Initial beam acceleration test of 1-MV electrostatic accelerator at KOMAC

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1. Introduction

1MV electrostatic accelerator is being developed at KOMAC. This device consists of a 200-MHz RF ion source, a high voltage power source for ELV-type acceleration, triplet, beam line equipped with raster scanner, and target chamber for beam irradiation.
One of the features of this device is that a small sized ion source is installed at the limited space in a SF_6 pressurization vessel up to 6 atm with the high voltage system. For this, an RF ion source with low power consumption is used. The ELV-type high voltage power source and compact RF ion source are suitable for long-term operation without maintenance, and are easy for actual maintenance [1]. Table.1 is the specification of 1-MV electrostatic accelerator.

Table.1.Specifications of 1-MV electrostatic accelerator

Beam current max	>1 mA
Accelerating voltage	0.2-1.0 MV
Ions	Gas (H2, O, N etc.)
Power for ion source	<1 kW
Life times of ion source	>2000 hr

We have now completed the 1-MV accelerated test of the proton beam. In addition, a facility inspection for the radiation generator is being prepared, and it will be used as an accelerator for power semiconductor irradiation this year. In this paper, we will describe each system of accelerator and the experiments performed.

2. Installation

2.1 1-MV electrostatic accelerator
Figure.1 shows the layout of the accelerator. It can be divided into HV vessel equipped with an Ion source and 1MV accelerating tube, beam line equipped with triplet and bending magnet, and beam irradiation chamber.

Figure.1. Layout of the accelerator

2.2 Ion source
The ion source consists of a 200-MHz RF, 5 kV extraction voltage power supply system and a plasma ignition system. First, the RF, extraction voltage power system is installed on dummy part above the secondary coil as shown in Figure.2. The induced voltage is applied from the primary coil to the base coil and supplies power through the capacitor for resonance matching and transformer.
Plasma ignition system consists of variable capacitors, a 1turn coil, permanent magnet, shielding box, and electrode for applying 5 kV extraction voltage.

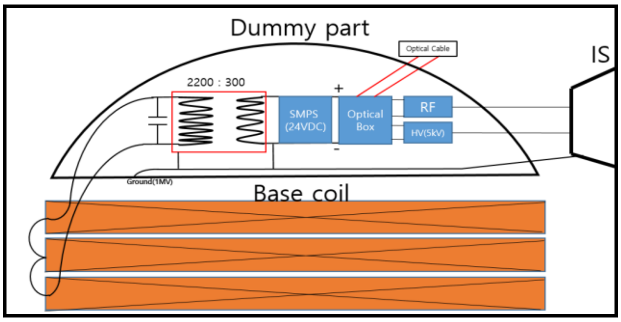

Figure.2 .Installation of the Ion source power system

2.3 1-MV accelerating system
The voltage boosting system is an ELV-type with a primary coil of 30 turns and 23 stacked secondary coils of 3000 turns per section. The 1-MV high voltage inductive from the primary coil to the secondary coil accelerates the extracted ions by 5 kV.

2.4 Control system
An optic-fiber convertor that controls RF and extraction power is already installed. This is due to the HV potential inside the vessel. In addition, Labview-based programming was performed for remote monitoring and control in the control room.
Therefore, the vacuum of Ion source and target chamber including the beam current can be monitored in control room. Also, Remote control of magnet and steerer is possible. Figure.3 is operating and monitoring panel.

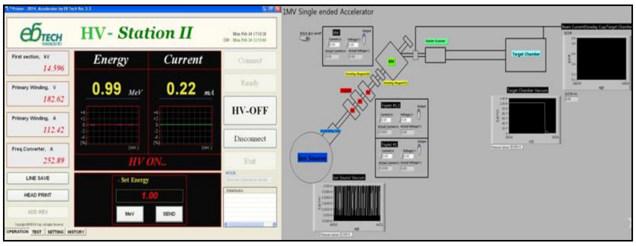

Figure.3 .Operating and monitoring panel

2.5 Interlock system

The entire interlock system includes device interlock, door, RMS, and control unit emergency stop interlock.

The device interlock contains matters related to the operation of the device, such as the flow rate of cooling water inside the high-voltage vessel, arcing during boosting, and abnormality in the internal circuit of the control unit. The door and control unit emergency stop interlock can be operated in emergency situations relating radiation generator and the laboratory. Currently, the 1-MV electrostatic accelerator has undergone facility inspection for the interlock system.

Figure.4 is the layout of the interlock system.

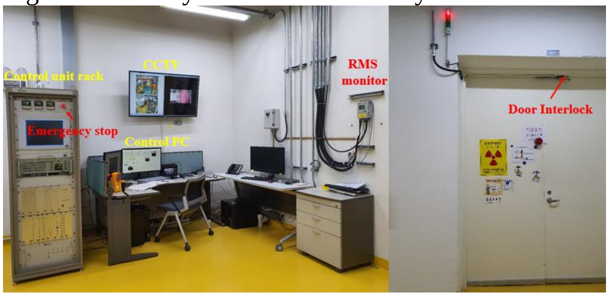

Figure.4 Layout of the interlock system

3. Test

3.1 Ion source test

First, an experiment was performed by creating plasma ignition test stand in an atmospheric environment. The variable capacitor was adjusted to perform 200-MHz RF impedance matching to minimize reflection power. As a result, plasma ignition was achieved at a driving vacuum of 1.0e-5 Torr. The RF shielding box after impedance matching was installed in the ion source inside the vessel, and plasma was tested again in the SF_6 gas environment. Figure.5 is plasma ignition vacuum according to the RF input power in the test stand system.

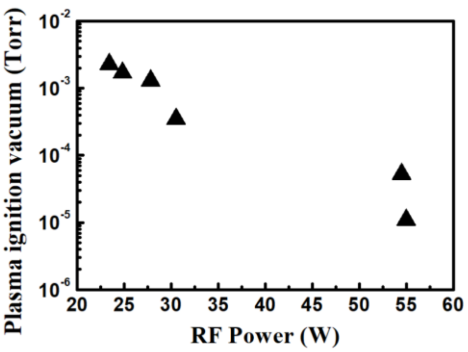

Figure. 5. Plasma ignition vacuum according to the RF input power

3.2 Beam current measuring test

Initially, the focusing beam current was measured through a Faraday cup after triplet on the beam line.

Figure.6 is focusing beam current according to HV at Faraday cup after triplet on the beam line.

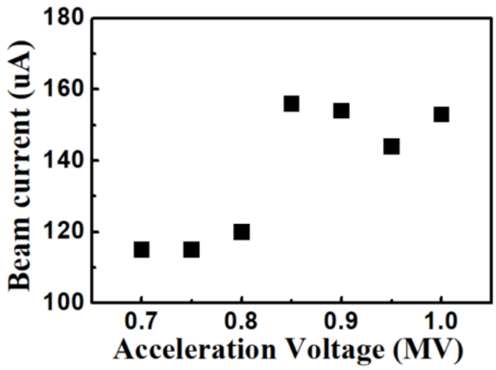

Figure. 6. **B**eam current according to HV

3.3 Electromagnet test

Through Beam optic code provided by NEC, we can calculate the current values of triplet and bending magnet by converting Gradient to current.

Figure.7 is beam optic code, Figure.8 is driven beam by bending magnet at the target chamber.

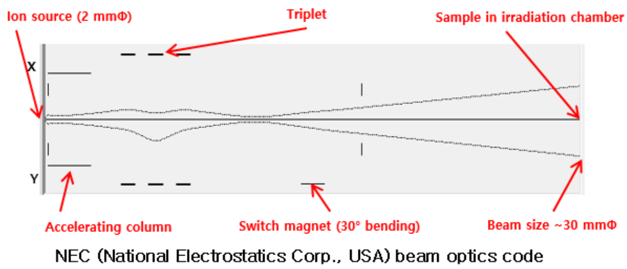

Figure.7 NEC beam optics code

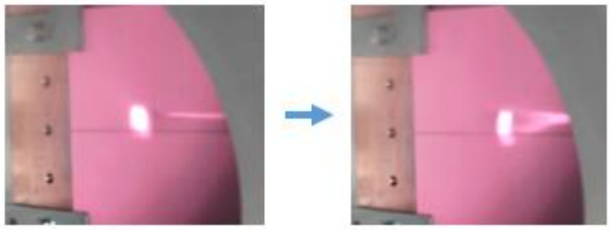

Figure.8 Driven beam by bending magnet

4. Conclusions

The 1-MV electrostatic accelerator is being developed by KOMAC. Recently, the facility inspection for the radiation generator has been completed. In the future, comprehensive tests will be conducted. For examples steering magnet, raster scanner test and BPM test for beam profile. Thereafter, there is a test for measuring the beam current reaching the target chamber.

REFERENCES

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