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DEVELOPMENT OF IHQ TYPE LINAC
2 MeV Proton Prototype Linac

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ABSTRACT

Characteristics of an interdigital-H type linac structure with focusing finger electrodes (IHQ) are studied. A prototype IHQ linac is designed to accelerate protons from 0.8 to 2.0 MeV and is under construction (ref. 1,2,3).

INTRODUCTION

In this structure design, the RF field is used for focusing of ions as well as for acceleration.
The recent success of RFQ linacs which use the RF electric field not only for acceleration but also for focusing has solved most problems associated with the acceleration of intense low velocity ions (ref. 4).

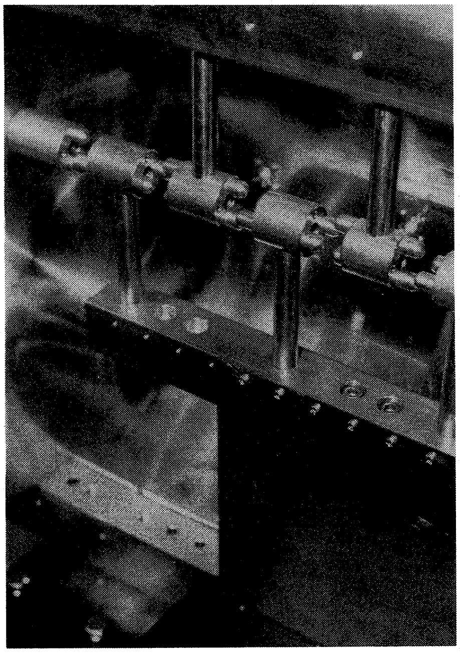

Fig. 1 1/2 scal IHQ model resonator

On the oter hand, the idea of spatially uniform acceleration and focusing scheme of Kapchinsky and Teplyakov (ref. 5) who have proposed the basic idea of RFQ linac is known to be applicable only to the low energy region of 2 MeV or less, because of its low effective shunt impedance. Boussard (ref. 6) tried an RF accelration and focusing by attaching circular fingers to the face of drift tubes. A similar configuration was proposed by R.W. Müller for his split coaxial structure (ref. 7).

We have begun to study an interdigital-H type linac structure with Boussard's electrode configuration as shown in Fig. 1 . The IH type structure is well known for its high shunt impedance (ref.8) at low and medium particle velocity. This type linac has a high effective shunt impedance and is applicable to the medium energy region.

BASIC MODEL EXPERIMENTS

A magnetic analogue of one acceleration cell as well as RF models have been constructed to study accelerating and focusing. In our structure, the electro magnetic field is expected to have complicated form. A detailed study of the behavior of the field components (as a function of the radial, azimuthal and longitudinal coordinates) is necessary. When we use RF models, it is difficult to separate the field into three dimensional components.

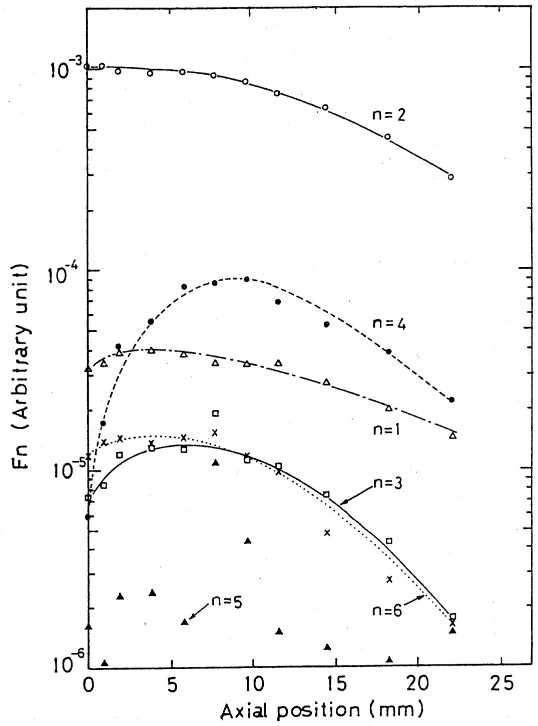

Fig.2 Relation between the amplitude of mulipole field components and axial position

The magnetic analogue model provides a better solution. The multipole and gap field distribution have been measured by using a Hall probe and a rotating coil. The amplitude of multipole components are shown in Fig.2. The multipole components higher than quadrupole are smaller than sevelal % of the quadrupole component. Results of the basic RF model and the magnetic analogue model measurements were used for the numerical calculation of beam orbit.
The magnetic analogue model and the magnetic field measurement system of the rotating coil are shown in Fig.3.

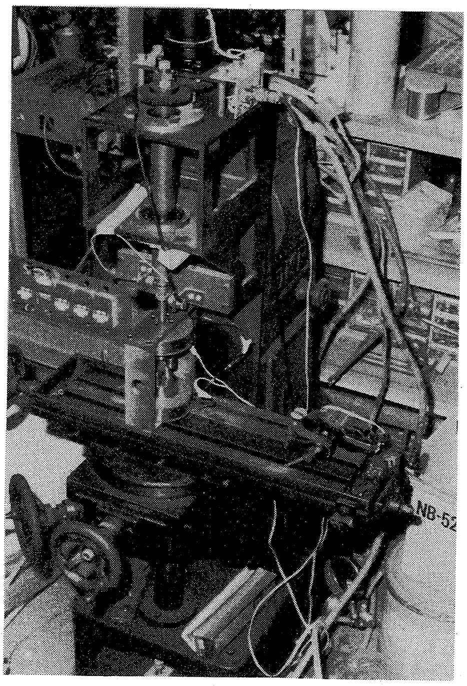

Fig.3 The magnetic analogue model and the magnetic field measurement system of the rotating coil

2 MeV PROTOTYPE LINAC

Based on successfull results of the low level RF measurements and the numerical calculation of beam orbit, a prototype IHQ linac is constructed to demonstrate the operational capabilities of the new structure. For the design work of the cavity, 1/2 scale model resonator was made of brass. The resonance frequency and the field distribution were checked by measurements on the model in term of the end cut of the ridge. The field distribution of the new structure (1/2 scal model) is shown in Fig.4.

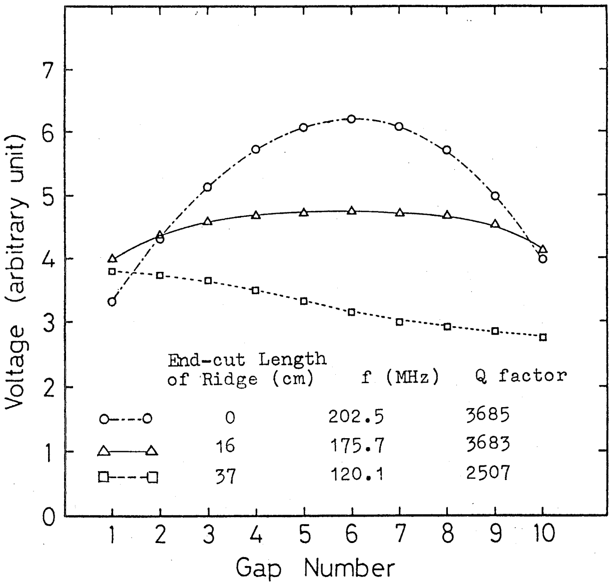

Fig.4 Field distribution of 1/2 scal IHQ model cavity

The particle trajectory was analyzed by mean of a modified computer programe LINOR (ref.9), where the most important input data were obtained from the model experiments. Calculated results of the phase, energy and radial profiles are shown in Fig.6.

Table

Parameters of Prototype IHQ Linac

Acceleration Particle	Proton
Energy Input	0.8 MeV
Output	2.0 MeV
Operation Frequency	101 MHz
Synchronous Phase	- 30°
RF Power	16 kW
Number of Cell	10
Focusing Sequence	FD
Element	RFQ with Finger
Drift Tube Bore Diameter	16 mm
Outer Diameter	48 mm
Stem Diameter	24 mm
Gap Distance	40 mm
Voltage	145 kV
Tank Inner Diameter	54 cm
Length	92 cm
Ridge Width	6.4 cm
Length	72 cm
Height	27 cm
Vacuum System	520 l/s TMP

The main parameters of the prototype IHQ linac are summarized in Table. The linac is designed to accelerate protons from 0.8 to 2.0 MeV with an operating frequency of 101.3 MHz. The geometrical dimension of the linac tank is 54 cm in inner diameter and 92 cm in length.

A photograph of fabricating center plate of the cavity is shown in Fig.5. Figure 7 shows fabricated prototype IHQ linac.

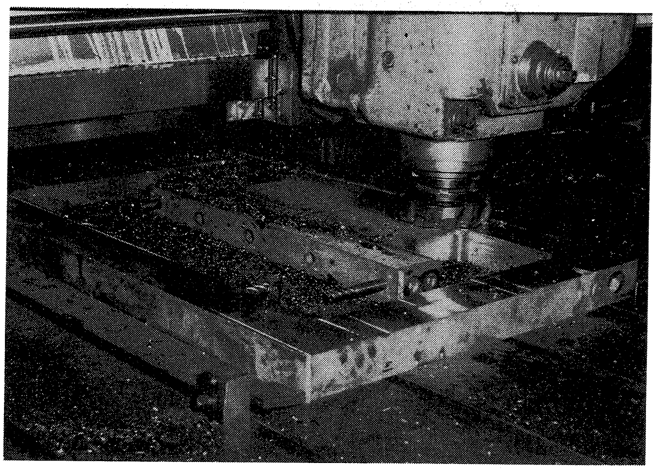

Fig.5 Photograph of the center plate maching operation

ACCELERATION TEST STAND (ref. 10)

Figure 8 shows the layout of the beam acceleration test stand at INS. The injector is the RFQ linac " TALL " (ref.11) which has capability accelerating up to 0.8 MeV/u. The accelerated protons up to 2 MeV are analized with an analyzer magnet having a bending angle of 90° and a momentum dispersion of 160 cm. Slit systems, multiwire profile monitors and Faraday cups are placed at the object and image points of the magnet (ref.12).

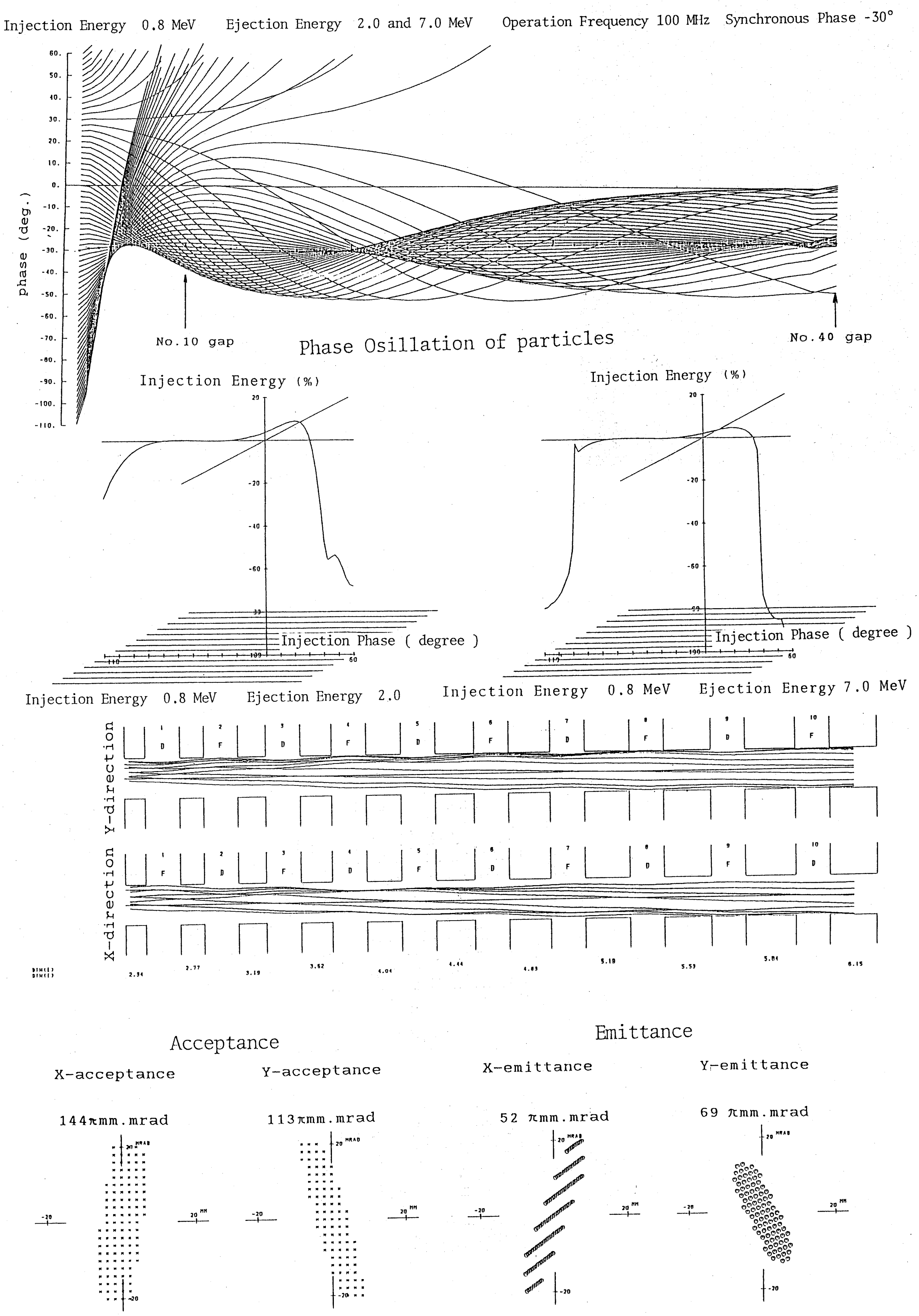

Fig.6 Phase, Energy and Radial Profiles of IHQ Linac

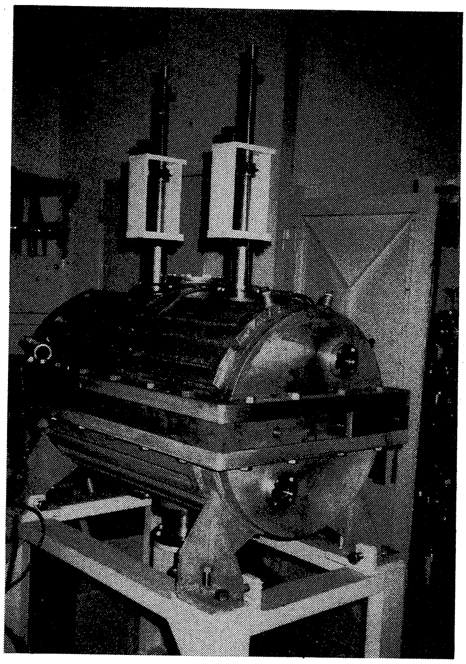

Fig.7 Photograph of fabricated 2 MeV IHQ Linac

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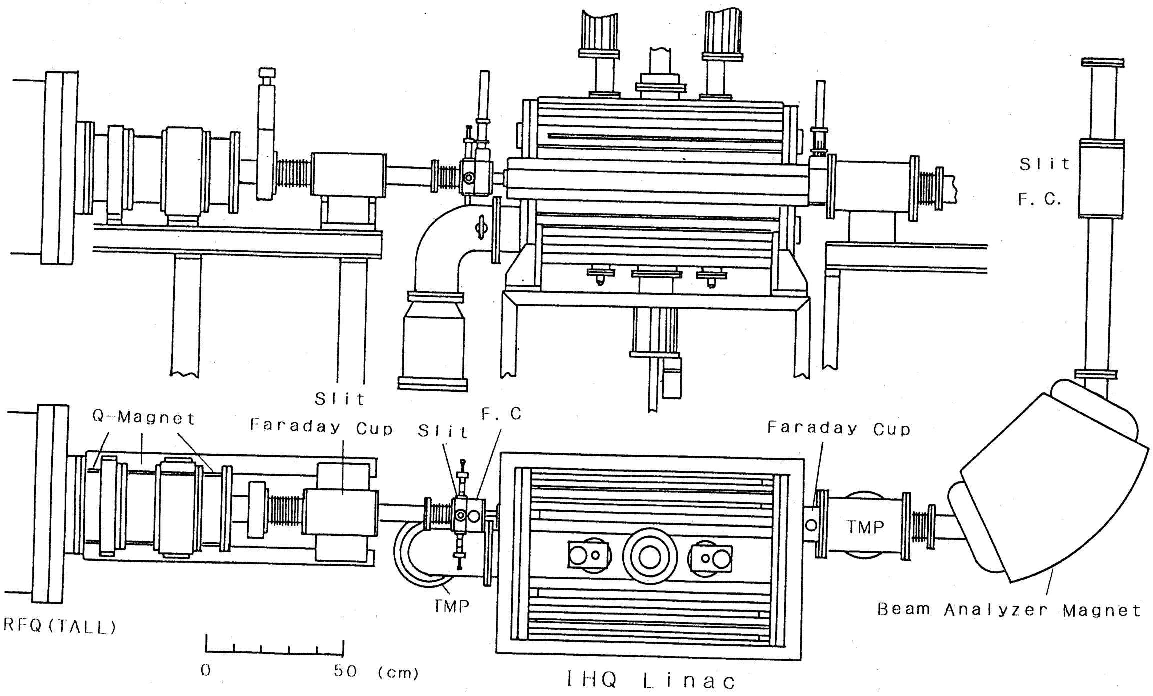

Fig.8 Layout of the beam acceleration test stand