PROPOSAL OF A 100 MeV SHORT PULSE HIGH CURRENT LINAC

Wang Daji, Wu Tielong, Gu Runguan
Institute of Atomic Energy, Academia Sinica, P.O.Box 275,Beijing,
People's Republic of China

Summary

In order to meet the demands of neutron physics and other research work, IAE has determined to build a 100 MeV short pulse high current electron linac. The major parameters of the LINAC-100 are listed below:

Energy (MeV)	Pulse Width	Pulse Current	Repetition Rate (pps)
100	5ns	10A	1000
100	10ns	5A	1000
100	1µs	300mA	300

Introduction

A linac as a prototype of the 100 MeV short pulse high current electron linear accelerator was built a few years ago in IAE. A pulse electron beam of 10-50 ns and peak current of 3A has been obtained with beam energy about 14 MeV[1]. The performance data provide useful experiences for construction of the new accelerator LINAC-100.

LINAC-100 consists of a grid controled electron gun, two prebunchers, one buncher and five accelerating sections of disk-loaded waveguide, which are fed by six homemade S-band D4009 klystrons. At the end of the accelerator, there are beam transport lines and three targets for neutron physics, physics of condensed matter and photo-nuclear reaction.

Injection of Electron Beam

A block diagram of LINAC-100 is shown in fig.1. A grid controled electron gun with energy of 120-150 keV, pulse current of 15-25A and pulse width of 5-20ns is being developed. The grid is a woven web made of Mo wires. A vacuum valve, which can be heated up to 350°C, is connected at the anode of the gun, so the electron gun assembly can be heated and activated in vacuum oven. There are several sets of lenses, steering coils, and beam monitors in the injector system in order to focus and monitor the injector beam current.

At the entrance of 1st prebuncher, there is an automatic control vacuum valve to isolate the gun from the accelerating system when the gun is in repair. For getting short pulse of 5ns, the grid pulser with a ferrite clipping line will be used.

Disk-loaded Waveguide

Design of the disk-loaded waveguide was based on many literature and our own works[2,3,4]. We exert effort to fulfill the main goal, to

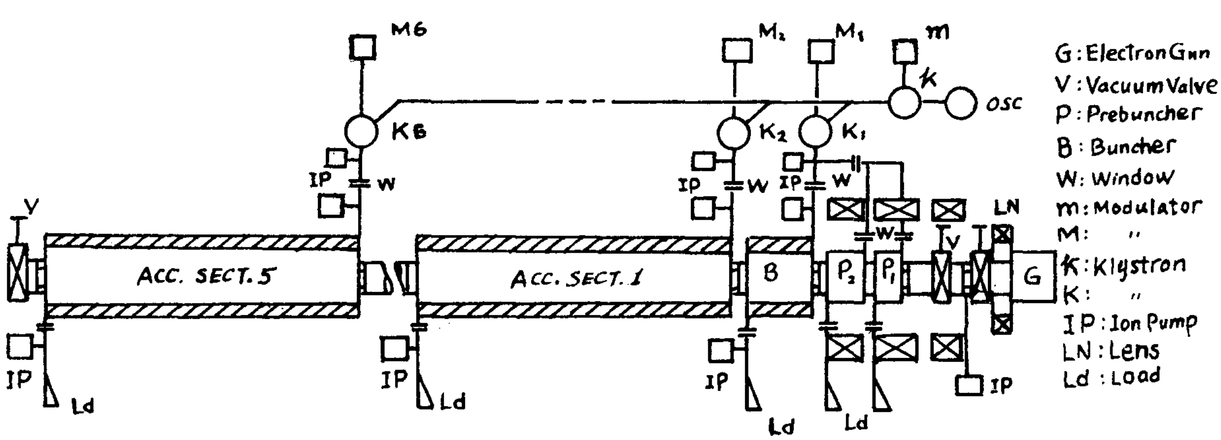

Fig.1. Block diagram of LINAC-100.

get as more accelerated electrons as possible in single pulse at transient state and to ensure a beam current of more than 300 mA with ±3-±5% energy spread at steady state.

The bunching system consists of one $\frac{\pi}{2}$mode, one $\frac{2\pi}{3}$mode prebuncher and one $\frac{2\pi}{3}$mode buncher, which has high initial field[3] strength and a rising phase velocity. The accelerating system consists of five $\frac{2}{3}\pi$ mode identical sections with nearly constant gradient construction and high field strength of 13.5 MV/m.

Their fundamental parameters are shown in table I below:

TABLE I.
MAIN PARAMETERS OF DISK-LOADED WAVEGUIDE

Quantity	Prebuncher I	Prebuncher II	Buncher	Accelerating section
Mode	$\frac{1}{2}\pi$	$\frac{2}{3}\pi$	$\frac{2}{3}\pi$	$\frac{2}{3}\pi$
Construction	Const. Imped.	Const. Imped.	Var. Imped.	Var. Imped.
RF Power Supply(MW)	0.003-0.03	0.012-0.12	1.2-5.5	12(15)
Field Strength (MV/m)	0.15	0.15	6.5-8.5	13.5
Length (cm)	9.4	12.5	42.8	240.9
Series Impedance ($M\Omega/m^2$)	0.82	0.24	9.6-19.4	14.6-34.4
Atteneuation Coef.(neper/m)	0.0675	0.0419	0.223-0.160	0.129-0.272
Group Velocity	0.0603	0.0774	0.0146-0.0134	0.0168-0.008
Fill Time (μ sec.)	---	---	---	0.674

RF System

The RF system consists of a quartz oscillator with frequency stability better than 1×10^{-6}, a 15 kW driving klystron and 6 high power S-band D4009 klystrons ($\hat{p}$=20MW, $\bar{p}$=20kW).

The RF output of 1st high power klystron is devided into three branches to feed prebunchers and buncher. The rest 5 klystrons supply 5 accelerating sections respectively.

The RF waveguide elements are fabricated by OFHC rectangular waveguide, metal sealed and evacuated to 5×10^{-8} Torr. But the RF waveguide elements for prebunchers are in atmosphere. Each vacuum system of RF system is independent and is seperated from the vacuum system of accelerating system by ceramic waveguide windows.

Modulaters

High power modulater consists of a 25kV D.C. power supply, a pulse-forming network and a pulse transfomer. The PFN is designed as a dual ten-section network, operating in parallel. The ratio of pulse transformer is 1:12. A home-made Model 4003 thyratron is used with rating voltage 50 kV and pulse current 2000A. The output pulse voltage of modulator is 250 kV with pulse width about 1.4 s(FWHM) and flatness of the pulse within ±o.5%. A De-Qing circuit and energy recovering device will be added to get the pulse to pulse stability of 0.25%.

Beam Transport and Targets

At the output of the linac, there are a shutter valve, a time delay pipe and an automatic control vacuum valve. The transport system is devided into three ways as shown in fig.2.

There are two triplet quadrupoles in the straight way and the beam with ±25% energy spread can be passed through to the neutron target. After the 1st triplet quadrupole, there is an achromatic system, which consists of three bending magnets, will be set to make a 3x30° deflection and the beam can passed through to the target for photo-nuclear reaction. After the 2nd triplet quadrupole, a set of bending magnet is mounted for deflecting the beam both in vertical and horizontal direction about several degrees, so the beam can be passed through to the target for physics of condensed matter.

Along these lines, several triplet quadrupoles, steering coils and beam monitors must be installed.

Building Arrangements

LINAC-100 will be sited in IAE in Beijing. The whole facility will be mounted underground.

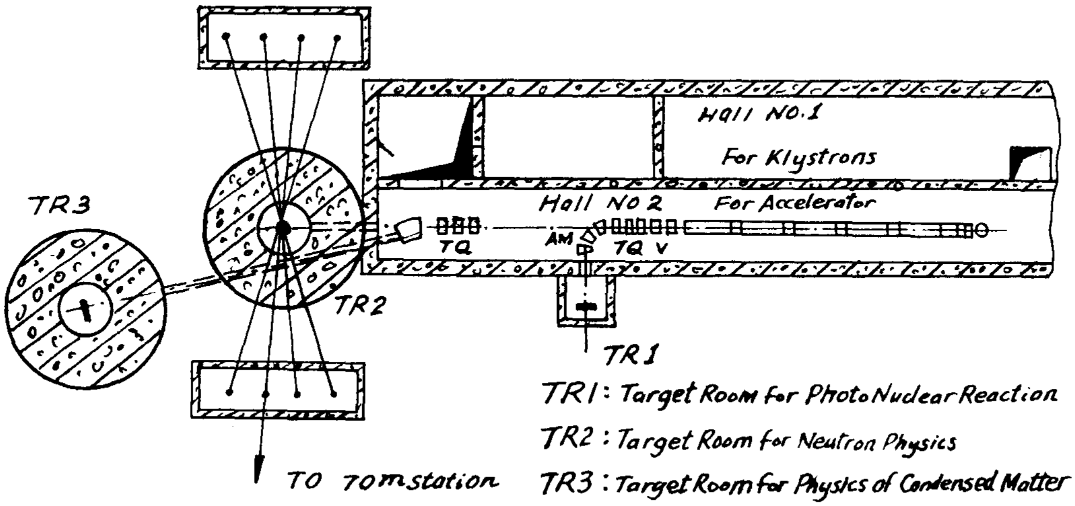

Fig.2. Plan view of the underground layout of transport system and target rooms.

There are two halls for the accelerator,one for the klystrons and modulators, the other for accelerating and transport system. There are three target rooms with their T-O-T pipes. Only the power sources, the cooling system, the control rooms, the subsidiary facilities and the experimental laboratories are on the ground.

References

1. Gu Runguan et al., this conference.
2. Masao Nakamura, J. Appl. Phys., **7**, No.3, 257(1968).
3. Gu Runguan, Chinese Journal of Nuclear Science and Engineering, **1**,76(1981).
4. Ye Xuanhwa et al., Report at 1979 Beijing Particle Accelerator Conference,p.48.