

§15. Development of a New Two Color FIR Laser Interferometer (II)

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Measurements of the refractive index of the plasma by using electromagnetic waves are a well-established tool for measuring electron density profiles in high temperature plasmas. In the Large Helical Device, a 13-channel far infrared laser interferometer has been routinely operated for the precise measurements of the electron density profile [1]. The optical configuration of the interferometer is of the Michelson interferometer type with a heterodyne detection system. The light source is a highly stable twin 118.8- μm CH_3OH laser pumped by a cw CO_2 laser. The overall accuracy of the system is about 1/100 of a fringe, corresponding to a line averaged density of $5.6 \times 10^{16} \text{ m}^{-3}$ at the central chord. The interferometer routinely provide density profiles almost every shot except in the case of a high-density plasma produced by an ice pellet injection. When a large sized pellet is injected into the plasma steep density gradient is formed in the peripheral region of the plasma, which sometimes causes the fringe jumps on the density traces measured by fringe counters. In order to overcome this difficulty we have been developing new laser sources in the wave length region of 40 to 70 μm , which is optimum value from view points of the plasma refraction and mechanical vibration effects, since the beam bending effect can be reduced by a factor of ~ 4 compared with that of 119 μm . On the way to search short wavelength laser oscillation lines, the most powerful line was found to be a 57.2- μm CH_3OD laser line [2] and be able to oscillate simultaneously at a 47.6 μm every 5 x 57.2 μm ($\sim 6 \times 47.6 \mu\text{m}$) by tuning the FIR laser cavity length. These new laser oscillation lines enables us to develop a new two color FIR laser interferometer [3].

One of the key issues to construct the two color interferometer system is to develop a high quality detector operating at the wavelength of $\sim 50 \mu\text{m}$. This fiscal year we have newly introduced Ge:Ga photoconductive detectors operating at liq. He temperature, which have a signal bandwidth of 1200 GHz centered at 3000 GHz. The responsivity of the detector is 0.4 amps/watt around 50 μm , which is about 30 % of the peak value. Figure 1 shows the experimental set-up for the detection of two color beat signals. Figure 2 shows the two color beat signals detected, 1.5 MHz for 57.2 μm and 900 kHz for 47.6 μm . The beat frequency of each oscillation line can be adjusted at a suitable value for phase measurement by tuning the length

of the FIR laser cavity and changing the operating pressure of the lasing molecule. The achieved signal to noise ratio is about 30 dB when the input power to the detector is reduced by 30 dB. These beat signals will be fed to a phase comparator for phase measurement after passing through a band-pass filter.

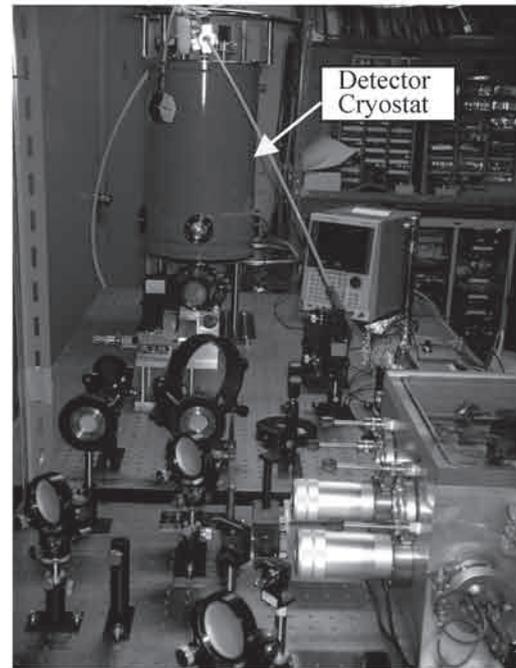


Fig.1. Experimental set-up for the detection of two color beat signals.

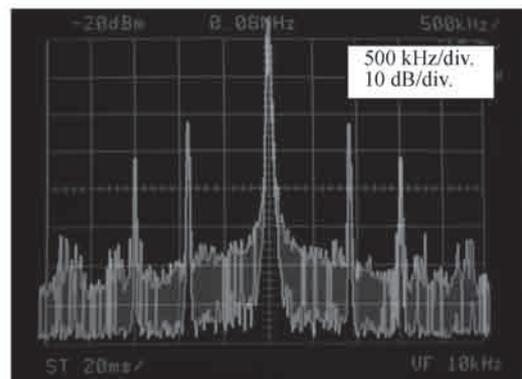


Fig.2. Two color beat signals at 1.5 MHz for 57.2 μm and 900 kHz for 47.6 μm .

3. References

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