OPTIMIZATION OF BEAM OPTICS IN THE KEKB RINGS

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Abstract

The lattice of the KEKB rings have a wide range of tunability. This paper represents various kinds of optics used for commissioning after the installation of the Belle detector.

1 OVERVIEW

The KEKB B-Factory[1] is an 8 GeV electron + 3.5 GeV positron double-ring collider (HER and LER). Each ring has four arcs and four 200 m-long straight sections. The arcs consist of 2.5 π unit cells with non-interleaved sextupoles connected by a pseudo $-I$ transformer[1,2]. Figure 1 shows a schematic view of the KEKB accelerator complex.

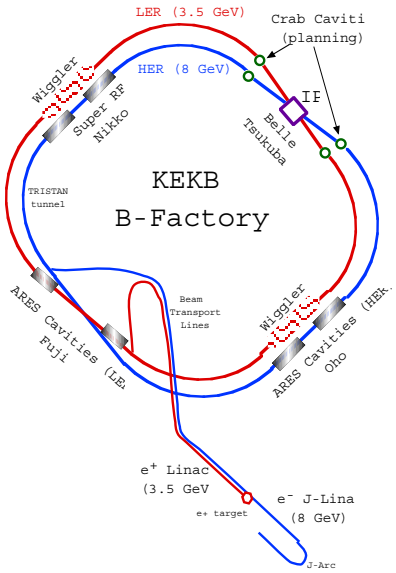

Figure 1: A schematic view of the KEKB B-Factory. The straight sections are functioned as: *Tsukuba* the interaction region for the Belle detector, *Fuji* for injection and RF cavities (LER), *Nikko* and *Oho* for RF (HER), wigglers(LER).

The main lattice parameters such as the emittance, the bunch length, the beta functions at the interaction point (IP) have been tuned flexibly according to the requirements from various operation status[3]. One big jump was switching to a high-emittance optics to increase the bunch current, since the number of bunches was almost limited to ~ 1000. To avoid instability and heating problems under high bunch-current operation, the bunch length was also increased as listed in Table 1. At present, the rings are operating with Optics HH2 and LH3. This paper describes how to adjust optics to meet requirements for higher luminosity. Almost all calculations related optics tuning done by the code SAD[4] developed KEK.

Table 1: Design parameters of nominal- and high-emittance optics.

HER	HM1	HH1	HH2
Emittance (10^{-8}m)	1.76	2.94	2.95
Momentum compaction (10^{-4})	1.89	2.48	3.39
Bunch length (mm)	4.79	4.90	6.43
RF voltage (MV)	9	11	9
Synchrotron tune	.0126	.0162	.0169
(measured)			.0162

LER	LM1	LH1	LH2	LH3
Emittance (10^{-8}m)	1.69	2.89	2.90	2.94
Momentum compaction (10^{-4})	1.05	1.11	2.42	3.13
Bunch length (mm)	3.41	3.50	5.16	5.86
RF voltage (MV)	5	5	5	5
Synchrotron tune	.0108	.0110	.0163	.0186
(measured)			.0161	.0184

2 CONTROL OF EMITTANCE AND BUNCH LENGTH

2.1 2.5 π cell

There are 7 quadrupole families in the 2.5 π cells as shown in Fig. 2. By adjusting the horizontal dispersion at dipoles (*B2E*/*B2P*), the horizontal emittance and the momentum compaction factor can be optimized independently, keeping the pseudo $-I$ conditions between non-interleaved sextupoles (4 constraints in both horizontal and vertical planes, then totally 6 conditions are applied). One free parameter still remains, which is utilized usually to suppress the beta beat as small as possible. By adjusting the momentum compaction factor, the bunch length can be set to be a target value with a given RF voltage.

2.2 wiggler

In LER, 152 wiggler magnets are now placed in Oho and Nikko sections. After the Belle installation, those wigglers turned on to shorten the damping time to 1/2. The orbit difference due to the wiggler excitation (13.8 mm) was adjusted by chicanes. The bending radius of the wigglers is

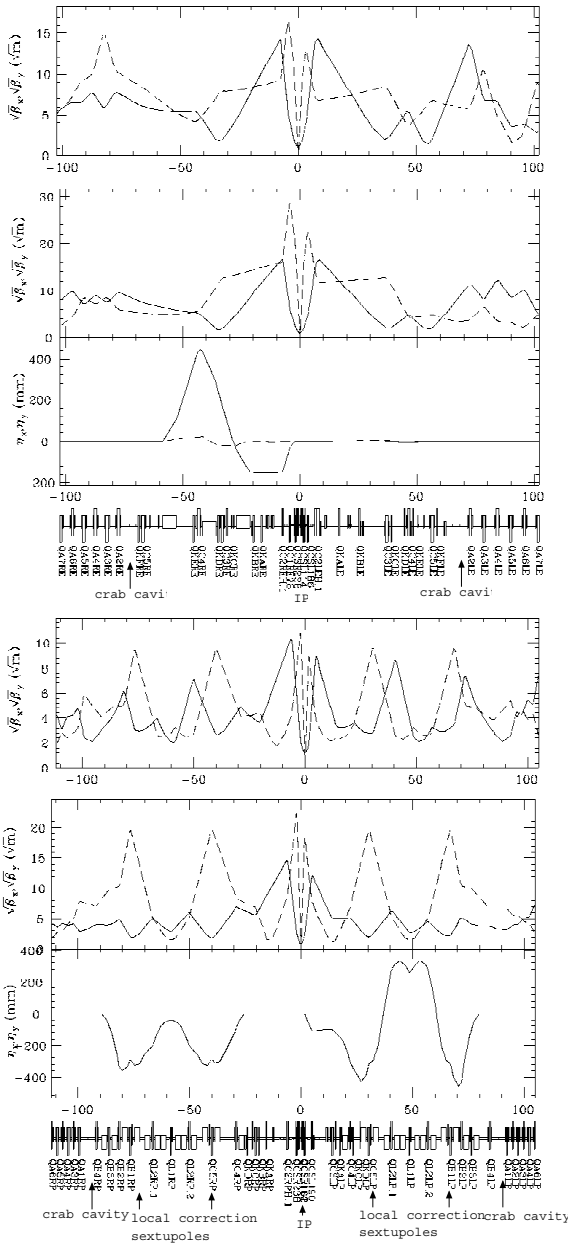

Figure 4: Optical functions in the IR: $\beta_x^*/\beta_y^*(\mathrm{cm}) = 150/3$ (HER), 63/0.7 (HER), 150/3 (LER), 63/0.7 (LER), from top to bottom.

rectly in a finite momentum band width, which is typically 1-2%[1,2]. In fine tuning, however, the linear chromaticities and the momentum dependence of the Twiss parameters at the IP are also adjusted according to conventional perturbation formulae so as to avoid a rapid change of sextupole strengths. A high vertical chromaticity of 10-12 is selected for stable high-current operation in LER.

The authors thank all the members of the KEKB accelerator group for helpful discussions and supporting the commissioning.

Table 2: IP beta functions and their luminosity performance. The "good" means to stand practical use for physics runs. (*) tried only for HER in a short period for machine studies.

β_x^* / β_y^* (cm)	1	0.7	0.6
100	good		
70		good	
63		good	
50		(*)	not good
33		(*)	

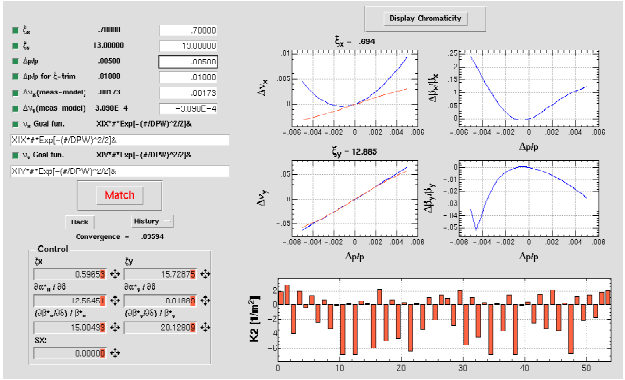

Figure 5: An example of chromaticity correction in LER.

6 REFERENCES

[1] KEKB B-Factory Design Report, KEK-Report 95-7, (1995).

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[3] K. Oide *et al.*, KEK-Proceedings 99-24, 12(2000). Y. Funakoshi *et al.*, in these proceedings.

[4] http://www-acc-theory.kek.jp/SAD/sad.html .