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KEK LINAC PRESENT STATUS

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ABSTRACT

KEK linac has run satisfactorily without serious problems from April in 1980 to July in 1981. The average beam intensity is about 120 mA. The downtime due to the linac failure, which is mainly the overload of RCA-4616 tubes and TH-516 tubes, is about 36.9 hr during the accelerator operation time of 4487.5 hr. More efficiently to inject the negative ions into the 500 MeV booster, the higher injection energy than the present one (20 MeV) will be required. A preliminary design for the extension of the present linac is discussed.

Introduction

Since August in 1974, when the first beam was accelerated in the KEK linac, KEK linac has run satisfactorily by improvements and modification of the various equipments, for exmple, improvements of RF window, high power isolators, modification of the RF system and so on. In particular, the maintenances done during the long shut-down would be very important to operate continually the linac without serious troubles. On June 20th in 1979, the maximum beam intensity of 200 mA, which is twice as the design value of 100 mA, was got[1]. Usually the beams with the average intensity of 120 mA, the normalized emittance of about 0.8 π cm•mrad and the momentum spread of $\pm$ 0.35 % are delivered from the linac to the 500 MeV booster. We have investigated reasons of the linac failure, which happened during the accelerator operation times from April in 1980 to July in 1981. The results are described in next subsection.

The construction of a new 750 keV preinjector has been started since April in 1980 for the acceleration of polarized protons. The other side, the acceleration of the negative ions of 30 mA $\sim$ 100 μs have been discussed.[2] At 20 MeV energy, which is the maximum energy in the present KEK linac, the negative ions will produce the excessive energy deposition in the stripping foils. So its life time would be limited with this deposition. Therefore, a preliminary study was carried out to increase the energy of the KEK linac. The posibilities of the extension of the present linac are discussed.

Operation

From April in 1980 to July in 1981, the total operation time of KEK proton synchrotron is 4487.5 hr and the downtime due to the linac failure is 36.9 hr. It is corresponding to 0.82 % of total operation times. This down time is not so large considering that the operation mode of KEK linac is fully 20 PPS and that under construction of the building for the second preinjector, it takes about five minutes to go to local control room of injector from the central control room to remove the interlock. We have investigated during these one half years where in KEK linac the troubles happended and what those causes are.

The RF system used presently in KEK linac is shown in Figure 1. In Table 1, the trouble numbers of times are given.

In long shutdowns, the usual maintenances were normally done, for example, the exchange of the vacuum tubes, the inspection of the cooling water system, the exchange of RF windows, the instrument checks of the high power system, the exchanges of the used switches and improvement of the casing lag easily to check the Q-magnet power supplies.

As given in Table 1, the overload of RCA-4616 tubes and of TH-516 tubes occurred sometimes. This would be because of the poor vacuum in RCA-4616 tubes. After exchange of RCA-4616 tubes in April 1980, we cannot get the high vacuum. The breakdown by the overload of RCA-7651 tubes would be due to the life time of the tubes. In KEK, the result that exchanging time of RCA-7651 tubes would be three monthes was obtained empirically.

Future plan[3)]

In KEK, the project for acceleration of polarized protons was started from April in 1980. Other side, acceleration of primary negative ion beam in the linac has been considered.

For a foil stripper and the linac beam parameters (30 mA, $\sim$ 100 μS, 200 PPS), the life of the foil is determined by the ionization loss of beam. This ionization loss is strongly dependent upon the beam energy. Thus, increasing the linac beam energy from 20 MeV to 60 MeV, the energy deposited in foil decreases by a factor of 2.7 (3.0 at 80 MeV, 4.5 at 140 MeV). At 60 MeV, the space charge limit becomes $\sim 7 \times 10^{12}$ particles per pulse ($\sim 2.5 \times 10^{12}$ PPP at 20 MeV). Therefore, it is important that the energy of the present linac be increased. The preliminary design for extension of the present linac was done.

Choice of design parameters is followings,

Acceleration Gradient: 2.5 MV/m, considering that the Kilpatrick breakdown criterion is about 15 MV/m at 200 MHz and that this criterion is too conservative by a factor of 2.

Frequency: 200 MHz, this frequency is used in the present linac. So there is nothing to develop the different technologies for the power amplifiers and then the problem of spares will be simplified.

Length: $\lesssim$ 24 m, as seen in Figure 2, the maximum of the available length is about 24 m. This length limits the maximum energy given by the extention of linac. To increase the beam energy, we must choose the twice frequency and so on. This choice requires the use of Klystron and careful measurements of the present beam characteristics.

Transverse focussing: permanent quadrupole magnet. So it would be possible to use the small drift tube. As mentioned above, the preliminary design was done under the most conventional and conservative conditions.

The assumption made to calculate the parameters of a linac is; transit time factor $\gtrsim$ 0.8 synchronous phase angle - 25°.

For the design of 60 MeV linac, the tank length is 22.5 m. This cavity will contain about 54 drift tubes. The total rf power required for the cavity with a 30 mA beam is estimated to be about 3.2 MW. This power would be supplied easily by two TH-116 amplifiers.

Figure 2 is the plan view of the extension of linac suggested by Dr. P. Grand. As seen in Fig. 2, the tank would be installed at the proper elevation on supports and lateral rollers, so that it could be moved as a whole into final position. The power supply gallery and etc are not yet discussed.

Acknowledgment

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References

1) S. Anami et al: "STATUS of the KEK INJECTOR LINAC" at 1979 Linear Accelerator Conference, U.S.A.

2) T. Kawakubo et al: Proceedings of the 3rd Symposium on Accelerator Science and Technology in Japan p. 31.

3) P. Grand: KEK 80-12.

		number of times of breakdown		exchange of tubes	
Low power system		14			
Overload		I	II	I	II
	RCA-7651	8	14	3(1)	4(3)
	RCA-4616	3	42	0	2
	TH-516	7	38	1	1
Buncher		1 (EP power supply)			
Debuncher		4			
Q-magnet		7 (random trigger pulses from CCR)			
High power parts		3 (exchange of spares)			
Interlock module		≧2			
Human errors		2			
Cooling water		2 (breakdown of electric cir.)			
Others		2			

(--) means the exchange of tubes during operation times

Table I Breakdown number

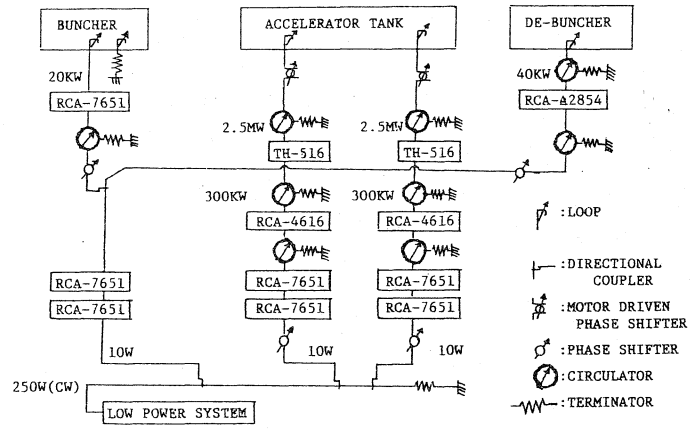

Fig.1 Block diagram of RF system

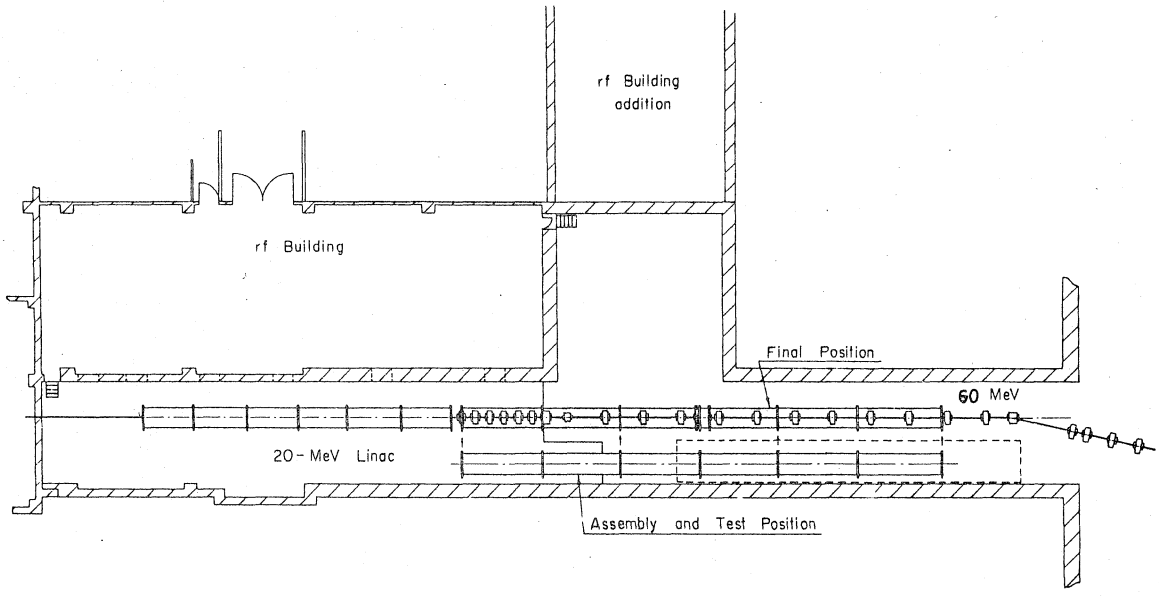

Fig. 2
Linac Extension 60 MeV