

§20. Accuracy Enhancement of a Millimeter Wave Interferometer for Study of Helical RFP Plasma Performance

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A spontaneous transition to the quasi-single helicity configuration is observed in the low aspect ratio reversed field pinch device RELAX [1]. Studies of its formation mechanism and confinement properties will provide important knowledge which is common among magnetically confined torus plasmas including helical system. Since the behavior of the electron density is necessary especially in the high density range ($2\text{--}3 \times 10^{19} \text{ m}^{-3}$), a millimeter-wave interferometer which uses a Gunn oscillator with a frequency of 140 GHz is developing.

We had already developed and installed a 60 GHz interferometer with a cross-detector via this research collaboration [2]. The main target of the interferometer is low density plasmas, less than 10^{19} m^{-3} . For measurement of higher density plasmas, higher frequency is preferable to suppress the beam deviation in a plasma. Hence we start to develop the 140 GHz interferometer. Figure 1 shows a schematic view of the 140 GHz millimeter-wave interferometer on RELAX. Before the installation of the 140 GHz interferometer, we installed 104 GHz heterodyne interferometer, which was borrowed from the University of Tokyo, on a trial basis. As shown in Fig. 2, the electron density around 10^{19} m^{-3} was successfully measured and confirmed that higher frequency than 100 GHz will be effective. As a first step, we installed a 140 GHz heterodyne interferometer with a frequency-swept Gunn oscillator. One of advantages of the method is that only one Gunn oscillator is necessary and the interferometer system becomes simple. However, the amplitude of the intermediate frequency (IF) signal was strongly modulated when the frequency was swept. Hence the phase evaluation with a phase counter was so perturbed. Then, we will add another Gunn oscillator with a frequency difference of 1 GHz as shown in Fig. 3. In addition to that, we will place the microwave system away from the RELAX device and transmit the microwave with an over-sized waveguide to reduce the electromagnetic noises at the capacitor discharges.

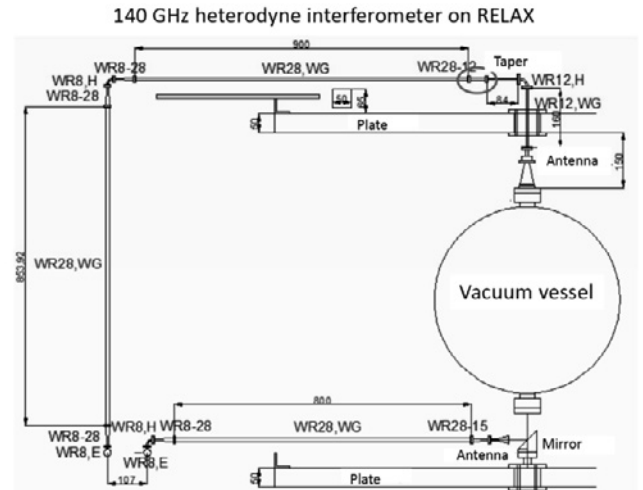


Fig. 1: A schematic view of a waveguide system of a 140 GHz heterodyne interferometer on RELAX

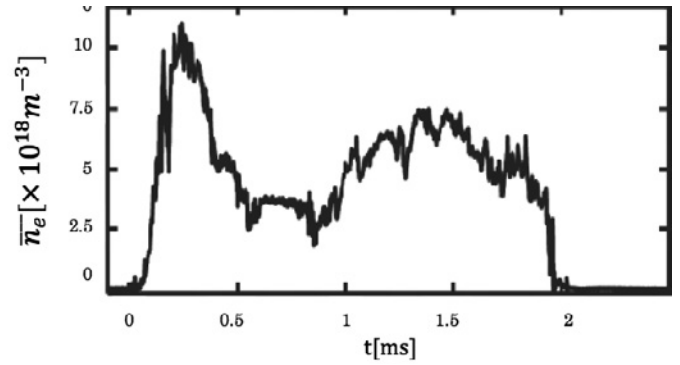


Fig. 2: The temporal behavior of the line averaged electron density in RELAX measured with a 104 GHz heterodyne interferometer.

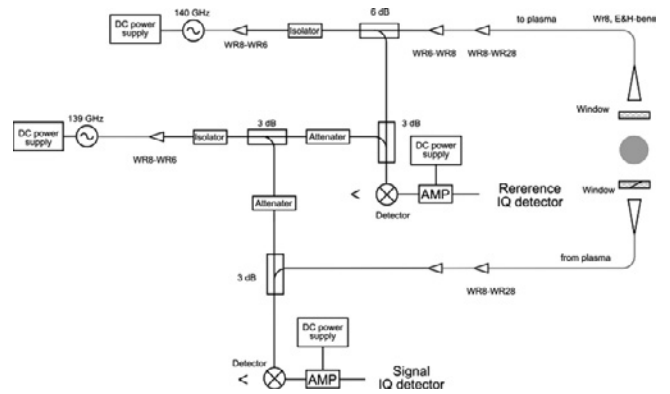


Fig. 2: A schematic view of a 140 GHz heterodyne interferometer with Gunn oscillators with a frequency of 140 and 139 GHz.

- 1) K. Oki *et. al.*, Plasma and Fusion Res. **7**, 1402028 (2012).
- 2) M. Sugihara *et. al.*, Plasma and Fusion Res. **5**, S2061 (2010).