§3. Application of Ultrashort-Pulse Reflectometer to LHD

Mase, A., Yokota, Y., Uchida, K., Kogi, Y. (KASTEC, Kyushu Univ.),
Hojo, H. (University of Tsukuba),
Kawahata, K., Tokuzawa, T.

Ultra short pulse reflectometry (USPR) is one of the methods to measure density profiles of plasmas. The frequency source of the reflectometer is replaced by an ultrashort pulse which pulse width is less than 100ps. The density profiles can be reconstructed by collecting time-of-flight (TOF) signal of each frequency component of an impulse reflected from each cutoff layer.

The detail of the USPR system was shown in elsewhere.[1] Remote control system using super science information network (super-SINET) has been introduced to the USPR system since 2003. Bandwidth of the main backbone and branch line is 10 Gbps and 1 Gbps, respectively. The control client can operate the control server by using this network. The general-purpose interface bus (GPIB) card is installed in the control server. The remote console, which has a graphical user interface (GUI) is prepared to control the instruments of the USRM via GPIB. The operations such as adjustment of supply voltage fed to amplifiers and the doubler, timing control of the impulse, data acquisition and monitoring can be performed from the remote site. In FY2004, the position of the transmitter and receiver antennas can be controlled remotely. The two antennas can be rotated in order to observe the cut-off layer depending on the various plasma conditions even between the plasma shots.

The remote site monitor can display the current view of a sampling scope for various times. The directly recorded signal by the sampling scope is analyzed and reconstructed by means of the signal record analysis (SRA) method. We have assumed the initial position where the electron density equals to 0 corresponds to the one of the separatrix.[2]

In Fig. 1 are shown the reflected signals from the wall and from the plasma and their frequency spectrum. In the LHD experiment, a multi-channel far-infrared (FIR) laser interferometer is utilized for measurement of density profiles. We have also utilized the density profiles obtained by the interferometer for the initial condition of density reconstruction. Figure 2 shows the comparison of the density profiles obtained by the USPR and the FIR laser interferometer. In the edge plasma region, the FIR laser interferometer can measure only a few chords. The behavior of the edge plasma and the plasma position is quite important for the control of the plasma. The USPR system seems to be useful for this purpose. However, in the edge plasma region ($n_e < 2.0 \times 10^{19}$ m^{-3}), the FIR laser interferometer can measure only two chords or less. The behavior of the edge plasma and the plasma position is quite important for the control of the plasma. This USPR system seems to be useful for this purpose

In summary, an ultra short pulse reflectometer has been applied to LHD for the measurement of edge region of plasmas. The whole system (both hardware and software) is controlled via the super-SINET from Kyushu University. The reflected waves are directly recorded by a high-speed digitizing scope, and analyzed by the signal record analysis for density reconstruction. The density profiles in the edge region are successfully determined during the shot and compared with those obtained by an FIR laser interferometer.

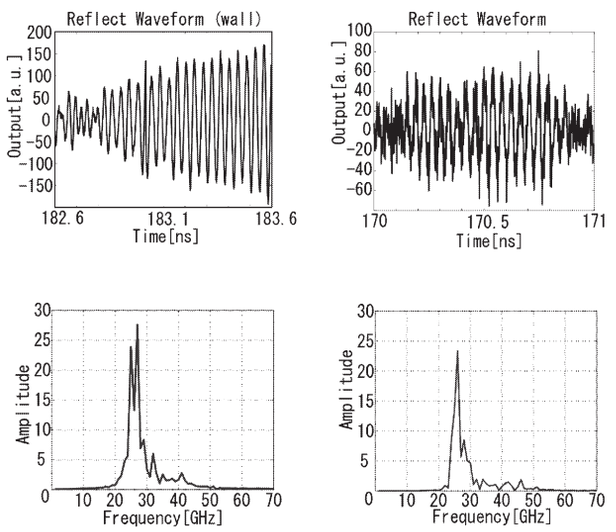

Fig. 1 Reflected waves from the wall (top left) and from the plasma (top right) and their spectrum (bottom).

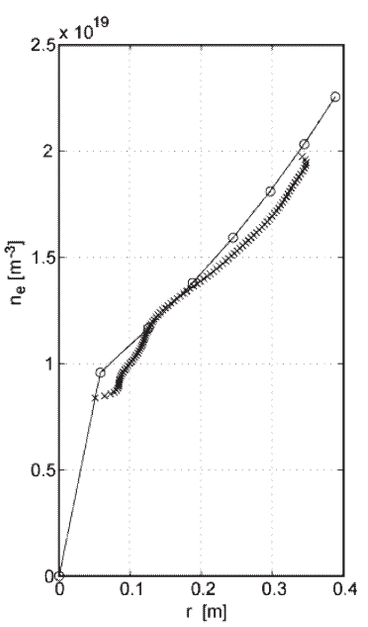

Fig. 2. Comparison of reconstructed density profiles obtained by the USPR and the FIR laser interferometer.

References
1) Kogi, Y., et al., Rev. Sci. Instrum. **75**, 3837 (2004).
2) Mase, A., Yokota, Y., Uchida, K., Kogi, Y., Ito, N., Tokuzawa, T. Kawahata, K., Tanaka, K., Nagayama, Y., and Hojo, H., to be published in Rev. Sci. Instrum.