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RCCS OPERATION AND CHARACTERISTICS IN RESONANCE FREQUENCY CONTROL MODE AT KOMAC

K.H. Kim †, H.S. Jeong, H.S. Kim, S.G. Kim, H.-J. Kwon, Y.G. Song, Korea Multi-purpose Accelerator Complex, Korea Atomic Energy Research Institute, Gyeongju-si, Republic of Korea

Abstract

A 100-MeV proton accelerator is under operation at Korea Multi-purpose Accelerator Complex (KOMAC). The resonance control cooling system (RCCS) has supplied the cooling water to drift tube linac (DTL). The DTL need to keep the resonant frequency of 350MHz during the operation. RCCS has a critical role in sustaining the acceptable resonant frequency error in DTL by adopting the resonance frequency control mode. Details on the RCCS operation in resonance frequency control mode will be given in this study.

INTRODUCTION

The 11 sets of Resonance Control Cooling System (RCCS) is under the operation in KOMAC. The RCCS was developed to control the resonance frequency of the DTL tanks. Because the DTL tanks are different from each other, the system was designed such that on RCCS controlled one DTL tank [1]. Regarding the radio frequency system The characteristics of the KOMAC radio frequency system are such that 4 independent DTL tanks are driven by one klystron only for DTL 21 ~ DTL 24 as shown in Fig.1 [2].

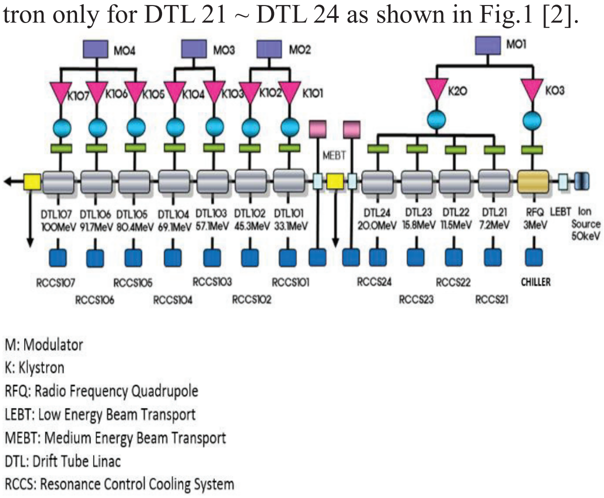

Figure 1: KOMAC linac layout [2].

The radio frequency characteristics of four independent DTL tank operated by a single klystron has been already studied [3]. The study shows the maximum relative phase deviation, which caused from the temperature variation of the tank wall and resonant frequency deviation of reference tank. But we also need to know the characteristics of RCCS control with this special arrangement in the resonance frequency mode which is not indicated yet. Thus this paper will mainly present the RCCS operation and characteristics in the resonance frequency control mode for DTL 21~24.

† kimkh@kaeri.re.kr

METHODS AND RESULTS

System Setup

The RCCS has the power & control panel and the cooling skid which is equipped with the pump, heat exchange and valves. The main components of the cooling skid are clearly shown in the piping and instrument diagrams in Fig. 2.

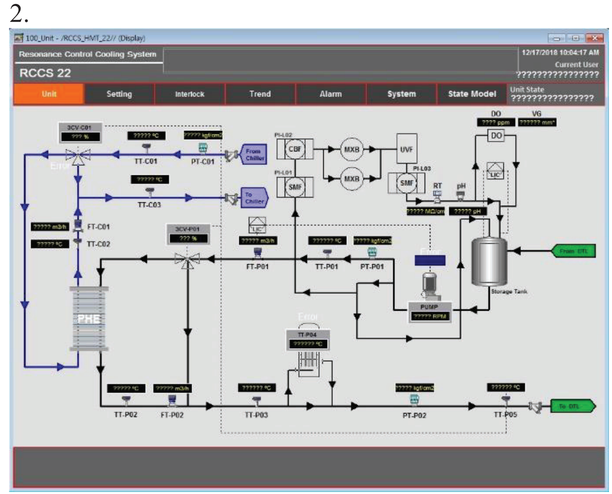

Figure 2: Piping and instrument diagram.

RCCS control mode is consisted with temperature control mode and resonance frequency control mode. In the resonance frequency control mode, the low-level radio frequency control system measures the frequency error from DTL tank and send the value to the RCCS controller for controlling 3way control valve. For the temperature control mode RCCS receive the value from temperature sensor on the skid and adjust the 3way control valve. The radio frequency power from the klystron is divided into four legs by magic tee and is delivered into each tank [3]. In the Fig 3, each DTL tank has the separated RCCS for stabilizing radio frequency power which has their own radio frequency properties.

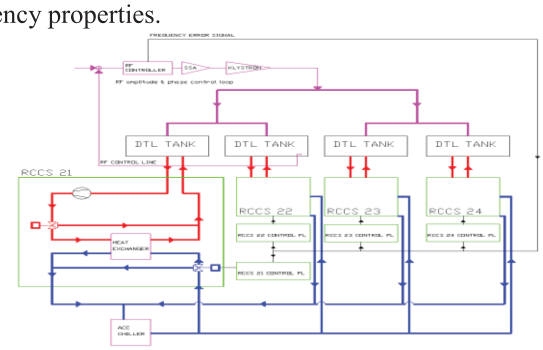

Figure 3: 20MeV radio frequency control scheme.

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Operational Experience

During the operation we noted that some disturbances was occurred in the temperature control mode. The short fluctuation in the resonance frequency error from RCCS 21 to RCCS 24 are shown in Figure 4. This fluctuation's time length is 20 min to 60 min and it happened around every 8 hour. It is originated from the DTL wall cooling skid's temperature fluctuation.

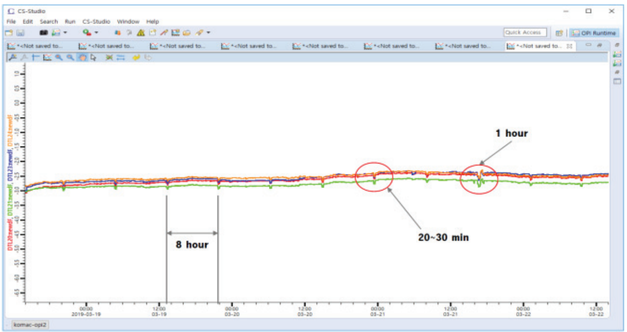

Figure 4: Resonance frequency error fluctuation.

It is the fluctuation but the operation with the temperature control mode is applicable due to the fluctuation size under the limit range. This control mode is essential when the radio frequency power is not available. However this minor perturbation need to be corrected during the radio frequency power supply.

Improvement

The resonance frequency control mode is that RCCS control the 3 way valve based on the resonance frequency error which come from the radio frequency controller. Due to the special arrangement of RCCS 21~24 we carefully initiated operation of the RCCS 21 ~ 24 simultaneously. The fluctuation in temperature control mode was disappeared according to Figure 5.

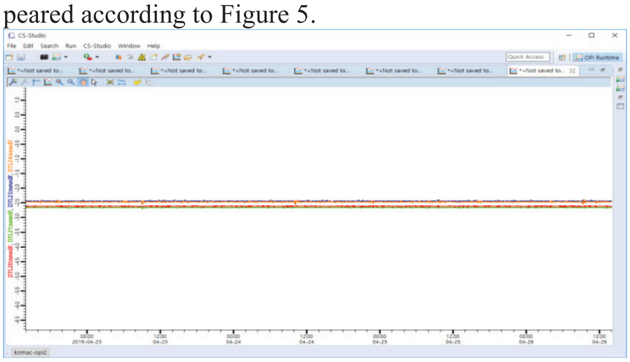

Figure 5: Resonance frequency error in long term.

The factors of the beam stability are consisted with the resonance frequency error, phase and reverse power. We closely gathered the data in resonance frequency control mode. Figure 6 indicate the resonance frequency error.

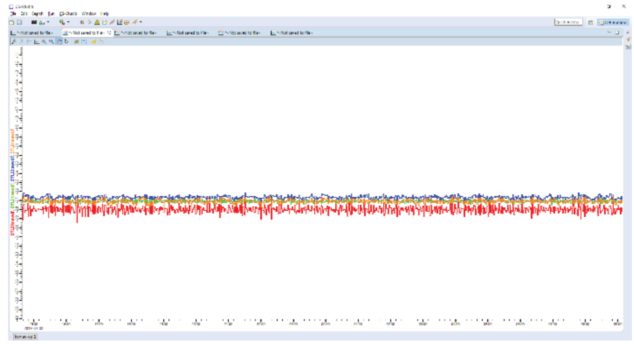

Figure 6: Resonance frequency error in short term.

Figure 7 shows the phase stability and Figure 8 displays reverse power of the radio frequency..

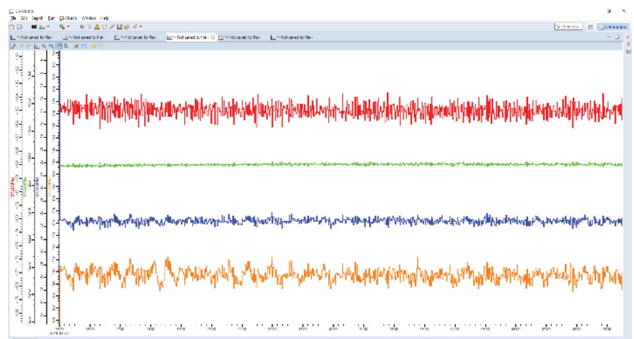

Figure 7: Phase stability.

Figure 8: Reverse power stability.

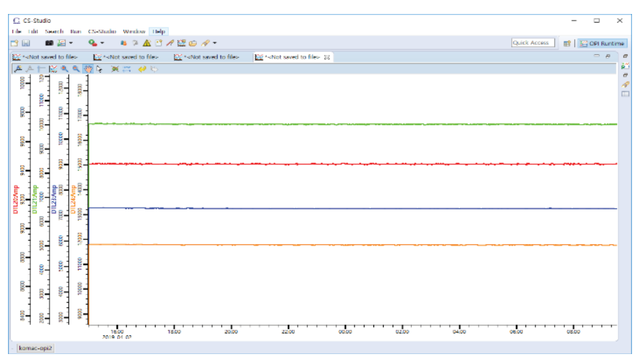

Figure 9: Amplitute stability.

Figure 9 demonstrates the amplitude which is also the stable condition. Based on the above figures the perturbation is clearly disappeared. The data was summarized in Table 1.

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Table 1: Operation Characteristics in Resonance Frequency Control Mode

Resonance Frequency Control Mode				
Standard deviation				
	dF (kHz)	Phase (deg)	Reverse (kW)	Amplitute (%)
RCCS 21	0.065	0.776	0.255	0.107
RCCS 22	0.036	0.103	0.225	0.176
RCCS 23	0.036	0.621	0.202	0.169
RCCS 24	0.044	0.641	0.258	0.106

The specific numbers are also indicated as the chart in Figure 10.

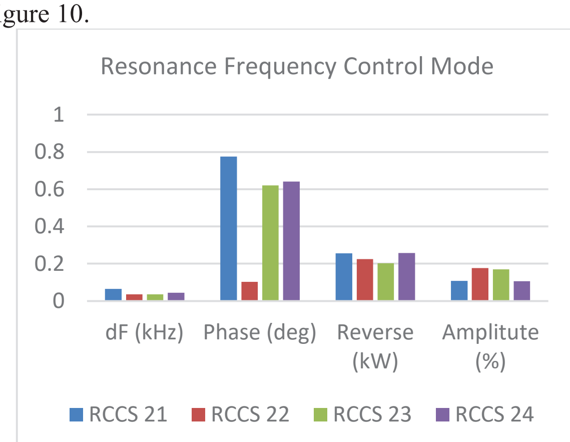

Figure 10: Operation characteristics graph.

Result

We found that the resonance frequency control mode is more efficient to remove the perturbation than the temperature control mode. The reduction rate of the resonance frequency error was calculated in Figure 11. The all values are improved, especially RCCS 24 about 62.86%.

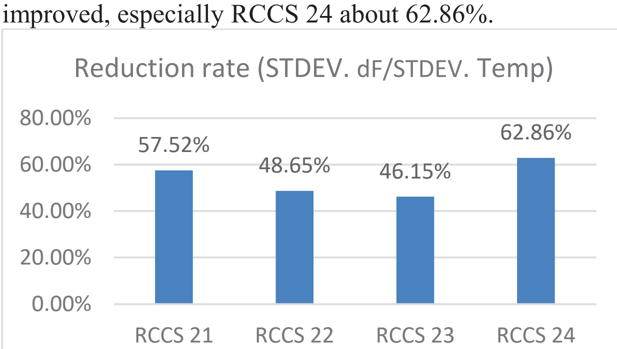

Figure 11: Reduction rate chart.

CONCLUSION

The resonance frequency control mode in RCCS to control DTL tank is more essential control method for the operation stability when the radio frequency power is inputted to the tank than the temperature control mode. But the temperature control mode is also needed when radio frequency power is lost by any activated interlock. So it is important to adopt these control mode to RCCS operation base on the various operation condition.

ACKNOWLEDGMENT

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