THE PHASING SYSTEM IN THE PF LINAC

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The phasing system and its control procedure in the PF linac are presented. The result of the phasing is also reported.

In order to maximize the accelerated electron energy and to minimize the energy spread in an electron linac, the electron bunches are to be coincided with the crest of the RF wave in the accelerator guides. The phasing is the adjustment of the klystron phase to achieve this requirement. In the PF linac, the phasing by a beam induction method is carried out. It has a higher sensitivity than by a beam loading method. The phasing condition in the beam induction method is that the phase of klystron RF wave is 180° away from that of the RF field induced by the electron bunches in the accelerator guides.

Figure 1 shows the RF system including the phasing system. The RF wave (2856 MHz, pulsed) in the accelerator guides to be monitored is extracted by the directional coupler of the accelerator guide termination. The reference wave (2856 MHz, cw) is transmitted from the sub-booster. The phasing system consists of a phase detector, a reference RF phase shifter, a coaxial selector switch, a trigger delay unit and a controller. The phasing process is as follows:

1) The operation of the klystron to be adjusted is turned in a stand-by mode from an acceleration mode. In the stand-by mode, the klystron RF wave pulse comes into the accelerator guides delaying 20 μsec after the electron beam pulse.

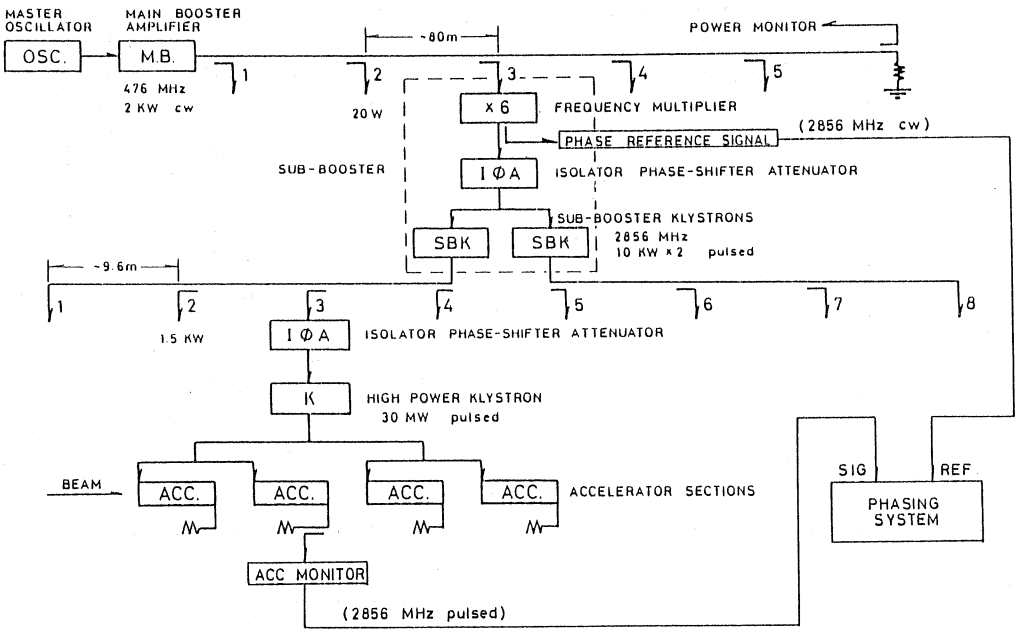

Fig.1 The block diagram of the RF system.

2) The phase of the reference RF wave is compared with the beam-induced signal and is shifted to be the same as that of the induced field. Then the reference phase shifter is locked.
3) The phase of the klystron RF wave is compared with the reference signal and is adjusted to be 180° away from the phase of the reference RF wave.
4) The klystron operation is returned in the acceleration mode.

The phasing controller is designed to perform the phasing automatically in the remote and the local modes. It is based on a microprocessor, and controls the following (shown in Fig. 2);

i) the coaxial switch for selecting the RF waves from the accelerator guides,
ii) the trigger delay unit for selecting the acceleration or stand-by mode of the klystron operation,
iii) the reference RF phase shifter.

The microprocessor reads the phase difference and rotates the klystron phase shifter till the phasing error is within the accepted tolerance.

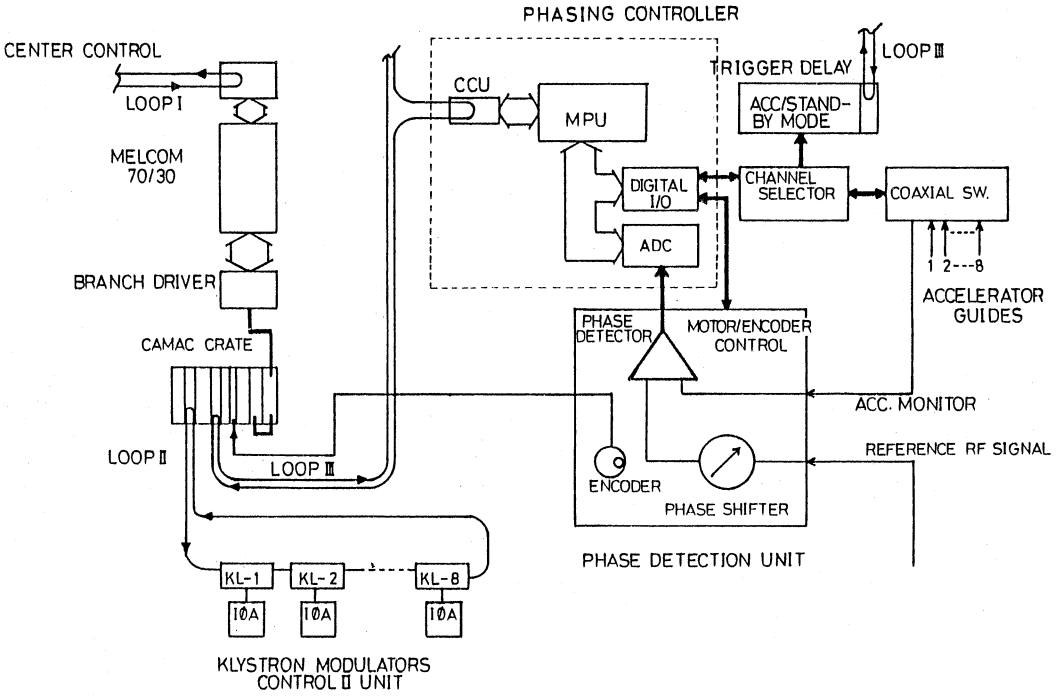

Fig.2 The block diagram of the phasing control system.

The measured phase accuracy of the hybrid phase detector used was within ±1° at null point over the range of 30 dB for the input signal power level. After the phasing by the beam loading method, the phasing of the 40 klystrons by the beam induction method using this detector was carried out without the automatic controller. The sensitivity was 1 mv/1° when the beam current was 40 mA. The phasing by the beam induction method made an energy increase of the electron beam by 1.9%. Considering the calculated value of the energy increase, 1.7%, obtained from the observed phase shift of each klystron, the phasing error was estimated to be at most 3°.