§2. Full Bias Experiments of Bias-type TWDEC on GAMMA 10

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Traveling wave direct energy converter (TWDEC) is a promising device for efficient energy recovery from high energy protons produced by D-^{3}He fusion. In order to study an influence of energy broadening to TWDEC, which was inefficient in the present, an experimental project of TWDEC on GAMMA 10 was planned. The bias-type TWDEC was proposed for this purpose[1], in which all electrodes of TWDEC were negatively DC-biased. Ions with an appropriate energy broadening flowing into a bias-type TWDEC are accelerated, thus the relative broadening can be controlled by adjusting the negative bias voltage.

In the initial experiment, measurement system (Faraday cup; FCP) was grounded[2]. In this report, full bias experiments are treated, in which the whole system including the FCP is biased with the same voltage (V_b), as the experimental arrangement is illustrated in Fig. 1. The RF system is also improved that RF power sources for modulator and decelerator are controlled independently, and RF amplitudes and relative phase difference ($\Delta\phi$) can be adjusted.

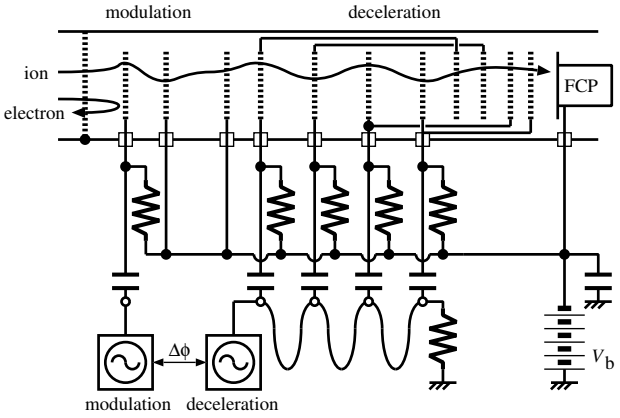

Fig. 1: Experimental arrangement.

The effect of negative bias was confirmed at first. Figure 2 shows approximate ion repeller voltage (V_IR) - collector current (I_C) characteristics of FCP for several bias voltages, which were 6th order polynomials fitted to moving averaged measured data. The currents in the figure are normalized by the value on $V_\mathrm{IR} = 0.1\,\mathrm{kV}$. According to the figure, horizontal shift of curves with almost the same amount of $|V_\mathrm{b}|$ can be found. Energy shift due to the negative bias is surely working.

The deceleration experiments are followed. Figure 3 shows approximate energy distribution functions, which were derived from approximate V_IR-I_C characteristics mentioned above. In the figure, dotted and solid curves are before and after RF application, respectively. Here, (a)∼(d) corresponds to variation of $\Delta\phi$ indicated in the figure. According to the figure, significant change due to RF application can be found on $\Delta\phi = \pi$ and $3\pi/2$. For these cases, the energy distribution is shifted to the lower energy side, that means ions are decelerated.

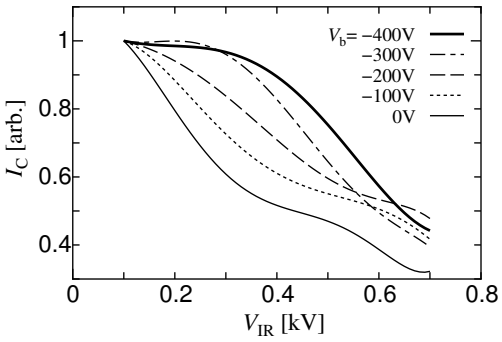

Fig. 2: Approximate ion repeller voltage (V_IR) - collector current (I_C) characteristics of FCP for several bias voltages.

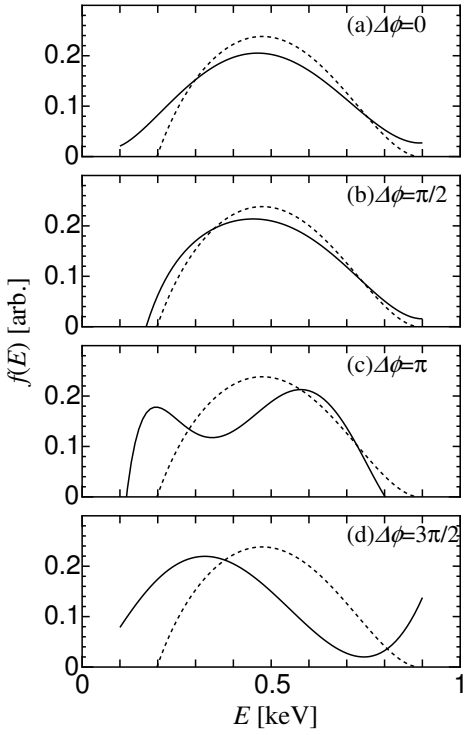

Fig. 3: Approximate energy distribution functions before (dotted) and after (solid) RF application.

The deceleration of end-loss ions of GAMMA 10 by bias-type TWDEC was confirmed.

1) D. Omoya, et al.: Trans. Fusion Sci. Tech. **55**(2009) 114.

2) Takeno, H., et al.: Ann. Rep. NIFS(2008-2009) 473.