§29. Development of Simple Circuit System for Millimeter Interferometer Applied for Low Density Plasmas

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Measurement of electron density profile of the edge and divertor plasma is very important issue for study of fusion plasma physics. A simple homodyne interferometer system has been developing to measure the electron density distribution in the diverter region. The homodyne interferometer system is simpler than standard heterodyne systems and can be developed at a reasonably low cost. One of the important issues of this study is the development of multi channel measurement system, which will be applied for low density regime such as diverter plasma of LHD. In this study, we have developed a prot-type interferometer system and applied for a low aspect ratio (A) reversed field pinch (RFP) plasma, which has low electron density $\sim 10^{17-18}$. All data are obtained from the low-A RFP device, REversed field pinch of Low Aspect eXperiment (RELAX):[1, 2] $R/a = 0.51$ m/0.25 m, $A = 2$. The device is operated with a 4 mm SS vacuum vessel (field penetration time $\tau_w < 3$ ms), where R is the major radius and a is the minor radius.

The schematic of developed system is shown in Fig.1. Microwave frequency for the probing beam has been carefully selected. Beam frequency must be much higher than the cut off frequency of the plasmas at the center since refraction by a plasma density gradient may become a serious problem at low frequencies. In this study, we choose 60 GHz microwave oscillator[3]. The microwave oscillator is IMPATT diode (HUGES, 47174H-1280), which has maximum power 25.4 dBm. In order to protect the oscillator from reflected wave, an isolator is inserted on circuit. A directional coupler (HUGES, 45324H-1210) splits the microwave to probe and reference signals. An attenuator (HUGES, 45723H-1000) modulates the output power of reference signal which has maximum decay rate 30 dB. The coupling of a mixing directional coupler (Mi-Wave, 561V-6/385) is 6 dB. The output signals are picked up by a detector (QUINSTAR, QEA-FBFBVP).

Here, we show a preliminary experimental result. The experiment is carried out the typical discharge of the low-A RFP device RELAX. Figure 2 shows the time evolution of (a) the plasma current I_p and (b) raw data of output signal V_{out} from the detector. An analysis from this experimental result is less-accurate because fringe jump is more likely to occur with much number of fringes.

In order to accurize our system, an teflon lens system has been developing to improving the signal-to-noise ratio by increasing the output signals. The new system can detect the signals about four times higher than the conventional lens system. Moreover, assessment of accuracy has been carrying out by comparison with another interferometer system, which makes use of 104 GHz microwave.

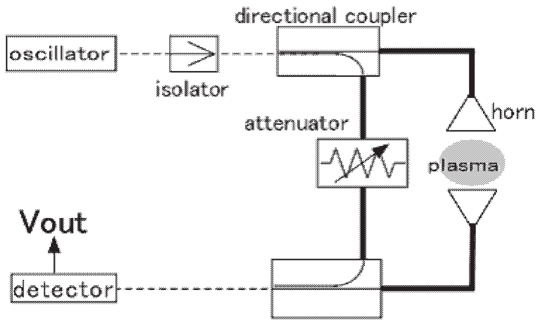

Fig. 1: Schematic of the developed interferometer system.

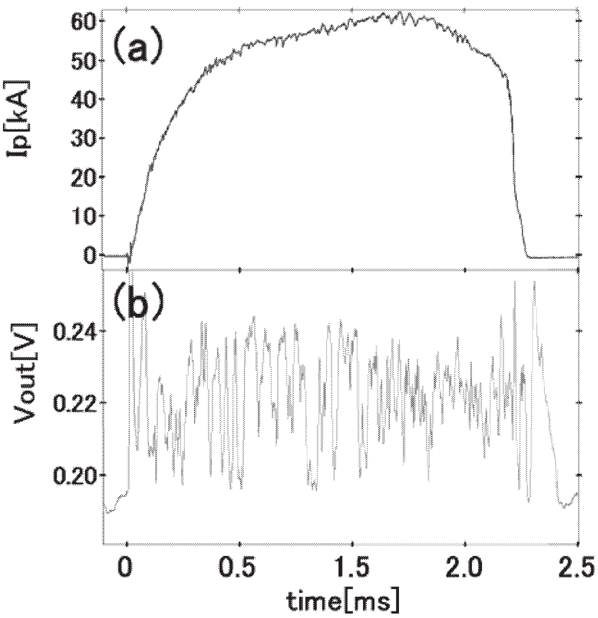

Fig. 2: Time evolution of (a) the plasma current I_p and (b) raw data of output signal V_{out}.

1) S. Masamune *et al.*, Trans. of Fusion Sci. Technol. **51** (No. 2T) (2007) 197.

2) S. Masamune *et al.*, J. Phys. Soc. Jpn. **76** (No.12) (2007) 123501.

3) I. H. Hutchinson, *Principle of Plasma Diagnostics* (2002).