§5. Suppression of Harmonic Frequencies of Induced Voltages in a Decelerator of a TWDEC Simulator

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Efficient energy recovery of fast protons of 14.7 MeV is one of the key issues to realize a D–^{3}He fusion power plant. As the energy of the fast protons is too high, use of a traveling wave direct energy converter(TWDEC) is necessary. In a TWDEC, a fast proton beam is velocity-modulated by RF, which becomes a density modulated beam in the downstream. The beam induces traveling wave in a transmission circuit, and fields created by the wave decelerate the beam.

We are studying desirable structure of TWDEC experimentally. We had performed proof of principle experiments of TWDEC, and investigated beam deceleration characteristics. We also try to enhance deceleration fields induced by an ion beam by improvement of a transmission circuit. We introduced a loop type transmission circuit, and succeeded in enhancement of deceleration field[1]. However, because of the problem of inductive elements in the circuit, the third harmonic frequency with large amplitude is observed. This is not desirable for operation of TWDEC, and we present improved experiments in this paper.

Schematic diagram of our experimental equipments is shown in Fig. 1(a). Helium plasma is created by helicon wave plasma production in the ion source. Helium ion beam, velocity-modulated by 7 MHz, is introduced in the decelerator. The electrodes in the decelerator are connected to a transmission circuit, the detail of which is shown in Fig. 1(b). In the last experiments, inductors L in the circuit were made of coaxial cables with a shorted end[1]. This method is simulating with coaxial tubes used in a practical TWDEC. The impedance of this element has a non-linear characteristic to frequency. Not only the existence of harmonic components in a modulated beam, but also this nonlinear characteristic might be the cause of an appearance of the third harmonic frequency. In this study, those elements are modified to usual loop-wire type ones with employing ferrite cores although it is difficult to apply them to a practical TWDEC.

After the modification of inductor elements and test operations by using oscillators as in the last time[1], we apply the new circuit to the TWDEC simulator. Fig. 2 shows an example of spectra of induced voltage in the transmission circuit. Solid and dashed curves indicate voltages on the terminals connected to D_1 and D_3(Fig. 1(a)), respectively. As shown in the figure, the third harmonic frequency is well suppressed in this time. However, it is found that 56 and 63 MHz components have large intensities, which correspond to eighth and ninth harmonic frequencies, respectively. These components are considered to be induced by inductive components of electrode-circuit lines and their stray capacities to the ground. We are planning some measures to reduce those effects.

Reference
1) Takeno, H., *et al.*: Ann. Rep. NIFS(2002-2003) 361.

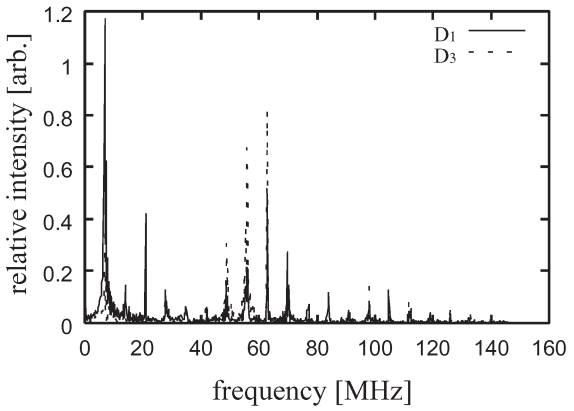

Fig. 2 An example of spectra of induced voltage in the transmission circuit.

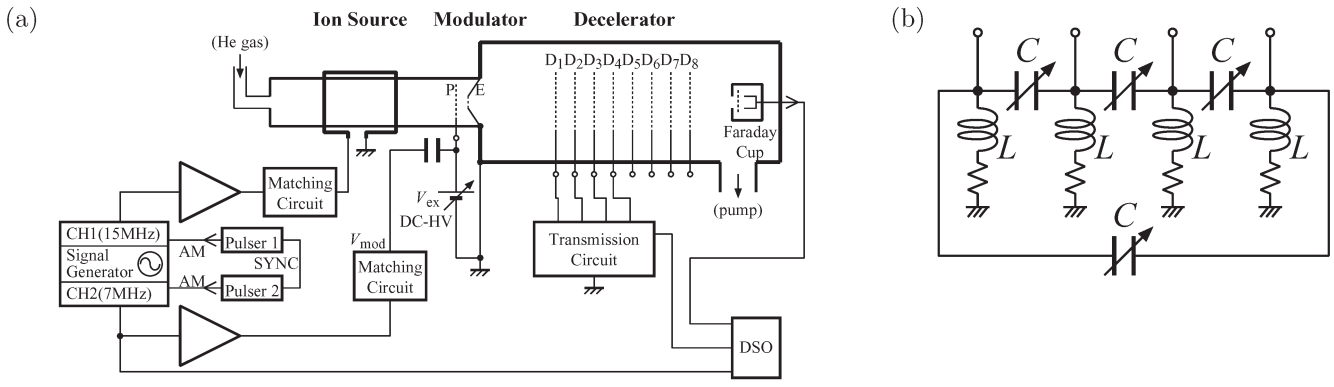

Fig. 1 (a) Schematic diagram of the TWDEC simulator, and (b) the transmission circuit.