rate. Recent introduction of ND:YAG pumped Dye laser for the laser-induced fluorescence (LIF) method 2) successfully revealed highly localized electric field distribution for the first time 3), putting an end to the 30 years debate on the existence of the potential double well due to space charge associated with spherically converging ions and electrons, which has been a central key issue to be clarified in the IECF.

In this study, in order to further increase both spatial and temporal resolution of the potential profile measurements, the LIF method for n = 4 transition of He (HeI forbidden transition from 2_1S to n_1D, electric field sensitivity of approximately 0.2 kV/cm) was studied instead of n = 3 (sensitivity of approximately 2 kV/cm).

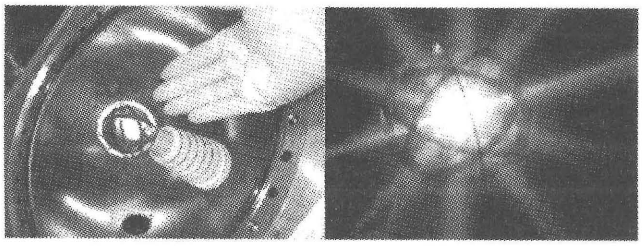

Fig. 1. The hollow cathode at the center of the spherical vacuum chamber as the anode, and an IECF plasma within the hollow cathode

Firstly, for evaluating the sensitivity of the present method for n = 4, the LIF measurements were made for the He plasma produced by use of the well-known U-shaped hollow cathode (see Fig. 2) instead of the spherical cathode shown in Fig. 1. Fig. 3 shows the measured field profile within the U-shape cathode at a negative potential of –200V, which is found to agree well with the expected one. It is found that the electric field as low as 0.1 kV/cm can be well measured.

Secondly, the method for n = 4 was, then, applied to the IEC He plasma by use of the spherical hollow cathode, and comparison was made with the previous results by the method for n = 3. As seen in Fig. 4, much lower electric fields were successfully observed owning to the higher sensitivity than the previous method.

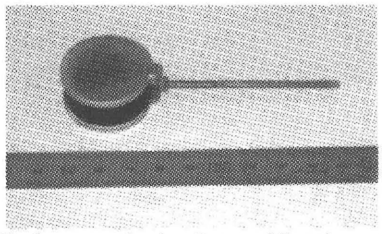

Fig. 2. The U-shape cathode, for verification of the present LIF method for n = 4

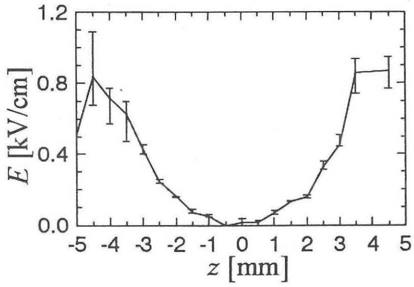

Fig. 3. Electric field profile between the two plates of the U-shape cathode, located at $z = \pm 5$ mm

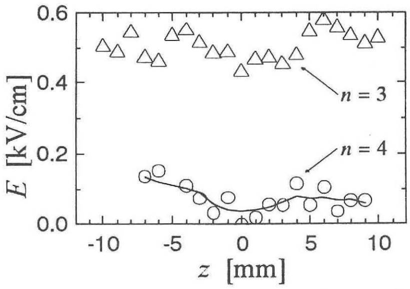

Fig. 4. Electric field profiles within the hollow cathode, comparing the LIF methods for n = 3, and 4

Reference

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