§35. Design Study of a Dispersion Interferometer on Heliotron J

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The electron density is one of indispensable parameters not only for physical analysis but also for fueling control. A heterodyne interferometry is a main density measurement method at present fusion devices. However, there are two disadvantages. One is measurement errors due to mechanical vibrations and the other is fringe jump errors in a high density range. These days, the electron density in Heliotron J is increasing by SMBI and configuration with low toloidicity. Hence, the density measurement method which can be used with high resolutions and high reliability even in the high density range is required. A dispersion interferometer can compensate the mechanical vibration by itself [1] and the vibration isolation system are not necessary.

From consideration in FY 2014, it is found that an output power of 1 W will be sufficient for the second harmonic generation. The candidate laser is L4S of Access Laser Co. Since this laser has an air cooling, the total system becomes more compact, compared with a laser with a water cooling. The nonlinear crystal is $AgGaSe_2$, which is used for the dispersion interferometer on LHD [2].

Figure 1 shows the line of sight in Heliotron-J. The radial line of sight is preferable because it always provides the line averaged electron density of the central chord. The corner cube mirror (CCM), whose diameter will be about 50 mm, will be welded on the inner wall. The probe laser beam passes through a plasma twice with a displacement 30 mm to separate back and forth beams, and goes back to the optical table. The beam diameter will be 6 mm at the position of the CCM. The vacuum window material is ZnSe, whose transmission is high enough for both the fundamental and the second harmonic components. The maximum beam diameter between the vacuum vessel to the optical table is smaller than 15 mm. For protection and safety reasons, a metal pipe, whose diameter is about 100 mm, should be used as a laser transmission duct. Figure 3 shows an example of arrangement of optical components. The size of optical table is 1.1×2.0×0.83 m and all optical components can be placed there. Supposing that the same phase resolution is obtained, the density resolution will be 3×10^{17} m^{-3} on Heliotron J. The previous time resolution was 100 μs, which was determined by the signal delay in the lock-in amplifier. New lock-in amplifier improved the circuit of DA converter and the delay seems to become 30 μs. These resolutions are sufficient for fueling control.

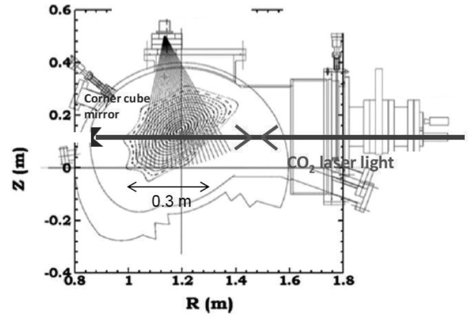

Fig. 1: Line of sight of the dispersion interferometer on Heliotron J

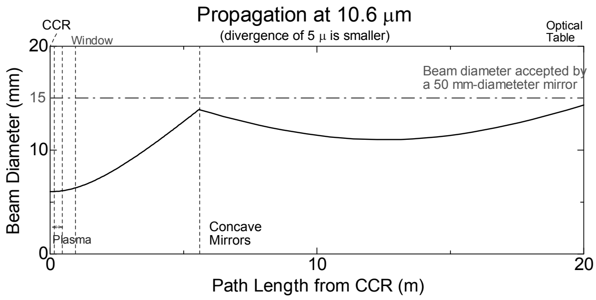

Fig. 2: Distribution of the diameter of the probe beam

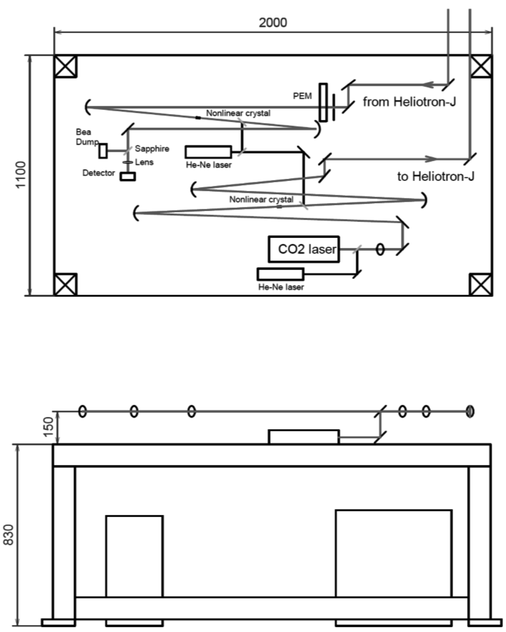

Fig. 3: Example of arrangement of the optical components and optical table.

1) P. A. Bagryansky *et. al.*, Rev. Sci. Instrum. **77**, 053501 (2006).
2) T. Akiyama *et. al.*, Rev. Sci. Instrum. **85**, 11D301 (2014).