Performance Results of the Modulator for the 100MeV Proton Linac

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1. Introduction

The modulator for the 100MeV proton linac has been installed at KOMAC (Korea of Multi-purpose Accelerator Complex) site [1]. The specification of modulator is 5.8MW peak power with 1.5ms pulse width, 60Hz repetition rate [2]. There are total 4 sets of modulator for 100-MeV proton linac including 3-MeV RFQ, 20-MeV DTL and 100-MeV DTL. A modulator drives two or three sets of the klystrons simultaneously. After installation and dummy test of 4 modulators, it has been operated for 100MeV proton linac. In this paper, the performance results of modulators for the 100MeV proton linac are presented.

2. Installation

2.1 Modulator

The modulators are located in 3rd floor of accelerator building for KOMAC. The modulator consists of control rack, SCR unit, high voltage converter modulator which includes oil tank basket, capacitor bank, IGBT switching plates, and tank assembly. The installed modulators are shown in the Fig. 1. There are installed the fire emergency system of 4 sets for MPS (Machine Protection System).

Fig. 1.Installed modulators in 3rd floor of accelerator building

2.2 Modulator and klystron system

The electron gun of klystrons is triode type. The modulating anode voltage was supplied by dividing the high voltage by using voltage dividing resistors installed inside commercial vessel with insulating oil. Fig. 2 shows the inside vessel for dividing resistors of the RFQ klystron.

Fig. 2 Inside of diving resistor vessel for RFQ klystron

The isolation transformers for klystron heaters are located inside or outside modulator oil tank for RFQ, 20MeV, 100MeV klystrons, respectively. The modulator and klystron system for 20MeV DTL is shown in the Fig. 3.

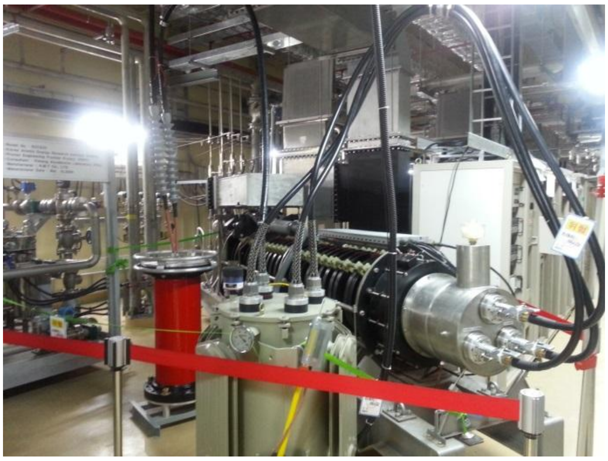

Fig. 3. Modulator and klystron system for 20MeV DTL

3. Measurement

The pulse profile of the modulator during the operation is shown in Figure 4. The voltage and total current was measured by using the controller signal, the current profiles of each klystron were measured by using the rogowski coil (PEM, CWT3LFB).

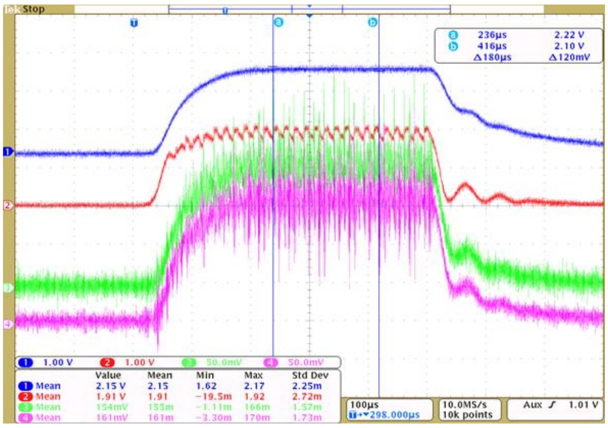

Fig. 4. Voltage and current profile of the modulator. (Ch 1: Voltage (40kV/V), Ch 2: Total current (20A/V), Ch 3: RFQ klystron current (1A/10mV), Ch 4: 20MeV DTL klystron current (1A/10mV), Horizontal scale: 100us/div.)

After adopting the droop compensation method using pulse frequency modulation algorithm, the voltage droop was decreased from 2% to 0.7%. The modulator output voltage after voltage droop compensation is shown in the Fig. 5.

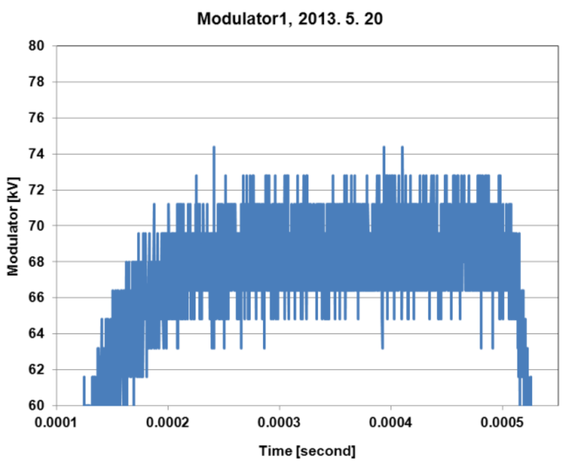

Fig. 5. Modulator o*utput after voltage droop compensation*

The peak voltage deviation was measured during the operation as shown in Figure 6. The voltage increased about 0.05% from initial value. The voltage fluctuation along the average was less than 0.04%.

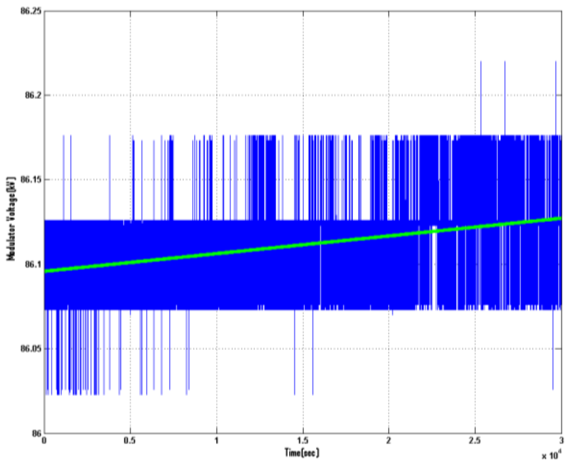

Fig. 6. Modulator voltage deviation during operation

4. Conclusion

4 modulators were installed and tested for the 100MeV proton linac. The modulator was measured to have about less than 1% droops at flat top for 500us pulse by using pulse frequency modulation droop compensation method. The long term voltage variation measurement showed that the voltage increased up to 0.05% for 8 hours. In future, the voltage droop and variation of modulator should be continuously checked in the high repetition rate.

ACKNOWLEDGMENT

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REFERENCES

[1] Ji-Ho Jang, et al., “BEAM COMMISSIONING OF KOMAC LINAC”, the proceedings of IPAC 2013, 3909 (2013).
[2] Hyeok-Jung Kwoṇ, et al., Test of the 20-MeV Proton Accelerator Using Modulator, Transactions of the Korean Nuclear Society Spring Meeting, Pyeongchang, Korea, May 27-28, 2010