RF Sytem Overview

E. Ezura

KEK

KEKB Machine Advisory Committee Review

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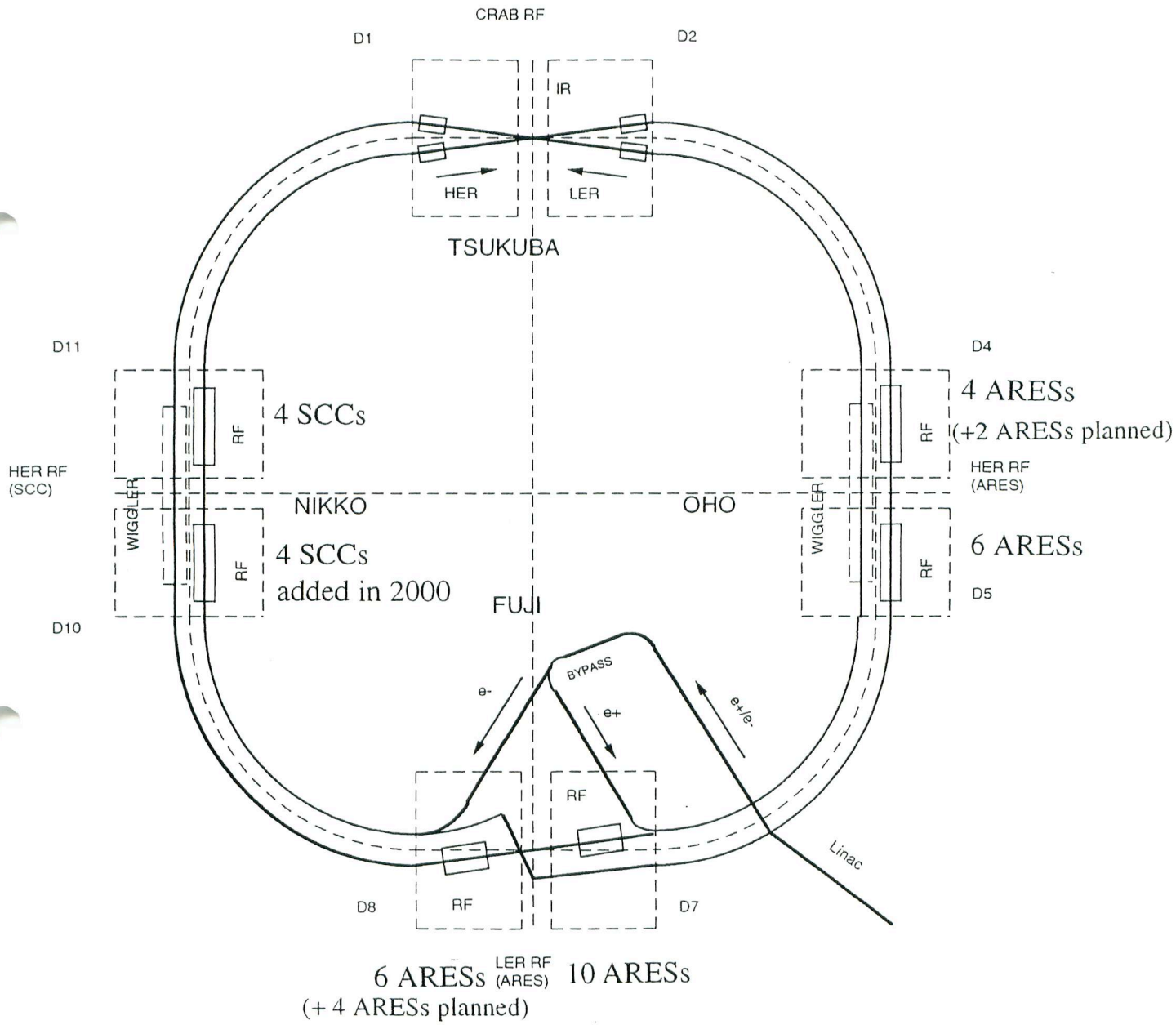
4 SC cavities were added in the summer of 2000.



Arrangement of RF cavities along the ring

RF-Related Machine Parameters

		LER	HER
Beam energy	(GeV)	3.5	8.0
Beam current	(A)	2.6	1.1
Bunch length	(mm)	4	4
Synchrotron tune		0.01 - 0.02	0.01 - 0.02
RF voltage	(MV)	4.9 - 9.4	8.7 - 16.2
RF frequency	(MHz)	508.887	
Damping time	(ms)	43 / 23*	23
Radiation power	(MW)	2.1 / 4.0*	3.8
HOM loss	(MW)	0.57	0.14
Total beam power	(MW)	2.7 / 4.5*	4.0

*with wigglers for LER

RF Parameters for the Maximum Voltage

Ring		LER	HER
		w/wiggler	hybrid
Cavity		ARES	SCC+ARES
Relative phase	(deg.)	-	10
RF voltage	(MV)	10	17.9
Number of cavities		20	8 + 12
R/Q	(Ω)	14.8	93 / 14.8
Q_0		1.1×10^5	$>1 \times 10^9$ / 1.1×10^5
Q_L	($\times 10^4$)	3.0	8.0 / 3.0
Input coupling		2.7	- / 2.7
Cavity voltage	(MV/cav.)	0.5	1.5 / 0.5
Input power	(kW/cav.)	375	250 / 340
Wall loss	(kW/cav.)	154	- / 154
Beam power	(kW/cav.)	221	250 / 250
Number of klystrons		10	8 / 6
Klystron power	(kW)	~810	~270 / ~740

■ Number of Operating Cavities

Period	98/12 ~99/07	99/10 ~00/07	00/10~	Design
LER				
ARES (installed)	10~12 (12)	14~16 (16)	14 (16)	20
RF voltage	4MV	5~6MV	6MV	5~10MV
HER				
ARES (installed)	6 (6)	10 (10)	8~10 (10)	12
SCC (installed)	4 (4)	4 (4)	5~6 (8)	8
RF voltage	8MV	9~11MV	11MV	8~16MV

Design values of RF voltage per cavity are 0.5MV/ARES and 1.5MV/SCC.

■ Parameters Achieved by Feb. 2001

	LER	HER
Beam current (mA)	860 (2600)	650 (1100)
Operating RF Voltage (MV) NC/SC	6 (5～10)	11 (8～16) 3.24 / 7.76
No. of cavities	14 (20)	NC: 10 (12) SC: 6 (8)
Operating Voltage / cav. (MV)	0.43 (0.5)	NC: 0.32 (0.5) SC: 1.3 (1.5)
Conditioned up to (MV)	0.5 (0.5)	NC: 0.5 (0.5) SC: >2.0 (1.5)
Total beam power (MW)	1.8 (4.5)	2.3 (4.0)
Beam power / cav. (kW)	130 (225)	NC: 130 (170) SC: 380 (250)
Beam power / cav. (kW) (by shifting RF phase)	180 (225)	NC: 200 (170)
HOM power / cav. (kW)	～1	SC: 3.25 (5.0)

Numbers in ( ) are design values.

■ Stored Beam Current

● No more than 860 mA has been intended to store in LER due to beam blow-up.

● Beam current in HER has been limited due to heating of movable masks. They will be replaced with improved masks.

● So far, beam current has never been limited by RF system.

● RF system can support more beam current as follows:

	LER	HER
Present RF system	1300mA (14NC)	900mA (10NC+6SC)
When sidelined cavities are back	1500mA (16NC)	1000mA (10NC+8SC)
With more conditioning	1800mA (16NC)	
With 6 more ARES's added	2600mA (20NC)	1100mA (12NC+8SC)

Trips, faults and system improvements

- RF trip rate : ～1 / day (trip with beam loss : 1 / 2～3days)
  Main causes of trips :
  reflection from cavity, large power from coupling cavity, arcing in input coupler, SCC quench, false crowbar work, etc.

- Loss time in physics run due to RF troubles
  Apr. 2000～Jul. 2000 23 hours / 4 months
  Oct. 2000～Feb. 2001 *47 hours / 4 months
  *(including 35 hours for replacing an ARES input coupler)
  Total loss time due to all RF troubles is only 70 hours in 8 months physics run.

- A coaxial-to-waveguide transition of input coupler was damaged by arcing. Arc detectors which look at the air side of the window are being prepared and will be mounted in this summer.

- Rate of false crowbar work has increased (2～3 times/ month). Conditioning of all ignitrons in the crowbar is necessary in this summer shutdown.

- To protect vacuum components from being hit by the beam, a fast beam-abort request signal will be prepared. The signal will be sent out when detecting a large beam-phase shift resulted from RF stations trip.

Main work to do

(1) ARES Installation

- 26 out of 32 ARESs planned have been installed and are now reliably operating.
- 6 ARESs to be added, 4 to LER and 2 to HER, have already been manufactured, fully processed and are ready for installation.
- Present 16 ARESs can support the LER beam current of 1.5A.
- Time of ARES installation depends on the rate of beam-current increase and the financial condition.

(2) Construction of SCC high-power test station

- Former SCC high-power test station was converted into KEKB D10-D station in last summer.
- New SCC test station is essential for maintenance of SC accelerating cavities and for developing SC CRAB cavities.
- Its construction is expected at D10 in the fiscal year 2001.

Summary

- RF system has been operating very reliably.
  Loss time due to all RF troubles is small, 70 hours in 8 months physics run.

- Up to now, RF system has not limited stored beam currents of both LER and HER.