STATUS OF THE JAERI LINAC

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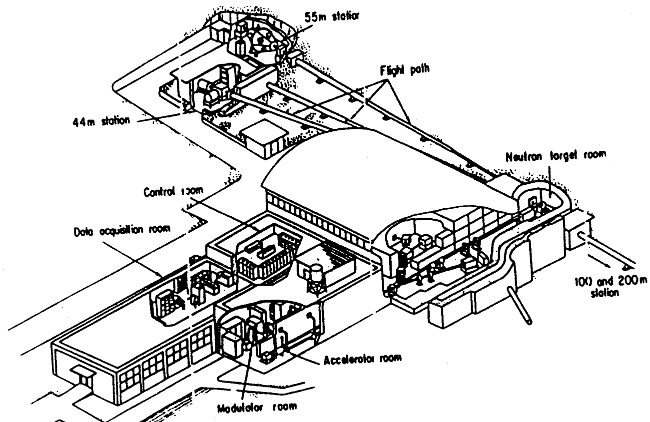
Abstract

Status of the linear electron accelerator(Linac) at the Japan Atomic Energy Research Institute(JAERI), Tokai, is presented with a brief review of the improvements of its performance and a future plan of its upgrading as a high-intensity short-pulsed white-spectrum neutron source for time-of-flight (TOF) measurements.

Description of the JAERI Linac facility

The present Linac is of the second generation. The first one was a small machine of 20-MeV [1], imported from HVEC, USA. The present Linac with associated experimental facilities was installed during 1974 to 1975 by our own hands [2]. Bird-eye's view of the Linac facility is shown in Fig.1. During the last decade, continuous improvements have been taken place; a buncher section was inserted, all accelerating tubes renewed and a newly designed injector system attached. Main specification and present performance of the Linac are listed in Table 1. Table 2 is the chronicle of improvement and replacement of the main parts with records of upgraded performance.



JAERI electron linear accelerator

Table 1. Specification of the JAERI Linac

RF-Frequency	S-Band, 2856 MHz
Accelerating Tubes	Buncher(1m), 2x2-m regular, 3x3-m regular sections
RF-powers	10-MW to buncher, 5x20-MW to each regular section
Output Energy	60 to 190 MeV(no load)
Output Current	6A(20ns), 4A(30ns), 0.5A(1 μs) at 120 MeV
Pulse Width	20 ns to 1 μs
Pulse Repetition	25 to 300 pps
Neutron Yield	Abt. 10^{13} n/pulse(6A,20ns)

Table 2. Chronicle of Improvements

1976	Buncher section(1m) newly installed	100 Mev, 0.5A, 120 ns, 150 pps
1977	The 1-st acc. tube (2m) replaced	120 MeV, 1.1A, 80 ns, 150 pps
1978	The 2-nd acc.tube(2m)	120 MeV, 1.4A, 80 ns, 150 pps
1979	Injector part improved(gun & pulser)	120 MeV, 1.8A, 30 ns, 150 pps
1980	The 3-rd acc. tube (3m), reduce RF-noise	120 MeV, 3.0A. 30 ns, 300 pps
1981	The 4-th acc. tube New injection gun	120 MeV, 6.0A, 20 ns, 300 pps
1982	The 5-th acc. tube	

Plan for power-up(upgrade)

A future plan for increase of the output beam power is stemmed from the followings; 1) demand from TOF experimenters, 2) suitable situation for this purpose. The Linac is being operated arround 90 % of total machine time for neutron TOF experiments. The experiment of this kind requires the following characteristics of then beam output from linac as a neutron source; 1) higher output power is desirable, since neutron yield is proportional to beam-power, 2) shorter pulse-width of the beam, since TOF-resolution depends on the width of neutron bursts, 3) higher pulse-repitition rate (PRR), since measuring time can be shortened inverse-proportionally to PRR, 4) auxiliary requirements; long-term stability of the beam intensity, lower RF-noise, capability of simultaneous measurements.

One measure(figure of merit),Q, can be defined for convenience

$$Q = E_b \times I_b \times PRR / t,$$

where E_b , I_b are energy and peak current of the beam, respectively. t is pulse width. The present Q yields 10,800 MWPPS/ns(E_b = 120 MeV, I_b = 6A, PRR = 300 and t = 20 ns).

All accelerating tubes have been replaced, that is, a heart of the Linac is renewed. 20-MW klystrons can be easily replaced by 30-MWs, which are already commercially available. Furthermore, more powerful ones may be expected. The beam output is proportional to the feeding RF-power. Thus, Q will increase by 50 %. Improvement of the injector system can lead remarkable increase of Q. Very short-pulse beam is accelerated in transient mode. In this mode, total charge of the accelerated bean is kept almost constant; i.e., a linac, which can accelerate the beam of 6 A, and of 20 ns, can also do that of 12 A, and of 10 ns, of the same energy, if the injection is successful. In this case, Q is increased by 4 times.

The Q-value is linear with PRR. The increase of PRR is thus effective. The PRRs of forign liancs(ORELA at ORNL,GELINA at Geel,HELIOS at Harwell) are higher(upto 2000 pps in HELIOS) than that of the JAERIs. It should be desired to double or triple PRR(600 to 900 pps) in our case.

The present capacity of D.C. power-supply for pulse-modulating circuits is not enough, when 30-MW klystrons are used and PRR is set to be 900 pps. In the operation of higher duty cycle, several pulser components should be replaced. In Fig.2, Q-values are plotted along year's scale with expected ones in power-up.

The injector system including pre-buncher and buncher section will remain subject to be improved furthermore, because of difficulty in the injection of high-current(over 15A) into regular sections.

The short-pulse generation for grid-driver of the electron gun can be achieved using an avalache-transistor circuit.

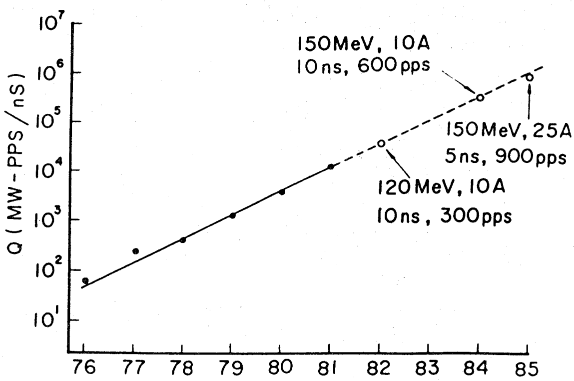


Fig.2 Plot of Q vs. years

References;

1) H.Hirakawa et.al., JAERI-Report 6014(1964)

2) H.Takekoshi et.al., JAERI-Report 1238(1975)