MPCS-2017-Hp01

Development of Very Small, High-Density Helicon Source for Propulsion

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Helicon plasma [1] source is very promising, since it can produce a high-density plasma up to ~ 10^{13} cm^{-3} over a wide range of external parameters. We have developed various helicon sources, aiming at plasma propulsion as well as fundamental studies with an electrodeless condition (no direct contact between a plasma and electrodes), leading to a longer operation time without wear of electrodes and impurity contamination. Here, plasmas with a diameter of 0.3 - 74 cm and an axial length of 4.7 - 486 cm could be produced [2,3].

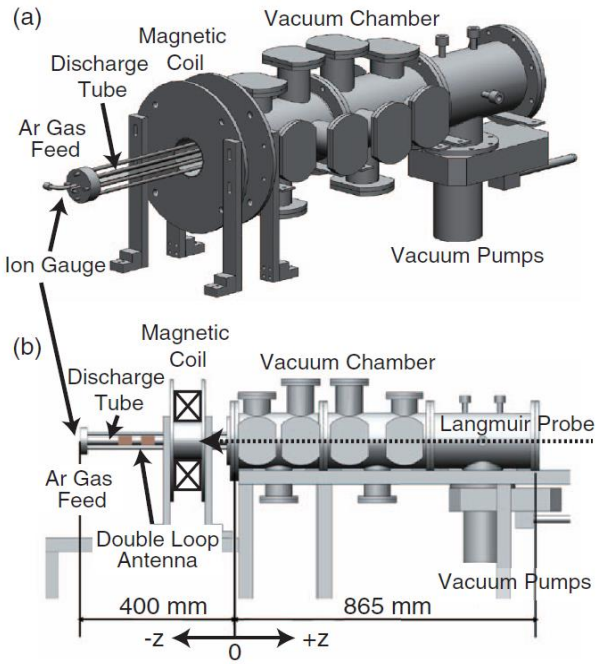

Figure 1. Small Helicon Device (SHD) (top).

In this presentation, we will show experimental results on a very small diameter plasma production and its acceleration with this electrodeless condition, using the Small Helicon Device (SHD) [4], as shown in Fig. 1. This device can accept various sizes of quartz discharge tubes with the use of permanent magnets and/or electromagnets.
We have produced high-density plasma with a very small diameter of 0.3-2 (0.1) cm with (without) the magnetic field, applying the RF frequency for a broad range: from 7 to 435 MHz [5,6]. We have also tried to accelerate a plasma with a scheme of an azimuthal mode number m = 0 half cycle acceleration [2,3], and found increases in electron density and ion velocity by ~ three times.

In characterizing a plasma, the following diagnostics were used: a Langmuir/Mach probe, and a laser for a Laser Induced Fluorescence (LIF) method. Additionally, spectroscopic measurements have been executed to adopt a collisional radiative (CR) model to estimate electron temperature and density.

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