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Initial Test of 1 MV Electrostatic Accelerator with Compact RF Ion Source at KOMAC

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1. Introduction

1 MV electrostatic accelerator is being developed at KOMAC (Korea of Multi-purpose Accelerator Complex). The accelerator such as a 220 keV ion implanter for gaseous ion beam, a 150 keV metal ion implanter and a 20 keV high-current ion implanter consists of ion source, beam transport system and target chamber. In our accelerator, the ion source is focused on required for compact size due to limited space to install inside the pressure vessel of high voltage power supply as well as long-term operation without maintenance [1]. Specifications are as shown in Table 1.

Table 1. Specifications of 1 MV electrostatic accelerator

Beam Current Max.	>1mA
Operating Voltage	0.2 – 1.0MV
Energy Stability	±0.5%
Ions	Gaseous (Proton, O, N, etc.)
Power for Ion Source	<1kW
Life Time of Ion Source	>2,000 hrs

A compact RF ion source with 200 MHz were tested to check its characteristics in 300 kV test-stand such as plasma ignition, beam current, and power consumption [2] [3]. The compact RF ion source was installed in a SF6 pressurization vessel up to 5 atm with a high voltage system [4]. In this paper, installation of 1 MV electrostatic accelerator is described and its initial test results are presented.

2. Installation

2.1 1 MV electrostatic accelerator

The accelerator typically consists of ion source, beam transport system and target chamber. This system without target chamber is shown in Fig. 1.

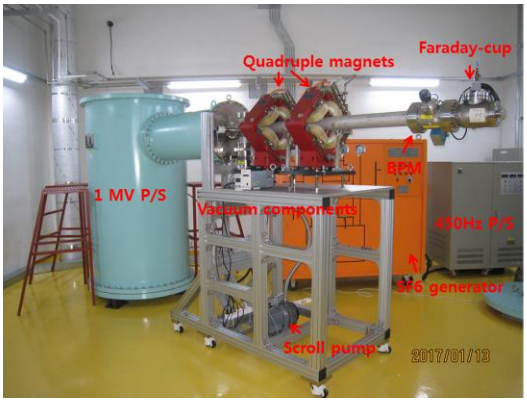

Fig. 1. 1 MV electrostatic accelerator.

The BPM (Beam Profile Monitor) and faraday-cup in the end of the beam pipe are installed to measure the beam characteristics.

2.2 Ion Source

A 200-MHz RF ion source consists of an air variable capacitor comprising a loading and tuning capacitor, a 1-turn coil, a permanent magnet, a shielding box, and an electrode. Ion beams are extracted by a high power supply up to 5 kV. Fig. 2 shows the schematic of 200 MHz RF ion source. It was operating plasma generated by its matching circuit.

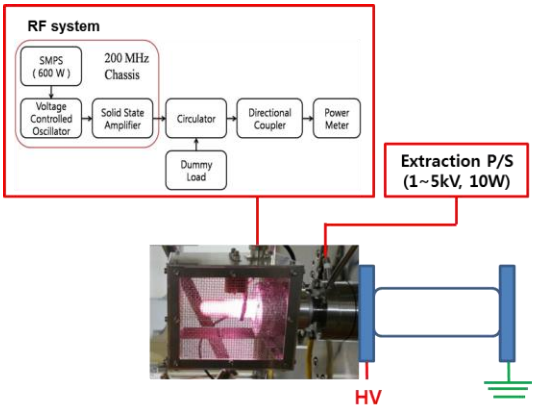

Fig. 2. Schematic of 200 MHz RF ion source.

2.3 Accelerating Column

The accelerating column consists of two sections, twelve Al2O3 insulator stages per each section. The resistor of 500 Mohm is connected between electrodes. In the resistor legs, there are beads to distribute the electric field gradient. Total 12 G resistors are used to divide the voltage equally. The accelerating column can withstand up to 1 MV in 5atm of SF6 gas. Fig. 3 shows the accelerating column and High Voltage shielding box.

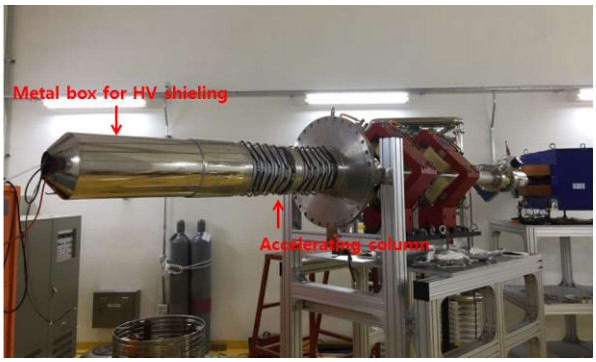

Fig. 3. Accelerating column and HV shielding box.

2.4 Control Unit

RF ion source and extraction voltage are controlled by optic-fiber method due to high voltage potentials. Transmission component of this system is installed on the ground side. Receive component is installed on the HV potential under the 5 atm SF_6 gas. The optic system can be controlled turn on/off the ion source and extraction power supply. The block diagram for accelerator control is shown in the Fig. 4.

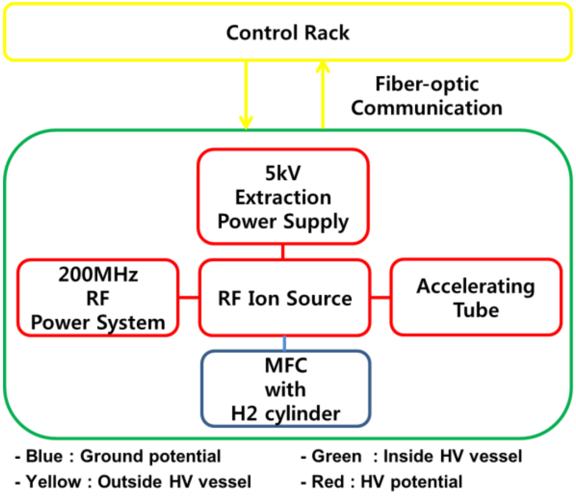

Fig. 4. Block diagram for accelerator control.

3. Tests

The beam currents are measured in 300 kV test-stand before it is installed inside HV vessel.

3.1 Beam current measurement in 300 kV test-stand

The result of beam current depending on hydrogen gas and extraction voltage is shown in Fig. 5. The beam current increases depending on the rising accelerating voltage but behaves differently depending on the hydrogen gas. The beam current in 1E-4 torr is increased up to about 400 uA depending on the accelerating voltage.

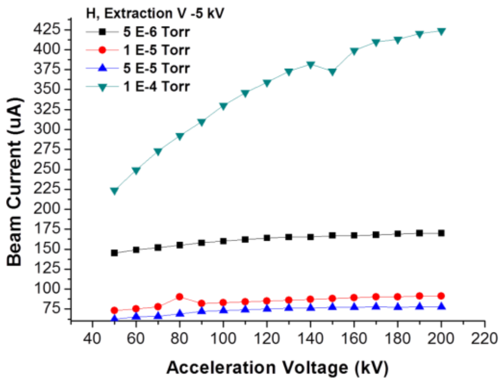

Fig. 5. Beam current depending on hydrogen gas and accelerating voltage.

3.2 High voltage test

Accelerating voltages are checked up to 1 MV which is connected to ion source with accelerating column. It proceeded while stepping up voltage up to the 1 MV step by step. 1 MV was maintained for about 1 hour without arcing. Fig. 6 shows the result of high voltage test at no load.

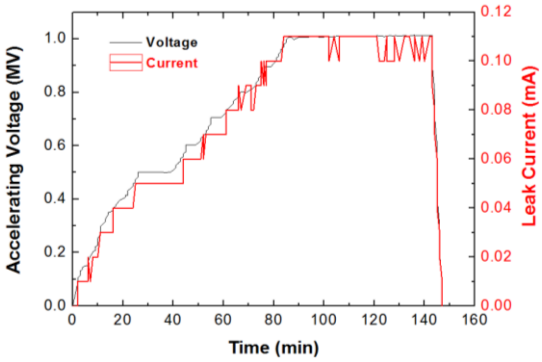

Fig. 6. High voltage test at no load

4. Conclusions

A 1 MV electrostatic accelerator is being developed at KOMAC. According to the description, it is necessary to confirm the partial and comprehensive test for the accelerator. And, we will try to operate the accelerator for long-term and to measure beam property using by the BPM and faraday-cup.

REFERENCES

[1] Yong-Sub Cho, Kye-Ryung Kim, Chan-Young Lee, Basic Design Study on 1-MV Electrostatic Accelerator for ion irradiation, Transactions of the Korean Nuclear Society Spring Meeting, Jeju, Korea, May 29-30, 2014.
[2] Hyeok-Jung Kwon, et al., Compact RF Ion Source for industrial Electrostatic Ion Accelerator, Rev. Sci. Instrum. 87, 02c105 (2016).
[3] Dae-Il Kim, et al., Modification of 300 kV RF Ion Source for 1-MV Electrostatic Accelerator at KOMAC, Transactions of the Korean Nuclear Society Spring Meeting, Jeju, Korea, May 7-8, 2016.
[4] Dae-Il Kim, et al., "Preliminary Test of 1 MV Electrostatic Accelerator at KOMAC" IPAC16, Busan, 2016.