THE DESIGN OF A PROPOSED 500 MEV ETL ELECTRON LINAC

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The conceptual design of a low running cost 100 KW electron linac is presented. The proposed linac, which will be installed in Tsukuba, consists of an electron injector and twenty constant-gradient accelerating sections of four kinds. Four sections are 2 m long and sixteen sections 3 m long. Rf power at frequency of 2856 MHz is provided by ten MW klystrons (each 25 kW average) whose operation efficiency is higher than 55 %. High efficiency of 55 % is an important feature demanded for these klystrons to realize a low running cost machine. The maximum beam duty cycle is 0.24 %. The proposed 500 MeV high power linac is used for the multipurpose use such as the electron injection to a SOR-ring, the studies of radiation damage, radiation chemistry and nuclear data, establishment of radiation standards, the RI production. For the multipurpose use of the electron beams, the electron beams with three different energies from low, medium and high energy sections may be simultaneously provided to four experimental areas by means of the combination of three pulsed magnets and four beam transport systems, as shown in Fig.1.

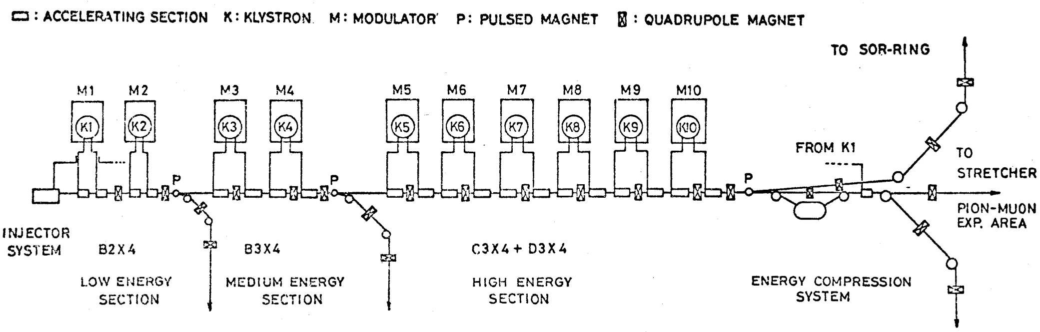

Fig.1 Schematic layout of the beam center line, klystrons, modulators and beam transport systems.

Another feature of the proposed linac is of high peak current and high power, not of high duty ratio and high power as the two machines operated at Saclay and MIT. The present design approach to avoid the cumulative beam blow-up and to keep a reasonable peak current results in a configuration of twenty constant gradient accelerating sections ($2\pi/3$ mode, 2856 MHz) of four kinds whose outlet iris diameter varies from 25 mm to 22 mm and twelve quadrupole triplets (or doublets) as shown in Fig.1. Fig.2 shows the variation of the group velocity Vg/C, the voltage attenuation constant τ (neper/m), the shunt impedance γ (MΩ/m) and the wave guide inside diameter 2b(cm) of the accelerating section as a function of the iris diameter 2a(cm) of loading disk ($2\pi/3$ mode, 2856 MHz).

The linac is designed to consist of the twenty accelerating sections of four kinds, namely, three types of B3 through D3 and the type of B2, which is an input side part 2 meter long of the type B3. The design parameters of the accelerating sections and the linac are listed in Tab.1.

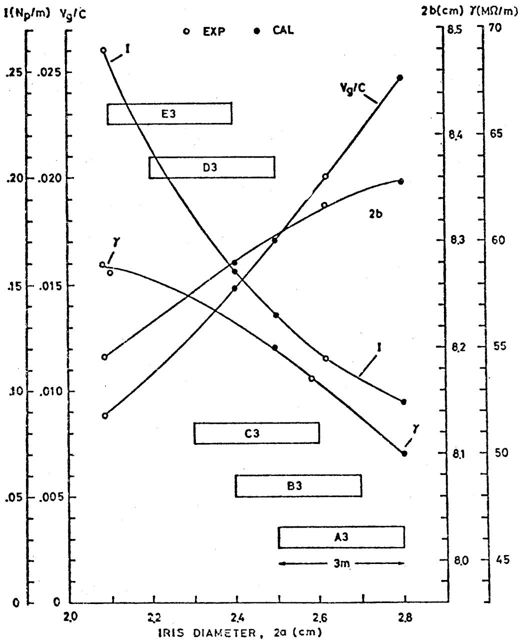

Fig.2
Design parameters of the accelerating sections against iris diameter.
The experimental data are quoted from the previous publications shown in 1).

Accelerating Sections				
Frequency	2856 MHz at 40° C			
Mode	2π/3			
Type	constant gradient			
	B2	B3	C3	D3
Length (m)	1.892	2.945	2.945	2.945
Shunt impedance (MΩ/m)	53.3	54.2	55.6	56.9
Voltage attenuation constant (neper/m)	0.120	0.129	0.148	0.171
Filling time (μsec)	0.33	0.55	0.63	0.73
Total length	76 m			
Type of accelerating sections	constant gradient (S-band)			
	B2	B3	C3	D3
Number of accelerating sections	4	4	6	6
Input peak rf power (MW)	8 (6)	8	8	8
Input average rf power (kW)	12.5	12.5	12.5	12.5
Beam pulse width	5 ns ~ 4 μs			
Pulse repetition rate	less than 600 pps			
Number of klystrons	10			
Maximum peak rf power per klystron at a duty cycle of 0.00125	20 MW			
Average rf power per klystron	25 kW			
Maximum duty cycle	0.003 at 8 MW			
Efficiency	more than 50 %			
Total unloaded beam energy	503 MeV (at 0 A)			
Total loaded beam energy	366 MeV (at 0.24 A)			
Loaded beam energy at the medium energy section	97.5 MeV (at 0.4 A)			
Loaded beam energy at the low energy section	39.1 MeV (at 0.4 A)			

Tab.1
Design parameters of the accelerating sections and the linac.

The electron beam emerging from each energy section shown in Fig.1 is kicked off by the pulsed magnet to the subsequent beam transport system, which delivers energy-analysed electron beam to the corresponding experimental room. For instance, the electron beam kicked off by the pulsed magnet from the high energy section is derivered to the SOR-ring room. The excess electron beam emergying from the high energy section is delivered directly to the π-meson and beam stretcher room or to the electron energy compression system, in which both energy resolution and stability of the electron beam are improved. The electron beam with better energy resolution may be delivered by two quadrupole doublets to the π-meson and beam stretcher room or by a beam transport system to high energy electron experimental room.

1) T. Tomimasu: Bull. Electrotechnical Lab. Vol.42, No.1 (1978)