A folded waveguide (FWG) antenna has been fabricated in 1997. It can launch RF power in the ion cyclotron range of frequencies (ICRF) in a reasonable size of fusion experimental devices. The cutoff frequency can be lowered to ICRF by folding a waveguide. The FWG antenna is designed to launch an ion Bernstein wave (IBW) to produce and heat an LHD plasma. The FWG antenna has 23 vanes (24 folds) and is 1050mm in width, 428mm in height and 3950mm in length. The resonant frequencies become 25.1, 37.4, 51.5 and 64.0MHz in accordance with the harmonic numbers of 1, 2, 3 and 4 along the vanes. The front face of the antenna is of a concave shape and is formed to match the shape of the LHD plasma. The FWG antenna will be installed at the LHD horizontal vacuum port during the 3rd experimental campaign in 1999. The FWG antenna is surrounded by a cylindrical vacuum container. The FWG antenna can be withdrawn toward the outside by 1150mm by a motor drive system in order to be completely housed in the vacuum container. The slant of the FWG antenna is 38.9° so that the vanes are perpendicular to the magnetic field line. Carbon protectors cooled by water are provided on both sides to protect the antenna from the plasma existing outside the last closed magnetic surface. The RF emission pattern can be changed by varying the combination of polarization plates attached at the exit of the FWG antenna.

An RF power can be fed through a ceramic feed-through and a movable electrode to the 2nd vane at the rear of the FWG antenna. An impedance matching can be obtained mainly by adjusting the position of the movable electrode. A liquid impedance matching system is set up between the FWG antenna and an RF generator. Tests at a high power with a long pulse were performed at several frequencies (f=25.1, 37.4 and 51.5MHz).

An aging of the FWG antenna was required for the high RF power test. The aging procedure takes several hours. The multipactoring discharge between vanes causes a vacuum pressure increase. The applied RF power and the duration time were gradually increased at a constant repetition rate. The test results at a high power with a long pulse are summarized in Fig.1 for 3 different frequencies, e.g. 25.2MHz, 37.4MHz and 51.5MHz. At 25.2MHz (solid circles), RF powers of 220kW and 100kW were injected to the FWG antenna for 2 seconds and for 10 seconds, respectively. At 37.4MHz (open circles), similar results were obtained. At 51.5MHz (solid square), however, an RF power of 230kW could be injected for only 0.3 seconds, because of the lack of sufficient time for aging.

The efficacy of the movable electrode has been examined. The impedance matching can be always attained at any position of the movable electrode by adjusting the stub tuner and the phase shifter of the liquid impedance matching system. Figure 2 shows two typical distributions of standing RF voltage: One is at the RF voltage reflection coefficient, \( \Gamma = 0.2 \) (solid circles and solid line) and the other is at \( \Gamma = 0.6 \) (solid squares and dotted line). It is easily found from this figure that the RF power of 220kW can be transferred at a highest RF voltage of 5.8kV by adjusting the movable electrode to the proper position. The highest RF voltage increases by 65% in the case of failure to adjust the movable electrode to the proper position.

Reference