A HEAVY ION LINAC USING A DEFORMED COAXIAL CAVITY

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The characteristic of a coaxial cavity in transmitting and storing the RF power has been well known and its TEM-mode has been fully understood. The aim of the present study is to construct an economical heavy ion LINAC operated at a fixed frequency using the $\lambda/2$ coaxial cavity, instead of the usual $\lambda/4$ type.

As shown in Fig. 1, the original cavity (a) has the induced radial electric field having a sine form. If we put drift tubes onto the respective inner walls (b), the axial electric fields are produced between the tubes, by which the successive acceleration for charged particles would be achieved. In order to economize the cavity length, we bent the inner axis (c) and use only the part of stonger field. With such a perturbation, the resonant frequency becomes considerably lower than the original one, but the acceleration principle still holds.

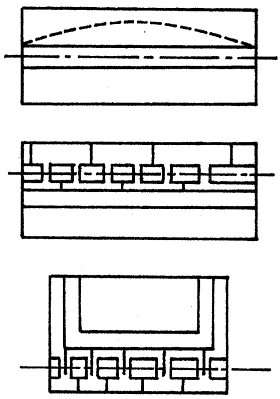

Fig. 1. Principle of a deformed coaxial cavity for LINAC.

The test cavity made was a stainless steel tank with 500 mm in diameter and 750 mm in length, and the inner wall was polished after metalizing with oxygen-free copper. The inner axis was an arch-type made of copper plates, on which the drift tubes ($1/2\cdot\beta\lambda$ length) were aligned. On the inner wall of the cavity, the earth-side drift tubes ($3/2\cdot\beta\lambda$ and $1/2\cdot\beta\lambda$ length) were placed, in the $3/2\cdot\beta\lambda$ tubes electrostatic Q-lens being set. The drift tubes were (3, 1, 1, 1, 3, 1, 1, 1, 3, 1, 1, 1, 3, 1, 1, 1, 3 in unit of $1/2\cdot\beta\lambda$) arrangement, thus having 16 gaps.

As illustrated in Fig. 2, N^+ ions of around 1.7 MeV in energy were extracted from a 4 MV Van de Graaff machine of Kyoto University. With the use of a charge stripper, N^{q+} (q = 2, 3, 4, ···) ions of the same energy were produced, and after a magnetic deflection and focusing, the N^{4+} ions were injected into the cavity. At the exit of the cavity, a thin gold target was placed and the coulomb-scattered ions were detected by a solid state detector (SSD).

When 1.85 MeV N^{4+} ions were injected into the LINAC excited by the RF power of about 3 kW at the frequency of 100.0 MHz, a 3.3 MeV peak was observed on an energy spectrum of the scattered ions. The Q-lens potentials up to ±5 kV were appropriately imposed. The spectrum indicates that N^{4+} ions were successively accelerated when passing through the LINAC gaps. The typical result in comparison with the design is presented in the table.

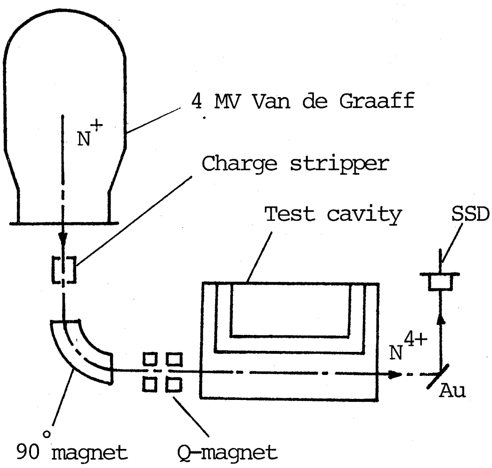

Fig. 2. Experimental arrangement.

Table. Result of heavy ion acceleration with a deformed coaxial cavity operated at 100.0 MHz.

	Injection energy (MeV)	Exit energy (MeV)	RF power (kW)	Shunt impedance (MΩ/m)
Calculated	1.7	3.2	~2.3	≳150
Observed	1.85	3.3	~3	~100

Reference

M. Sakisaka, F. Fukuzawa, M. Tomita, K. Yoshida, K. Norisawa and S. Okumura: Report on Heavy Ion Science, Scientific Research Expenditure, May 1977.