

## §45. 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. The idea of this low-cost and maintenance-free NBI system was obtained by combining the washer-gun plasma source techniques with the electrode design technique.

In 2009 we increased the ion acceleration voltage  $V_{acc}$  of the NBI system up to 15kV to maximize its beam power. Figure 1 shows the time evolution of the ion beam current extracted from the plasma source (blue curve) and applied electrode voltage (red curve). Under acceleration voltage of 15kV, we studied how to condition the electrode system without any arcing problem and finally attained the maximum beam current of 25A. Its beam power  $\sim 0.37\text{MW}$  is already larger than our initial design value 0.3MW. In the present setup, the maximum beam power is determined by plasma mass balance inside the plasma source. The large amount of beam extraction was observed to cause significant decrease in plasma density inside the plasma source. As shown in Fig. 2, the NBI system was already installed on TS-4 ST device. As shown In Fig.3, the 0.3MW NBI was found to increase successfully the plasma current and poloidal flux of ST plasma by 10-20%. The next issues are to increase the duration times of washer gun current and gas injection by upgrading the present hand-made washer gun power supply and the gas injector.

1) T. Asai, Y. Ono et al., “Development of ion source with a washer gun for pulsed neutral beam injection”, Rev. Sci. Instrum. 79, (2008), 063502.

2) Y. Ono: “Pulsed High-Power Heating of Magnetic Reconnection for Spherical Torus Plasmas”, 10th Int. Workshop of IPELS, Stockholm, Sweden, June 8-11. 2009 (Invited).

3) Y. Ono. H. Imanaka, K. Sato et al., “Development of ion beam source by a washer gun”, Trans. IEEJ 128-A, (2008), 600.

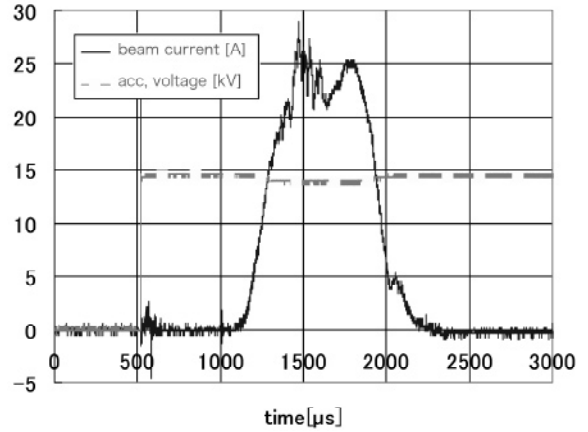


Fig. 1: Time evolutions of beam current (blue) and acceleration electrode voltage (red).

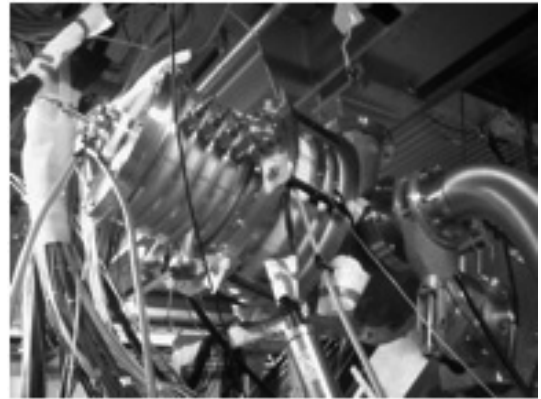


Fig. 2 : Photograph of NBI system installed on TS-4 ST device.

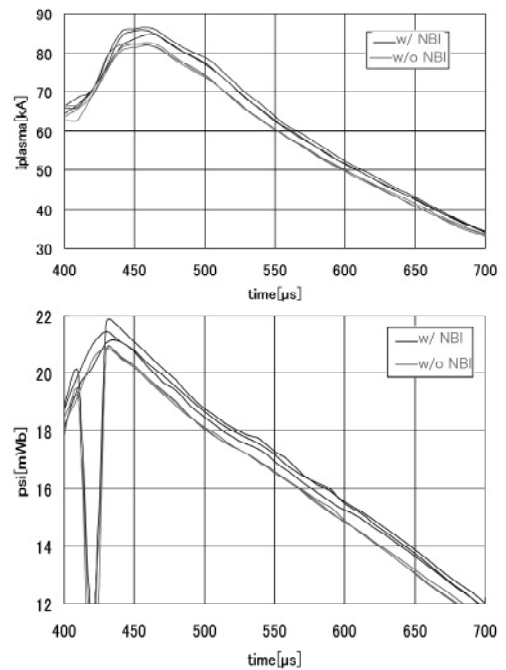


Fig. 3: time evolutions of plasma current (top) and poloidal fluxes of ST (bottom) with and without neutral beam injection (by blue / red curves).