§46. Development of an Ion Beam Source for a Low Voltage / High Current Neutral Beam Injector

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The Low-voltage and high-current neutral beam injector (NBI) is essential to sustainment of ultra-high beta STs at UTST device, one of core experiments for the all-Japan ST research project. The required properties for this NBI are its beam energy <25kV, its beam current >20A, and maintenance-free, while its pulse length can be as short as a few m-sec. We organized a new NBI team composed of Univ. Tokyo, Nihon Univ., Osaka Univ. AIST and Kyusyu Univ. to develop low-cost and maintenance-free ion beam source by combining the washer-gun plasma source techniques at Univ. Tokyo with the electrode design technique at Nihon Univ., AIST and Osaka Univ.

In 2006-2007, we installed the new electrode system for ion acceleration and deceleration and their hand-made power supplies to the multi-cusp plasma source with the washer gun. We completed the test module of ion beam source and measured ion beam for the first time. Figure 1 shows our ion beam system under development, which is composed of the washer gun plasma source, the plasma source chamber and the electrode system. Figure 2 shows the time evolutions of the washer gun current and the ion beam currents measured by Faraday cups under five different voltages applied to the acceleration electrode. It was clearly observed that the ion beam current increases linearly with the electrode potential V_{acc}. The linear dependence of ion beam current on the acceleration electrode voltage is shown in Fig. 3. The waveform of gun current was optimized as shown in Fig. 1(top) to maintain ion beam current almost constant for about 1msec. Unlike the conventional filament method, the high-density source plasma ~10^{18}[m^{-3}] was economically controlled by the washer gun but need more capacitor bank energy for longer pulse operation.

We completed the test module for new low-voltage/ high–current/ pulsed ion beam source and demonstrated ion beam experiment using total cost lower than 1/20 for the pulsed NBI at Osaka Univ. within two years. The next issues are to increase the beam power and the duration time by upgrading the present hand–made power supplies for the electrodes .

References

[1] Y. Ono et, Fusion Energy 2006, EX/P7-12, (2006).
[2] T. Asai, Y. Ono etc., in preparation for submission.

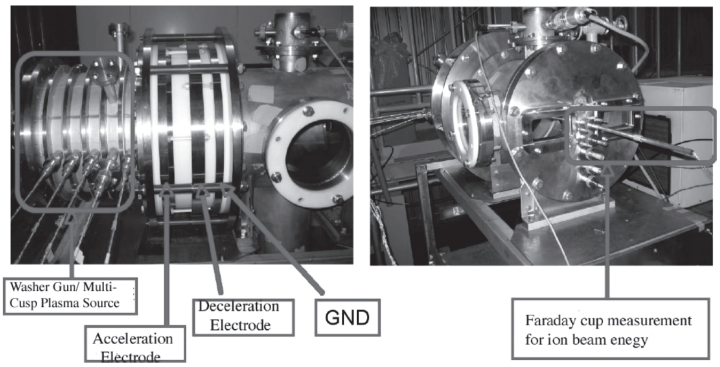

Fig. 1 Low-voltage/ high-current NBI device with washer gun, where new electrode system was installed.

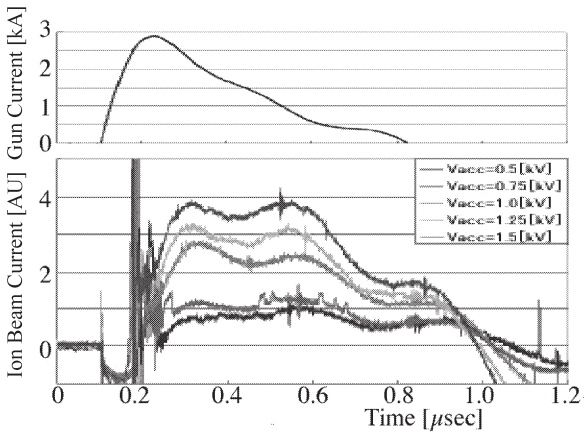

Fig. 2 Time evolutions of the washer gun current and ion beam currents measured by Faraday cup under five different voltages applied to the acceleration electrode.

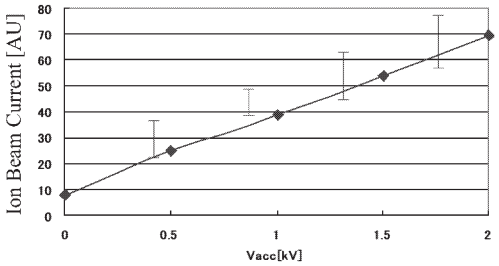

Fig. 3 Dependence of the ion beam current on the acceleration electrode potential.