OPERATION OF SPLIT COAXIAL RFQ

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SUMMARY

A split-coaxial RFQ accelerating structure for protons has been investigated. A cavity in which dc beam from an ion source is bunched was constructed. The diameter of the cavity is 107 mm and the length is 360 mm. Four modulated copper rods of 15 mm diameter are placed parallel to the cavity axis. Two of the rods are terminated to one of the end plates of the cavity, and the other two are terminated to the other end plate. Operating frequency of the cavity is 88.6 MHz. RF power test and beam test are going on.

INTRODUCTION

The general features of the split-coaxial RFQ are, 1) a stable rf mode of lowest frequency, 2) flat quadrupole field along a cavity axis, 3) relatively high Q value and good shunt impedance, 4) simple mechanical structure and easy fabrecation. The first split-coaxial RFQ structure was studied at Frankfurt University[1] and the structures for heavy ion acceleration have been developed at GSI[2]. We have been studying the split coaxial RFQ of simple mechanical structure for development of economical low-energy accelerators[3)4)]. Experiments about bunching and acceleration of particles are compared with PARMTEQ calculations which are excuted using assumed parameters.

MECHANICAL DESIGN

Designed parameters of split coaxial RFQ are shown in Table 1 and the RFQ cavity is shown in Fig. 1. All of the cavity was made of copper and was assembled by soldering. Rods were modulated by milling machine as shown in Fig. 2, and a hole was bored at the axis of rod. The hole formed the circuit of cooling water. Quadrupole field generated by such simple modulation contains many higher harmonies components[5)], and precise beam dynamical calculations are difficult. So experimental results are compared with PARMTEQ calculations excuted about proton motion in ideal field derived from Kapchinskij theory.

At entrance into the cavity protons accept strong longitudinal rf field from the open ends of two rods and also at exit. These field give serious effects on particle motion in the case of small modutation like bumching section. In optimum shape of the open end of the rod will be determined by experiments.

EXPERIMENTS

A cusp field type ion source was constracted. A few mA of $H^+ + H_2^+ + H_3^+$ ion beam are obserbed. The proton ratio was about 30%, normalized emittance of the beam is 0.04π cm. mrad. Extracted beam from the ion source are focused on the entrance hole of the RFQ by an einzel lens. The rf power is supplied to the cavity by a power amplifier system. The final power tube is Eimac 4CW 2000 tetrode. Rf power of 1 kw is obtained at present stage, but it will be increased to 10 kw by replaceing 4CW 2000 to 4CW 25000. The rf power is fed to the cavity through coaxial cable by a movable capacitive coupler.

Vacuum environment is provided by a 500 l/s oil diffusion pump and 5×10^{-6} torr is obserbed at the cavity. The energy of the beam ejected from the RFQ cavity is analyzed by a magnet, and bunching of the beam is obserbed by a sampl-

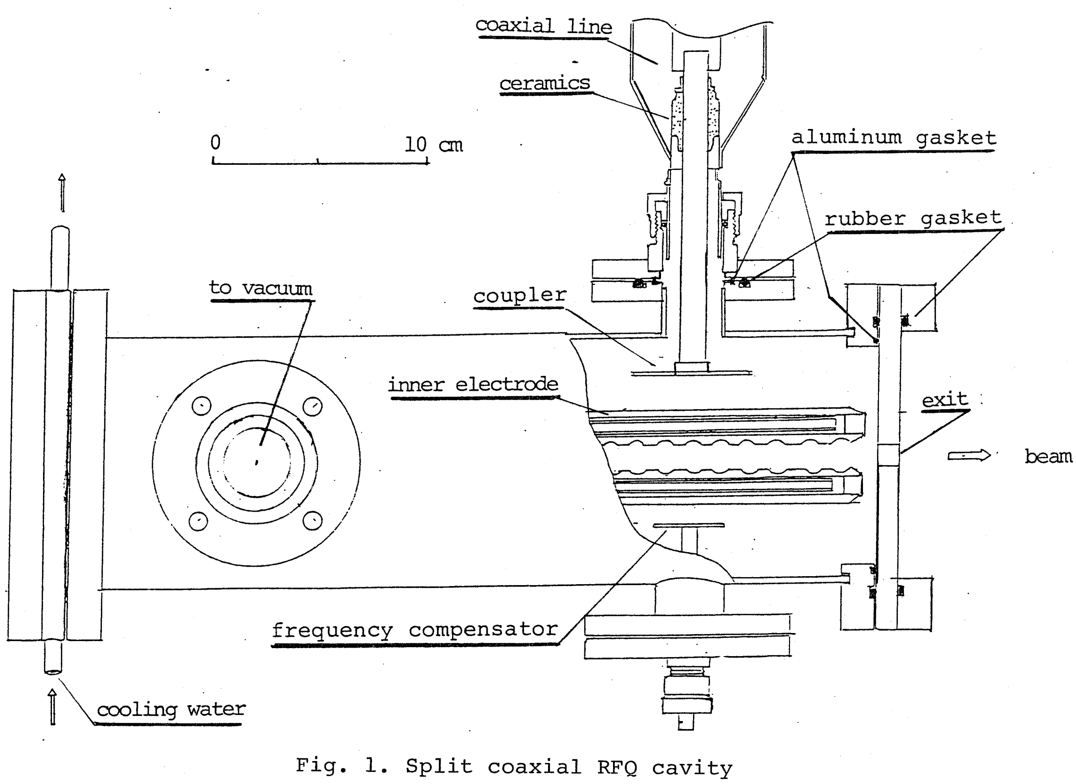

Fig. 1. Split coaxial RFQ cavity

ing oscilloscope and a spectra analyzer. Rf power test are going on and at prelimimary beam test enhancement of proton beam are obserbed at the exit of the cavity when rf was swiched on the cavity.

Table 1

RFQ disign parameters

injection	5.5 keV proton
frequency	88.6 MHz
cavity	R = 53.5 mm, l = 362 mm
internal electrode	r = 7.5 mm, l = 355 mm
number of cells	60
minimum aperture size	d = 12 mm
interelectrode voltage	20 kV
cynchronous phase	-90° → -30°
final energy	7.3 kV

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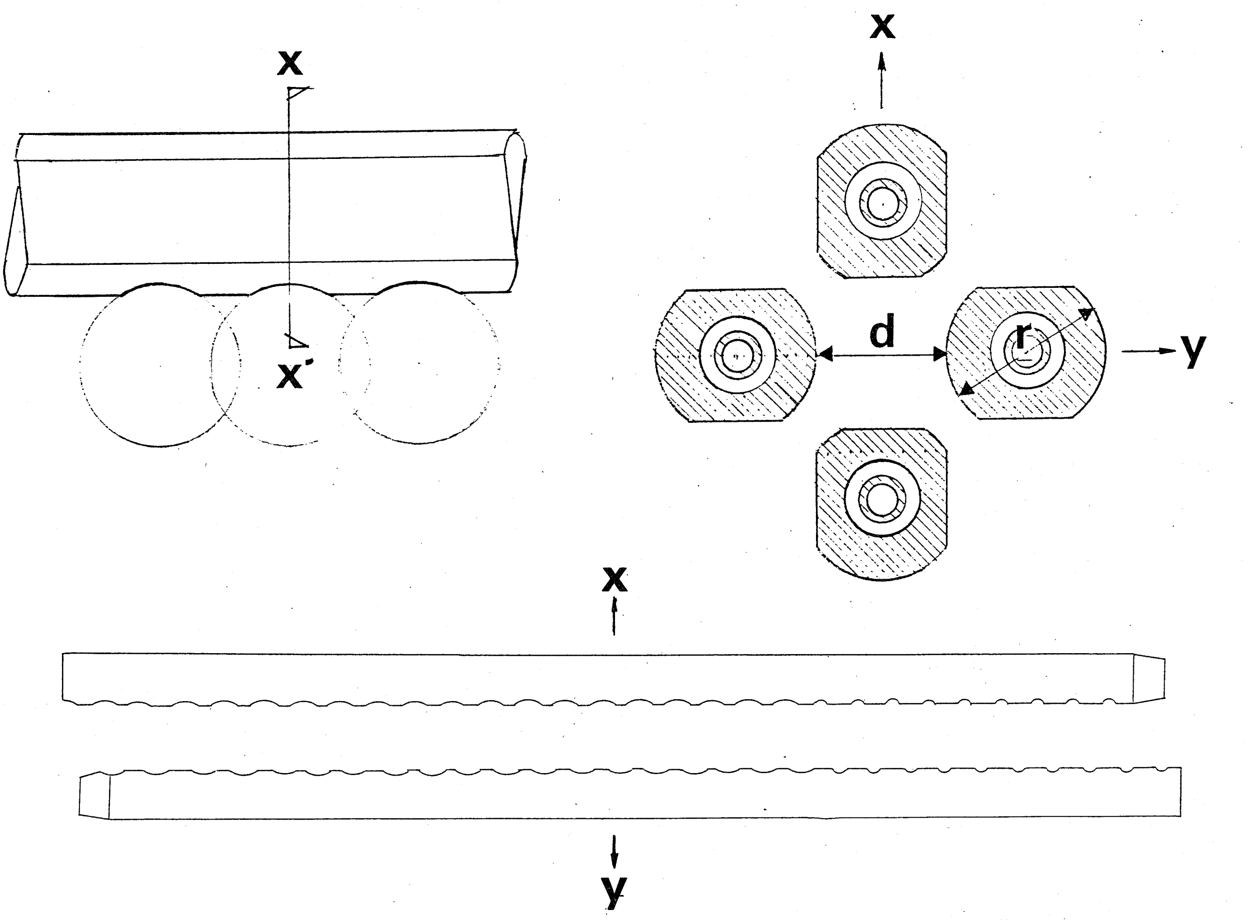

Fig. 2. Modulion of inner electrodes