PARTS OF THE 203D COAXIAL WAVEGUIDE IMPROVED AT KEK

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Abstract

The WX-203D Coaxial Waveguides are used at KEK to feed a high rf power to the proton linac tank, which is excited with 2 input couplers to suppress the TM011 mode. Usually, it is very troublesome that coaxial waveguides should be lined up with a good rf contact and the equal length. Hence, we have developed the L-type WX-203D waveguide and the variable-length straight waveguide with the new mechanical structure. In this report, we shall present the mechanical structure of the coaxial waveguides developed at KEK and high power test results.

1 INTRODUCTION

Coaxial waveguides as large as WX-203D are used to feed pulsed rf power of 1 MW or more to proton linear accelerators. Since they have to be connected tightly at the outer and inner conductors simultaneously keeping good rf contact, precautions are needed for their mechanical precision. Moreover, careful design is required to install them between the rf amplifier and the linac cavity, even if both are already fixed at the assigned sites. In addition, the KEK and JAERI/KEK Joint Project proton linac have the two-feed system, that is, each DTL tank is excited with two input couplers at 1/4 L and 3/4 L from the low energy end, where L is the tank length, to suppress the TM011 mode [1]. At the same time, rf power for each coupler is reduced by the factor two compared with that of the ordinary single-feed system. For the two-feed system, output power of the amplifier, klystron, is divided and transferred to the couplers. Since the electrical lengths from the power splitter to the couplers should be equal, it is preferable to introduce a variable-length section between the splitter and the coupler. Therefore a WX-203D based variable-length coaxial waveguide is developed.

It becomes sometimes necessary to dismantle partly an assembled transmission line. When we want to remove a conventional L-type waveguide or elbow, so far the adjoining waveguides should be moved in advance. To simplify the process, a modified WX-203D 90° elbow was designed and successfully tested. The new models are already being installed into the rf power transmission lines to the DTLs.

2 VARIABLE-LENGTH WX-203D COAXIAL WAVEGUIDE

The outer and inner conductors of a variable-length WX-203D waveguide are shown in Figure 1. Sliding parts of the inner and outer conductors have a little bit different diameters from the ordinary section. They are staggered as shown in Figure 2 keeping the characteristic impedance of 50 ohm constant. Finger contactors are used at the outer conductors as usual, but the inner conductor is equipped with Multilam contactor (Multi-Contact, Model LACU/0.15-0.5AG) because of higher rf current density. The Multilam contactor has edges that break the oxide layer on the conductor surface to make good electrical contact. The contactors are commonly used as anchor sets for connecting the inner conductors.

Figure 1: Variable-length WX-203D coaxial waveguide. The outer (upper) and the inner (lower) conductors.

3 RF CHARACTERISTICS

The rf characteristics of the variable-length WX-203D coaxial waveguide were measured with a network analyser (HP 8753E). The waveguide is connected to the network analyser with N-type connectors and cables as shown in Figure 3. The VSWRs are about 1.06 for the frequency range of 324±5 MHz.

4 RF HIGH POWER TRANSMISSION TEST

The variable-length WX-203D coaxial waveguide was tested for high power transmission. It was put into a coaxial line that transfers rf power from the testing power source to a SDTL (Separated Function Drift Tube Linac) [2] as shown in Figure 4. Sparking or serious reflection was not detected for a transferred power level of 500 kW at 324 MHz. The pulse width and repetition rate were 600 μs and 50 Hz. Test will be done for higher power levels in the future.

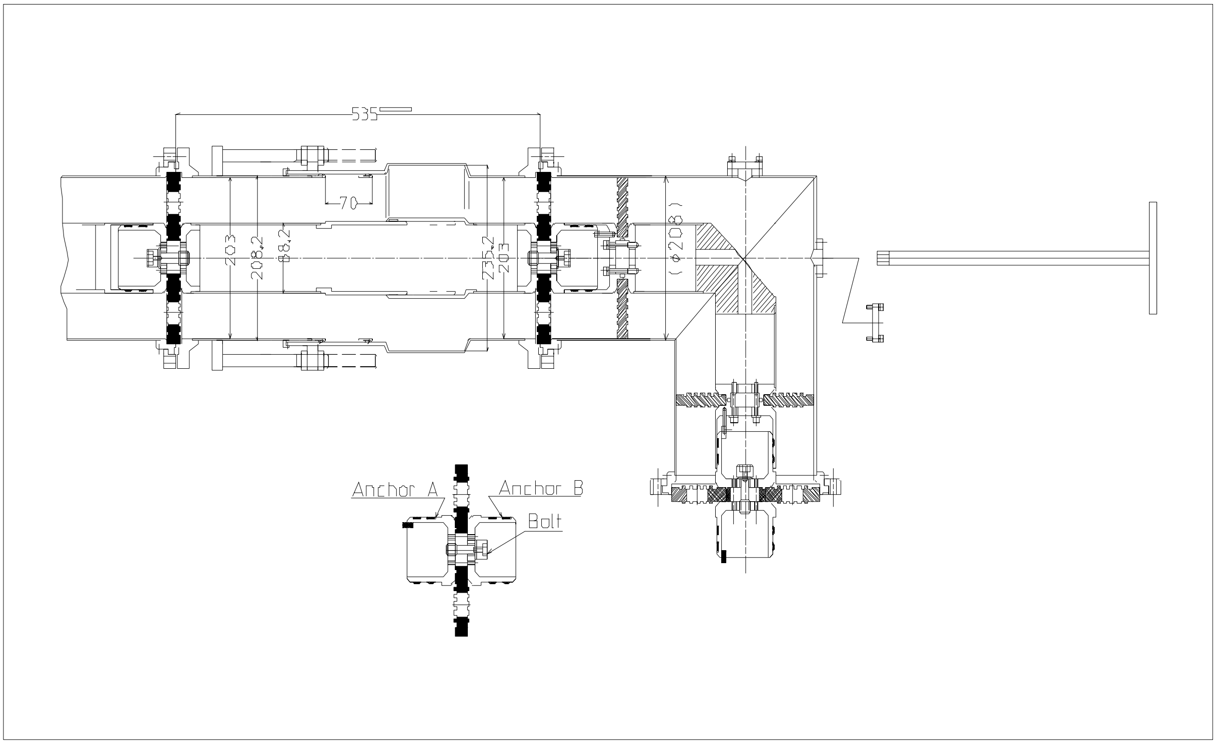

Figure 2: Cross-sectional drawing of a variable-length WX-203D coaxial waveguide with a modified L-type WX-203D waveguide or elbow (upper) and an anchor set to connect the inner conductors (lower).

Figure 3: Setup for rf characteristics measurement of a variable-length WX-203D coaxial waveguide.

5 MODIFIED L-TYPE WX-203D COAXIAL WAVEGUIDE

Conventional L-type coaxial waveguides or 90° elbow are connected to other waveguides as follows: first an anchor set is fixed to the inner conductor of the adjoining waveguide, second the inner conductor of the elbow is put to the anchor, then the outer conductors with flanges of both waveguides are connected together. To achieve this, the adjoining waveguide or the elbow should be moved at least by the length of the anchor longitudinally.

A cross-sectional drawing of the modified WX-203D 90° elbow is schematically shown with that of the variable-length WX-203D coaxial waveguide in Figure 2. The anchor B is separated from the anchor set and attached to the inner conductor of the elbows so that the ends of the outer and inner conductors of the elbow are almost on the same plane. Thus it becomes not necessary to move the ad-joining waveguides for attaching or detaching the elbow.

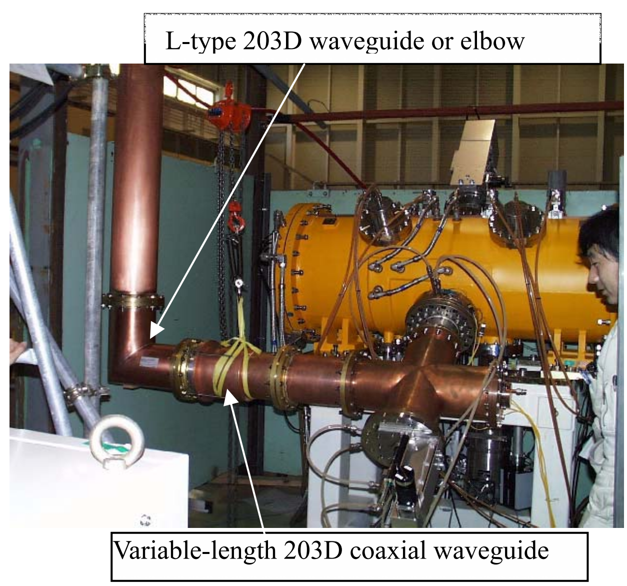

Figure 4: A variable-length WX-203D coaxial wave-guide and a modified elbow. They are installed into the transmission line to a SDTL for rf high power test.

The anchor B is tightly connected to the anchor A or equivalent by a bolt which is turned from the outside with a T-wrench. Small holes of the inner conductor for the wrench have no appreciable effect because of cutoff characteristics. Small holes of the outer conductor are covered with small flanges to prevent leakage of rf power to the outside. The other end of the elbow can be connected to other waveguide following the same procedure.

According to rf testing, the VSWRs of ten models are ranging from 1.010 to 1.020 at 324 MHz.

One of the modified elbows was tested for high power transmission with a variable-length coaxial waveguide as shown in Figure 4. No sparking was observed for a transmission power level of 500 kW.

Some of them are being installed into the transmission lines of the JAERI/KEK Joint Project injector linac as shown in Figure 5.

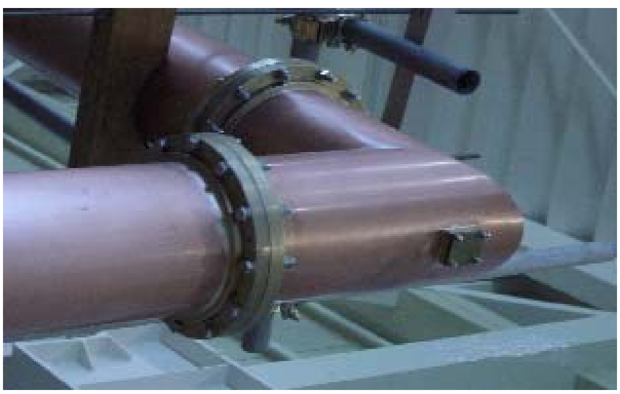

Figure 5 Modified L-type WX-203D coaxial waveguide or elbow in a transmission line of the JAERI/KEK Joint Project injector linac.

6 CONCLUSIONS

A WX-203D based variable-length coaxial wave-guide and a modified L-type coaxial waveguide or 90° elbow are successfully developed. Sparking or serious reflection was not detected for a transferred power level of 500 kW at 324 MHz. The elbow could avoid inevitable displacements of adjoining coaxial waveguides for insertion or extraction of a conventional elbow to or from a transmission line. Ten models are already made and being installed into the transmission lines of the JAERI/KEK Joint Project injector linac.

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8 REFERENCES

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