§20. Design and Bench Testing of the Divertor Interferometer on LHD

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Transmitted transport, which increases wall recycling and make density control difficult is commonly observed in tokamaks and linear machines [1]. “Blobs” are thought to induce such the transport. In the case of LHD, the Hα intensity is strong around X-points in regions that are far from the vacuum chamber wall. This observation suggests that blobs go to the diverter due to short magnetic field lines. In addition, L-H transitions, which change the particle and heat flux, and Serpens modes, in which radiation belts rotate in the edge region, are observed in LHD and the dynamic change in particle flux to the diverter is expected. Accordingly measurement of the electron density and the temperature in diverter legs will provide useful information on the transport.

Figure 1 shows design of waveguides and the reflection plate which will be installed in LHD from 3-O port. The reflection plate is use to make millimeter wave double path. That is fixed to the Colgate waveguide for the ultra-short pulse reflectometer. The measured position of the diverter leg is at the middle point between the X-point and diverter plates. LHD already has interferometers and reflectometers which measure plasma edge region (upper stream) and diverter probes on divertor plates (down stream). Since blobs tends to cascade during transport [2], multi-points measurements and comparisons of those data will provides valuable information to understand intermittent transport in LHD.

The schematic illustration of the interferometer system is shown in Fig.2 (a). The frequency of RF is selected in order to be the second harmonic frequency at the measurement point for electron temperature measurement based on the electron cyclotron absorption (ECA) which is combined with the interferometer. The second harmonic frequencies are 66.5 and 68.9 GHz in the cases of R_{ax} are 3.75 m and 3.60 m with B_{ax} of 2.64 T and 2.75 T, respectively. Since the resonant frequency slightly varies according to magnetic configurations, a Gunn oscillator with the wide frequency is used for the RF oscillator 67 ±3 GHz. This is a typical heterodyne interferometer system with an intermediate frequency (IF) of 1 GHz. The IF frequency is converted down to 1 MHz with the super heterodyne detection circuit. The frequency drift of the raw signal is confirmed to be small, about only 10 MHz from 1 GHz, for several hours. About 10 μs time constant of blob signal is reported from several tokamaks, this IF signal is enough for measurement of intermittent transport. An extruded aluminum circular pipe with inner and outer diameters of 21 and 25 mm is used for an oversized waveguide to reduce the cost and make the system design flexible.

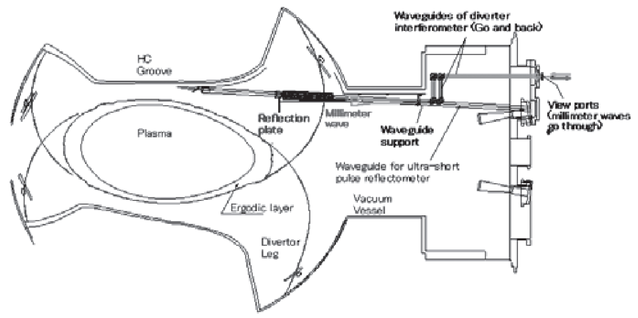

Fig.1: Design of the diverter interferometer installed in LHD (3-O port).

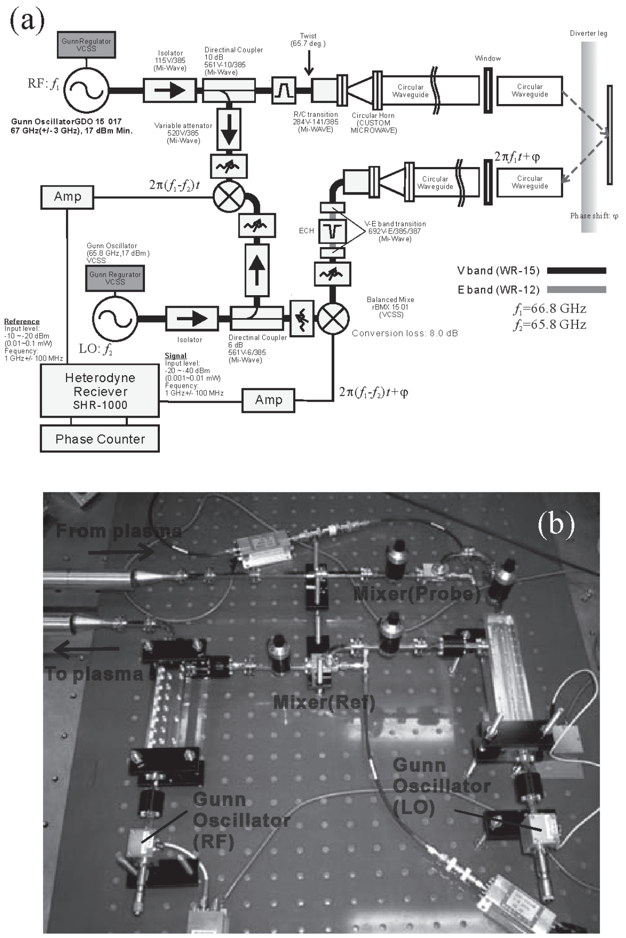

Fig.2: (a) Schematic illustration and (b) photograph of the millimeter-wave system of the diverter interferometer. Heterodyne detection with an intermediate frequency of 1 GHz

This system will be installed in July 2007 on LHD to start the measurement in the 11th operational campaign.

Reference

1) T. Ohno, J. Plasma Fusion Res. **80** (2004) 212.
2) D.A. D’Ippolito *et. al*., Phys. Plasma **10** (2003) 1287.