§25. Improvements of Dispersion Interferometer

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One of advantage of a dispersion interferometer is that it is free from phase errors due to mechanical vibrations. So far, a vibration isolation system and/or a massive flame are equipped with interferometers to reduce the phase errors. However, suppression of the vibration will be difficult on future large fusion devices. The wavelength of the light source is determined to have a larger phase shift than that due to the vibrations for conventional interferometers. In the case of the dispersion interferometer, the restriction is not necessary because of the immunity to the vibration. Hence a short wavelength whose phase shift is smaller than 2π can be used. Then, the phase is determined without ambiguity. This means that this interferometer is free from fringe jump errors. From these advantages, the dispersion interferometer is suitable to future large and high density fusion devices such as high density operations of LHD and ITER.

The bench-testing of the CO_2 laser dispersion interferometer has been made at the diagnostic laboratory[1]. In the previous annual report, successes of the new phase extraction method and effects of return beam to the laser were reported. Since the previous optical setup was back-and-forth configuration in the object to be measured, the small fraction of the back beam goes back to the laser (back-talk). The back beam made the laser oscillation unstable and the phase resolution and long-time stability was deteriorated. Figure 1 shows the modified optical setup to slolve the back-talk[2]. The probe beam takes only one way in the object.

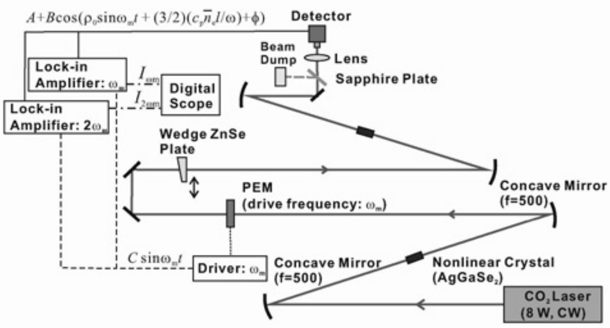

Fig. 1: Optical setup of the dispersion intererometer

For simulation of a plasma, a ZnSe plate with a wedge angle tan θ of 0.25 deg. was put at the optical path and was scaned by δl vartically to change the thickness. The measured phase is given by following expression.

$$\Phi = A\frac{4\pi(\delta l)tan\theta}{\lambda}(n_{2\omega} - n_{\omega}) \qquad (1)$$

where A is 2 or 1 for double path (previous setup) or sigle path (present), n_ω and $n_{2\omega}$ are the reflectivity of the fundamental and second harmonics, respectively. The dips of the phase of previous setup were caused by the output instability of the laser due to the back talk. They are completely solved by this configuration modification as shown in Fig.2.

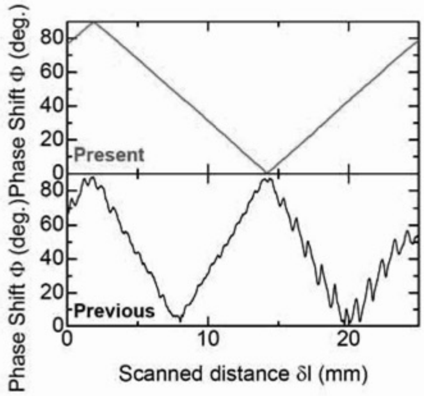

Fig. 2: ZnSe scan experimernts before and after modification of the optical setup

Figure 3 shows variations of the zero lines for 1 second before/after modification of the optical setup. The vertical line is converted to the line density. The present variation width is $\pm 1.3 \times 10^{-17}$ m^{-2} with a time constant of lock-in amplifiers of 100 μs. The width of the variations is improved by a factor of about 4 by solving the back talk.

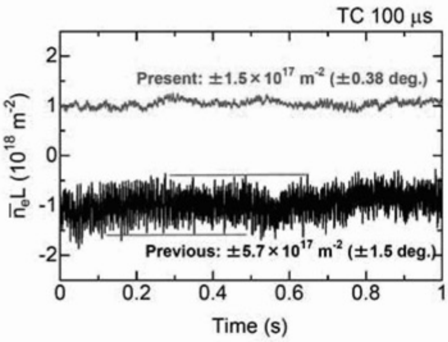

Fig. 3: Comparison of variations of the zero line before and after modification of the optical setup

The dispersion interferometer on LHD is underconstracting.

1) T. Akiyama *et. al.*, Rev. Sci. Instrum. **81**, 10D501 (2010).

2) T. Akiyama *et. al.*, Plasma and Fusion Research **5**, 047 (2010).