OPERATION OF THE KEK-PF RF SYSTEM

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Abstract

The PF storage ring[1] achieved beam current of 0.2 A at an electron energy of 2.5 GeV with multi-bunch mode this summer. We describe the present status of the RF acceleration system[1,2] briefly and give some operational experiences.

Acceleration voltage is provided with four single cell cavities[3] installed in the two straight sections in the ring. Two cavities in each section are powered by the 180 kW (cw) klystron[4]. The voltages and phases of the klystron outputs are stabilized by the feedback loops[2] within errors of 1% and ±1°, respectively. Typical operational parameters of the high power equipments are given in the Table I.

1. Cavity Voltages and Phases

Using measured values of RF powers at various points, klystron power (Pg), cavity wall loss (Pc) and reflected power (Pr), we obtained the values of beam power (Pb) from the relation Pb = Pg - Pc - Pr. These values are compared with independently calculated ones from Pb = ioVs (io: beam current, Vs: acceleration voltage). An example at E=1.88 GeV is given in Table II, showing good agreements. Deviations of the voltages among four cavities are also measured and the voltages are all properly given within ±3% deviation.

Appling phase modulation to the cavities and varing its frequency, we measured the synchrotron oscillation frequency (fs) at low beam currents. The values are consistent with evaluated ones using cavity voltage obtained from above method.

Phase adjustment between two branches is made by the electronic phase shifters located just before all low level control circuits in each branch. The phase locked loops give the stable phases at the inputs against various phase changing effects. The loops are closed by sampling the signals from directional couplers (-55 dB) just before the cavities. The phase stable cables, SFZE50-7-P, are used as the feedback cables and phase relations between them at 500 MHz are trimmed carefully.

The tuner position in the cavity is automatically adjusted to find the resonance by measuring a phase of the cavity power. In this way the beam loading effect of the cavity-power phase is also compensated.

At low energy the RF power in one branch is able to produce the field enough to store the beam. The beam induced signals of the pick-up port at an unused cavity are used to bring the relative phase to the proper acceleration phase.

Because acceleration phase is about 80°, the deviation of 1° among cavities gives 10% difference of the beam loading in the cavities. Measuring the beam loading of each cavity, we found the phase deviations within ±1.5° at io = 48 mA and 160 mA (Table III).

2. Cavity Voltage Control

The automatic gain control circuit was planned to compensate the beam loading effects. Sometimes, however, this circuit increased the klystron power in spite of bad vacuum condition. Recently developed computer control system is able to bring carefully RF power to calculated values using measured beam current (io) and beam energy (E), by checking the vacuum pressures and other cavity and beam conditions.

References

1) Photon Factory Design Manual.
2) Proceedings of the 3rd symposium on accelerator science and technology, 1980, p219.
3) Proceedings of the 3rd symposium on accelerator science and technology, 1980, p225.
4) Proceedings of the 3rd symposium on accelerator science and technology, 1980, p217.

Table I

Klystron (E3774) operational parameters

Frequency	500.08 MHz
Bandwidth (at 0.5 dB)	0.5 MHz
Beam voltage	40 kV
Beam current	7 A
Operational RF output power	120 kW
Gain	47 dB
Efficiency	55%

Cavity operational parameters

Shunt impedance	8.0 M
Maximum gap voltage	0.7 MV
Dissipation power (operational)	40 kW

Table II

io (mA)	54	100	127
$P_b = i_o V_s$ (kW)	6.9	12.8	16.2
P_b (measured) (kW)	6.5±0.5	14.0±0.4	16.7±0.4

Table III

Cavity No.	1	2	3	4
i_o = 48 mA	0.0°	0.2°	0.0°	-0.2°
i_o = 160 mA	0.1°	-1.4°	-1.3°	0.1°