Beam Profile Measurement of 300 kV Ion Source Test Stand for 1 MV Electrostatic Accelerator

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1. Introduction

The KOMAC (KOrea Multi-purpose Accelerator Complex) has been developing a 300 kV ion source test stand for a 1 MV electrostatic accelerator. An ion source and accelerating tube will be installed in a high pressure vessel. The ion source in a high pressure vessel requires high reliability. To confirm the stable operation of the ion source, a test stand was proposed and developed. The ion source will be tested at the test stand to verify its long-term operation conditions. The test stand consists of a 300 kV high voltage terminal, a battery for the ion source power, a 60 Hz inverter, a 200 MHz RF power, a 5 kV extraction power supply, a 300 kV accelerating tube, and a vacuum system. The beam profile monitor was installed at the downstream from the accelerating tube. Wire scanner and faraday-cup was installed at the end of the chamber. In this paper, RF ion source, test stand of the ion source and its test results are presented.

2. Methods and Results

2.1 200 MHz RF Ion Source

A 200-MHz RF ion source was installed at the test stand. It consisted of an air variable capacitor comprising a loading and tuning capacitor, a 1-turn coil, a permanent magnet, a shielding box, and an electrode [1]. The plasma was confined by an axial magnetic field produced by permanent magnets placed around a 20-mm pyrex tube. The magnetic field of the permanent magnet was 0.1 T at the center. Impedance matching was adjusted using L-network air variable capacitors. The extraction-hole diameter was 4 mm, and the distance between the electrodes was 7 mm; this was modified for the beam extraction.

2.2 Beam Profile Monitor

The Beam Profile Monitor (NEC, BPM83) is installed at the downstream from the accelerating tube [2], its installation was shown in Fig. 1. NEC beam profile monitors can measure the beam shape and position of the beam cross section in both X and Y coordinates. The BPM works by having a helical wire scan the beam. When the beam hits the wire, electrons are scattered off and collected by a cylinder. A cylindrical collector around the grounded wire collects beam-induced secondary electrons from the wire to provide a signal proportional to the intercepted beam intensity at every instant.

There are three pulses on the fiducial signal each time when the wire turns once. There is a larger one that is the start of rotation. And two smaller ones for the center of the X and Y axes, its fiducial signal measurement result was shown in Fig. 2. Beam profile measurement result was shown in Fig. 3.

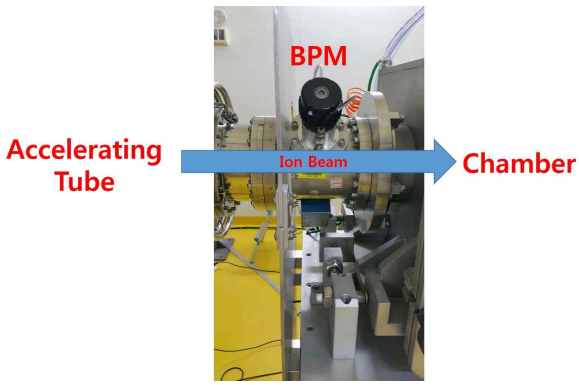

Fig. 1. Installed BPM at the end of the accelerating tube. Ion beam move to right direction.

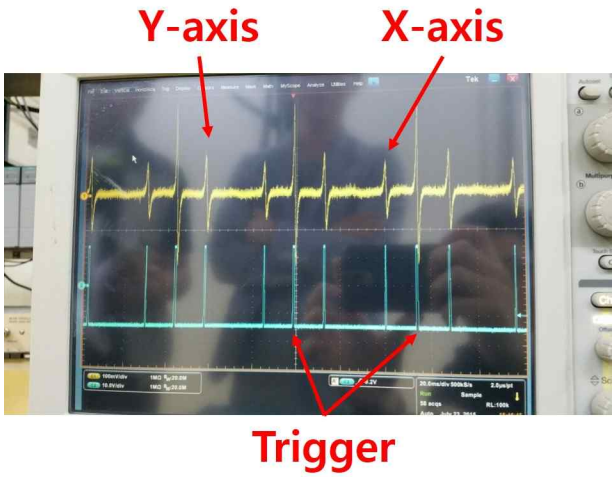

Fig. 2. Fiducial mark measurement by oscilloscope.

Fig. 3. Beam profile measurement at the pressure of 1E-5 Torr.

2.3 Wire Scanner and Faraday Cup

The wire scanner measured the beam current of the beam profile at the beam dump. The beam profile at the beam dump was measured by using the NI Labview software and equipment for controlling the motor and data aquisition for the beam current. The beam profile measurement was shown in Fig. 4. Its measurement conditions were 200 nA/V sensitivity of a current preamplifier, -5 kV extraction voltage and 200 kV high voltage.

The beam current monitoring system for a 300-kV test stand, which components are composed of a faraday cup, a low-noise current preamplifier (SRS SR570), a PLC (Allen-bradley, SLC-500) and a NI Labview. The faraday cup is installed inside the chamber. The beam signal from the faraday cup is processed by the low-noise current preamplifier, the sensitivity of which was 100 ㎂/V. After the beam current signal converted to voltage value which can be used to read at the PLC analog input chassis (1746-NI8). We can measure the beam current signal, but the PLC cannot save the data or configure the data logs, which need other software. We used to configure the data logs with NI Labview. We composed the OPC server to communicate with the PLC and NI Labview to obtain data from the PLC.

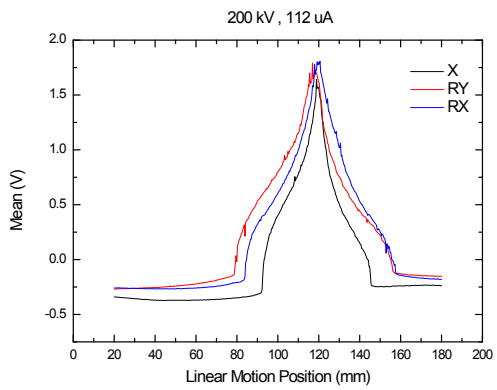

Fig. 4. Beam profile measurement by using wire scanner.

3. Conclusions

Beam profile was measured at the downstream from the accelerating tube and at the beam dump by using BPM and wire scanner. The RF ion source of the test stand is verified by measuring the total beam current with a faraday cup in the chamber.

ACKNOWLEDGMENTS

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[2] http://www.pelletron.com/bpm.htm