§6. Initial Results of TWDEC Experiments in GAMMA 10 Tandem Mirror

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Traveling wave direct energy converter (TWDEC) was originally proposed as a device for energy recovery from high energy protons produced by D-^{3}He fusion. The principle of TWDEC is an inverse process of a linear accelerator, so it is desirable that the objective particle beam is monochromatic. In the case of the beam of fusion produced high energy protons, thermal energy spread is not negligible, thus the conversion efficiency will degrade.

The authors proposed improved structures of TWDEC for a beam with energy spread. One is a fan type[1)] in which orbits of particles are separated according to their energy, and the shape of electrodes is modified to be a fan suitable for separated orbits. The other is a bias type[2)] which is for a beam with wider energy spread, such as an end-loss flux of thermal ions from a tandem mirror.

A bias type TWDEC applicable to the end-loss flux of GAMMA 10 was designed[3)], the schematic diagram of which is shown in Fig. 1. All electrodes except the top and bottom ones are negatively biased, so the inside of this TWDEC is in negative potential where injected ions are accelerated and electrons are eliminated. TWDEC works for this accelerated ions, so the purpose of the device is not energy recovery, but examination of properties of TWDEC for a beam with wide energy spread.

The device was constructed and installed at the end of GAMMA 10. In the present system, the ELA in TWDEC is not negatively biased as an initial experiment. Figure 2 shows time evolution of the collector current of ELA in TWDEC (I_C) together with diamagnetic loop and line density signals. With an application of DEC RF (110–130 ms), the ELA signal increases.

Energy analysis of I_C was performed with varying phase difference of RFs between the modulator and the decelerator ($\Delta\phi$ in Fig. 1). The collector current versus the ion repeller voltage V_{IR} is illustrated in Fig. 3. It is found that the variation of I_C due to DEC RF application is different according to V_{IR} and $\Delta\phi$. The ions seem to be influenced by the applied RF fields. In the next stage, the negative bias is also applied to ELA, and energy recovery will be evaluated.

1) Y. Yasaka, et al.: Nuclear Fusion **49** (2009) 075009.
2) D. Omoya, et al.: Proc. 7th Int. Conf. Open magnetic system for plasma confinement, P13 (2008).
3) Takeno, H., et al.: Ann. Rep. NIFS(2007-2008) 492.

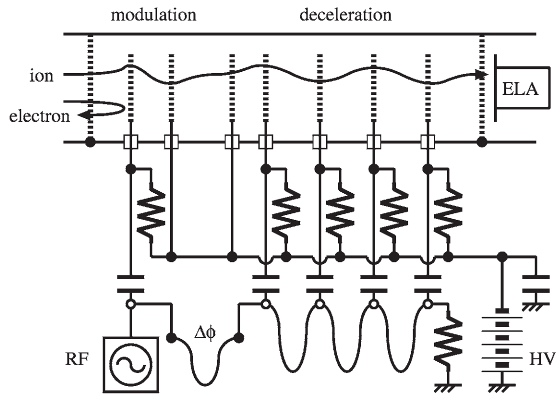

Fig. 1: Experimental arrangement.

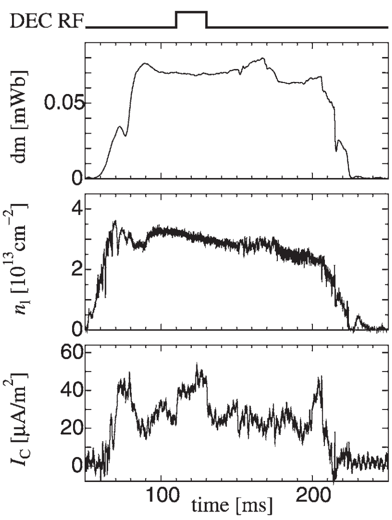

Fig. 2: Time evolution of signals of diamagnetic loop, line density, and ELA.

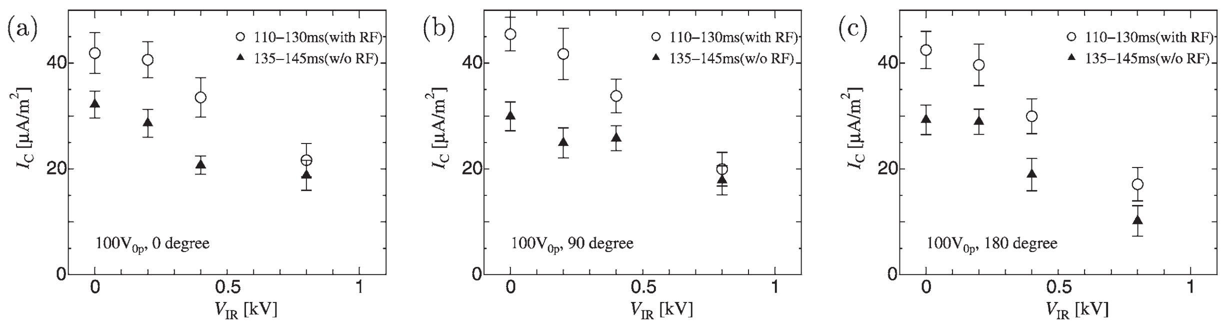

Fig. 3: Collector current of ELA versus ion repeller voltage for $\Delta\phi$ = (a) 0, (b) 90 degree, and (c) 180 degree.