§42-18 Development of an ICRF Wave Measurement System

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ICRF heating is a main tool for steady state operation experiments in present fusion devices. The heating efficiency, however, is not always good enough, and the non-absorbed power, which may be deposited in the SOL plasma near the antenna, could be a serious problem for the steady state operation. While the deposition profile can be predicted by various codes, their quantitative accuracies are affected by many practical factors in experiments. In the case of LHD, three dimensional magnetic field (shape and strength) configuration is one of the difficult factors to take into account in codes. In such a situation, internal wave field measurement and comparison between the measured data and the code results are quite important.

In order to measure the RF wave strength inside the plasma, we are developing a microwave reflectometer, by which RF density fluctuation amplitude is obtained, and the RF field is estimated assuming appropriate wave properties (e.g. radial wavenumber). An O-mode microwave reflectometer has been designed and installed at port 3.5U of LHD [1]. In FY 2014, the reflectometer was upgraded from a one probing frequency system to a two probing frequency (28.8 and 30.1 GHz) system (Fig. 1). The local microwave frequency is 29.3 GHz, and the resultant IFs are 0.5 and 0.8 GHz. The IF signals are fed directly to a fast oscilloscope with a sampling frequency of 2.5 GHz. The phase information is obtained by numerical mixing of the IF signals.

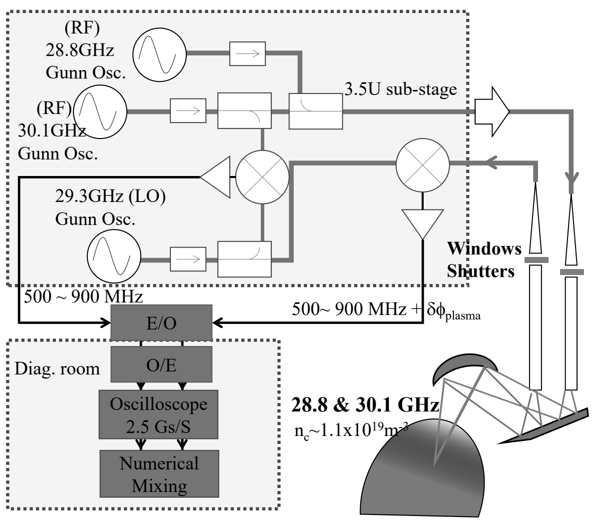

Fig. 1 Schematic drawing of the two frequency microwave reflectometer.

Figure 2 shows the time evolutions of the measured density fluctuations and some plasma parameters. The plasma is generated by ECH and sustained by ICRF power. The cutoff positions are located near the edge and the typical distance between them is 10 mm. The typical relative density fluctuation amplitude is 10^{-4}.

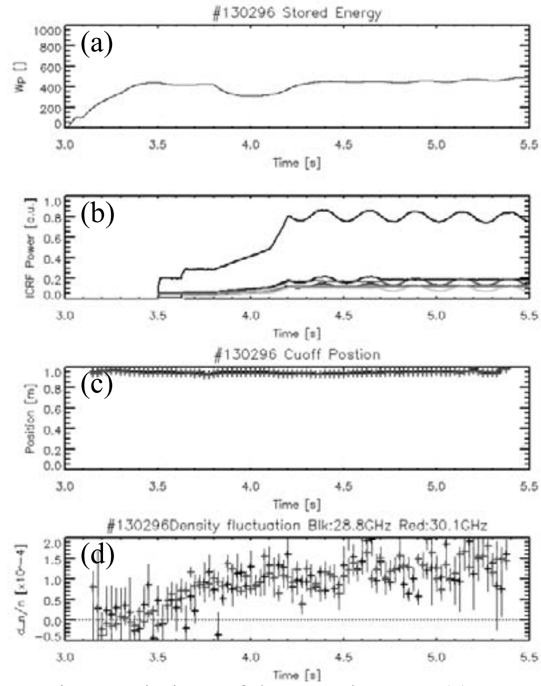

Fig. 2 Time evolutions of the stored energy (a), net ICRF powers (from each antenna and total) (b), minor radii of the cut off layers (c) and the rms amplitudes of the relative density fluctuations (d). Black and red symbols in (c) and (d) denote those for the two probing microwave frequencies of 28.8 and 30.5 GHz, respectively.

Figure 3 shows the relationship between the density fluctuations for the two probing microwave frequencies for the data shown in Fig. 2. A good correlation can be seen in this case.

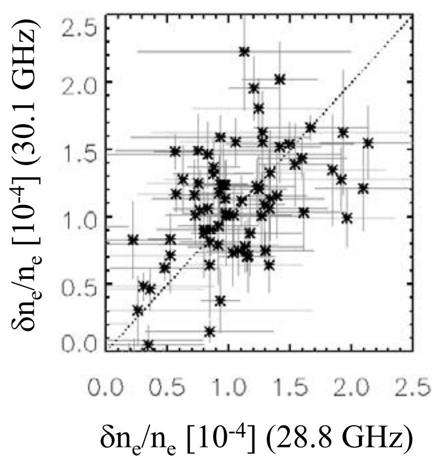

Fig. 3 Relative density fluctuations for the two probing microwave frequencies.

1) A. Ejiri, et al., JPS Conf. Proc. 1, 015038 (2014).