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磁気スラストチャンバーにおけるプラズマの振る舞いに関する実験
Experiment of plasma behavior in a magnetic thrust chamber

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Laser Fusion Rocket (LFR) is a spaceship utilizing an extravagant amount of nuclear fusion energy and controlling fusion plasma with an external magnetic field. LFR has a potential to produce large thrust and high specific impulse simultaneously, so that it is expected as a rocket of interplanetary missions [1]. In interplanetary missions, long duration of the exposure of cosmic ray and living in an enclosed space deteriorate both physical and mental health of astronauts, and reducing mission period is indispensable. LFR is expected to solve this issue because of its potential to generate large thrust. In addition, the thruster can control the exhaust mass and velocity with wide range so that it enables an optimal design of the thruster depending on missions [2-3]. In this paper, such a thruster is called “Magnetic Thrust Chamber”.

In previous researches, some experiments in laser facilities with the energy of 4 J to 1 kJ have been performed. Maeno *et al* have directly measured thrust generated by a magnetic thrust chamber [4]. Yasunaga *et al* have examined the interaction between magnetic field and laser-produced plasma, and observed the diamagnetic cavity [5]. We examined the plasma structure in a magnetic thrust chamber by observing the light emission of a laser-produced plasma with several magnetic field strength as shown in Fig. 1. We observed the plasma deceleration.

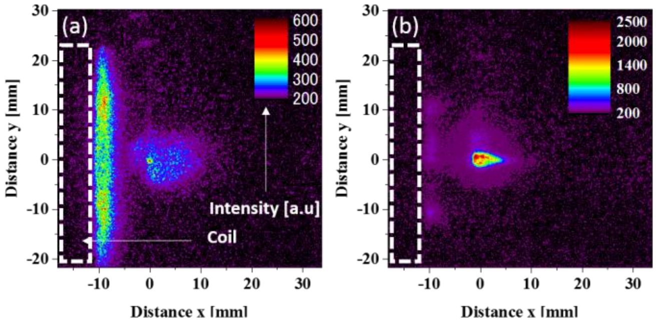

Fig. 1 The light emission from the plasma (a) without and with the magnetic field of (b) 1.1 T, at 0.3 μs after laser irradiation. In these figures, target was set at the coordinate $(x, y) = (0, 0)$ and was irradiated with the laser from left side through the hole of the coil. The magnetic field is in horizontal direction and the center axis of the magnetic field corresponds to the x-axis at y = 0.

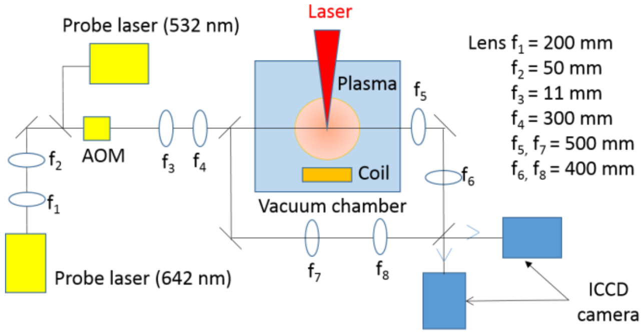

Fig.2　Mach-Zehnder interferometer

In this paper, we examine plasma density by Two-wavelength Mach-Zehnder interferometer to observe the plasma behaviour in strong magnetic field.

The experiment was performed at the Extreme Ultra-Violet (EUV) database facility of the Institute of Laser Engineering (ILE) in Osaka University as shown in Fig. 2. A plasma was created by focusing a 1064 nm Neodymium: Yttrium Aluminum Garnet (Nd:YAG) laser onto a polystyrene ($[-CH_2-CH(C_6H_6)-]_n$) spherical target with a diameter of 500 μm. The pulse width of laser is 9.0 ± 0.5 ns and the laser energy is 5.5±0.7 J. The target is suspended by a carbon fiber attached to a glass rod to reduce the plasma formation of glass rod. The distance between the coil surface and the target is 13 mm.

Magnetic field was generated by flowing current into a 96-turn electromagnetic coil with the inner radius of 13 mm and outer radius of 25 mm. The magnetic field of 1.1 T was generated at the initial target position by applying 500 V on the capacitor bank.

We measured plasma electron and neutral particle of plasma and compare these results with the results of plasma light emission.

References

[1] C.D. Orth *et al.*, UCRL-TR-110500 (2003).
[2] S. Uchida, J. Plasma Fusion Res **81**, 186 (2005) (in Japanese)
[3] S. Uchida, Plasma Fusion Res **83,** 271 (2007) (in Japanese)
[4] A. Maeno *et al.*, Appl. Phys. Lett., **99**, 071501 (2011).
[5] M. Yasunaga *et al.*, Trans. JSASS Aerospace Tech. Japan, **10**, 28, 109-114 (2012).