§26. Stabilization of 48- and 57-μm CH_3OD Lasers for Two Color Interferometer/ Polarimeter

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Simultaneously oscillated 48- and 57-μm CH_3OD lasers pumped by 9R(8) CO_2 laser have been developed as an optical source of interferometer/polarimeter for high density plasma such as LHD and ITER. The two color interferometer is capable measuring the vibration compensated electron density profiles[1]. First of all, only the 57-μm laser has been stabilized by using a frequency stabilized CO_2 laser. We reported that the performances are power stability of ± 2.4 %/40 min. and beat frequency stability of 765±25 kHz/40 min. in the previous annual report. In this study, the powers and the beat frequencies of the simultaneously oscillated 48- and 57-μm lasers have been stabilized by controlling the cavity length.

Figure 1 shows the feedback stabilization system of the twin type FIR laser. The frequency of the pump 9R(8) CO_2 laser has been stabilized by an external Stark-cell modulation. The performances were the power stability of ± 0.74 %/h and the frequency stability of ± 580 kHz/h. The FIR laser is twin type (A, B) owing to a heterodyne beat modulation for the interferometer. The laser tube is a 3.0-m long, 25-mm bore, Pyrex tube with a water jacket. The cavity mirrors consists of an Au coated input mirror with off-axis hole in order to reduce an back-talk from the FIR laser cavity to the CO_2 laser cavity and a Si hybrid output mirror. A change of the cavity length is main cause of the output and frequency instability. For passive output and frequency stabilizations, the distance between the laser mirror mounts is fixed by using two Super Invar rods. For active feedback stabilization, the laser cavity length is controlled by a stepping motor. Either 48- or 57-μm laser is used as the feedback signal by using a polarizer and an electronic filter. The output power is stabilized at the slope of the detuning curves (Fig. 2(a)). Two color beat signals (Fig. 3(a)) detected by a Ge:Ga photoconductor are F-V (frequency and voltage) converted after passing through the electronic filters. The FIR laser cavity is tuned so that the beat signal is locked to a set point value.

Figure 2(b) and 3(b) show temporal changes of the output powers and the beat frequencies of both lasers in controlling by the 48-μm laser. The stabilities were ± 2.0 %/30 min. and 1260±26 kHz/30 min. for the 57-μm laser and ± 2.6 %/30 min. and 400±16 kHz/30 min. for the 48-μm laser. These instabilities are caused by the back-talk. When there is the stabilization point on the detuning curves in anti-phase, there is sensitive of the pump CO_2 laser instability. We were confirmed that the stabilization of the 57-μm laser was also possible by the control of the 48-μm laser. The back-talk will be reduced by using an optical isolator in future.

1)Kawahata, K. et al.: Rev. Sci. Instrum. 79 (2008) 10E707

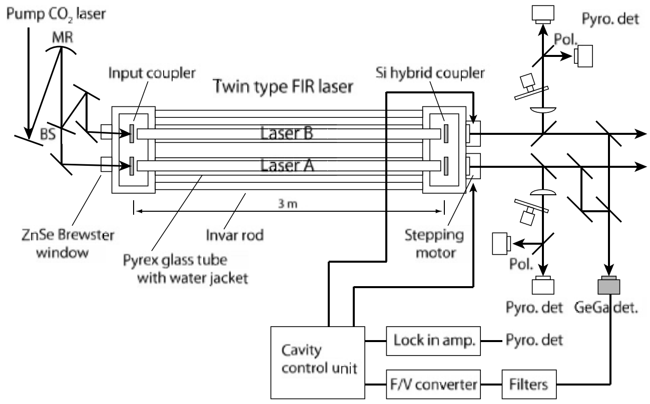

Fig. 1. Stabilization systems of the twin type FIR laser.

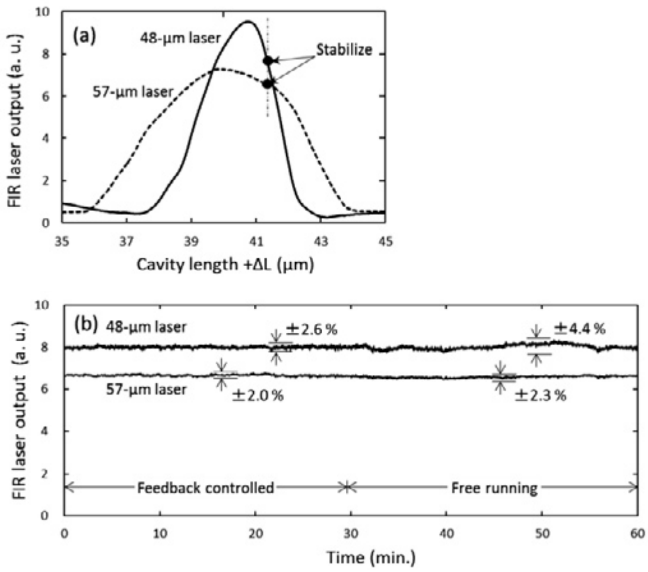

Fig. 2. (a) Detuning curves and (b) output stabilities of simultaneously oscillated 48- and 57-μm CH_3OD lasers.

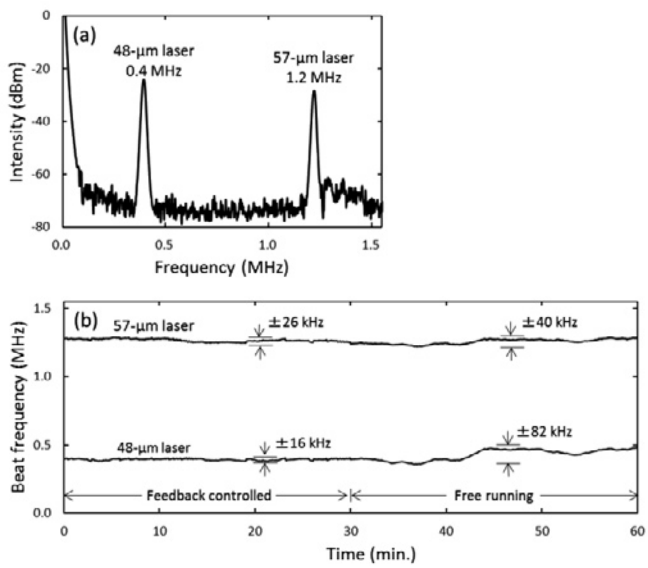

Fig. 3. (a) Beat signals and (b) beat frequency stabilities of simultaneously oscillated 48- and 57-μm CH_3OD lasers.