§23. Development of a 60-GHz Imaging Interferometer Using a Local Oscillator Integrated Antenna Array for Divertor Simulation Experiments on GAMMA 10/PDX

Kohagura, J., Kanno, S., Wang, X., Yoshikawa, M.,
Sakamoto, M., Nakashima, Y. (Univ. Tsukuba),
Kuwahara, D. (TUAT), Ito, N. (UNCT),
Nagayama, Y., Tsuchiya, H.,
Mase, A. (Kyushu Univ.)

In conventional multichannel/imaging microwave diagnostics of interferometry and reflectometry, a local oscillator (LO) signal is commonly supplied to a receiver array via irradiation using LO optics. Our previous microwave interferometer system to observe electron line density in a divertor simulation experimental module (D-module) on GAMMA 10/PDX had utilized a horn-antenna mixer array (HMA).[1,2] HMA is a compact, stackable microwave receiver with built-in diode mixer. It is an effective tool for imaging diagnostics. However, HMA requires an irradiation of local oscillation (LO) wave to generate IF signal.

In this work we have developed a 60-GHz interferometer with a new eight-channel receiver array, called a local oscillator integrated antenna array (LIA).[3,4] An outstanding feature of LIA is that it incorporates a frequency quadrupler integrated circuit for LO supply to each channel. This enables simple and uniform LO supply to the receiver array by using only a 15-GHz LO source and a coaxial cable transmission line instead of using a 60-GHz source, LO optics, and a waveguide transmission line. Figure 1 shows the newly developed interferometer system with LIA for divertor simulation experiments. LIA is arranged to measure line density distribution on z-axis. The observation range on the axis is about 10 cm.

D-module is a rectangular chamber with an inlet aperture installed on the end region of GAMMA 10/PDX for divertor simulation study. Two tungsten target plates are mounted in V-shape inside D-module. Gas injection lines are installed for investigation of radiation cooling and plasma detachment. Figure 2(a) shows the time behaviors of line density inside the D-module obtained by four channels of LIA with H_2 gas plenum pressure at 280 mbar. The pressure was changed from 200 to 1000 mbar. No clear difference is observed in line densities of different lines of sight along z-axis. Time dependence of line density with different gas pressure is shown in Fig. 2(b). Main plasma in the central cell is produced and heated by ion cyclotron range of frequency (ICRF) waves (RF1 and RF2). The density in D-module increases during the additional heating RF3 in the anchor cell. H_2 gas plenum pressure dependence is shown in Fig. 2(c). Line density inside D-module increases with increasing H_2 gas plenum pressure up to 600 mbar, however, it is saturated when the gas pressure exceeds 600 mbar.

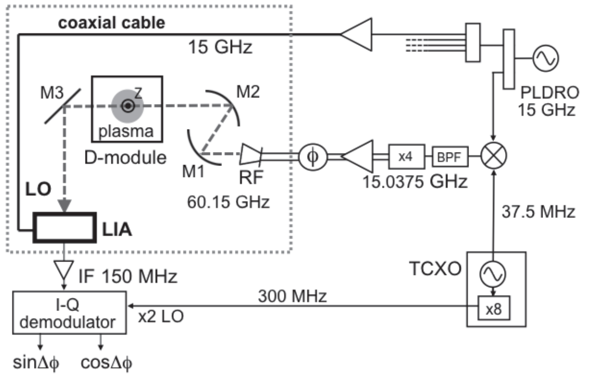

Fig. 1. New interferometer system with a local oscillator integrated antenna array (LIA).

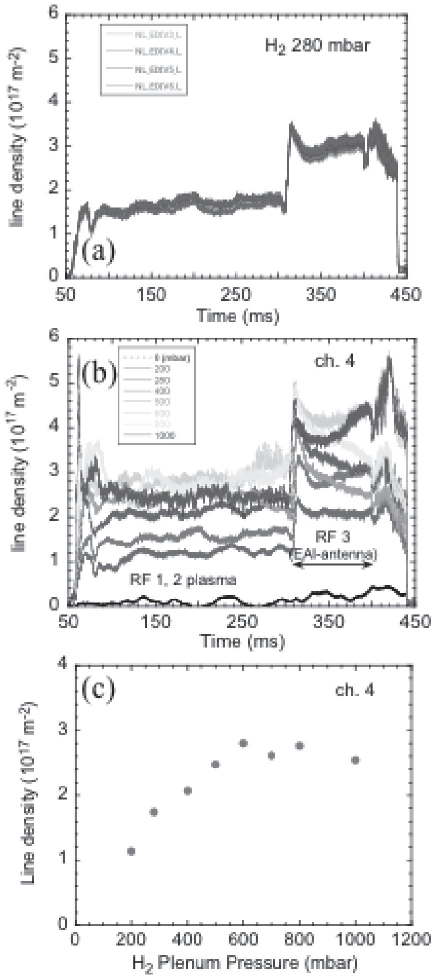

Fig. 2. (a) Line densities with H_2 gas plenum pressure at 280 mbar. (b) Time behavior of line density with different plenum pressure. (c) Plenum pressure dependence of line density.

1) Nagayama, Y. *et al.*: Rev. Sci. Instrum. **83** (2012) 10E305.
2) Kohagura, J. *et al.*: J. Instrum. **10** (2015) C12024.
3) Ito, N. *et al.*: Plasma Fusion Res. **10** (2015) 3402034.
4) Kuwahara, D. et al.: Rev. Sci. Instrum. **85** (2014) 11D805.