§7. Design of Bias-type TWDEC for an Application of End-loss Flux of GAMMA 10 Tandem Mirror

Takeno, H., Yasaka, Y. (Kobe Univ.),
Tomita, Y.,
Ishikawa, M., Nakashima, Y. (Univ. Tsukuba)

The authors have been studying direct energy conversion scheme applicable to fusion produced charged particles, in which the main devices are CUSPDEC and TWDEC. CUSPDEC is for particle discrimination and energy conversion for thermal ions, and TWDEC is for energy conversion for fast protons produced in D-^{3}He fusion. The authors performed experiments of direct energy conversion from end-loss flux of GAMMA 10 tandem mirror by using a small-scale CUSPDEC device[1]. A demonstration of direct energy conversion on a fusion experimental device was achieved.

As for TWDEC, simulation experiments have been performed by using a small-scale simulator[2], but any demonstrations in a fusion experimental device have not achieved yet. The application of TWDEC to end-loss flux of GAMMA 10 tandem mirror is discussed in this report. In general, TWDEC cannot achieve high efficiency for an ion flux with wide energy band, but the detail has not been studied yet. The end-loss flux of GAMMA 10 has a wide energy band, so the application of TWDEC to GAMMA 10 also has a purpose of studies for a wide energy band flux.

The authors propose a bias-type TWDEC for this purpose. Figure 1 shows schematic diagram of a bias-type TWDEC for GAMMA 10. It was designed with considering various kinds of limitations. There are two modulator electrodes and four decelerator electrodes. Negative DC voltage V_n is supplied to all electrodes except earth electrodes. The electron flux flowing in the system is repelled by this negative potential. The ions are accelerated by this negative potential, so the averaged energy of ions increases, and it means relative broadness of energy spread is reduced which is controlled by V_n.

For an estimation of energy recovery, orbit calculation was performed[3]. The conditions of incident ion flux were settled by referring measured values: the typical values of averaged energy and FWHM of ions in the end-loss flux of GAMMA 10 were 0.42 keV and 0.36 keV, respectively. Figure 2 shows a contour plot of energy recovery to modulation and deceleration voltages (V_mod and V_dec). This is the case of $V_\mathrm{n} = 0$, and expected efficiency is less than 0.2 %. On one hand, in the case of $V_\mathrm{n} = -2$ kV of Fig. 3, the maximum energy recovery is expected about 4%. It is not necessarily large, but the release of limitation, such as the length of decelerator, might be enhance the efficiency. The study is continuing to perform the experiments on GAMMA 10.

The authors acknowledge cooperations with Dr. M. Hirata and Prof. T. Cho. of University of Tsukuba.

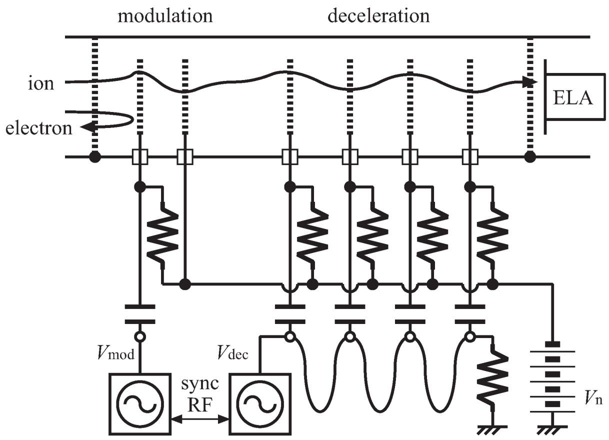

Fig. 1. Schematic diagram of a bias-type TWDEC.

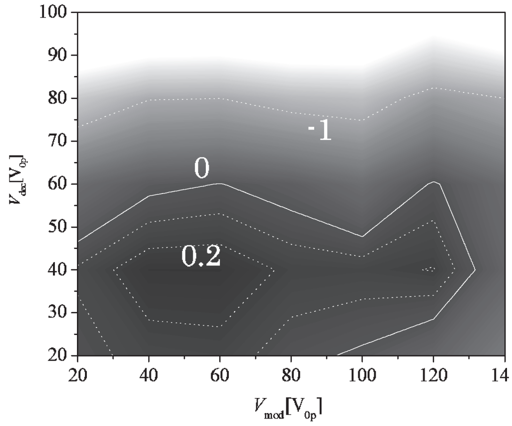

Fig. 2. Calculated Deceleration Efficiency with $V_\mathrm{n} = 0$.

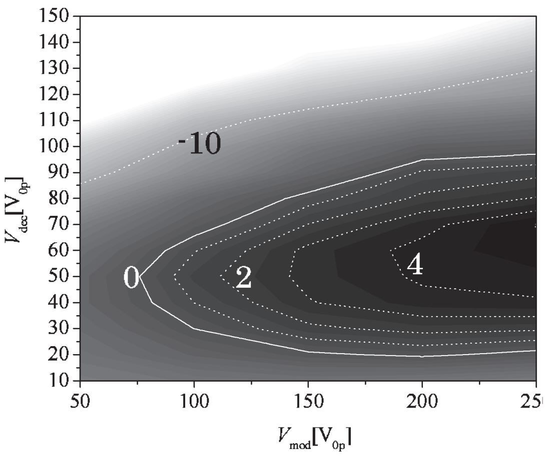

Fig. 3. Calculated Deceleration Efficiency with $V_\mathrm{n} = -2$ kV.

1) Y. Yasaka, *et al.*: Nucl. Fusion **48** (2008) 035015.
2) Takeno, H., *et al.*: Ann. Rep. NIFS (2005-2006) 212.
3) H. Takeno, *et al.*: Jap. J. Applied Phys. **39**(9A) (2000) 5287.