OPERATION STATISTICS AND RELIABILITY OF KEK-PS

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ABSTRACT

Operation statistics of KEK-PS have carried out since 1977 and are still continuing; we report the results obtained so for.

It is the purpose of this statistics to inform about degree of reliability of the accelerator that had been constructed by us in comparison with other large accelerators and to discuss a method of effective maintenance in future.

Operations History of the KEK-PS

This is summarized in Fig. 1.

Operation Statistics of the KEK-PS

The result of operational reliability are shown in Fig. 2.

System Reliability in the KEK-PS

The schematic diagram and the constitution of the KEK-PS are shown as a table (Table 1, Fig. 3) and Fig. 4-1, -2, -3 shows the reliability of systems. As in Fig. 4-1, 4-2, when we compare 1976-79 with 1980-83, the equipment in operation during the years, 1976 to 1983 was almost the same, but the value of MTBF (mean time between failure) increased by a factor 3 from 1976-79 to 1980-83. The value of MTTR (mean time to repair) similarly increased by a factor 5 from 1976-79 to 1980-83. When rearranging the results of operational reliability, it was appear that the machine has essentially reached the middle part (the random failure period) of the well-known failure rate ("bath tube") curve. It is easy to consider as follows; the down time of the KEK-PS will be happen by a failure of 15 min at 24 hours intervals.

KEK-PS System Failure Distribution

The linac topped and the 500BT (500 MeV beam transport system) followed in the ranking of the system failure. (Fig. 5)

Statistics of Repair Time (compared 1979 with 1982)

Compared with the statistics in 1979, that in 1982 achieved satisfactory maintainability. (Fig. 6)

Distribution Ratio of Failure Frequency in Three Shifts (compared 1979 with 1982)

In 1979, the result is that there is a maximum ratio (47%) in day shift, night shift follow this, and the minimum lies in midnight shift. Exact solution to the couse could not be obtained. But there are no special reason except the relation to physical activities of persons concerned in KEK-PS and the supply of electric power.

Accelerated Beam Intensity

Fig. 8-1 is the accelerated protons since 1979, Fig. 8-2 is the average proton intensity since 1980. Recently an accelerated average proton intensity of nearly $3.8 * 10^{12}$ proton per pulse was reached in the main ring, making a total increase of more than 20 % in peak intensity during 1980. Fig. 8-3 is the beam availability since 1979. The value of the beam availability was almost the same as the value of operating efficiency. The KEK-PS has truly been a very reliable machine as the continued beam availability of about 100 % is shown here.

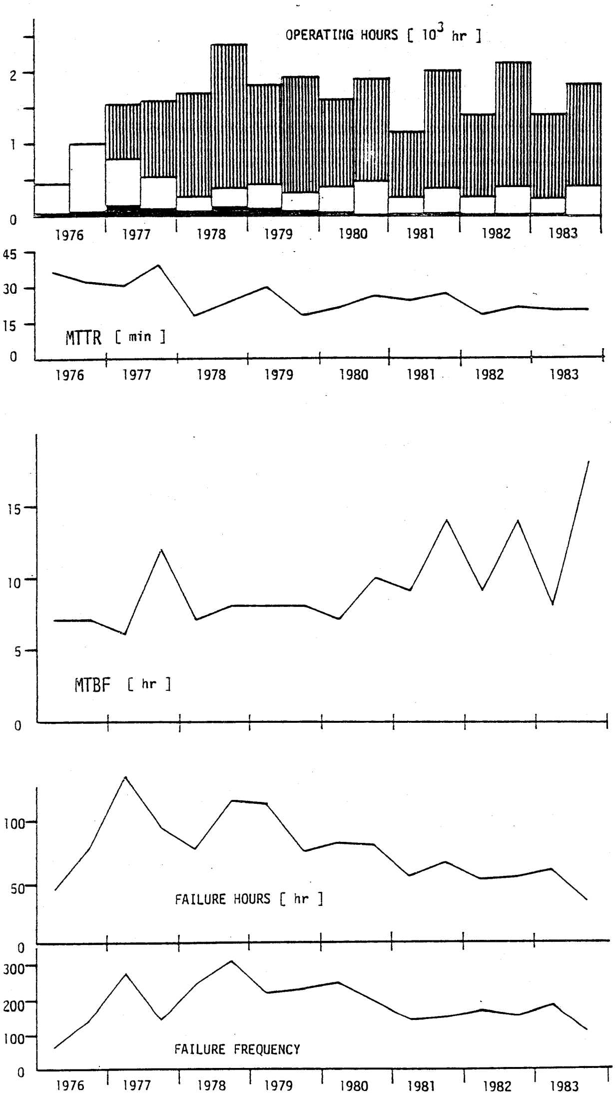


FIG.2 OPERATION STATISTICS OF KEK PS

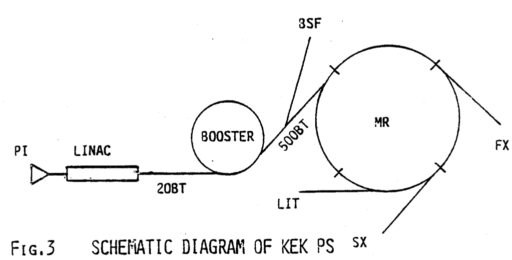
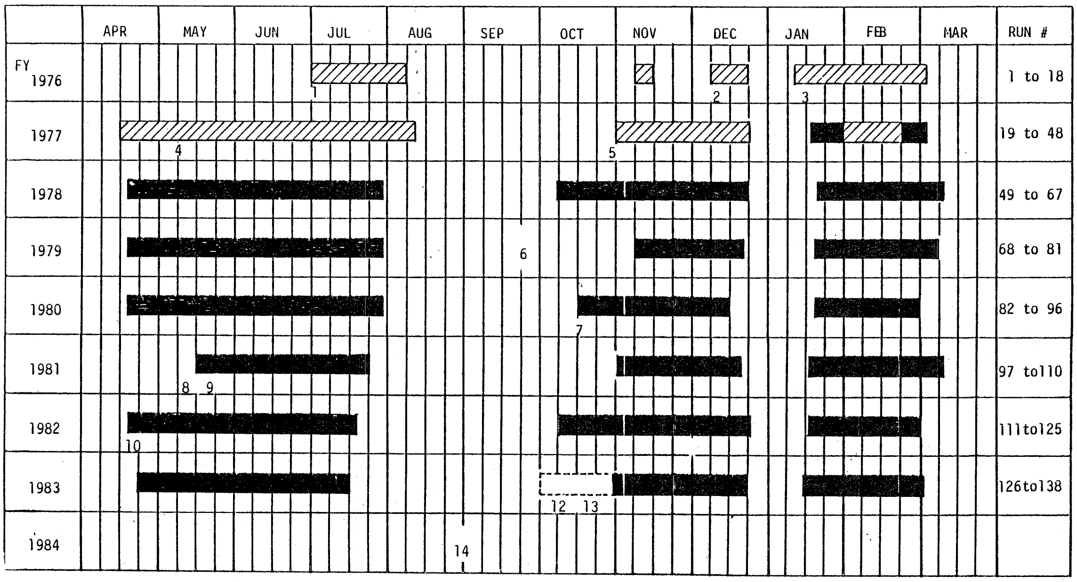


FIG.3 SCHEMATIC DIAGRAM OF KEK PS



OPERATIONS ACTIVITY

1 INTERNAL TARGET 2 ENERGY 12 GEV 3 FAST EXTRACTION (FX)

4 PHYSICS EXPERIMENT START 5 SLOW EXTRACTION

6 MR BEAM DUCT ETC. RECONSTRUCTION, COUNTER EXP.HALL ENLARGEMENT

7 BOOSTER SYNCHROTRON UTILIZATION FACILITY (BSF) 8 TRISTAN PROJECT START 9 TEMPORARY EMPLOYEES JOIN TO OPERATIONS CREW 10 H^{2+} ACC.TEST (LINAC), CHARGE-EXCHANGE INJECTION (BOOSTER) 11 CLINICAL TRIAL START AT BSF 12 H^- ACC. STUDY 13 POLARIZED BEAM ACC. STUDY 14 LONG SHUTDOWN ON ACCOUNT OF TRISTAN CONSTRUCTION

OPERATING CYCLE

ONE WEEK CYCLES (3--4 DAYS)

TWE WEEKS CYCLES (10--11 DAYS)

Fig. 1 OPERATIONS HISTORY OF KEK-PS

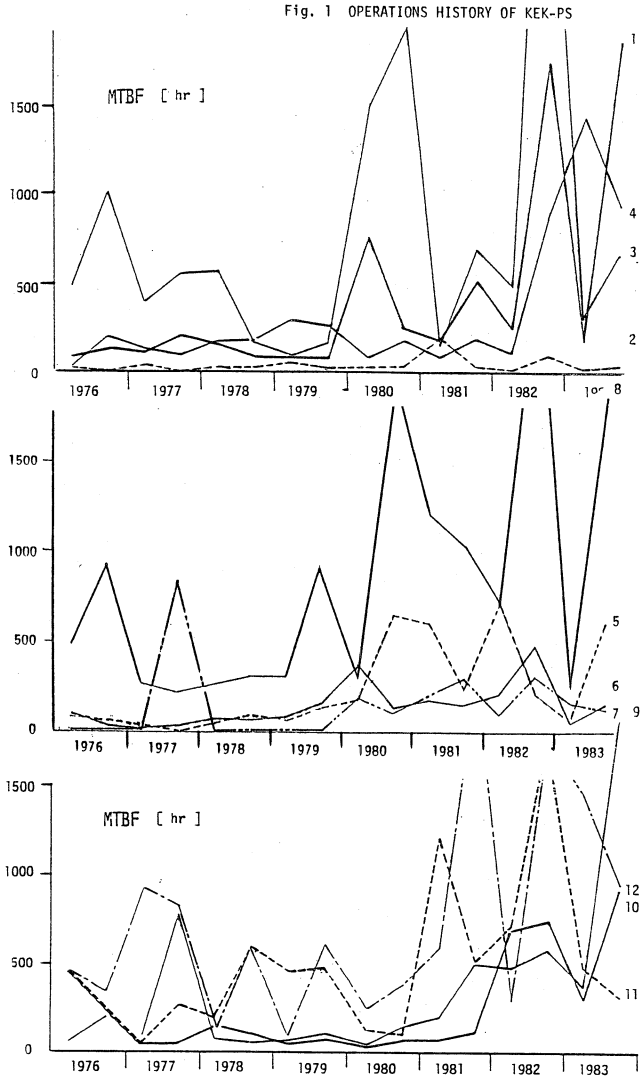


Fig.4-1

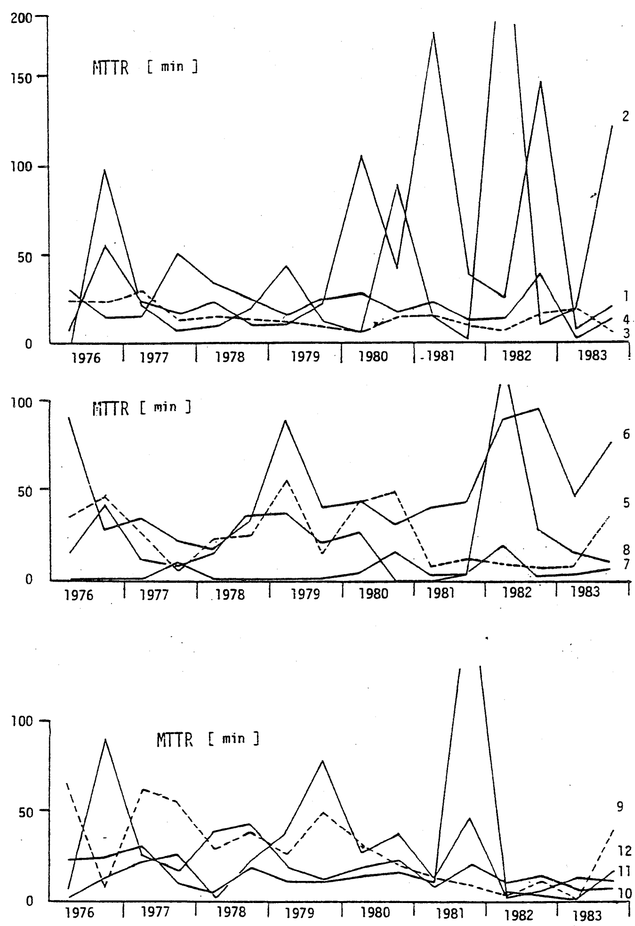


Fig.4-2

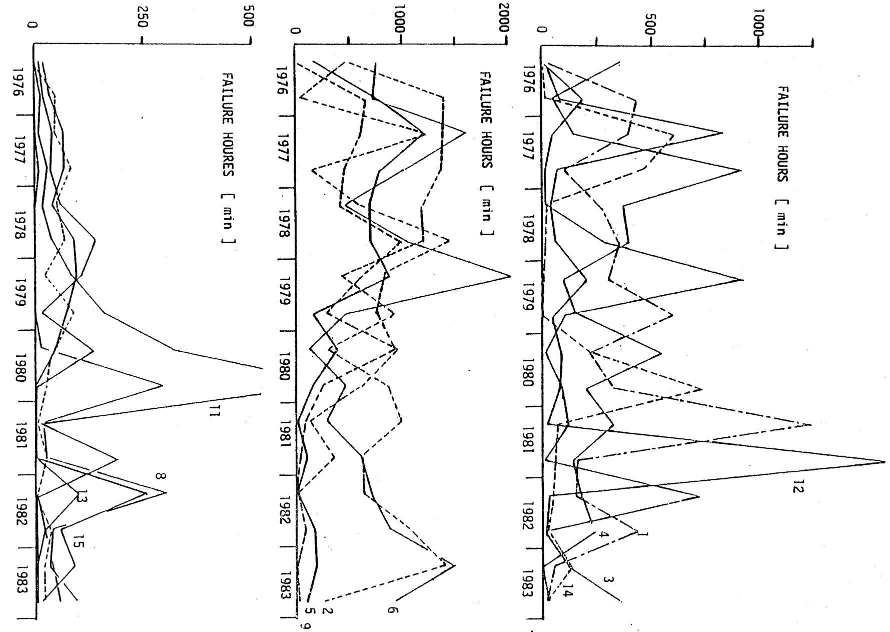


Fig.4-3

TABLE 1 CONSTITUTION OF KEK-PS

SYSTEM CODE	CONSTITUTION DEVICE OF SYSTEM
1. PI	ION SOURCE, HV GEN., ACC.COLUMN, LEBT/MONI., VAC(TMP*2,GV*2)
2. LINAC	TANK, 516 PA(2), 4616 PA(2), PRE/DEBUNCHER, VAC(IP*12), DRIFT TUBE, WATER COOLING CONTROL
3. 20 BT	HEBT, VAC(IP*5,GV*6), ANALYZER/MONI.
4. B MAG	MAG(8+1), P.S., FIELD MEAS./FEED BACK, CORRECTION
5. B RF	8F/4CX PA(1+1), FERRITE BIAS(1+1), CAVITY(1+1), LOW LEVEL/BEAM CONTROL
6. 500 BT	BSTR INJ.MAG(SEPT*2,BUMP*2), BSTR EXT.MAG(KICKER*4,BUMP*2, SEPT*2), MR INJ.MAG(KICKER*5,SEPT*2)
7. BSF	BSF LINE MAG, VAC(IP*2), PROFILE MONI.
8. M MAG	BEND(49), Q(58), FIELD MEAS., CORRECTION
9. M PS	6.6KV BUS LINE(ACF,REACTOR,TR), SCR CONTROL(TQC,DCCT,DCF), HIDIC-350, OP.CON.
10. M RF	8F/4CX PA(4), FERRITE BIAS(4), CAVITY(4), LOW LEVEL/BEAM CONTROL, HP-2100(1+1)
11. EXTRACTION	SX/IT MAG(SEPT*5,BUMP*6,ESS,EQ*3,RQ*3,O), FX MAG(SEPT*5,BUMP*4,FB*2,EQ,O)
12. CONTROLS	KEK STD.CONTROL(CCR,LOCAL*6), DISPLAY BOARD, BEAM SW, MELCOM-70
13. MONITOR	MR(INTENSITY,PROFILE,POSITION,LOSS), BSTR(INTENSITY,PROFILE,POSITION)
14. B M VACUUM	MR VAC(IP*56,GV*6,PRESS.GAUGE*28), BSTR VAC(IP*6,PRESS.GAUGE*6)
15. HUMAN ERROR	

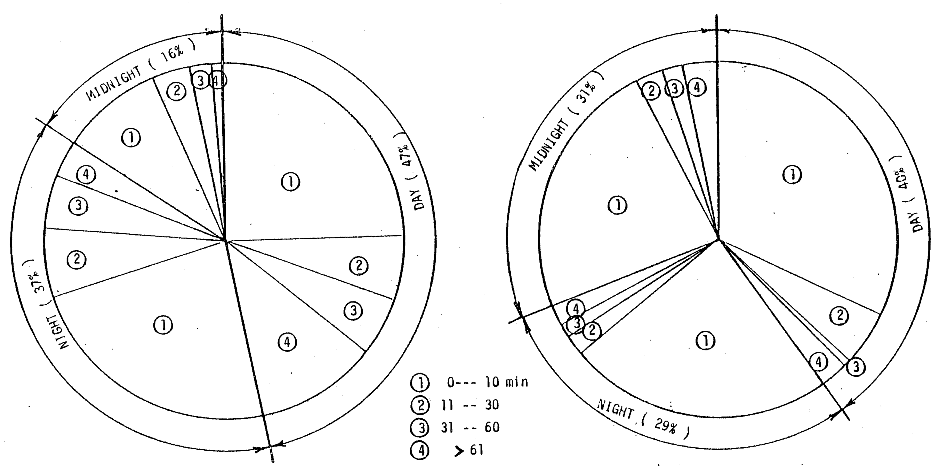


Fig. 7 FAILURE FREQUENCY FOR DUTY PERIOD IN THREE SHIFTS

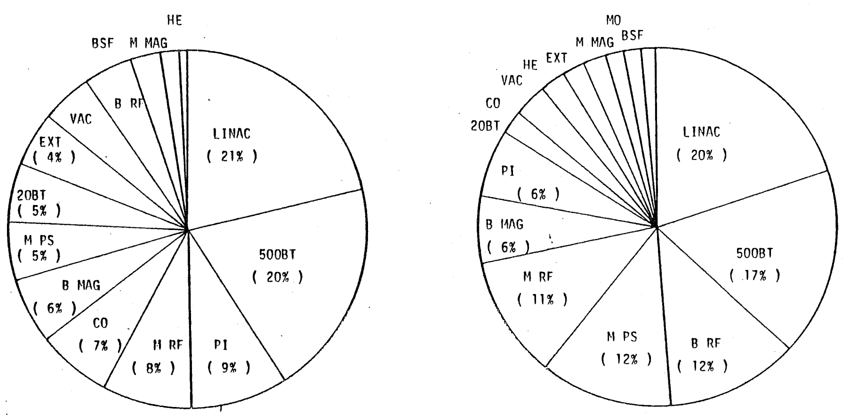


Fig.5 FAILURE DISTRIBUTION OF KEK-PS SYSTEMS

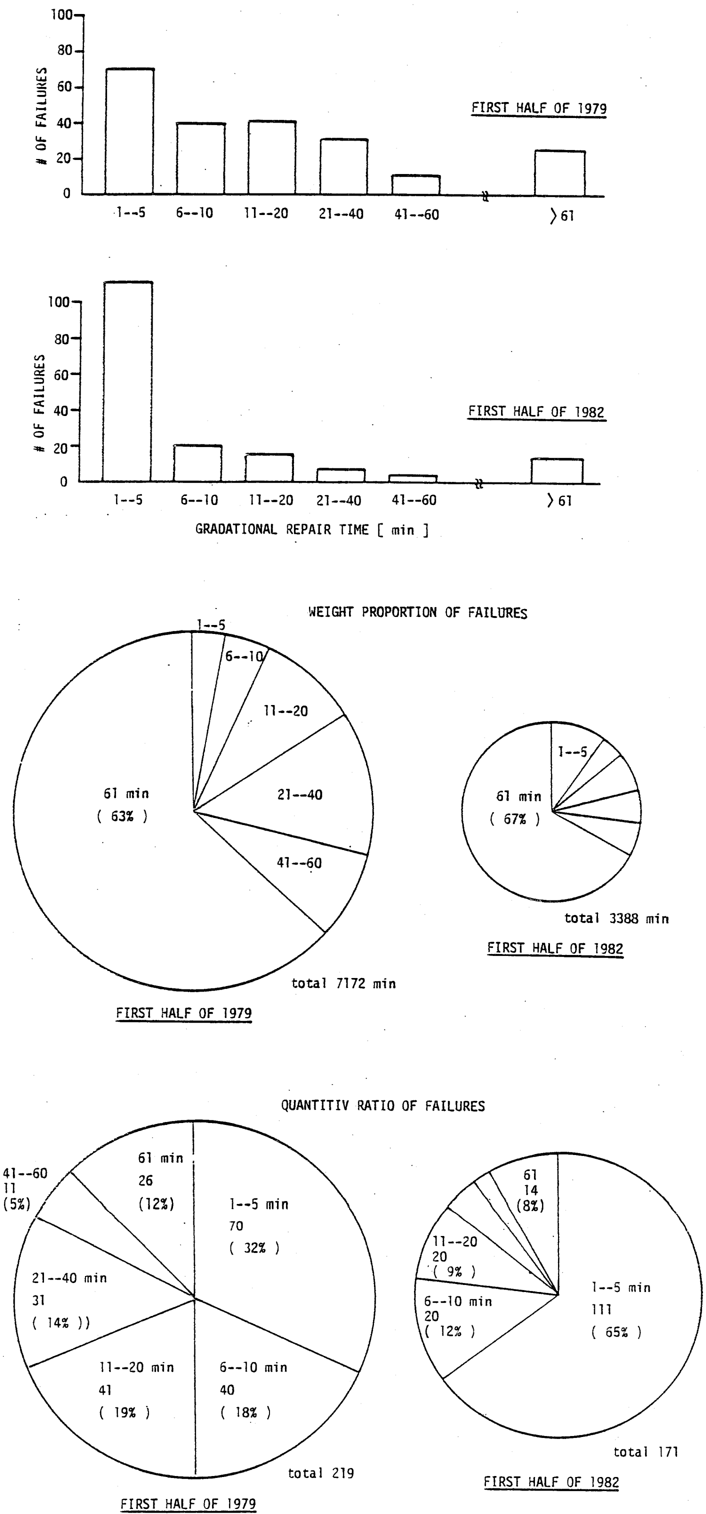


Fig. 6 STATISTICS OF REPAIR TIME(FAILURE HOUR) COMPARED 1979 WITH 1982

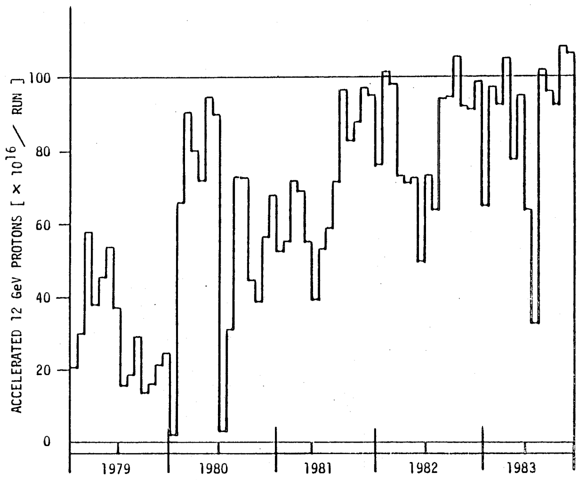


Fig. 8-1

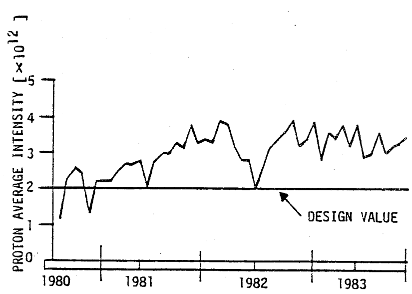


Fig. 8-2

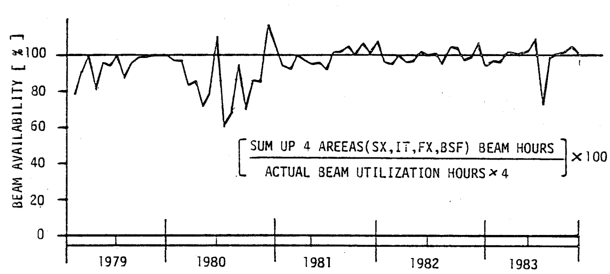
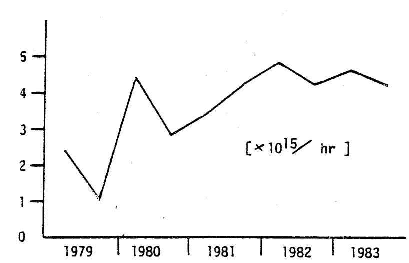


Fig. 8-3



ACCELERATED PROTONS AT BEAM UTILIZATION