§3. Development of CO_2 Laser Imaging Interferometer

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An imaging interferometer by using a CO_2 laser (wavelength is 10.6μm) is under developing. The purposes of this diagnostics are to be a reliable density monitor in high-density discharge like pellet injection, to measure precise electron density profiles, and to measure electron density fluctuation. A 13ch FIR laser interferometer by using 119μm CH3OH laser is routinely working on LHD and provides density profiles. However, the FIR interferometer sometimes suffers from phase jump due to the steep density gradient when pellet is injected. And 90mm spatial resolution is not enough to measure steep edge density gradient precisely, which plays important role on transport. A CO_2 laser interferometer is designed to overcome above problems. By using 10.6μm CO_2 laser, refraction effect, which is proportional to square of the laser wavelength, becomes negligible. An imaging technique by using slab beam and detector array makes millimeter order spatial resolution possible. Also, this fine spatial resolution makes possible to measure density fluctuation and can provide wavenumber-frequency spectrum. On the other hands, the followings are critical issues for the development. A small phase shift measurement due to short wavelength, compensation of the mechanical vibration by using second color interferometer, realization of imaging optics without distortion, and spatial resolution along beam axis for fluctuation measurements. Bench top experiments were done to check feasibility of above issues.

Fig.1 shows schematic view of the CO_2 laser interferometer. Every optical component is placed on the vibration-isolating stand of the FIR interferometer. Three slab beams cover the LHD plasma. The detection optics is placed on the top of the stand. This Mach-Zender type one path configuration is free from distortion of the image due to the diffraction effect. Local and reference beam pass outside of the plasma in vacuum vessel. Although these beams pass divertor leg, the phase shift due to divertor leg is negligible. Fig 2 shows results of test experiments to check spatial resolution. 2 and 4mm width teflon sheet were scanned perpendicularly to beam axis and phase difference of the two channels of the linear detector array were measured. As shown in fig.2, 2 and 4mm width phase objects were well distinguished by the imaging optics. Fig.3 shows comparison of the vibration measurement between CO_2 laser interferometer and HeNe laser (wavelength is 633nm) interferometer. By using two color scheme, vibration can be canceled down to 0.2μm vibration, which corresponds to 1/50 fringe of CO_2 laser interferometer. The phase shift due to ultra sonic sound, of which phase shift was $3x10^{-5}$ fringe, was measured. This phase shift corresponds to $7x10^{15}m^{-2}$. And this result indicates micro turbulence is possible to measure by using this diagnostics. The development of local measurement of fluctuation along beam axis is under going. The system will be installed on LHD on 2001 the fifth cycle campaign.

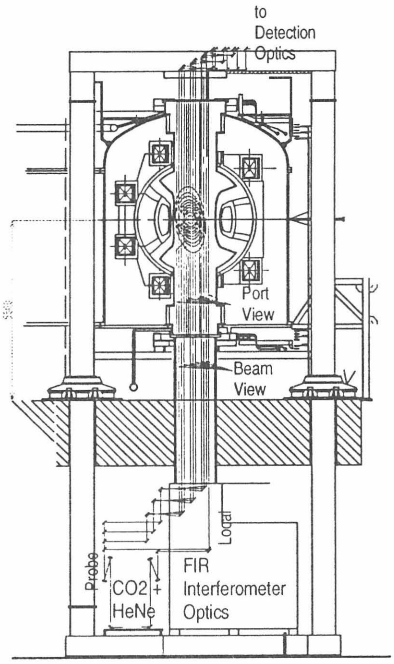

Fig.1 Schematic View of CO_2 Laser Imaging Interferometer

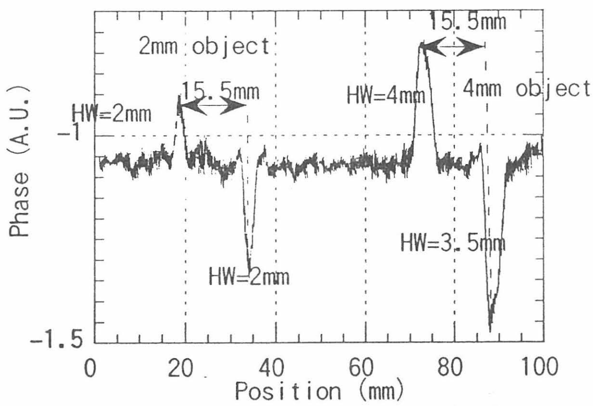

Fig.2 Check od Spatial Resolution

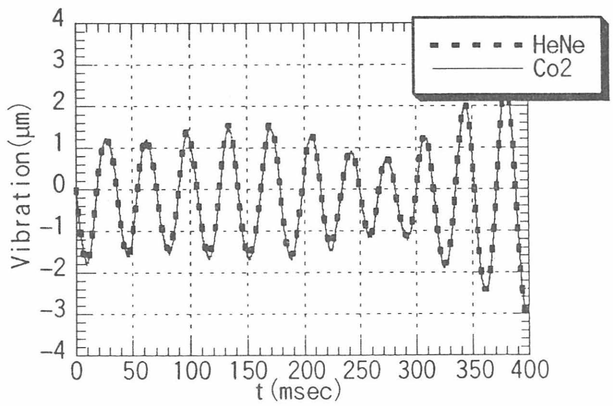

Fig.3 Comparsion of the vibration measurement