§46. Development of a New NBI System by Washer Gun-type Ion Beam Source

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The Low-voltage and high-current neutral beam injector (NBI) has been developed for sustainment of ultra-high beta STs in the UTST experiment, one of core experiments for the all-Japan ST research project. The requested beam properties are its beam energy <25kV, its beam current >15A, and maintenance-free, and its pulse length can be as short as m-sec. The idea of this low-cost and maintenance-free NBI system was obtained by combining the washer-gun plasma source techniques at Univ. Tokyo with the electrode design technique at Nihon Univ., AIST and Osaka Univ.

In 2008 we increased the ion acceleration voltage V_{acc} up to 10kV to demonstrate the high energy NBI operation using our hand-made power supplies for the ion deceleration. Figure 1 shows the time evolution of the Faraday cup signals of ion beam current extracted from the plasma source with the multi-cusp magnetic field. Under the low acceleration voltage, the waveform of beam current was almost constant for about 0.4msec, which was determined by particle balance inside the plasma source. However, the beam current increases significantly with increasing V_{acc} over 5kV and its duration time was observed to decrease significantly inversely with the washer gun current. It was because the plasma density in the multi-cusp source decreases by large amount of beam extraction. The gas injection and the washer gun voltage have to be increased for the purpose of increasing the beam current over 10A. The next issues are to increase the duration time of washer gun current and gas injection time by upgrading the present hand–made washer gun power supply and the gas injector. Even under large beam extraction, the beam profile was peaked at the center, as show in Fig. 2.

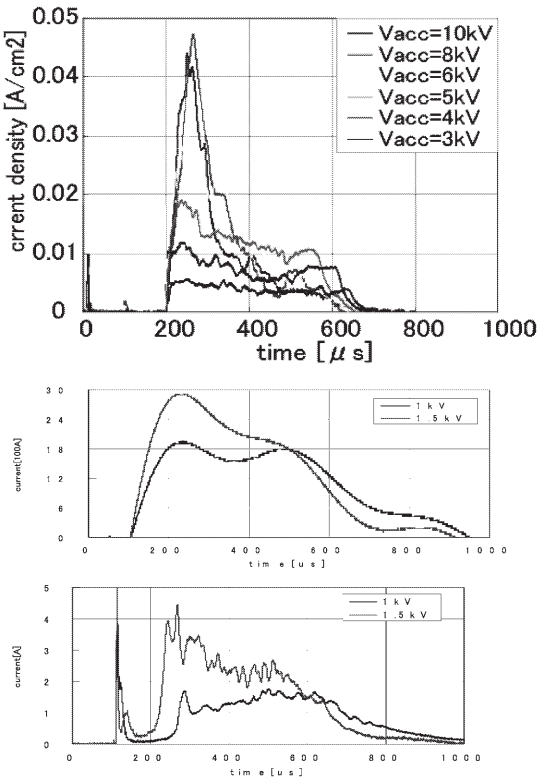

Fig. 1 Dependence of the ion beam currents measured by the center Faraday cup on the acceleration voltage under the condition of washer gun voltage ~ 1kV (top), the gun current (middle) and the beam current (bottom) in the cases of gun voltage 1kV and 1.5kV.

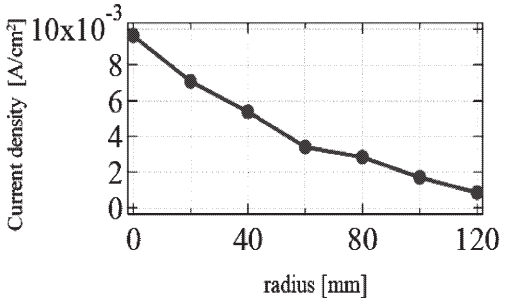

Fig. 2 Radial profile of the ion beam current measured by radial scan of Faraday cup.

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