§70. Development of Washer-Gun-Type Plasma and Magnetic Helicity Source

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The successful development of high-current neutral beam injector (NBI) was due to the washer gun for its high density plasma production [1]. This washer gun plasma source is also useful for plasma productions in the Asian Three ST collaboration and the All Japan ST program. It is noted that optimizations of the washer gun structure significantly benefits the ST formation and sustainment, especially for (A) efficient plasma source whose ionization rate is much higher than the conventional pre-ionization method and also for (B) efficient magnetic helicity source. Their important keys will be (1) relationship between directions of magnetic field and washer gun alignment, (2) number of washers, (3) polarity and amplitude of bias voltage applied to the gun and (4) control of surface discharges on the washer gun electrondes for maximum plasma production.

In the fiscal year 2013, we constructed a new washer gun with flexible numbers and size of washer, as shown in Fig. 1. Its isolated electrodes allow us to apply the arbitrary bias voltage to them. In the present power supply, the duration time of 1.5-2msec is upper limit for the gun current. We also arranged 1D electron density measurements of electrostatic probe array.

Figure 2 shows the time evolutions of electron densites at five radial positions at z=500mm. Figures 3 show radial profiles of electron densities at z=500mm for its first peak density averaged over 1750-1850 μ s and, (b) the second peak density averaged over 2750- 2850 μ s. The axial magnetic field 200G is uniformly applied parallel to the washer gun discharge current. A new finding is that the electron density is uniform (within 10% error) inside r=90mm and also that it sharply decreases to zero between r=105mm and 150mm. The uniform density area r<90 mm almost agrees with the radius of washer gun electrodes. The more detailed optimization for washer gun plasma source will be made using this flexible setup of washer gun and the 2D electron density diagnostics.

1) T. Ii, Y. Ono et al., "Development of a low-energy and high-current pulsed neutral beam injector with a washer-gun plasma source for high-beta plasma experiment", RSI 83, 083504, (2012).

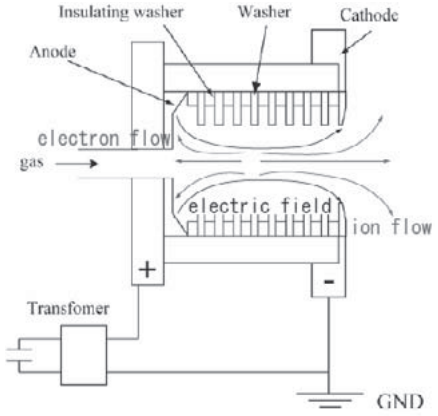

Fig. 1 Ion and electron flows in washer gun

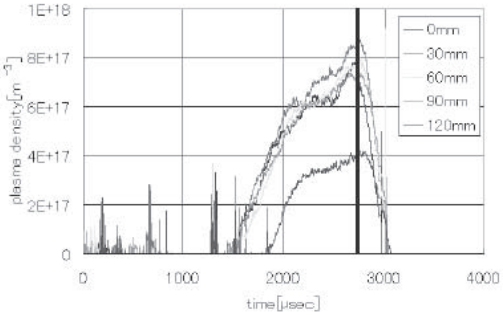

Fig. 2 Time evolutions of electron density at z=500mm in uniform axial magnetic field.

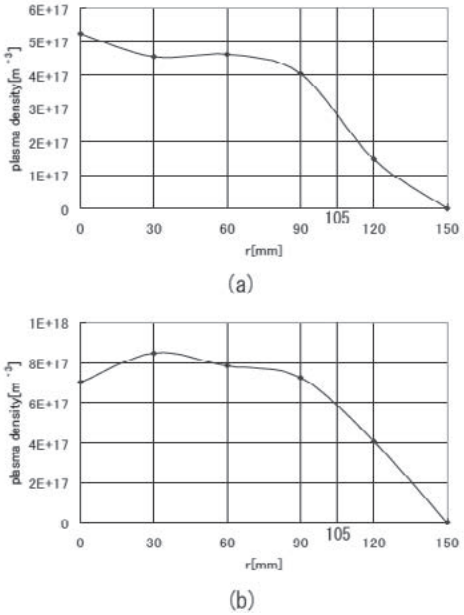

Fig. 3 Radial profiles of electron density at z=500m: (a) the first peak density averaged over 1750-1850μs and, (b) the second peak density averaged over 2750-2850μs.