

## Experimental Simulation on Particle Discrimination for Direct Energy Conversion

Y. Yasaka<sup>1</sup>, H. Takeno<sup>2</sup>, M. Ishikawa<sup>3</sup>

<sup>1</sup>Dept. EE Eng., Kobe University, Nada-ku, Kobe 657-8501, Japan, yasaka@eedept.kobe-u.ac.jp

<sup>2</sup>Dept. EE Eng., Kobe University, Nada-ku, Kobe 657-8501, Japan, takeno@eedept.kobe-u.ac.jp

<sup>3</sup>Institute Eng. Mech. & Systems, University of Tsukuba, Tsukuba 305-8573, Japan, misikawa@kz.tsukuba.ac.jp

A direct energy conversion system designed for D-<sup>3</sup>He fusion reactor based on a field reversed configuration employs a Venetian blind type converter for thermal ions to produce DC power and a traveling wave type converter for fusion protons to produce RF power.<sup>1)</sup> It is therefore necessary to separate, discriminate, and guide three major particle components; electrons, thermal ions, and high-energy protons.

For this purpose, proposed is a cusp magnetic field, in which the electrons are deflected and guided along the field line to the line cusp, the thermal ions are less deflected but flow into off-axis region, and the protons pass through the point cusp maintaining on-axis orbit.

We have constructed an experimental device, which consists of a low-energy plasma or ion source, a guide field section, and a cusp magnetic field section. The device is capable of changing the curvature of the magnetic fields from normal cusp to slanted cusp field. We inject the plasma or ion beam into the slanted cusp field to simulate the separation of electrons and ions or the discrimination of ions with different energies.

The cusp field is created by two magnetic coils A and B, with currents  $I_A$  and  $I_B$ , respectively. A plasma beam is injected into the point cusp of the coil A side. We measure the ion and electron fluxes with changing  $I_B$  for a fixed  $I_A = 30$  A. We define the transmission ratio of the particles as the ratio of the flux at the point cusp of the coil B side to that at the entrance. When the cusp field is formed, most of the electron flux flows into the line cusp and most of the ion flux into the point cusp, yielding the transmission ratio of electrons to a small value and that of ion close to 1. The best separation of electrons and ions is obtained when  $I_B / I_A = 1.4$  and the location of the electron collector is at a half way to the line cusp exit. The transmission ratio of electrons in this case is as low as 0.05.

By using the ion source, we simulate the energy discrimination of the thermal ions from the protons in a reactor. The ratio of the ion current at the point cusp to that at the line cusp is measured versus the energy of the incident ion beam. The ratio increases steeply and then saturates as the energy of incident ions is increased from 0.1 to 1 keV, showing that higher energy ions preferentially flow into point cusp.

These experiments will be performed for a variety of energy range to establish a scaling law of particle discrimination in the cusp field for the direct energy conversion.

### References

- 1) H. Momota et al., "Conceptual Design of the D-<sup>3</sup>He Reactor Artemis", *Fusion Technol.* **21**, 2307 (1992).