§24. Development of Two Color THz Laser Diagnostics

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Measurement of the plasma current density profile is indispensable for the so-called advanced modes of tokamak operation. In ITER, a poloidal polarimeter based on the Faraday effect of a far-infrared (FIR) laser beam passing though the plasma has been designed[1)] to measure the profile. A 118.8-μm CH_3OH laser line is proposed as a probing light source for the polarimeter, since the CH_3OH laser line is the shortest and high power FIR laser oscillation line among many oscillation lines applied on fusion devices so far. The Faraday rotation angles that can be expected in ITER are large enough to be measured accurately. However, the Cotton-Mouton effect is also large, and then should be taken into account for evaluation of the rotation angle. Therefore, we have been developing shorter wavelength laser oscillation lines around 50 μm, since the Faraday rotation angle is still large enough and the Cotton-Mouton effect is small enough. We already achieved high power laser oscillation lines, 57.2 μm and 47.7 μm by using a CH_3OD laser optically pumped by the 9R(8) CO_2 laser line.

In order to investigate diagnostic performance of the two color system we have constructed a test stand with the configuration of Michelson interferometer type, where affects of the mechanical vibration on the polari-interferometer are investigated. To simulate mechanical vibration a reflecting mirror of the interferometer is modulated. Figure 1(a) shows the vibrational displacements of the reflecting mirror evaluated from 57.2 and 47.7 μm interferometers. Frequencies of the added vibrations are 3, and 140 and 300 Hz. The former low frequency is added by a vibrating mirror driver by a piezoelectric transducer. The latter two high frequencies are added by hitting the mirror by a tool intermittently. The subtracted signal between two wavelength shows there is no low frequency component corresponding to the vibrations. As is shown in Fig. 1(b), high frequency noise is also well cancelled out. At the present, the uncompensated noise level of about 0.6 μm, which is thought to be caused by the detector noise or laser oscillation noise, corresponds to the line averaged electron density error of 4×10^{17} m^{-3} in ITER. Polarimetry is thought to be intrinsically immune to the mechanical vibrations. However, it slightly suffers side-effects depending on the measurement method and the direction of the vibration. In order to examine the immunity to the mechanical vibrations of the polarimeter with PEMs, one of the mirrors is vibrated along the optical path as illustrated in Fig. 2(a). The vibration component is not observed in the evaluated polarization angle α as demonstrated in Fig. 2(b). The bending effect of a probe beam by a plasma may change the incident angle to the PEM. The error from the beam bending effect is smaller than the target resolution 0.05 degrees in ITER

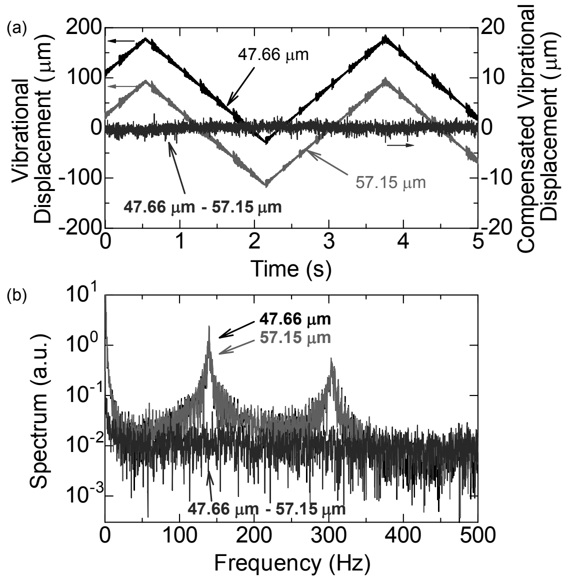

Fig.1 a) The vibrational displacements of 57/48-μm interferometers and the vibration compensation with them. (b) Noise spectra of each interferometer and the vibration-compensated signal.

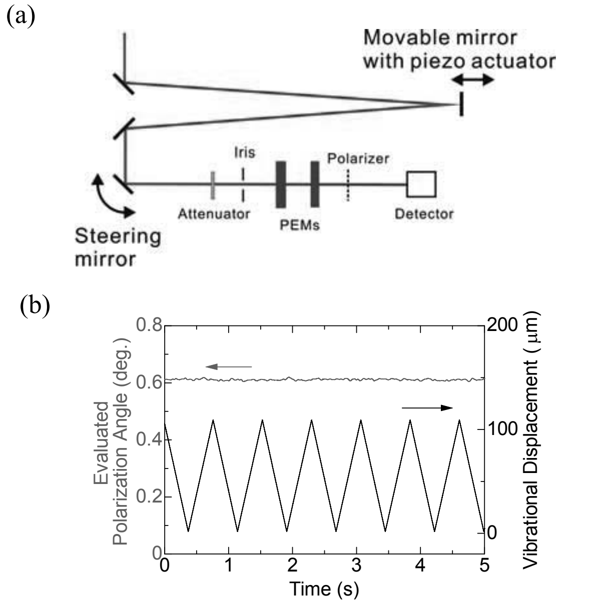

Fig.2. (a) Optical setup for tests of how the mechanical vibrations affect the measurement. (b) The evaluated polarization angle when the optical path length changes by a distance of 110 μm.

1)A.J.H. Donne, et al., Rev. Sci. Instrum. **75**, (2008) 4694.