§48. 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 using a washer gun for sustainment of ultra-high beta ST experiment[1,2]. 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. Figure 1(a) shows the experimental setup of NBI installed on the TS-4 device. In 2010 we maximized the NBI power to 0.6MW (40A, 15kV) for the pulsed high beta ST/ CT experiment, which is significantly higher than our initial design value 0.3MW[3,4]. Figure 1(b) shows time evolutions of the ion beam current extracted from the plasma source and applied electrode voltage. 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. The 0.6MW NBI was found to increase successfully the plasma current and poloidal flux of ST and CT plasmas by 10-50%[4]. A new finding is that this NBI increased significantly the plasma life time of FRC produced by the counter-helicity merging spheromaks[4]. As shown in the right of Fig. 1(c), the FRC is unstable for MHD modes in large-s (plasma radius/ ion gyro radius) region, disrupting itself within 50μsec. However, the NBI stabilized the whole FRC during the NBI duration time, as shown in the left of Fig. 1(c). 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.

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3) T. Yamada, Y. Ono et al., "Merging Start-up and Neutral Beam Injection in the University of Tokyo Spherical Tokamak Experiments", Fusion Energy 2010, EXS/P2-19, Oct. 11-16, 2010, (Daejon, Korea).

4) M. Inomoto, Y. Ono et al., "Kinetic Behaviors of Energetic Ions in Oblate Field-Reversed Configuration", Fusuin Energy Conference 2010, ICC/P7-1, Oct. 11-16, 2010, (Daejon, Korea).

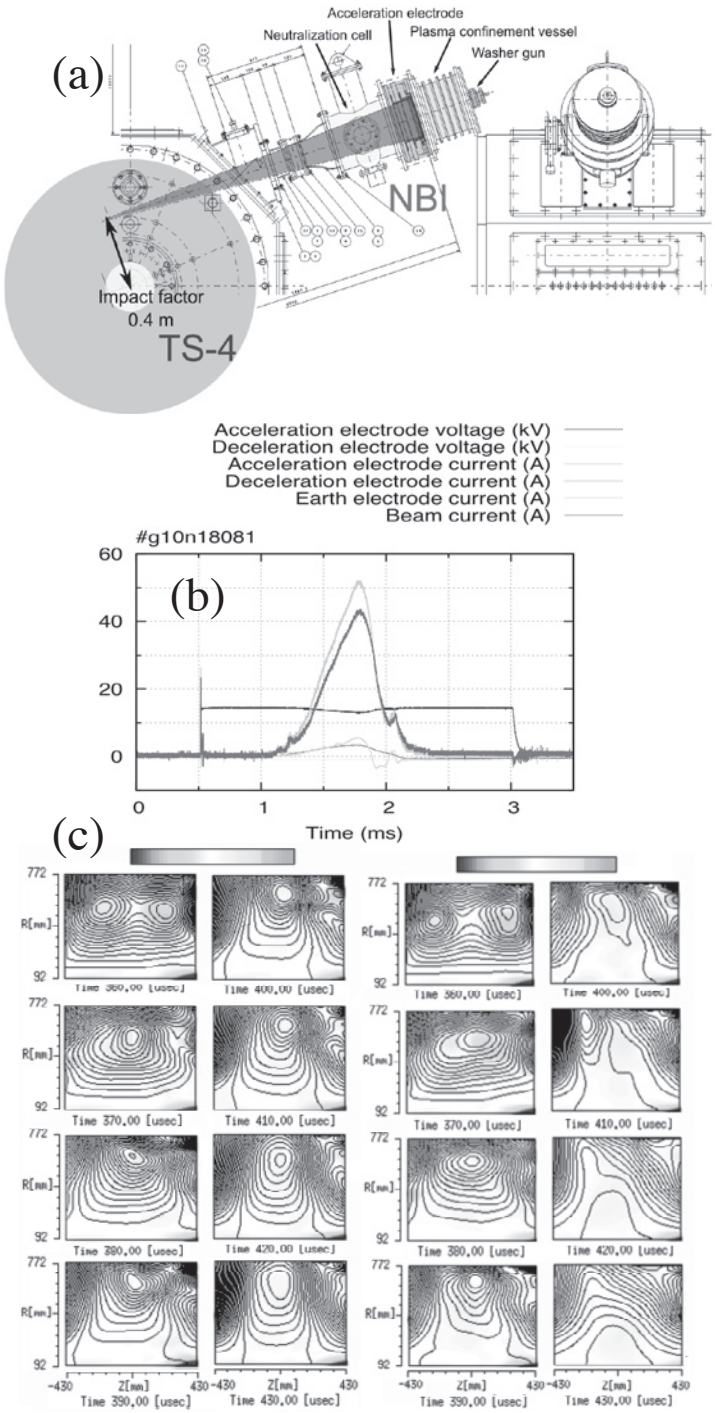

Figure 1(a): Setup of NBI for TS-4 CT/ST Merging Device, (b): Time evolution of electrode voltage and beam current. (c): Evolutions of poloidal flux contours with (left) and without (right) NBI.