§6. Stable Twin 119-μm CH_3OH Laser of Single Mode Using for Beat-Modulated Interferometer

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Research and development of a twin 119-μm CH_3OH laser have been carried out to use for a beat-modulated FIR laser interferometer on LHD [1,2]. The laser installed in the stationary measurement system is required to satisfy the followings : (a) high power, (b) single mode, (c) low noise, (d) high stability for output power and frequency, (e) easy handling, (f) maintenance free, (g) low running cost, and (h) high safety. To evaluate the performance of the laser system, the characteristics have been measured in free-running operation.

On the 9P(36) CO_2 laser, cw output power over 100 W is available for FIR laser pumping. The single mode oscillation is obtained by precise alignment of the optical axis in the CO_2 laser tube and the cavity. The feedback effect of pumping light for CO_2 laser is reduced at less than 1 % by optimization for incident angle and beam expansion of incident pumping beams from off-axis input coupling holes of the twin FIR laser cavity. The output power change of the CO_2 laser is less than ±1 % for long term (1 h) and short term (Fig. 1).

On the 119-μm CH_3OH laser, the single mode oscillation is obtained by adjusting the laser cavity. The long term drift of the laser output is less than ±2 % for 1 h, and the short term fluctuation is about ±1 % (Fig. 1). No self beat signal is observed in the heterodyne beat spectrum obtained by mixing the 119-μm laser outputs (Fig. 2). The

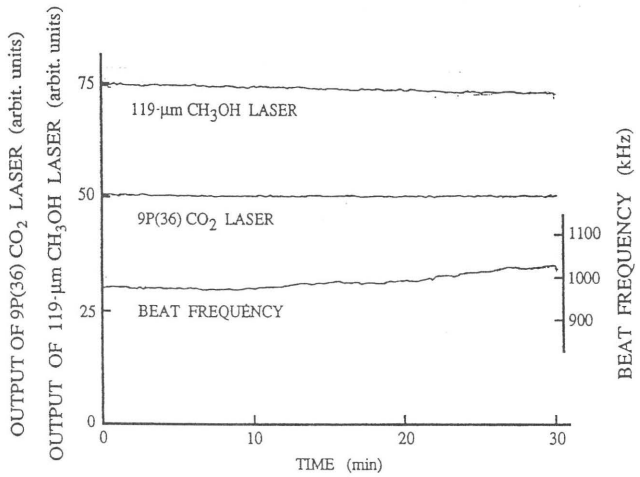

Fig. 1. Long-term stability of 9P(36) CO_2 laser and 119-μm CH_3OH laser outputs and beat frequency for free-running operation.

long term drift of the beat frequency (~1 MHz) is about ±40 kHz for 30 min.

To evaluate the short term stabilities of laser output and the beat frequency considering integration time, a 2-channel real time processing system using PC-9801 personal computer has been developed. As shown in Fig. 3, the short term frequency stability evaluated by square root of Allan variance is about 4 x 10^{-4} for 0.1 to 1 s of integration time, which corresponds to laser frequency stability of about 2 x 10^{-10}.

On LHD diagnostics, maintenance-free operation over one week is required. To realize the operation, the active stabilization system is under development.

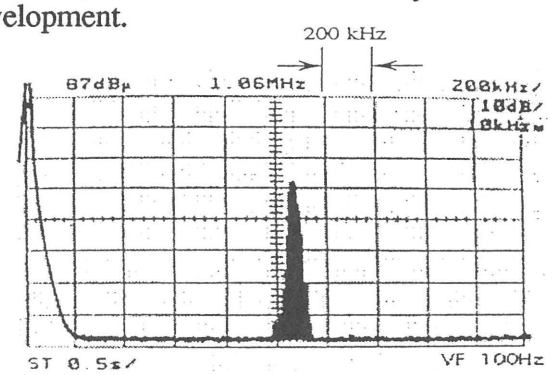

Fig. 2. Heterodyne beat signal obtained by mixing the outputs from twin 119-μm CH_3OH laser.

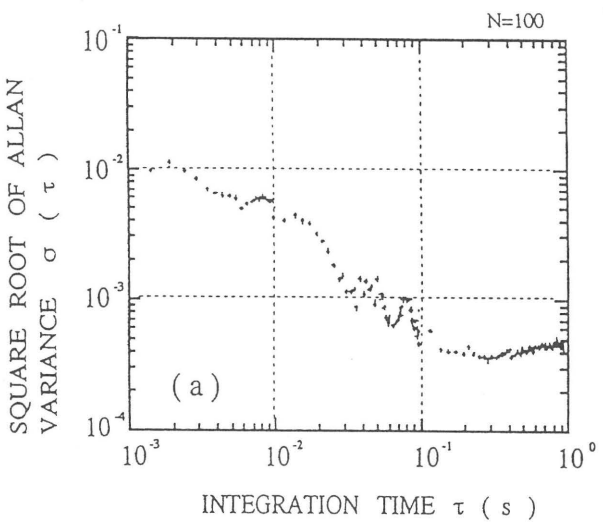

Fig. 3. Stability of the beat frequency (1 MHz) for free running twin 119-μm CH_3OH laser.

References
1) Okajima, S.,Kawahata, K., et.al., Conf. Digest of 17th Int. Conf. on IR and MM Waves (Pasadena, USA), Vol.1929 (1992) p.366.
2) Okajima,S., Kawahata, K. et.al., Conf. Digest of 19th Int. Conf. on IR and MM Waves (Sendai, Japan), (1994) to be published.