PRESENT STATUS OF THE 500-MeV ETL ELECTRON LINAC "TELL" AND THE PION CHANNEL

T. Tomimasu

Electrotechnical Laboratory

Abstract

The 500-MeV electron linac "TELL" is operated since Dec. 1980. The main features of TELL are high efficiency, high current-high power acceleration and economical beam sharing. The available beam current is 240 mA (~180 μA) at 300 MeV at present. The ETL pion channel (QQDQ) with solid angle larger than 0.15 sr is now under construction. It has an absorber at the axis of the front quadrupole magnet to eliminate n and γ backgrounds.

The 500-MeV linac has been constructed in six months at the Electrotechnical Laboratory (ETL) in Tsukuba. The ETL linac is called TELL, the Tsukuba Electrotechnical Laboratory Linac. Teru is a Japanese verb meaning "to shine" and (William) Tell is an expert archer in a famous tale. The main features of TELL are high efficiency, high current-high power acceleration and economical beam sharing[1].

TELL is using high operation efficiency klystrons (45 - 50 %) developed with Toshiba Electric Corp.. The operation efficiency of 50 % is an important feature demanded for our klystrons to realize a high efficiency-low cost linac, since the higher operation efficiency klystron enables us to use the smaller modulator. To realize high current-high power acceleration, special attention has been paid to the configulation of linearly tapered iris type accelerating waveguides (LTWG) developed with Mitsubishi Electric Corp., quadrupole magnets and steering coils. The structure of LTWG is simple and the fabrication cost is lower than that of the constant gradient type.

Fig. 1 shows a schematic layout of TELL and research program in each experimental room. Three kinds of LTWG (C2, C3 and D3) have been made to have common cavities as many as possible in their structures to reduce the fabrication cost. Total length (77 m) of TELL, including two pulsed deflection systems at low and medium energy sections, is shorter than 40 % of the lengths (~200 m) of the high duty ratio-high power machines operated at Saclay, MIT and NIKHEF-K. The merit of the low duty ratio-high power machine like "TELL" is clear. TELL has the low, medium and high energy sections to satisfy the various requirements for the characteristics of electron beams, and five experimental rooms are arranged around the accelerator room. For the economical beam sharing, the thinned out pulsed deflection system developed at ETL is installed at each outlet of the low, medium and high energy sections. Fig. 2 shows the beam sharing. The main parameters of TELL is shown in Table 1.

The ETL pion channel is a QQDQ type spectrometer. A schematic layout of this channel is shown in Fig. 3. A lead shield plate with an eliptical hole is set between a copper target and the inlet of the channel. The function of the first and the second quadrupole magnets is to get solid angle larger than 0.2 sr. An absorber with an eliptical cross section is set at the axis of the first quadrupole magnet to eliminate neutron and gamma ray backgrounds, while it reduces solid angle to 0.15 sr. The flight path length is about 4 m. The focal plane crosses the centers of the small quadrupole magnets Q_3 and Q_4. The vertical focusing is provided by Q_3 and Q_4. Negative pions (150 MeV/c ±5%) from a copper target of 2.5 cm Ø x 2.5 cm can be focused in a beam size of 3 cm x 3 cm near the point A. Therefore, a 100 kW, 400 MeV electron linac can provide enough negative pions needed to treat a tumor of 27 cm^3, using this pion channel. With the progress in diagnosis technology of tumor, it is expected that a tumor treatment volume is smaller than a table tenis ball(29cm^3).

1) T. Tomimasu: IEEE Trans. on Nucl. Sci., Vol. NS-28, No. 3, 3523 (1981)

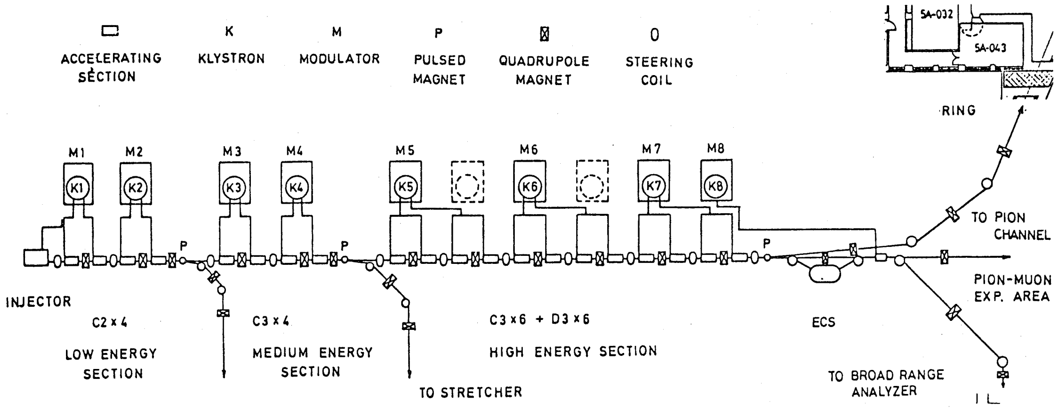

Fig. 1
Layout of TELL and research program in each exp. room

Low energy exp. room	absorbed dose standard for e⁻ and brems.
Medium energy exp. room	150 MeV beam stretcher and small ring
High energy exp. room	inner-shell ionization by 350-450 MeV e⁻ shielding technology
Pion exp. room	absorbed dose standard for pion 150 MeV/c, 0.15 sr pion channel
Storage ring room	600 MeV ring

Total length	77 m
Electron energy at a 100 kW beam	400 MeV
Beam current	
peak	250 mA(240 mA)
average	250 μA(180 μA)
Beam pulse width	4 μsec.
Repetition rate	600 pps
No. of klystrons	10 (7)
Peak rf power	25 MW
Efficiency	50 %(45-50 %)
First beam, date	Dec. 22, 1980

Table 1 ( ) shows present values

low energy section
pulse current
beams to low energy exp. room
medium energy section
pulse current
beams to medium en. exp. room
high energy section
pulse current
beams to storage ring room
beams to pion or high energy exp. room

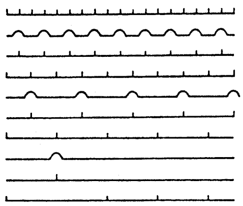

Fig. 2 Beam sharing at each energy section

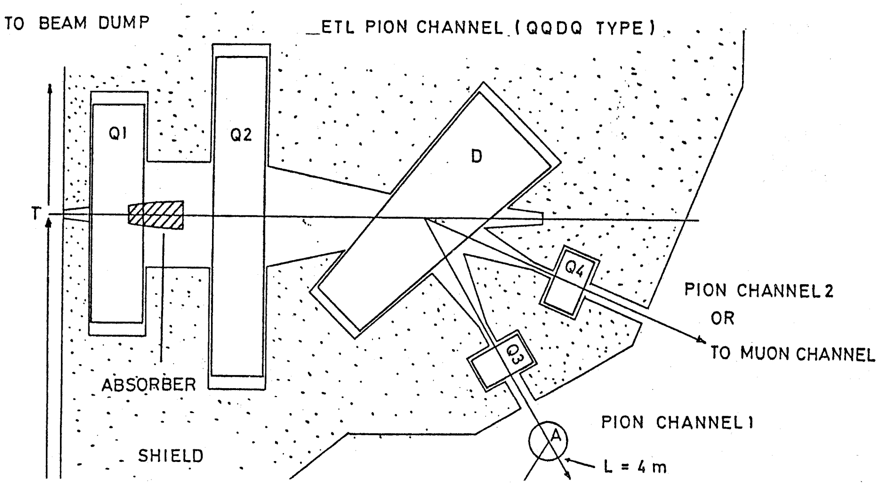

Fig. 3 Layout of the ETL pion channel