RF Power Measurements and Monitoring for the PEFP 20MeV Accelerator Operation

Kyung-Tae Seol*, Hyeok-Jung Kwon, Han-Sung Kim, Dae-Il Kim, Young-Gi Song, and Yong-Sub Cho
PEFP, KAERI, Deojin-Dong 150, Yuseong-Gu, Deajeon, Korea
ktseol@kaeri.re.kr

1. Introduction

The PEFP (Proton Engineering Frontier project) 20MeV proton linear accelerator has been operated for the RF and beam experiments in KAERI (Korea Atomic Energy Research Institute) site [1-2]. The 20MeV accelerator consists of a 3MeV RFQ and a 20MeV DTL, which is composed of 4 tanks. The required RF power is 450kW for the RFQ and 200kW/tank for the DTL. The operation and control of the RF system are performed in a control room. During the 20MeV accelerator operation, it is necessary to measure and monitor the RF power at the RF transmission line and cavity, which is the forward RF power to the cavity, the reflected RF power from the cavity, and the RF power in cavity. To monitor the RF power during the operation, the calibration due to the coupling of the pickup, the loss of the transmission cable and the use of the RF detector should be done. RF power measurement and calibration for 20MeV accelerator operation are presented.

2. RF power calibration

The PEFP 20MeV accelerator has been operated in a pulse mode. RF detectors were used for measuring the RF pulse, which output voltage signal in accordance with 350MHz RF input level, and RF pulses were monitored at the oscilloscope. During the operation, the voltage signals measured at RF detectors should be converted to the RF power to measure and monitor the forward RF power to the cavity, the reflected RF power from the cavity, and the RF power in cavity. Figure 1 shows the measured voltage of RF detector to be converted to the RF power.

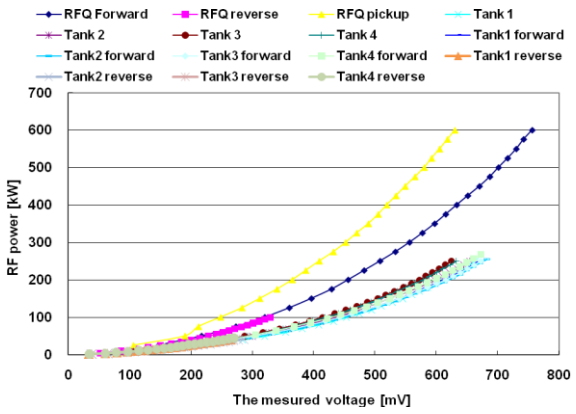

Figure 1. The measured voltage of RF detector in accordance with the input RF level

This calibration includes the coupling of pickup, the loss of the transmission cables, and the conversion in the RF detector. From these measured results, we can obtain the equations to be converted to the RF power and the equations can be used at the LabView program to monitor the RF power during the operation.

RF amplitude and phase of the cavity are measured and controlled by the feedback control board [3-5]. The down-converted 10MHz IF signal is input to this board during the operation. The maximum input level of this board was limited to +5dBm, so the input level of 10MHz signal should be determined. Figure 2 shows the block diagram for the input level calibration of the feedback control board. 340MHz LO signal level was 14.07dBm for the RFQ and 14.4dBm for the DTL respectively and 10MHz IF signal level was determined to 2.95dBm for the RFQ board and 2.98dBm for the DTL board at the normal operating power level, which is 400kW for the RFQ and 150kW/tank for the DTL.

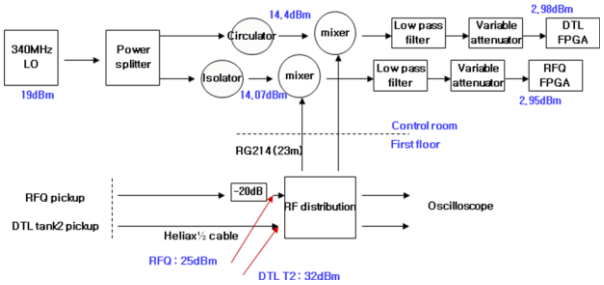

Figure 2. RF input power level calibration for RF feedback board (FPGA).

3. RF power measurements

During the operation, the RF power was measured and monitored.

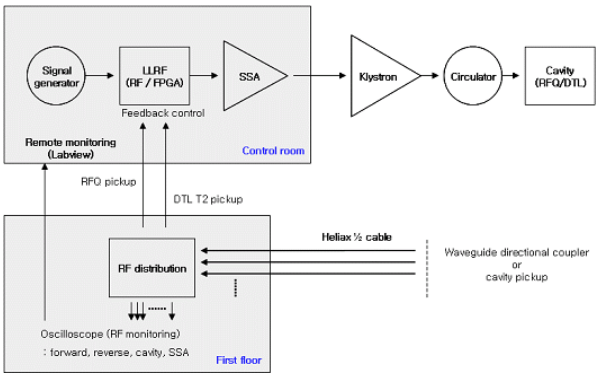

Figure 3. The block diagram for RF measurement and monitoring

Figure 3 shows the block diagram for the RF measurements and monitoring. The RF power from the pickup and directional couplers was split and detected in the RF distribution chassis, and measured at the oscilloscopes. The RF signal measured at the oscilloscopes was monitored and converted to the RF power by the LabView program in a control room as shown in Figure 4. To be converted to the RF power, the equations obtained from the calibration were used. The LabView code acquired and controlled the data of the oscilloscope through the TCP/IP. Figure 5 shows the installed oscilloscopes and other systems for the RF distribution and measurement.

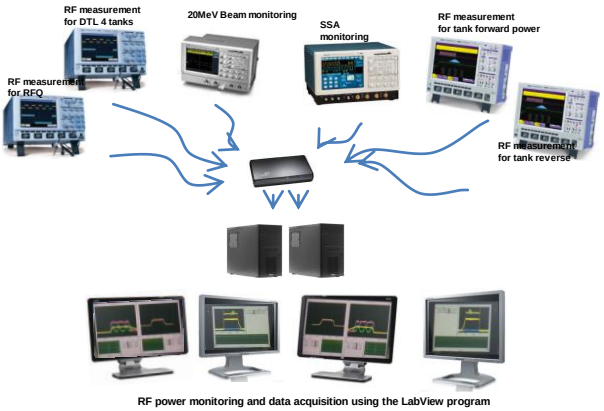

Figure 4. Data acquisition for RF power monitoring

Figure 5. RF power distribution and measurement system

3. Summary

To measure and monitor the forward RF power to the cavity, the reflected RF power from the cavity, and the RF power in the cavity, the measured voltage of RF detector was calibrated. The input level of the RF feedback control board was also calibrated for the RF amplitude and phase control of the RFQ and DTL. During the 20MeV accelerator operation, the RF power was measured and monitored by the Labview code in a control room. For the 100MeV accelerator, RF measurement system will be installed and remote-monitored in a main control room.

ACKNOWLEDGEMENTS

This work is supported by the Ministry of Education, Science and Technology of the Korean Government.

REFERENCES

[1] Yong-Sub Cho, Hyeon-Mi Choi, Sang-Hyo Han, In-Seok Hong, Ji-Ho Jang, Han-Sung Kim, Kui-Young Kim, Yong-Hwan Kim, Hyeok-Jung Kwon, Kyung-Tae Seol, Young-Gi Song, "Development of PEFP 20 MeV Proton Accelerator," Proceedings of EPAC 2006, Edinburgh, Scotland, 2006, p. 1609.
[2] B. H. Choi, Proceedings of PAC 2005 (Knoxville 2005), p.576.
[3] H. S. Kim, et al., "Development of the Digital RF Control System for the PEFP Proton Accelerator", Proc. of Asian Particle Accelerator Conference, Indore, INDIA, 2007
[4] Han-Sung Kim, Hyeok-Jung Kwon, Kyung-Tae, and Yong-Sub Cho, J. Korean Phys. Soc. **52**, 756 (2008).
[5] Kyung-Tae Seol, Hyeok-Jung Kwon, Han-Sung Kim, Dae-Il Kim, and Yong-Sub Cho, J. Korean Phys. Soc. **52**, 756 (2008).