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ヘリオトロン J における遠赤外線レーザー干渉計の開発
Development of Far Infrared Laser Interferometer in Heliotron J

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Recently, high density plasma production with $n_e > 10^{20}$ m^{-3} was successfully achieved with advanced fueling control techniques such as Supersonic Molecular Beam Injection (SMBI) and short-pulsed High Intensity Gas Puff (HIGP) in Heliotron J [1, 2]. For the study of such high density plasma production, a Far InfraRed (FIR) laser interferometer is being developed, which utilizes short-wavelength waves compared with that of a microwave interferometer being used in Heliotron J.

Figure 1 shows a schematic view of the Michelson interferometer constructed on Heliotron J. This system uses an HCN laser (λ = 337 μm, output power = 30 mW) as the light source. Two laser beam lines are used in this system. One of the laser beams is injected into the vacuum chamber as a probe beam from a lower port and is reflected back with a corner cube mirror located at an upper port. The frequency of the other beam is shifted by 1.45 MHz with a Super Rotating Grating (SRG) [3] for heterodyne detection. These two beams are mixed and detected with Schottky barrier diodes and the resultant beat frequency is 1.45 MHz, which can realize a high time resolution faster than 1 μs.

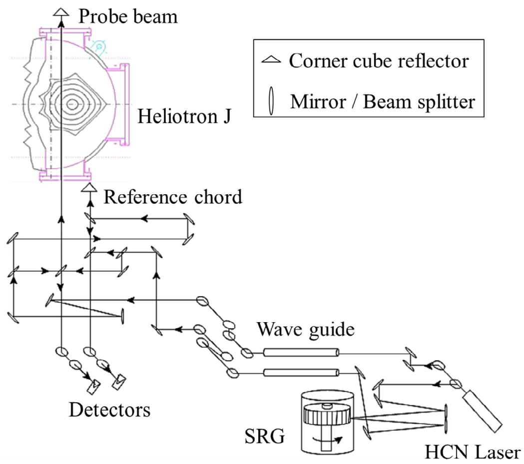

Fig. 1: Conceptual scheme of FIR laser interferometer in Heliotron J

The influence of refraction of the probe beam is investigated in this system using a ray tracing code, TRAVIS [4] since the refraction makes the laser beam deflected from the original axis and degrades a signal level significantly at the detector. Assuming several types of electron density profiles as shown in Fig. 2 (a), horizontal deviations at several important components, e.g. the corner cube mirror, the beam splitters, the vacuum windows and the detector were evaluated. The estimated beam deflection at these optical components is small enough compared with the beam diameter and is negligible. At the detector, the deviation is less than 15 mm in case of $n_e(0) = 1\times10^{20}$ m^{-3} as shown in Fig. 2(b), however the two beams can still overlap since the beam diameter at the detector is roughly 40 mm. Therefore, high density plasmas produced by SMBI or HIGP can be considered to be measureable using this system in Heliotron J although sufficient laser power is required to increase signal-to-noise ratio.

The details of FIR interferometer system and the refraction effect will be shown and discussed.

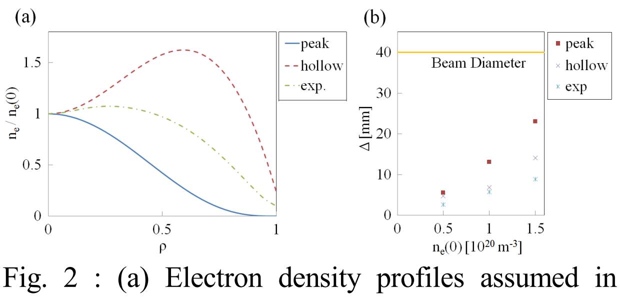

Fig. 2 : (a) Electron density profiles assumed in TRAVIS calculation. Exp. is a fitted curve of an experimental data.
(b) Beam axis deviation at the detector of probe beam. The yellow line indicates the beam diameter at the detector.

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