§32. Development of Millimeter Wave Components for High Power ECH

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Reliability of diagnostic components under a circumference in high electromagnetic fields is essential to control and monitor a target quantity. Electron cyclotron heating (ECH) increases the output power of ~ 1 MW for a gyrotron, and the protection of millimeter wave components from the stray radiations are desired. Therefore we have designed and fabricated a 77 GHz notch filter for a stray radiation inside the vacuum vessel of LHD. On the other hand, diagnostic system in general increases channels to obtain the information on high spatial resolution. Millimeter wave components are also the same situation. Therefore highly dense circuits are desired for ECH and related diagnostics (collective Thomson scattering/electron cyclotron emission; CTS/ECE).

A notch filter in 70 GHz range is developed to eliminate an intense undesirable electromagnetic signals for plasma diagnostics using millimeter waves. We require a robust and narrow band characteristic for the notch filter. The external profile was shown in Fig. 1. We fabricated to construct resonated cavities and waveguide inside the notch filter block of oxyide free copper. Since the previous notch filter which we reported contains the spurious notches in Fig. 2(a), the plungers are improved to reduce the spurious notches. The lossy disks infill the gaps between the plungers and the cavities. The insert of the lossy disks minimizes the spurious notches around 76-78 GHz, while the insertion loss increases in the frequency range from 77.5 to 80 GHz in Fig. 2(b). The plungers with differential screws are also used to make the tunning fine. These modifications improved the adjustment procedure.

For further performance increase and easier fabrication, based on the same cavity mode, the design of coupling slits was modified to coupling holes. The software COMSOL MULTIPHYSICS® is used to understand how a modification affects the filter characteristics. The simulated results in the case of coupling holes predict the characteristic of less than 50 MHz at −3 dB bandwidth and less than −50 dB with two cavities and −100 dB with eight cavities at the maximum attenuations. A test piece will be fabricated based on this simulation result.

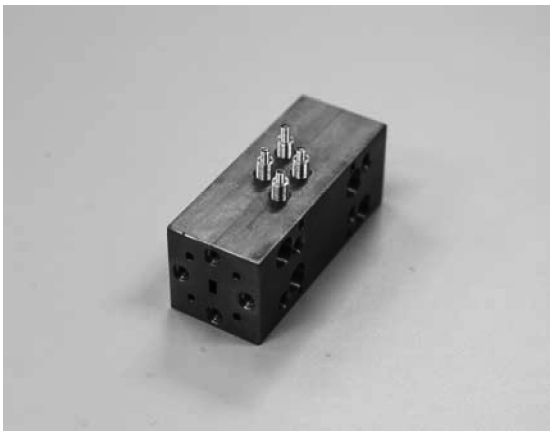

Fig. 1 The improved notch filter in 70 GHz range for plasma diagnostics

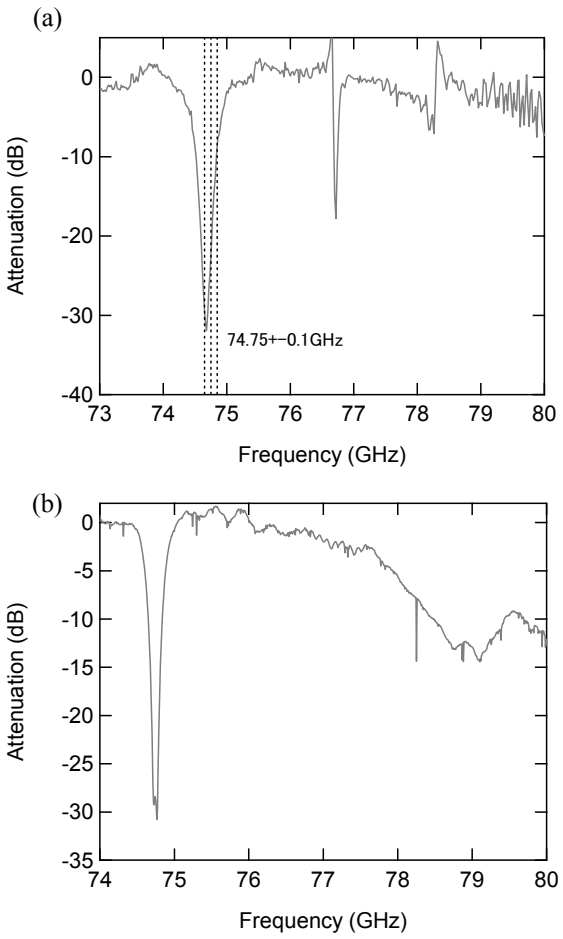

Fig. 2 The characteristic of the improved notch filter in 70 GHz range for plasma diagnostics. (a) Old plunger. (b) New plunger.

1) Nishiura, M., Kubo, S., Tanaka, K., Kobayashi, S., Okada, K., Okada, K. J., Nishimura, T., Mushiake, T., Shimozuma, T., Mutoh, T., Saito, T., Tatematsu, Y., and Yamaguchi, Y., Journal of Instrumentation, Vol 10 (2015) C12014, 1-6.