§40. Development of a Coil-Gun for Fast Ignition

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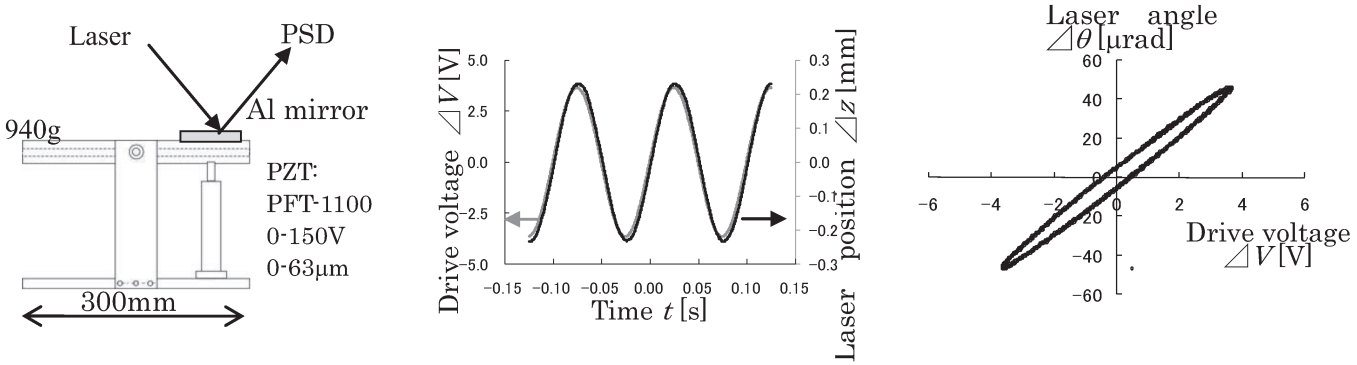
Two types of laser beam stirring system of a coil-gun are studied[1,2]. One is standing on Stimulated Brillouin Scattering (SBS) Phase Conjugate Mirror (PCM). Partially scattered probe laser beam is amplified and reflected backward by the SBS-PCM. The other is a mechanical stirring mirror. The progress of later is reported here. The mechanical specification of beam stirring mirror for IFE reactor should be a few meter and several hundred kilograms. Over 10 Hz repetition speed and around ten mrad stirring angle are required at enough accuracy for laser irradiation on a injected target. Multi piezoelectric devices (PZT: lead zirconium titanate) array is one of candidates for that mechanical stirring mirror. In order to design and develop it, fundamental characteristics were evaluated by using the single PZT driven mirror.

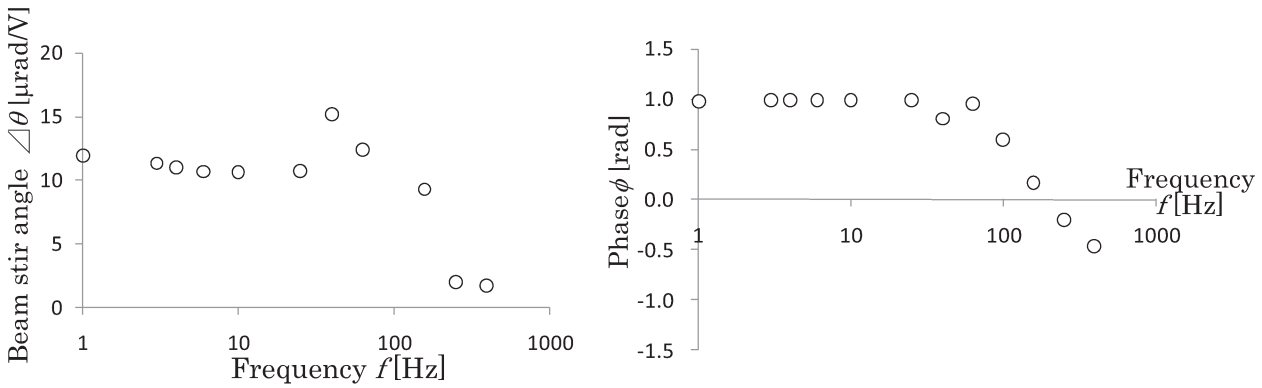
The structure of single PZT driven mirror is shown in Fig. 1(a). An aluminum mirror is attached on a seesaw mechanism mount. A He-Ne laser beam is stirred by it. The position / stirred-angle of laser beam is measured by the Position Sensitive Device (PSD; Hamamatsu Photonics, S1880). The PZT device (NIHON CERATEC, PFT-1100) actuates the seesaw mechanism mount by high voltage drive signal. The inertial moment of it is 0.1kgm^2. The time response of single PZT driven mirror is shown in Fig. 1(b) at the frequency of 400Hz. The stirred beam position is plotted with the drive signal. The hysteresis of them is shown in Fig. 1(c). We can see some deviation which can be minimized by compensated drive signal. From the relation between the input signal and the reflected laser beam, the frequency response is plotted in Fig. 2. Its characteristics are basically determined as the classical second-order lag system with the response frequency of ~100Hz for 0.1 kgm^2 inertia moment. The resonant frequency of it gives small affects at around 60 Hz. These characteristics can be extrapolated for a multi PZT array driven large inertia moment stirring mirror. The resonant frequency also can be tuned by mechanical design.

1) H. Yoshida, Recent Study of Target Injection and Tracking at Gifu University, Japan-China Bilateral Workshop on Target Materials, Huang Shan, China, Jul.28-Aug.1(2007).
H. Yoshida, Coil Gun for IFE Target Injector, IFSA2007, Kobe, Japan, Sept.9-14 (2007).
2) H. Yoshida, Experimental Study of a Coil Gun for Injection and Tracking, IAEA-TCM, Kobe, Japan, Sept.13(2007).



(a) Structure (b) Drive voltage- beam position (c) hysteresis characteristics

Fig.1 Single PZT driven mirror and charcteristics at 400Hz.



(a)Beam stiring angle (b) Phase response

Fig. 2 Frequency response of the single PZT driven mirror.