§22. Development of Two Color THz Laser Diagnostics

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We have been developing an innovative laser diagnostics[1] for the establishment of reliable electron density/current density profile measurement technique. Figure 1 shows a schematic drawing of the optical configuration of a polari-interferometer with a two color laser system. The probe beam (ω_1, ω_2) is divided into many probe beams and a reference beam by beam splitters made of highly resistive silicon. Each probe beam is led to the waveguide and injected into the plasma via a focusing mirror, and reflected back with a corner cube retro-reflector. The reflected beam goes back to the diagnostic room through the same waveguide, and finally is divided into two parts, Faraday rotation measurement with dual PEMs (PM1 and PM2) and phase shift measurement with heterodyne detection. In the polarimeter part, one wavelength has to be selected for the detection of a rotation angle. Then, we have developed a Fabry-Perrot filter operating in THz wavelength regime. Figure 2 shows a constructed tunable Fabry-Perot filter (a) and its power transmittance (b) as a function of cavity length. A metal mesh was applied as a reflector. In the polarimeter part, one wavelength is selected for the detection of a rotation angle as is shown in Fig. 3(a). Figure 3(b) shows an effect of the usage of the Fabry-Perot interferometer filter on the angle resolution. Compared with that in the case that 57.2 μm is selected with a polarizer, the angle resolution slightly deteriorates. The deterioration is thought to be due to contamination of other wavelength, 47.7 μm, whose added retardation by the PEM is different. This would be improved by optimization of the Fabry-Perot interferometer filter, since larger cavity length would
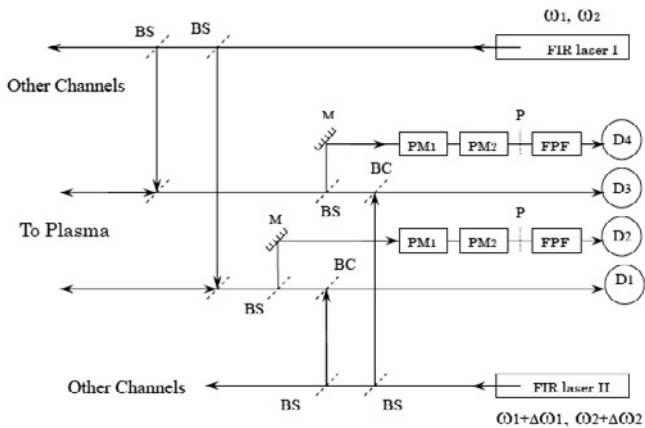
provide good elimination of unwanted component. In the real application, we need to take into account the Faraday effect on the laser beam propagating through the vacuum windows. The rotation angle of θ is proportional to the beam path l_w through the window and to the magnetic field strength parallel to the beam propagation at the window H, that is $\theta = Vl_wH$, where the constant V is well known as the Verdet constant. By the use of the two color polarimeter, the Faraday rotation component at the vacuum window is expected to be eliminated[2].
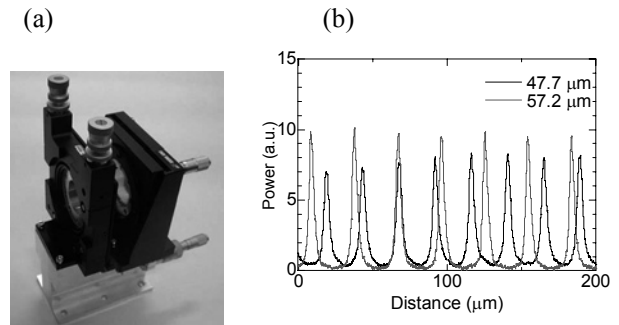
(a)   (b)

Fig. 2 (a) Fabry-Perot filter (b) Power transmittance as a function of a cavity length. Horizontal scale is measured from the initial position of the reflector.
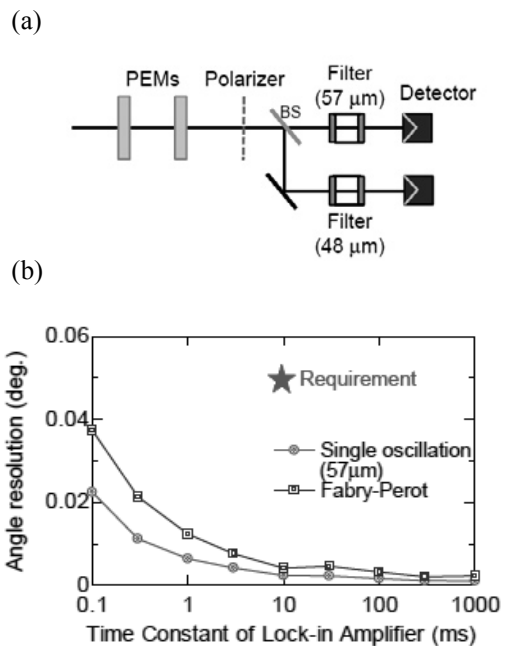
(a)

(b)

Fig.3 (a) a polarimeter part of the optical system, (b) angular resolution with and without the Fabry-Perot interferometer.

Fig. 1 Schematic drawing of the polar-interferometer with the two color laser system.

[1] K.Kawahata, et al., Rev. Sci. Instrum. **79**, (2008) 10E707.
[2] Y. Kawano, et al., Rev. Sci. Instrum. **70**, 1 (1999) 714.