Formation Process of Non-neutral Plasmas by Multiple Electron Beams on BX-U

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In BX-U, simultaneous confinement of pure lithium ion and electron plasmas has been achieved [1, 2]. Then, the density profile and the parameter dependence of the non-neutral plasma are now extensively measured. The density distribution has been measured in terms of the 2D luminosity distribution by ejecting the plasma along magnetic field $B_0$ onto a phosphor screen [3]. In this study, for the forthcoming experiment of testing two-fluid plasmas on BX-U [1], the relaxation process of multiple electron beams toward a non-neutral plasma is experimentally examined.

An imaging diagnostic system with the handmade phosphor screen and a high-speed camera has been applied to identify the dynamics of electron beams [3]. Figure 1 shows the time evolution of the density distribution of three individual electron beams. The merging process of the three electron beams into a pure electron plasma is clearly observed. By a self-organization process, the pure electron plasma is successfully formed on the machine axis 200 $\mu$s after the electron injection is completed.

Using the diagnostic system, the dependence of number $N_e$ of formed electron plasmas on experimental parameters has been also measured. From a set of obtained images, the radius of the relaxed electron plasma can be estimated to be $\sim 3.3$ mm. Assuming that the plasma is a spheroidal shape, the value of $n_e$ is thus varied in the range between $2.2 \times 10^6$ and $4.4 \times 10^8$ cm$^{-3}$ on BX-U, which satisfies the required value for testing two-fluid plasmas.

Figure 1: Time evolutions of the density distribution of three individual electron beams. The rigid circle in each figure indicates the inner edge of the electrode installed in the vacuum vessel of BX-U.