§11. Extension of the Acceleration Electrode of SPICA

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SPICA (SPheromak Injector using Conical Accelerator) is a compact toroid (CT) injector developed for LHD. During the initial experiments, short acceleration electrode of 0.8 m length has been used to demonstrate the CT formation and acceleration. The former study [1] has pointed out that the acceleration efficiency increases with the inductance of acceleration electrode. In other words, longer acceleration electrode has a possibility to realize the better acceleration efficiency. It has been scheduled to extend the acceleration electrode to longer one after the initial experiment. On Oct. 2001, the reconstruction of SPICA has been started to extend the acceleration electrode, and finished on Feb. 2002. Schematic of SPICA with the extended electrode is drawn in Fig. 1. Length of the outer electrode becomes to 2.6 m, after the reconstruction.

Two-stage acceleration experiment with the extended acceleration has been carried. As a initial results, the line-averaged electron density, $\bar{n}_e$, of 6×10^{21} m^{-3} has been obtained. Typical waveforms are shown in Fig. 2, where the charging voltage of the CT acceleration bank is 10 kV. In this case, the CT velocity, v_{CT}, estimated from the time-of-flight of the magnetic probe signals set on the acceleration electrode, is 54 km/s. Then, the CT length of 0.49 m is obtained from the FWHM of $\bar{n}_e$. This length is about twice of the CT diameter at the measured position (~ 0.2 m). Such a high-density, simultaneously achieving the short CT length, has not been obtained with the short acceleration electrode.

On the other hand, the total particles transferred by the short CT is less than 1×10^{20}, and are not sufficient to fuel LHD plasmas that contain more than 1×10^{21} of particles. Larger density is therefore necessary. The CT magnetic field, B_{CT}, is one of the parameters to be explored ($B_{CT} < 0.1$ T, to date). To transfer the CT for a long distance (more than 5 m is supposed for CT injection on LHD), long lifetime of CT is desired, and it is thought that B_{CT} determines the CT lifetime [1].

The optimization of the gas puffing, trigger timings of the power sources, the strength of the bias magnetic field, will be carried out to accomplish the requirement for CT injection experiment on LHD.

Reference

1) Miyazawa, J. et al., Fusion Eng. Des. **54** (2001) 1 – 12.

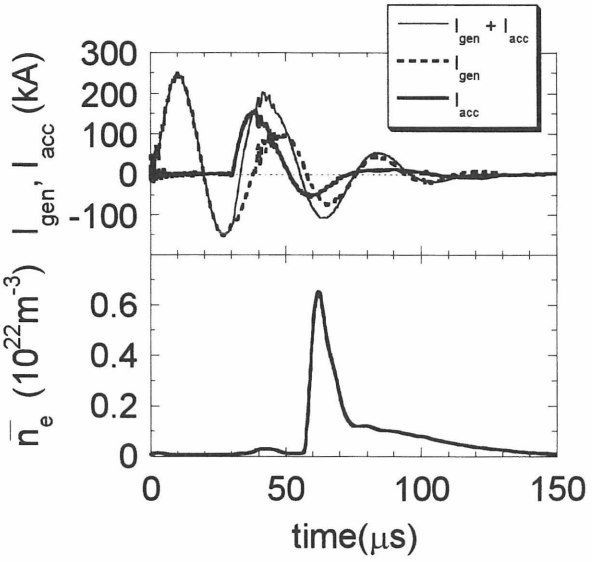

Fig. 2. Typical waveforms obtained with the extended acceleration electrode. Shown on the top are the CT generation current, I_{gen}, CT acceleration current, I_{acc}, and the total current $I_{gen} + I_{acc}$. Line –averaged density is shown in the bottom figure.

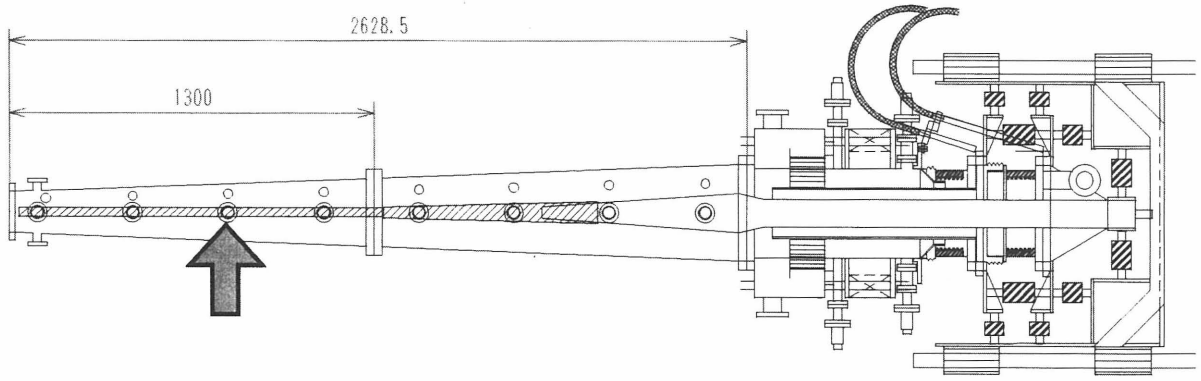

Fig. 1. Schematic view of SPICA after extension of the acceleration electrode. Extended inner acceleration electrode is hatched. Gray Arrow indicates the position where $\bar{n}_e$ shown in Fig. 2 is measured.