Current Status of the 10 MeV RF Electron Linear Accelerator for KAERI Electron Beam Irradiation Facility

Sungsu Cha[a,*], Yujong Kim[a], Kyuongtae Lee[b], Pikad Buaphad[a,d,e], Youngwoo Joo[a,e], Hyerie Lee[a,e], Jae-Ho Kim[c], and Young-Ouk Lee[a]

[a]*Nuclear Data Center, Korea Atomic Energy Research Institute(KAERI), Daejeon 34057, Korea*
[b]*Business Center Institute of Industrial Science & Technology, Pohang-si,Gyeongbuk, 1201 Korea*
[c]*Advanced Radiation Technology Institute, Korea Atomic Energy Research Institute(KAERI), Jeongeup-si, Jeollabuk-do 56212, Korea*
[d]*Radiation Technology eXcellence(RTX), Daejeon 34025, Korea*
[e]*Accelerator and Nuclear Fusion Physical Engineering, University of Science and Technology(UST), Daejeon 34113, Korea*
[*]*Corresponding author: sscha@kaeri.re.kr*

1. Introduction

The Korea Atomic Energy Research Institute has used a 10 MeV 10 kW RF electron linac for beam irradiation service. In general, linear accelerators consist of various components [1-7]. This linac consists of an electron gun, beam focusing solenoid, accelerating structure (traveling and standing wave combination), beam current transducer, scanning electromagnet, scanning chamber, beam absorber, klystron, modulator, cooling system, control cabinet, and material transport system. The detailed accelerator specifications are summarized in table 1. This accelerator was imported from Russia about ten years ago and has been shut down due to the aging during operation. As a result, we replaced the klystron last year and want to upgrade the modulator this year. In this paper, we report current status of the linac and its future upgrade plans.

2. Status of linac components

The accelerator is installed in the building as shown in Fig. 1, and a detailed design drawing is shown in Fig 2. This accelerator does not operate a pulse repetition rate of up to 300 Hz, but operates at a maximum of 150 Hz.

Table 1: RF Linac Specifications

Parameter	Value	Unit
Particle	Electron	-
Operation Mode	Pulse	-
RF Frequency	2856 ± 5	MHz
Pulse Repetition Rate	10 - 300	Hz
Pulse Width	16 - 20	μs
Beam Energy (Max)	10	MeV
Beam Power (Average)	10	kW
Beam Current (Average)	1	mA
Scanning Size	800 × 200	mm

Fig. 1. 10 MeV linear electron accelerator facility

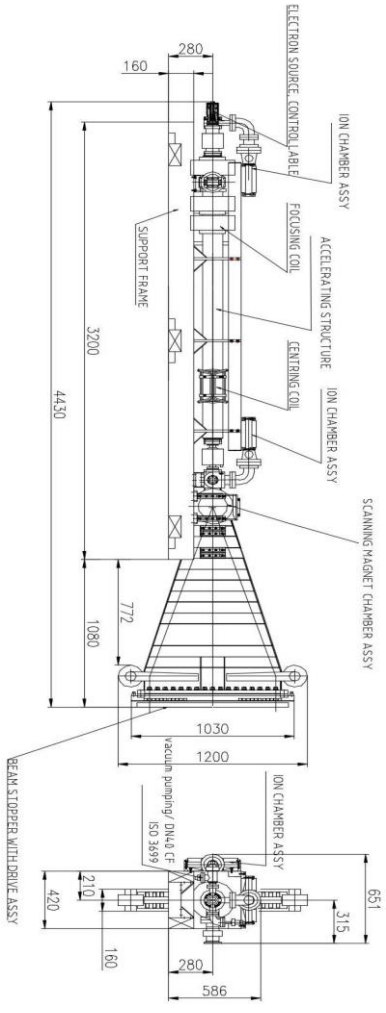

Fig. 2. Structure of 10 MeV linear electron accelerator

Fig. 3. Rusty modulator for 10 MeV accelerator

The modulator is a high-voltage pulse power supply for the klystron (KIU-147A), and is used to form a rectangular high-voltage pulse on the cathode of the klystron, and has the specifications summarized in Table 2.

Table 2: Klystron Modulator

Parameter	Value	Unit
Pulse Forming Network, PFN	LC delay line	-
PFN Impedance	12.7	Ω
PFN Capacitance	0.7	μF
PFN Inductance	113	μH
Charging Voltage (max)	30	kV
Max Repetition Rate	300	Hz
Matching Transformer Conversion Ratio	1:3.7	-
Klystron Cathode Voltage	55	kV
Klystron Cathode Voltage Stability	1	%

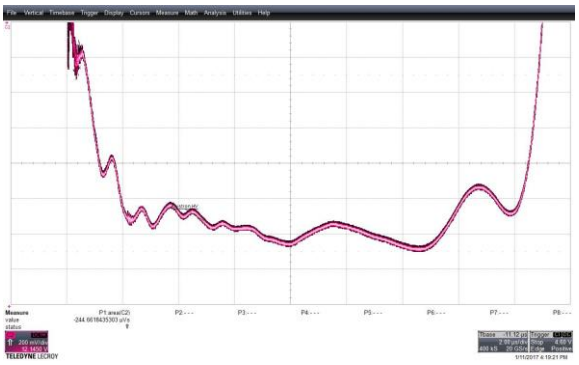

Fig. 4. Poor PFN pulse width owing to rust of the modulator.

As shown in Fig. 3, modulator capacitors will be exchanged owing to the ten-year operation of the accelerator and its rust. Figure 4 shows the modulator pulse waveform of one pulse. It can be seen that the pulse waveform is not well-conditioned. The pulse width is within about 20 μs.

3. Conclusions

The Korea Atomic Energy Research Institute operates a 10 MeV 10 kW class linear electron accelerator. It was designed from Russia about 10 years ago. Therefore, most of the devices are out of operation owing to rust and radiation activation. One of them is the capacitor of the modulator. The waveform is not good, and accordingly all capacitors are being replaced. It was designed to be less than 20 μs to conform to existing specifications. From now on, we will make an effort to research and exchange the commercial product such as electromagnets and electron guns, ion pumps, and control systems.

REFERENCES

[1] T. P. Wangler, RF Linear Accelerators, Wiley-VCH.: Weinheim, 2008.
[2] H. Padamsee and J. Knobloch and T. Hays., RF Superconductivity for Accelerators, Wiley-VCH.: Weinheim, 2008.
[3] M. Pozar., Microwave Engineering, John Wiley & Sons, Inc., 3rd edition, 1998.
[4] S. Lee, Accelerator Physics, World Scientific.: 2nd edition, 2004.
[5] Varian, C-series Clinac Accelerator System Basics, Varian medical systems, 2005.
[6] Y. Kim, 'Development of S-band and X-band RF Electron Linacs for Medical and Industrial Applications', lecture Osaka, 2015.
[7] Y. Kim, Advanced Accelerator Physics Tutorial for Linac Based Free Electron Laser Projects, Summer Lecture, Korea, 2012.