INPUT COUPLER FOR THE KEKB NORMAL CONDUCTING CAVITY

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The input coupler for the normal conducting RF cavity of the KEK B-factory (KEKB) was designed comprising a disk-type coaxial ceramic window and a door-knob transition. We designed two different types of window structure; one is a choke-type structure and the other is a under- and over-cut structure. The fabrication of two types coupler is underway in order to confirm the RF properties.

I. INTRODUCTION

The reliability of the input coupler is usually the critical technical issue for the development of the cavity system. At present stage the cavity for KEK B-factory requires about 400KW (CW) RF-power per cavity (the RF frequency is 508.8 MHz) [1]. In order to keep the stable operation at 400 kW, the coupler should be able to transmit RF-power significantly higher than 400 kW. Thus we have set the target value of the transmitted RF power on 800 kW (CW) that is twice as high as the required power.

Since the reliability of the coupler strongly depends on that of the ceramic window in the coupler, we recognize that the choice of the window structure is most important for the design of the coupler. In order to transmit the 800 kW RF power we have chosen a disk-type ceramic for the coupler window. The rational for this choice is described in the next section.

Other mechanical structures of the coupler are decided by boundary conditions of the coupler: (1) RF power is fed from a klystron through the WR1500 rectangular waveguide; (2) the coupler couples with the cavity by a loop (magnetic) coupling which connects with the WX77D coaxial waveguide.

The coupler has several transitions which transmits the RF power from the rectangular waveguide to the coaxial waveguide with a minimum reflection of the RF power. Each transition part is designed so that their VSWR is less than 1.05 and that of the coupler assembled with the transitions amounts to less than 1.1 around the RF frequency of 508.8 MHz.

Experience obtained with the output couplers of the UHF klystrons for TRISTAN was fully taken into account in order to design the present coupler. The first design for the RF structure has been finished by using a computer simulation called "High frequency structure simulator" (HFSS) [2]. The fabrication of the high-power model of the coupler is in progress. The RF properties of the coupler will be measured by a low-power model so as to confirm the simulated results.

II. CHOICE OF WINDOW STRUCTURE

In the coupler many troubles are related to the multipactor on the window. Several experiments and considerations of the ceramic window in couplers suggest the following [3,4]: the uniformity of the electric field distribution around the window is very important in order to prevent the local heating of the ceramic induced by the multipactor; the multipactor induced by the electric field that is perpendicular to the window causes the damage on the surface, while the multipactor induced by the parallel field causes no serious problem.

Two types of ceramic window are in use for the coupler in the KEK at UHF band: a cylindrical ceramic window and a disk-type ceramic window. The former is used in the input couplers for both of the alternating periodic structure (APS) cavity of the TRISTAN ring and the single-cell cavity of the PF ring. It was tested up to 300 kW (CW) RF-power [5]. The latter is adopted in the following couplers: the output coupler of the UHF klystron in the TRISTAN, which transmits 1.2 MW (CW) RF-power [3]; the input coupler of the super conducting cavity (SCC) of the TRISTAN [6]; the input coupler of the high-power models of the RFQ [7] linac and DTL [8,9] for the Japanese Hadron Project (JHP).

Since the result of the klystron output coupler is sufficient for our target value which is RF power 800 kW (CW), we chose the disk-type ceramic as the window of the coupler.

The disk-type ceramic window is located in the coaxial waveguide. The waveguide near the window requires an impedance matching section in order to compensate for the permittivity of ceramic. One of the typical matching section is a choke structure. The output coupler of the klystron and the SCC input coupler have this structure. Another structure for the matching section is a combination of the undercut and overcut (under/over-cut) type. This structure is in use for the couplers of the RFQ and DTL for the JHP.

We designed the two types of coupler. One has the choke structure and the other has the under/over-cut structure. The final decision for the impedance matching structure of the window will be done by comparing the results of the high-power test with two types of couplers.

III. DESIGN

The coupler is composed of three transition sections: (1) the door-knob transition between the WX152D coaxial waveguide and the WR1500 rectangular waveguide; (2) the disk-type ceramic window in the WX152D waveguide; (3) the transformer between the coaxial waveguide of the WX77D and that of the WX152D.

The door-knob transition has a capacitive iris so that the size of the door-knob becomes smaller than that without the iris. The diameter and the height of the door-knob are 340 mm and 123 mm, respectively. The height of the iris is 46.4 mm. The schematic view of the door-knob transition is shown in the Fig. 1. The simulated VSWR is shown in Fig. 2.

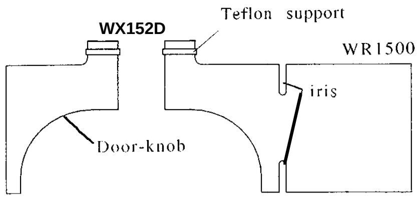

Figure 1: Schematic view of the door-knob transition.

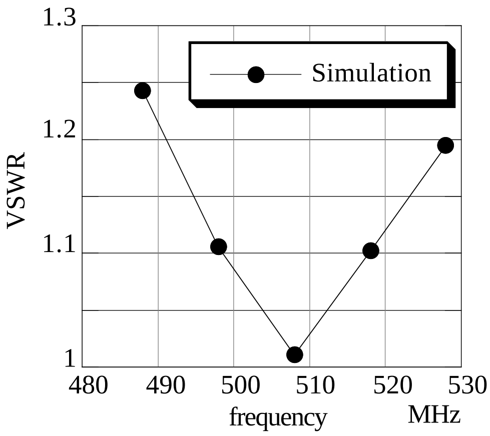

Figure 2: Calculated VSWR for the door-knob transition.

The choke and the under/over-cut structures of the window are respectively shown in the Fig. 3 and 4. The inside and the outside diameter of the ceramic window are 166 mm and 38 mm, respectively. The thickness of the window is 10 mm.

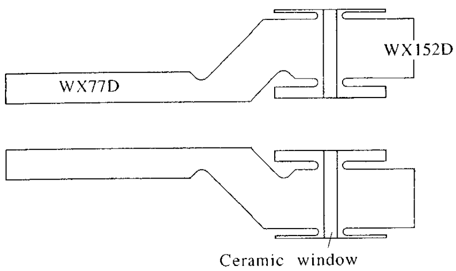

Figure 3: Schematic view of the choke window structure.

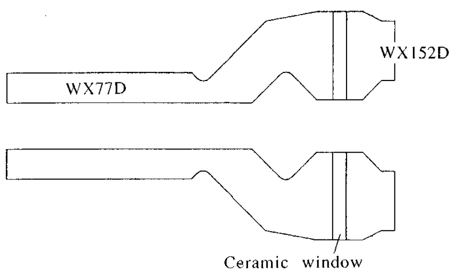

Figure 4: Under/over-cut window structure.

Both figures include the transition from the WX152D coaxial waveguide to the WX77D coaxial waveguide. The bumps located at the transition shield the window from a beam and a cavity in order to reduce the direct irradiation of the x-ray and charged particles made by collision between the beam and residual gases and to avoid the adsorption of Cu sputtered from the cavity wall. The shield should certainly increase the reliability of the coupler.

VSWR of the transitions for the window is plotted in the Fig. 5. Figure 6 shows the radial dependence of the electric field strength 1 mm away from the window surface for both the structures. The value is normalized by the field strength on the surface of the inner cylinder of the WX152D coaxial waveguide.

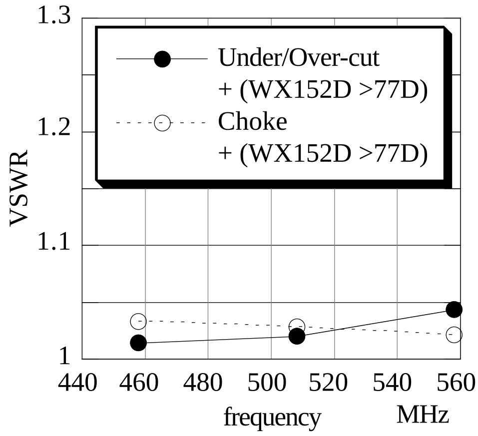

Figure 5: Calculated VSWR of the windows.

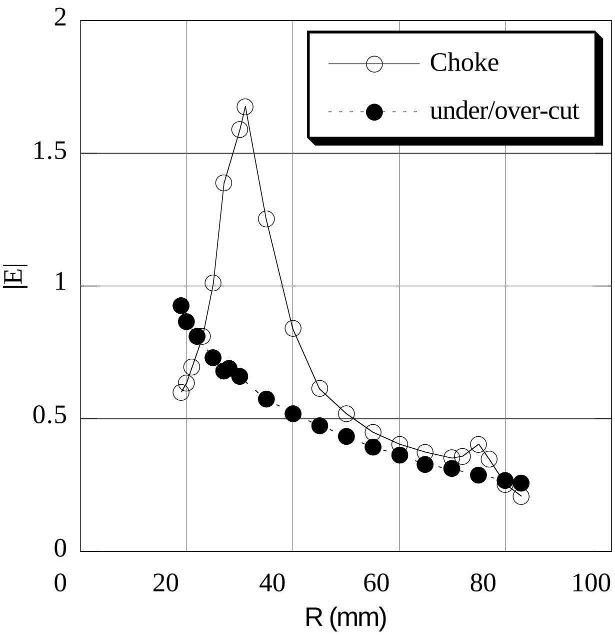

Figure 6: Calculated the electric field strength on the windows.

This plot shows:(1) the field strength of the under/over-cut structure is more uniform than that of the choke structure;(2) the field strength of the choke structure near the inner triple junction of the window is about 30 % lower than that of the under/over-cut structure. The simulation shows that the direction of the electric fields almost parallel to the window for the under/over-cut structure, while for the choke structure the field concentrates and the field direction is perpendicular to the window near the tip of the choke.

The low-power model of the coupler with the under/over-cut structure has been developed. The model has no loop coupler but matched terminator at the end of the coaxial waveguide. The measured VSWR of the model is shown in Fig. 7 by white circles. The data are consistent with the result of the simulation shown in the figure by black circles. The model with the choke structure will be also measured in order to confirm the RF properties. The simulated VSWR for the model with the choke structure is shown in the Fig. 7 by white squires.

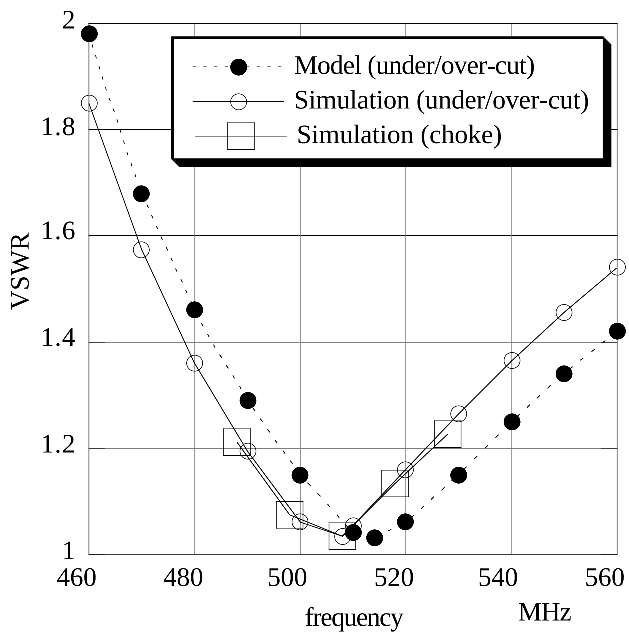

Figure 7: VSWR of the couplers

IV. CONCLUSION

We have designed the input coupler for the normal conducting RF cavity of the KEK B-factory (KEKB). The input coupler has the disk-type ceramic window in the coaxial waveguide. We designed two different types of window structure; one is a choke structure and the other is a under- and over-cut structure. The fabrication of the high-power models of both types are underway in order to test their performance at an RF power up to 800 kW(CW). The VSWR of the low-power model of the coupler with the under- and over-cut structure has been measured. The data are consistent with the result of the simulation.

V. REFERENCES

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