§3. Development of Ultrashort Pulsed Radar Reflectometer for Electron Density Profile Measurement

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We have been developing a new type of reflectometer which uses an ultrashort sub cycle pulse. It is called as an ultrashort pulsed radar reflectometer. An ultrashort pulse has broad band frequency components in a Fourier space. It means one ultrashort pulse can take the place of a broad band microwave source.

In LHD 10th experimental campaign a new impulse source, whose amplitude is -2.0 V and FWHM pulse width is 18 ps, is utilized as a source. Compared with the previous system, additionally U-band (40-60 GHz) frequency components are usable newly. From this impulse to obtain the desired frequency components, we utilize the base-band waveguide and get each chirped wave. Now the system has 3 frequency bands; those are X-band, Ka-band, and U-band. Each frequency component is amplified by corresponding microwave power amplifier and combined to one transmission line. When the different frequency band microwaves are combined to one waveguide, we use a directional coupler. In this case, each frequency component loses more than -6 dB of power. Therefore we make a new designed multiplexer for this aim.

Figure 1 shows the new multiplexer, which consists of 2 multi-layer mesh filters. The benefits of this multiplexer are : (1) low loss, (2) free polarization requirement, (3) two-way transmission, and (4) relatively compact package. Transmissivity of each frequency component is showed in Fig.2. Here the input microwave is launched to the corresponding waveguide and detected after the combine/divide space. Therefore the loss of all frequency components becomes lower than that of the previous directional coupler system.

New impulse reflectometer system is installed and tested preliminary. This system is currently two channels. An example of the temporal behaviors of the TOF of each reflected pulse is shown in Fig. 3. The delay time is defined by the traveling time from the plasma edge, the position of which is calculated using the result of *in situ* calibration and a MHD equilibrium calculation, to each cut-off layer. When the first pellet is injected, corresponding cut-off layer moves outside. But after several pellets have been injected and the density grows up, the corresponding cut-off layer reaches near the plasma edge and does not move any more.

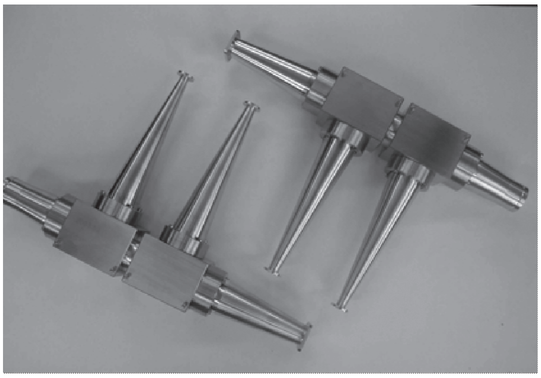

Fig. 1. Photograph of three port multiplexer.

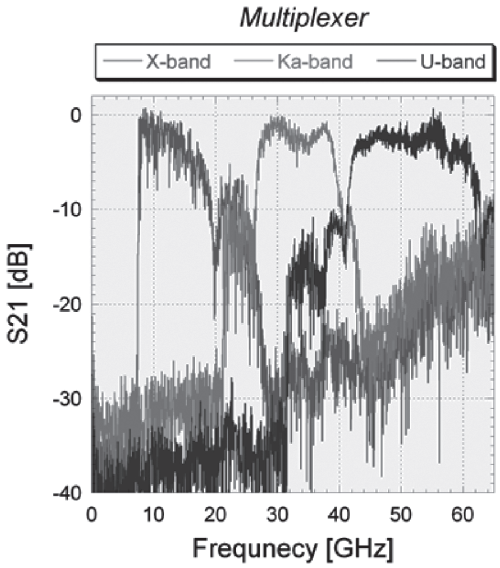

Fig. 2. Frequency characteristics of the transmissivity of each frequency component.

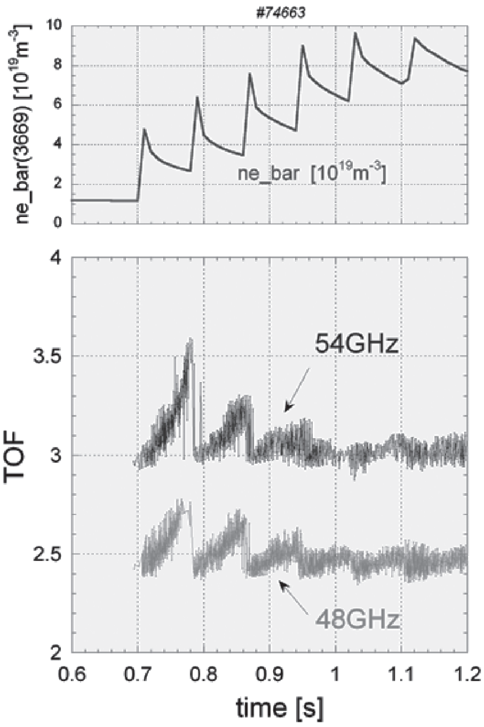

Fig. 3. Time evolution of the averaged density (top) and the delay time of the reflectometer each channel (bottom).