§7. Power Circulation System on LHD Combline Antenna

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A power circulator should be used in order to draw full performance from the LHD combline antenna. A "ring power coupler" is employed as illustrated in Fig. 1 [1].

Let α^2 (=1-β^2) be the power transmission coefficient defined as the power transmitted to the other end of the antenna normalized to the input power. Since the combline antenna has a wide area, it is expected that α^2 is smaller than that of a conventional antenna. Yet, it is not expected to be too small, being in the range between 0.5 and 0.9. In the present analysis, $\alpha^2 = 0.7$ is assumed [2]. A small value of α^2 is desirable in principle from the point of view of power handling capability. It is noted that a well-defined wave spectrum will not be obtained with a too small value of α^2.

The antenna system will have a phase shifter and two impedance matching circuits. The No-3 port of the ring power coupler is terminated with 50-ohm dummy load. The RF power out of the No-2 port is circulated to the No-4 port. The RF generator is connected to the No-1 port. Z_a and Z_b are characteristic impedance of the coaxial lines composing the ring power coupler. For $\alpha^2 = 0.7$, $Z_a = 27.6$ ohm and $Z_b = 33.1$ ohm are chosen so that power is re-circulated appropriately. The characteristic impedance of other coaxial lines Z_0 is 50 ohm.

Electrical properties of the whole system were studied [2]. In Fig. 2(a), P_{ref}/P_{in}, P_{dummy}/P_{in} and P_{abs}/P_{in} are plotted versus frequency. We find an improvement of factor 3 in P_{abs} at the central frequency of 65MHz over the case without the circulator. The optimal frequency band 5MHz is not enough to cover the entire frequency range of the combline antenna. Therefore, it will be needed to develop a frequency tunable circulator. The parameter β^2 depends on plasma parameters. Therefore, it is important to examine the sensitivity of the circuit to β^2. In Fig. 2 (b), P_{ref}/P_{in}, P_{dummy}/P_{in} and P_{abs}/P_{in} are plotted versus β^2. It is find that the power circulation circuit works well over wide range of $0.1 < \beta^2 < 0.5$, i.e., $0.5 < \alpha^2 < 0.9$.

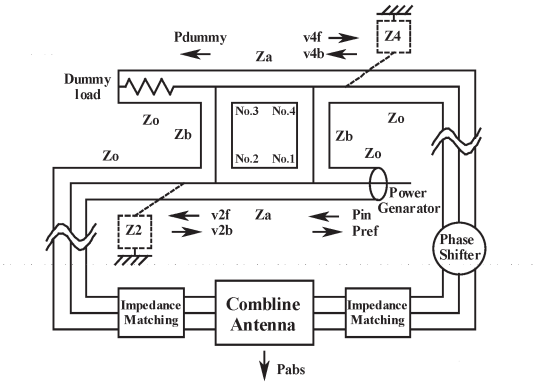
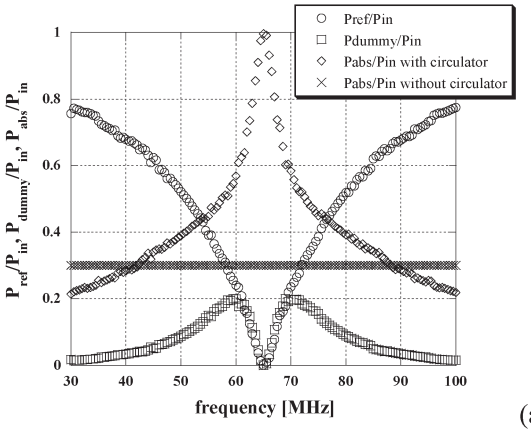
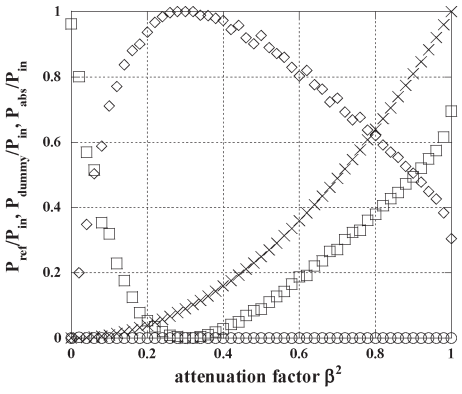


Fig.1: Power circulation system



(a)



(b)

Fig.2: Calculated performance with a power circulator

Reference

[1] H. Ikezi, GA-C23396 (2000).

[2] Takeuchi, N., *et al.*, to be published in Fusion Science and Technology (2005) .