7MeV-PROTON LINAC AT ICR

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Abstract

The construction of 7MeV-433MHz proton linac was started at 1986. The accelerator was installed in a new building at Uji campus of Kyoto University in 1988 and is under testing.

Introduction

The new accelerator is constructed at new Accelerator Laboratory building of Institute for Chemical research (ICR) in Uji campus of Kyoto University. It consists of 2 MeV-RFQ linac and 7 MeV-Alvarez DTL. The main specification is shown in Table 1. The operating frequency is 433.3 MHz throughout the system. The frequency is about twice higher than conventional systems and the size is about a half of them. klystrons are available at that frequency. Because the cost performance problem of higher energy part is important for a long high energy linear accelerators, the higher energy part will be operated at 1.3 GHz. 433.3 MHz is one third of the frequency. For simultaneous acceleration of positive and negative ion, the denominator is odd number.

The space of new accelerator building is 2650 m^2 total, and the 1 meter thickness shielded area is 600 m^2. The compactness of the accelerator tube makes a space for a future accelerator test stand.(Fig.1,2)

Injector

A multicusp-field ion source.is used to produce 50 kV H+ ion. The arc voltage of the ion source is switched for pulsed operation of up to 10% dutycycle. The designed peak beam current is 60 mA. There is an einzel-lens and a profile monitor after the 50 kV accelerator column. For the future simultaneous acceleration of positive and negative ion, the LEBT (Low Energy Beam Transport) has a 45 degree mixing magnet. After the mixing magnet, a solenoidal focus coil is used to match the beam into the RFQ.

Ion source	
multicusp field type	
proton 50 keV	
Accelerating structure	
four vane RFQ	50 keV ~ 2 MeV
vane length	2195 mm
cavity inner diameter	170 mm
characteristic radius	3 mm
min. bore radius	2 mm
intervane voltage	80 kV
transmission efficiency	95% (at 30 mA)
DTL (Alvarez)	2 MeV ~ 7 MeV
cavity length	1868 mm
number of drift tubes	28
focusing Q magnet	NdB iron permanent magnet
RF power source	
frequency	433.3 MHz
peak power (for each tube)	1 MW
repetition rate	≤180 Hz
duty factor	1%
klystron	Litton L-5773

Table 1

Accelerator

RFQ

The 4-vane RFQ is operated at the frequency of 433.3 MHz. (Fig. 3) The vane tips are cut by concave cutter and have constant cross section along the axis direction. [1,2] Each vane has a 20 mm diameter cooling channel in it. For field distribution tuning, 6-plug-tuners are installed in each quadrant. The designed intervane voltage is 80 kV. RF power is generated by 1.25MW-peak-power klystron L-5773 through WR-2100 waveguide, and coupled by a loop into the RFQ cavity after a waveguide-to-coaxial line transition. A 270 litter-turbo molecular pump is installed at the entrance side. A 700 litter cryo pump is also installed at RFQ-DTL connecting section to evacuate from RFQ exit side.

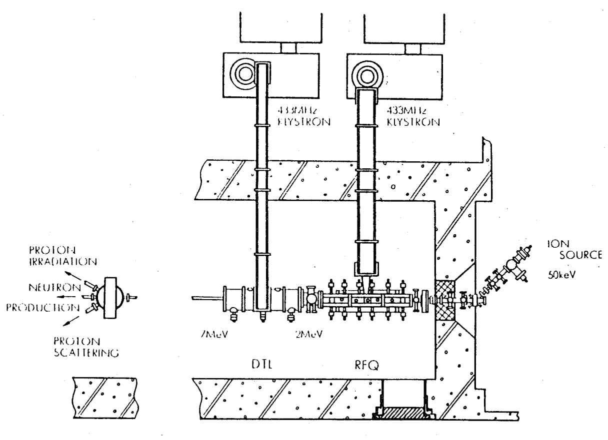

Fig. 1 Accelerator system

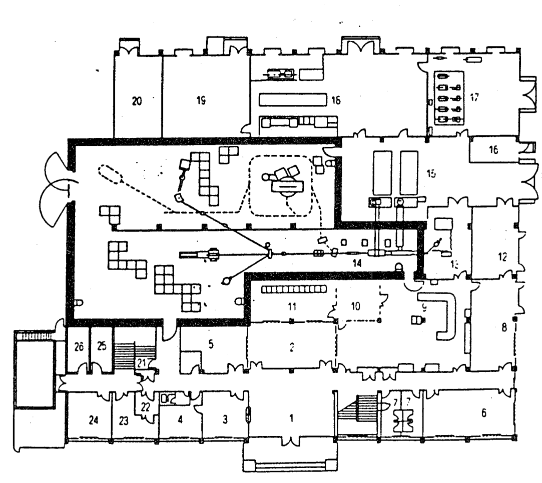

Fig. 2 Accelerator building 1st floor

Beam Matching Section

Permanent quadrupole magnets are used to converge the diverging output beam from RFQ. Four of them are installed before a buncher and another four quadrupole magnets are installed before the DTL cavity. The buncher is needed to match the beam into the DTL longitudinally. Beam monitors will be installed in this area to investigate the output beam from the RFQ.

DTL

The drift tube diameter is 55 mm and the bore radius is 5 mm. [3] Permanent quadrupole magnets are installed in the drift tubes to focus the beam. [4] Each drift tube is supported by a stem from a bottom plate which is demountable from the tank. (Fig. 4) The 28 drift tubes are aligned on the plate outside the tank. 5 tuners of 10 cm diameter are installed on the tank. Two of them are fixed, and three are tunable. The same klystron is used as the RFQ for power source and the power is coupled by a 5 cm width slot on tank top. (Fig. 5) The average accelerating field is 4 MV/m.

RF System

Because of the high operating frequency, klystron is available for the High power RF source. Two Litton L-5773 feed the two accelerator tube separately. The tubes are a four-cavity, pulsed klystron amplifier. It can produce a peak power output of 1.25MW at an average RF power.output of 75 kW at 6% duty factor with a minimum power gain of 35 dB. For this accelerator system, the operating duty factor is up to 1%.

Each klystron is driven by a 300 W solid state booster which is a pulsed A-class FET amplifier. The system frequency is phase locked at resonant frequency of the RFQ. The frequency of the other systems (buncher,and DTL) is same as that of the RFQ. The phase in each cavity is controlled to a reference phase by PLL. The amplitudes are also controlled.

Control System

The total system is computer controlled by distributed controllers, called UDC (Universal Device Controller). The controllers are connected to a control computer by optical fiber cables. The control computer communicates to a man-machine interface computer by an optical fiber link loop LAN. Both control and man-machine interface computers can be distributed on the loop LAN for increasing CPU load with an expanding necessity.

Extension Plan

There is a plan of an extention to a synchrotron using this accelerator as an injector. The synchrotron will produce 7 to 200 MeV proton beam. The broken line in Fig. 2. shows the possible beam line.

References

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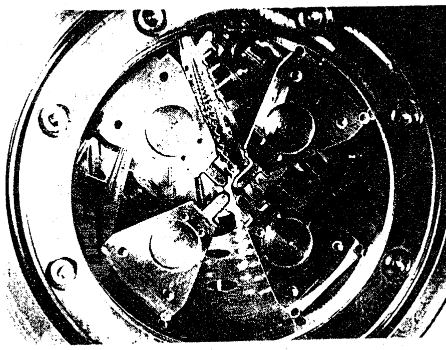

Fig.3 Inside view of the RFQ cavity from the exit

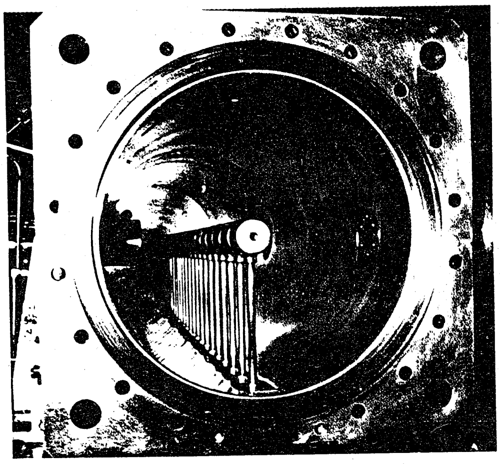

Fig.4 Inside view of the DTL cavity

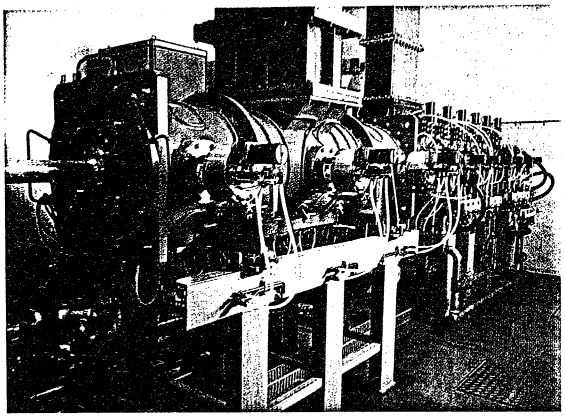

Fig. 5 General view of the accelerating tubes from DTL side. The wave guide is connected to the top of the DTL tank.