

1. Machine Operation

The operation timetable of the PF Storage Ring and the PF-AR in FY2000 are shown in Fig. 1.

Time	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT
Date							4.1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PF														BA							
AR																					
Date	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	5.1	2	3	4	5	6
PF				B							B										
AR																					
Date	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
PF											B							B			
AR																					
Date	28	29	30	31	6.1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
PF				B							B							B			
AR																					
Date	18	19	20	21	22	23	24	25	26	27	28	29	30	7.1	2	3	4	5	6	7	8
PF				B							B(SB)								B		
AR																					
Date	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25				
PF				B							B										
AR																					
Date	10.1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
PF																					
AR																					
Date	22	23	24	25	26	27	28	29	30	31	11.1	2	3	4	5	6	7	8	9	10	11
PF				B							B(SB)							B			
AR																					
Date	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	12.1	2
PF				B							B								B		
AR																					
Date	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
PF				B							B								B		
AR																					
Date	1.14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	2.1	2	3
PF																					
AR																					
Date	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PF				B(SB)							B								B		
AR																					
Date	25	26	27	28	3.1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
PF				B																	
AR																					

PF: PF ring

- Experiment using SR (2.5 GeV, 36 nrad)
- Ring machine study
- BA** Beam alignment
- Single bunch operation at 2.5 GeV
- Tuning and ring machine study
- Short maintenance and/or machine study
- Experiment using SR (3 GeV)
- B** Bonus time during maintenance and/or machine study of injector linac

AR: PF-AR

- Experiment using SR
- Tuning and ring machine study

Figure 1. Originally scheduled timetable of the machine operation in FY2000.

PF-Ring

The PF-ring was operated almost successful but some unfortunate accidental stops occurred. The operation statistics are presented in Table 1. Figures 2-4 show the trends of operation time, average stored current, injection interval, and a product I (stored current) $\times \tau$ (lifetime).

We had some failures in FY2000. In June to July, the operation stopped accidentally in several times. They were due to lightning damages to the power-supply system outside of KEK. Sudden off/on of electric power caused circuit failures of the electric power supplies for the magnets. We spent longer time to repair them. In addition, slow vacuum leaks occurred to the ceramics windows of an RF coupler. Thus, the ratio of the failure time against the operation time increased than that in the preceding fiscal years, as shown in Fig. 5.

During the winter run, we had to stop the operation of the super-conducting vertical wiggler (VW#14), because impurity gas plugged the liquid-helium charging line. We blew-out the plug impurities using high-pressure helium gas after the warming of the wiggler system. It succeeded and the VW#14 could come back to the operation in the 2001 spring user run.

In the summer run of June and July, we experienced beam-orbit drift caused by the temperature change of the cooling-water system. The system usually controls the water temperature automatically, but stood in out-of-control because the summer of 2000 was too hot. We had no choice but to control the system manually. It is an important issue that the power of the heat-exchange system is to be enhanced to stabilize the beam orbit.

Table 1. Statistics of the storage ring operation during FY2000.

	Multi-bunch	Single-bunch	Total
Ring operation time (hours)	5032.0	432.0	5464.0
Scheduled user time (hours)	4200.0	432.0	4632.0
Net user time T (hours)	4049.9	404.9	4454.8
Time used for injection (hours)	80.4	20.9	101.3
Integrated current in T (A \times hours)	1350.0	19.0	1369.0
Average current in T (mA)	333.3	46.7	--
Number of injections	173	36	209
Interval between injections (hours)	20.8	7.5	--

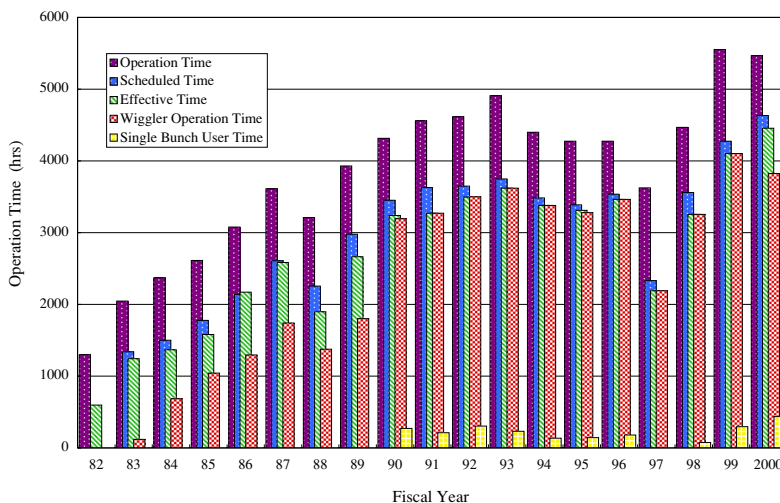


Figure 2. Operation time history of the PF Storage Ring.

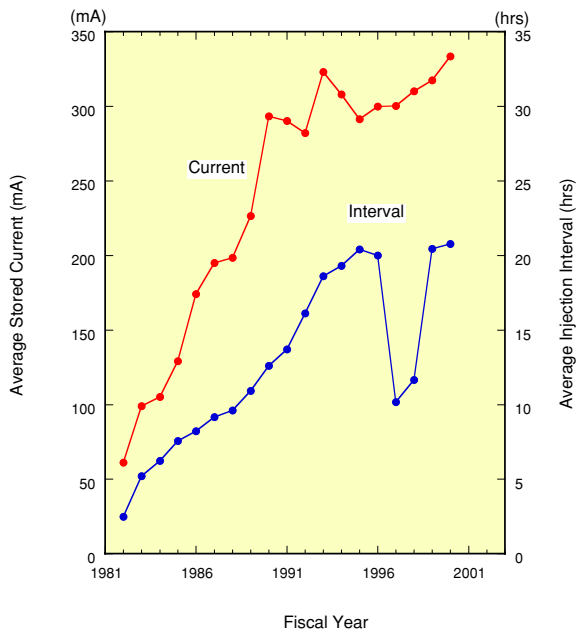


Figure 3. Average current and injection interval of the PF Storage Ring.

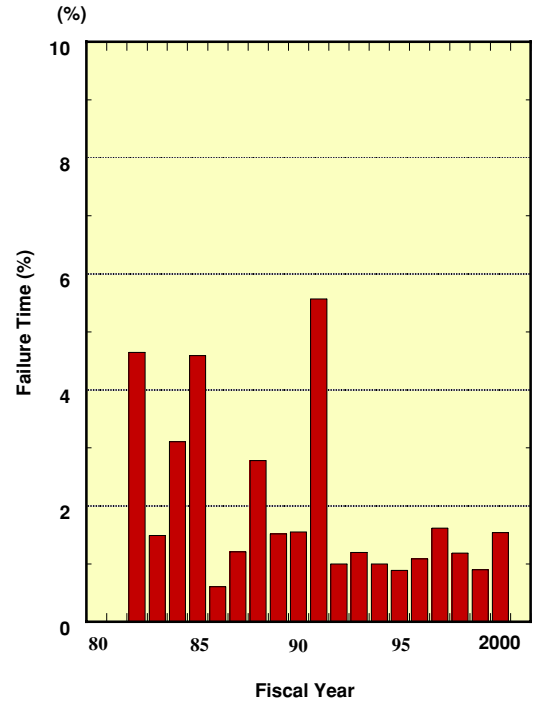


Figure 4. Failure time history of the PF Storage Ring.

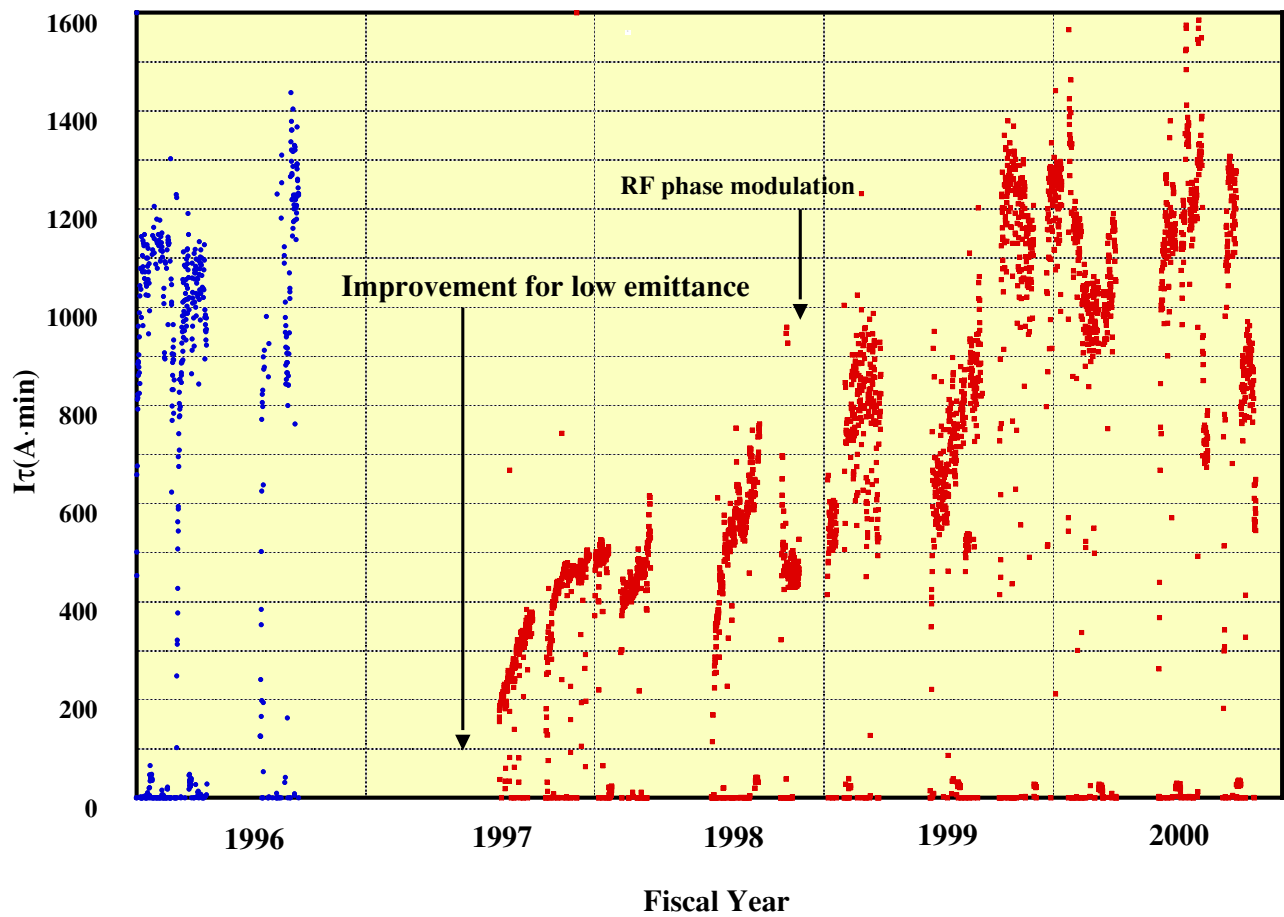


Figure 5. $I\tau$ history of the PF Storage Ring in recent 5 years.

PF-AR

The principal parameters and the operation statistics of the PF-AR are presented in Tables 2 and 3. The operation time history, an example of one-day operation, trend of the product $I \tau$ (stored current) $\times \tau$ (lifetime) are shown in Figs. 6-8, respectively. The value $I \tau$ increased gradually with the integrated beam current at first but decreased after 100 A-hr. In accordance, the average pressure normalized by the beam current (p_{av}/I) decreased gradually but increased when the integrated current reached 100 A-hr. These phenomena are due to the failure of vacuum pumps and vacuum leak from a BPM feedthrough. The vacuum system of PF-AR is too old and too suffered by high-energy photon irradiation. Thus, it is quite difficult and partly impossible to recover its original performance by the usual maintenance treatments. As described in Sec. 3, work concerning the upgrading project has started just after the stopping the FY2000 operation.

Table 2. Principal parameters of the PF-AR.

Energy	6.5 / 5.0 GeV
Bending radius	23.708 m
Circumference	377.26 m
RF frequency	508.58 MHz
Harmonic number	640
Betatron tune (H/V)	10.15 / 10.23
Emittance	294 nm-rad
Initial current	40 mA

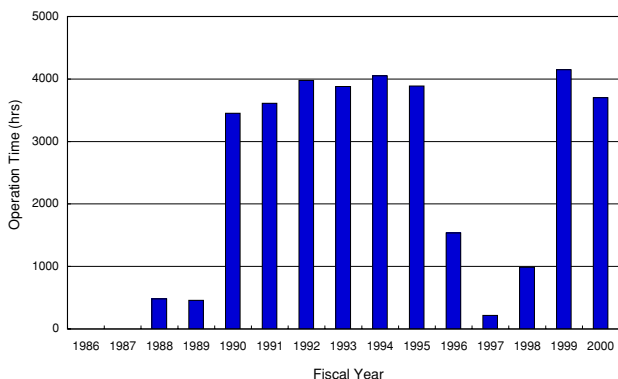


Figure 6. Operation time history of the PF-AR.

Table 3. Operation statistics of PF-AR in FY2000.

Operation Time	5184.0 h	100.0%
SR Experiment	4533.0 h	87.4%
Beam Development	266.0 h	5.1%
Failure	291.5 h	5.6%
Miscellaneous	93.5 h	1.8%

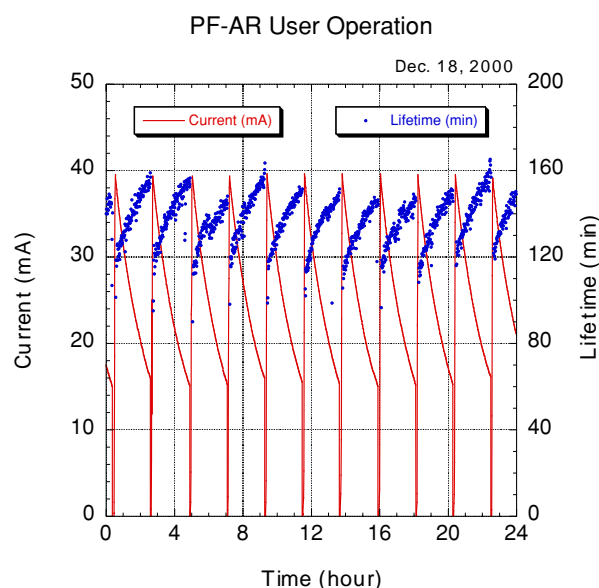


Figure 7. Typical one-day operation of the PF-AR.

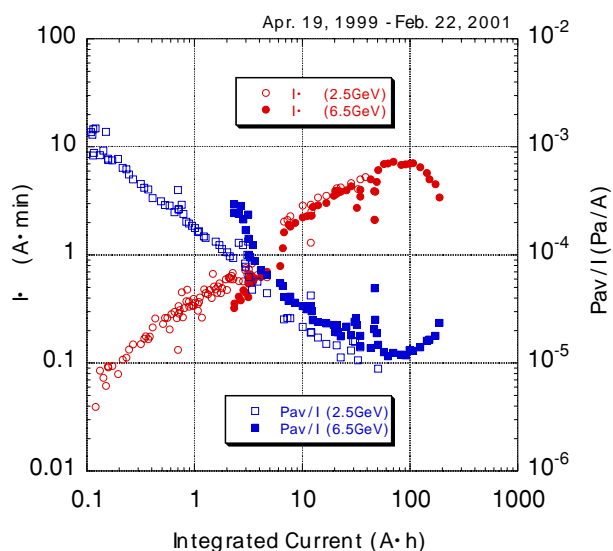


Figure 8. $I \tau$ and average pressure of the PF-AR during FY1999 and FY2000.