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Beam Extraction for 1-MV Electrostatic Accelerator at the 300 kV Test Stand

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1. Introduction

The Korea Multipurpose Accelerator Complex (KOMAC) has been developing a 300-kV test stand for a 1-MV electrostatic accelerator ion source [1]. The ion source and accelerating tube will be installed in a high-pressure vessel. The ion source in the high-pressure vessel is required to have a high reliability. The test stand has been proposed and developed to confirm the stable operating conditions of the ion source. The ion source will be tested at the test stand to verify the long-time operating conditions. The test stand comprises a 300-kV high-voltage terminal, a battery for the ion-source power, a 60-Hz inverter, 200-MHz RF power, a 5-kV extraction power supply, a 300-kV accelerating tube, and a vacuum system. A beam extraction experiment for the test stand was performed, and the beam current was measured using a faraday cup in the chamber. A beam extraction results for the RF ion source will be presented.

2. Methods and Results

2.1 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 [2]. The plasma was confined by an axial magnetic field which was 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. We used hydrogen and pressure maintained at 1.0 E-5 torr after generating the plasma. The hydrogen plasma is shown in Fig. 1. The extracted beam current was obtained at a 5-kV extraction voltage. The high-voltage power supply (Cockcroft-Walton) for the high-voltage terminal was operated from 0 to 300 kV. A beam extraction experiment for the test stand was performed, and the beam current was measured using a faraday cup in the chamber.

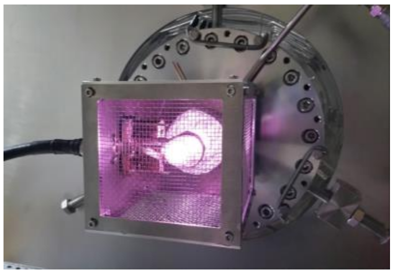


Fig. 1. Hydrogen plasma at test stand.

2.2 Beam Current Monitoring System

The beam current monitoring system for a 300-kV test stand is summarized in Fig. 2. These 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 was installed at the inside of chamber. The beam signal from the faraday cup is processed by the low-noise current preamplifier which sensitivity was 100 ㎂/V. After the beam current signal is 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 it is impossible for PLC to save data or to configure data logs which need other software. We used NI Labview to configure data logs. We composed the OPC server to communicate with PLC and NI Labview to get data from the PLC.

OPC is a software interface standard that allows windows programs to communicate with industrial hardware devices. OPC is implemented in server/client pairs. The OPC server is a software program that converts the hardware communication protocol used by a PLC into the OPC protocol. The OPC client software is any program that needs to connect to the hardware, such as an HMI. The OPC client uses the OPC server to get data from or send commands to the hardware.

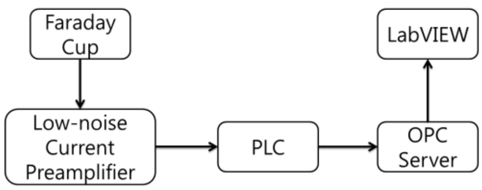
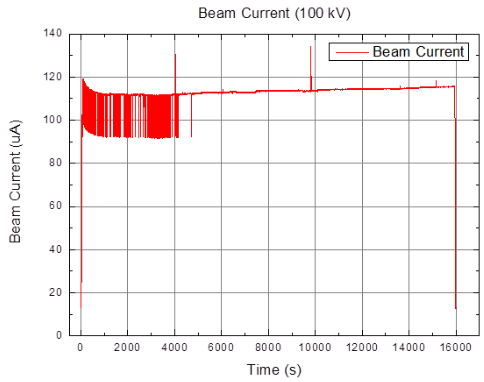


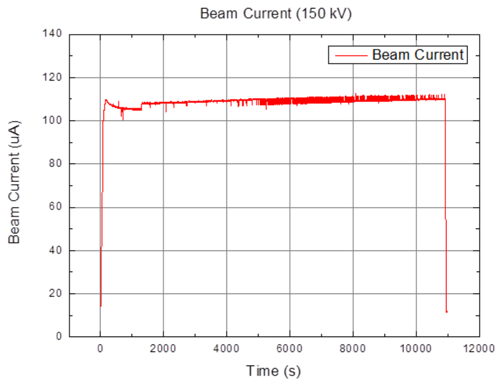
Fig. 2. A block diagram of beam current monitoring system.

2.3 Results

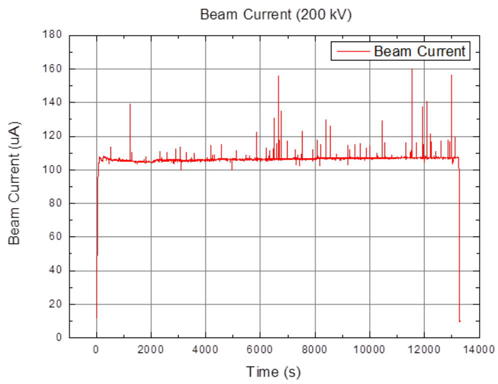
The data acquisition comprises NI Labview and PLC with the OPC server. The data acquisition sampling rate of the present system is 500 ms which can be used to adjust sampling rate. NI Labview is able to configure any name tags from the OPC server. NI Labview acquires beam current data from PLC name tag of N7:0 which displays graphs of performance of beam extraction and configures data logs. The measured beam current is shown in Fig. 2.



(a)



(b)



(c)

Fig. 2. Beam current of 300 kV test stand that have been measured at the faraday cup with a 500 ms sampling rate.

3. Conclusions

Beam extraction from the RF ion source of the test stand is verified by measuring the beam current with a faraday cup in the chamber. Thus far NI Labview, PLC and faraday cup have been used to measure the beam current. The OPC server is useful for monitoring the PLC values. The average beam current of (a), (b) and (c) shown in figure 2 are 110.241 ㎂, 105.8597 ㎂ and 103.5278 ㎂ respectively.

ACKNOWLEDGMENTS

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[2] Jeong-tae Kim, Kwang-mook Park, Dong-Hyuk Seo, Han-Sung Kim, Hyeok-Jung Kwon, Yong-Sub Cho, Hydrogen Plasma Generation with 200-MHz RF Ion Source, Transactions of the Korean Nuclear Society Autumn Meeting, Pyeongchang, Korea, October 30-31, 2014.