DEVELOPMENT OF RF CONDITIONING SYSTEM FOR RISP RF POWER COUPLERS *

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Abstract

RF power coupler prototypes have been conditioned for a heavy ion accelerator of the Rare Isotope Science Project (RISP) in Korea. The RF couplers operate for 162.5 MHz half-wave resonators at 6 kW RF power. The RF couplers are a 50-Ohm coaxial structure with a disk type ceramic window at room temperature. The control system using Labview software supported automatic process for RF conditioning, data acquisition and interlock system. The conditioning system and the result of conditioning of RF coupler are presented in this paper.

INTRODUCTION

A heavy ion accelerator of the Rare Isotope Science Project(RISP) is under construction at the Institute for Basic Science (IBS) in Daejeon, South Korea. The heavy ion accelerator consists of superconducting linacs with three types of superconducting RF cavities such as Quater-Wave Resonator (QWR), Half-Wave Resonator (HWR) and Single-Spoke Resonaotr (SSR) cavities in order to accelerate ion beams from proton to Uranium(up to 200 MeV/u, 8.3pμA) with 400 kW beam power [1].

The RF input power coupler supplies the electromagnetic energy into the cavities in the form of continuous wave by keeping the cavity vacuum from the air. At the IBS, prototype couplers for HWR cavity has been developed, which is designed for transferring 6 kW RF power. The HWR cavity is operated at 162.5 MHz and accelerates beams of relativistic beta, $\beta = 0.12$. The RF couplers for HWR cavity are a 50-Ohm coaxial capacitive type having a disk-type ceramic window at room temperature and thermal intercepts at 4.5 K and 40 K.

An RF conditioning system was established to perform a high power test and an RF conditioning of the RF couplers. The test system consists of a test chamber, a control system by LabVIEW software, and a high power RF source. The prototype RF couplers were tested and conditioned. Using the test system, data was aquired using a PC with LabVIEW during the test.

This paper describes a configuration and a components, such as the test chamber and the control system of the RF conditioning system. The preparation and the result of the RF conditioning of the RF couplers are followed as well.

RF CONDITIONING SYSTEM

An RF conditioning system was established to transfer an RF power through two RF couplers via a test chamber and diagnose the coupler status. High power test was performed using the conditioning system.

Configuration of System

An RF conditioning system consists of the test chamber, the control system and several instruments for measurement and dianosis. Fig. 1 is a scheme of the system, and the whole system is shown as Fig. 2 and based on the scheme in Fig. 1 [2], [3]. The used instruments are shown in Fig. 3.

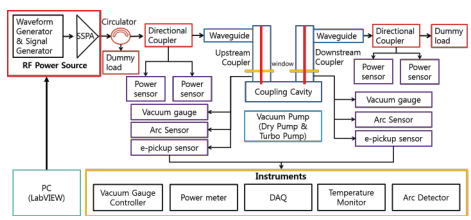

Figure 1: Scheme of RF conditioning system

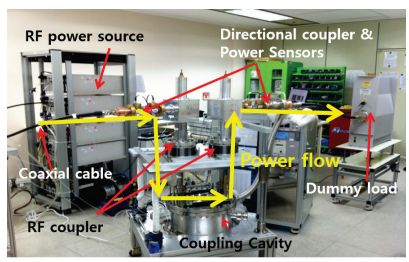

Figure 2: RF conditioning system

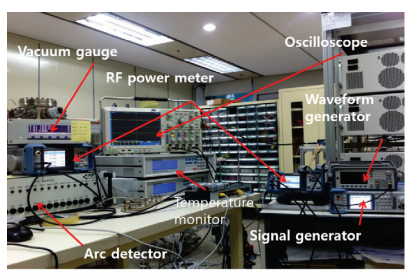

Figure 3: Instruments of the system

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TEST CHAMBER

The RF conditioning system requires the test chamber, which helps to test two couplers at the same time by acting like a band pass filter. The test chambers for the HWR and QWR RF couplers of RISP are developed and described at the followed section.

HWR Test Chamber

The test chamber for the HWR coupler test is shown in Fig. 4. It is a coaxial-like structure with ϕ400 and 180 mm height. Two couplers are assembled on the upper side of the cavity.

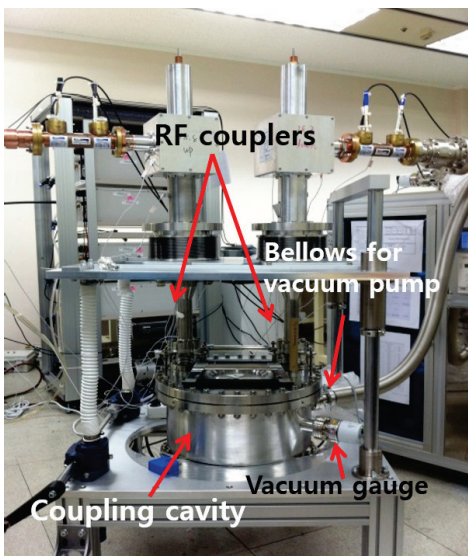

Figure 4: Test chamber assembled with RF couplers

The RF measurement were performed to characterize the transmission and the reflection of the test chamber, and the result is shown in Fig. 6. The cavity has a peak S_{11} value at near 162.5 MHz and a wide bandwidth around 20 MHz according to simulation and test results. It has filter-like characteristic, which passes only a certain frequency range.

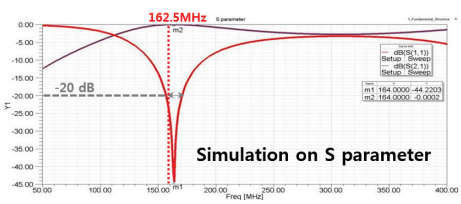

Figure 5: Simulation result on S parameter

QWR Test Chamber

The test chamber for the QWR coupler is shown in Fig. 7. It is a similar structure to the one for HWR coupler [4], but with frequency tuner at the center with ϕ640 and 350 mm height.

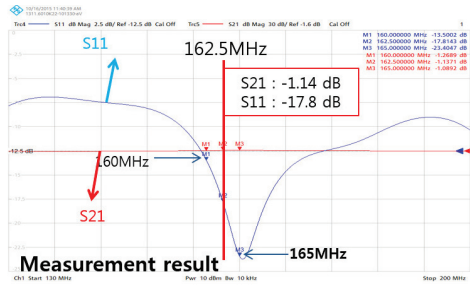

Figure 6: Measurement result on S parameter

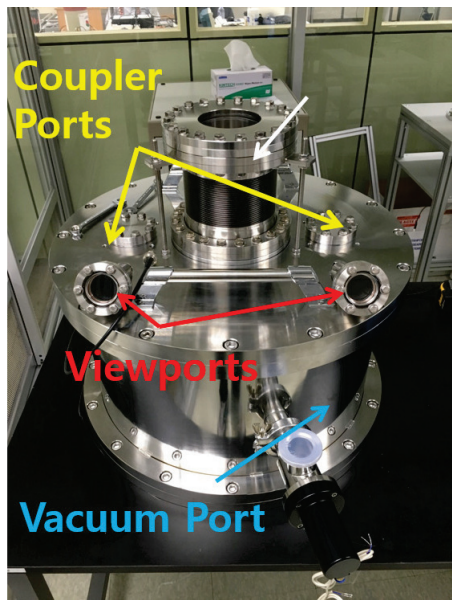

Figure 7: Coupling cavity for QWR RF coupler

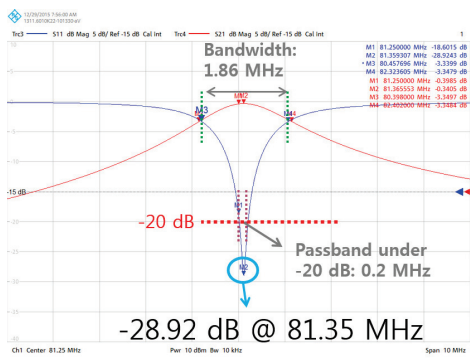

Figure 8: Measurement result on S parameter

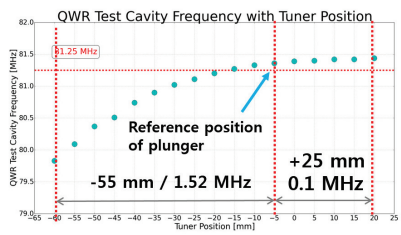

Figure 9: Behavior of the frequency tuner

CONTROL SYSTEM

The control system has been developed for data acquisition, a protection of the couplers, particularly the ceramic window, from the unwanted events, like arc discharge etc., as shown in Fig. 10.

Figure 10: Control system

RESULT OF RF CONDITIONING

On the established system, the HWR RF coupler prototypes have been tested and conditioned in both a pulsed and a CW mode. The RF power in the pulsed mode is shown in Fig. 11 and Fig. 12 shows a vacuum state for the pulsed mode operation. The RF conditioning was performed up to around 1.4 kW due to the limit of the power source. It will be done up to 24 kW in the future.

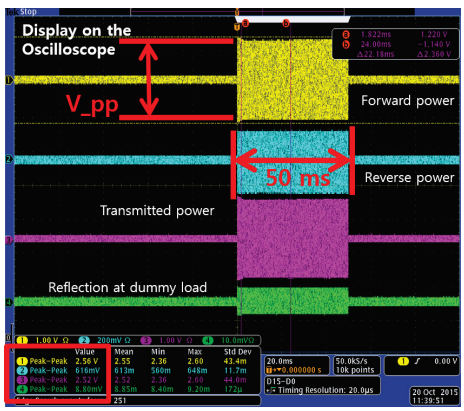

Figure 11: Pulsed power

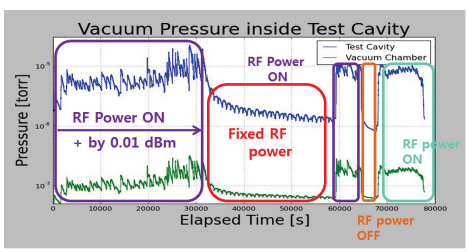

Figure 12: Vacuum state in pulsed mode

The RF power in the CW mode is shown in Fig. 13 and Fig. 14 is the vacuum state for the cw mode operation right after the pulsed mode conditioning. Any severe problem, like an arcing on the window, did not happen in this power level.

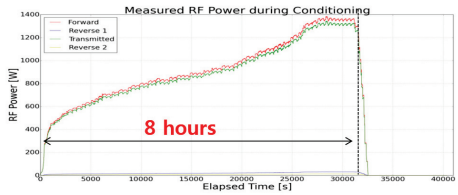

Figure 13: Continuous wave mode

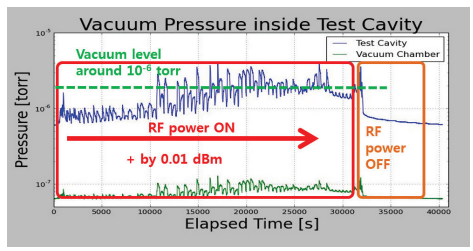

Figure 14: Vacuum state in continuous wave mode

FUTURE PLAN

The couplers will be tested and conditioned up to 24 kW as long as the RF power sources are prepared.

CONCLUSION

The RF conditioning system for the RF coupler for the QWR and HWR type cavities has been developed. The RF coupler prototypes have been tested and conditioned with the system successfully.

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