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Magnetic Control of Laser Ablation Plasma for High-flux Ion Injectors

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S. Ikeda, M. Nakajima, J.Hasegawa, T.Kawamura and K. Horioka

Department of Energy Sciences, Tokyo Institute of Technology,
4259 Nagatsuta-cho, Midoriku, Yokohama 226-8502, Japan

We investigated the interaction of a laser ablation plasma with a longitudinal magnetic field, intending to create a directional moving plasma for development of high-flux and low-emittance ion injectors [1]. The laser ablation plasma expands adiabatically and evolves to a collisionless moving plasma from a dense collision dominated state through an intermediate relaxation region in the magnetic field.

The multi scale interaction processes between such plasma and longitudinal magnetic field have not been quantitatively well understood. To deepen our understanding of the plasma dynamics, we have started an interaction experiment of the laser ablation plasma with longitudinal magnetic field [2].

We produced the plasma by Nd:YAG laser (~ 109 W/cm2) irradiation on copper surface in a longitudinal magnetic field. The magnetic field was generated by a solenoidal coil, 10 mm in diameter and 30 mm in length. We measured the plasma flux and its transverse distribution at 17 cm from the target by a biased Faraday cup as a function of the magnetic field up to 0.2T. The charge state distribution of the plasma was measured with an ion energy analyzer.

The results show that, in the presence of magnetic field, the ion current density increases about 5 times in the forward direction and the transverse distribution becomes shaper. These results indicate that the ion current density and its distribution can be controlled by moderate (~0.2T) magnetic field. We also observed that, in case of magnetic filed application, the plasma flux has two peaks and the first peak is composed of highly charged ions. This means the magnetic field can preferentially increase highly charged ions in the ablation plasma.

[1] M. Okamura, A. Adeyemi, T. Kanesue, J. Tamura, K. Kondo et al.,
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[2] S. Ikeda, M. Nakajima and K. Horioka,
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Primary author: IKEDA, S. (Department of Energy Sciences, Tokyo Institute of Technology,)

Presenter: IKEDA, S. (Department of Energy Sciences, Tokyo Institute of Technology,)

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