PRESENT STATUS OF THE KEKB B-FACTORY

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Abstract

The KEKB B-factory is an energy-asymmetric e+e- double-ring collider at KEK. It has been operated since December 1998, and has recently marked the peak luminosity of 7.35 /nb/s which is the highest value in the history of colliders. By several improvements such as solenoid windings in LER, new moving-chamber masks in HER, etc., the luminosity performance of KEKB has been significantly upgraded last year. This paper mainly describes the progress after the summer shutdown in 2001.

1 OVERVIEW

The luminosity performance of KEKB, both peak and integrated luminosities, has been almost doubled in a year, as shown in Fig. 1. The main beam parameters at the peak record are listed in Table 1, compared with those about a year ago. While the main optical parameters, ε_x, $\beta^*_{x,y}$, σ_z, and the number of bunches were almost unchanged, the beam-beam parameters increased as the bunch current increased. The total beam currents are now mainly limited by heating of the IR masks closest to the IP, due to both HOM and synchrotron light.

Table 1: Beam Parameters of KEKB.

	2002 May		**2001 May**		
	LER	**HER**	**LER**	**HER**	
Energy	3.5	8.0			GeV
Circumference	3016				m
Current	1350	900	854	675	A
Bunches	1224		1154		
Curr./bunch	1.10	0.74	0.74	0.58	mA
Spacing	2.4		2.4		m
Emittance ε_x	18	24	18	24	nm
β^*_x	59	61	59	63	cm
β^*_y	0.62	0.7	0.7	0.7	cm
Hor. Size @IP	103	121	103	123	μm
Ver. Size @IP	2.7	2.7	2.6	2.6	μm
$\varepsilon_y/\varepsilon_x$	6.7	4.5	5.3	4.0	%
Bunch Length	5.3	5.5	5.5	5.8	mm
RF Voltage	6.5	12.0	6.0	11.0	MV
ξ_x	.079	.073	.065	.048	
ξ_y	.049	.042	.047	.029	
Lifetime	100	300	133	259	min.
Luminosity	7.35		3.84		/nb/s
Lum/24 hrs	387		207		/pb
Lum/7 days	2524		1302		/pb
Lum/30 days	8783		4047		/pb

2 HIGH CURRENT OPERATION

For higher current operation, several improvements were took place after the summer shutdown in 2001:

- More solenoid windings in LER to suppress the photo-electron cloud. The total length of the solenoid is shown at the bottom in Fig. 1. At present, almost all of the field-free regions are covered with the solenoid field of more than 30 Gauss.
- New moving-chamber masks in HER: Heads of the masks were made by combination of Cu and Al or Ti to avoid damaging the mask heads by a direct hit of the beam.
- Faster kickers for the beam abort system which enable to shorten the abort gap from 10% to 4.6% of the circumference, thus increasing the number of bunches.
- Better beam abort system with loss monitors which consist of PIN diodes.
- New abort chamber for both rings to avoid vacuum leakage at high-current aborts.
- More cavities and the 0 and -1 mode feedback system.
- Better cooling system around the interaction point (IP).

With those improvements, the peak and the specific luminosities were improved successfully as the stored current increased. No significant single-beam blowup of the vertical beam size was observed in LER up to 1500 mA [1]. The stability of the luminosity performance was also improved, so that the luminosities were quickly recovered after a short break for maintenance and hardware repair. At higher current, it is important to tune the transverse bunch-by-bunch feedback system frequently for stable operation.

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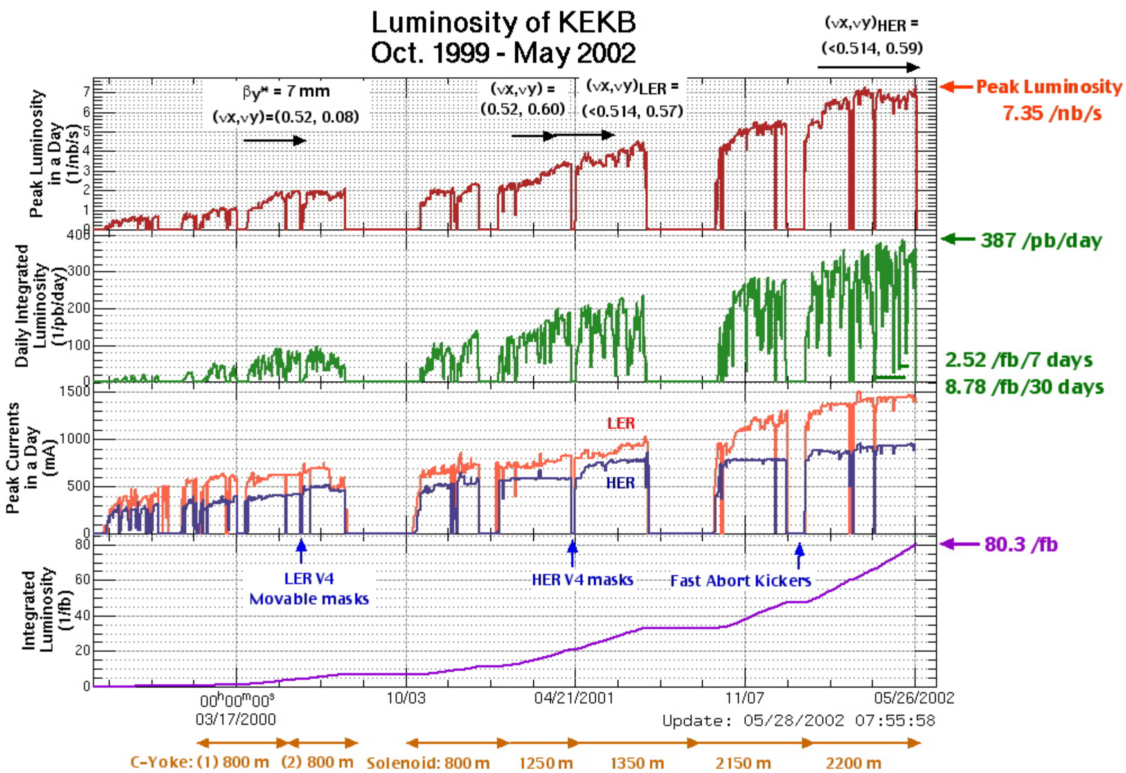

Figure 1: History of KEKB Luminosity.

3 OPTICAL PARAMETERS

KEKB has been successfully operated with low-β_y^* optics. In order to keep a high luminosity stably, beam-optical functions are measured and corrected with an on-line model by SAD during daily operation[2]. Improvements in the beam-optical parameters are listed as below:

- Horizontal tunes more closer to half-integer resonances [3].
- Better correction of the x-y coupling by using both (a) correction factors of skew quadrupoles and (b) vertical symmetric bumps at $-I'$ sextupole pairs, at the same time.
- Better correction of the global β correction by adjusting the horizontal orbit as small as possible at strong sextupoles, in particular in HER.

Fine control of the betatron tunes is necessary for the stable operation at close to the half-integer resonance. A measurement system with a gated tune-mater[4] has been developed and working well as shown in Fig. 2.

4 LUMINOSITY PERFORMANCE

Figure 3 shows the improvement of the specific luminosity during this period. The first jump was brought about by good suppression of the electron clouds with extended solenoid windings. The second one came from the closer ν_x to the half integer, in particular in HER as shown in Fig. 1.

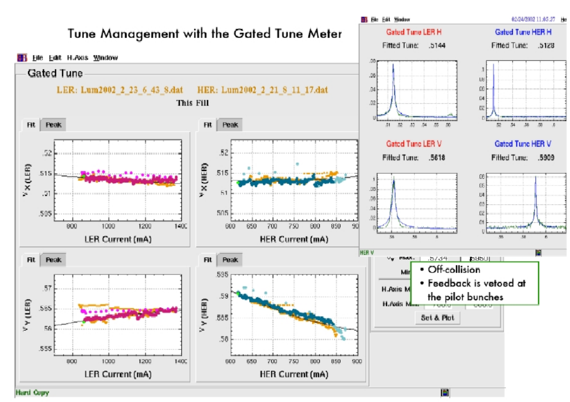

Figure 2: Example of tune management with gated tune mater.

5 ORBIT DRIFT

As a result of the optics corrections, the *golden* orbits with local bumps at sextupoles are determined. In daily operation, the orbits are maintained by continuous closed-orbit corrections in every 20 seconds. The horizontal orbits, however, gradually drift in a few days, which cause the tune drift and may degrade the luminosity performance as shown in Figs. 4 and 5. The horizontal drifts have not been suppressed even with the adjustment of the circumference by chicane in LER. On the other hand, no significant drifts of the vertical orbits were observed. The horizontal drift is cured practically, by restoring the horizontal steer-

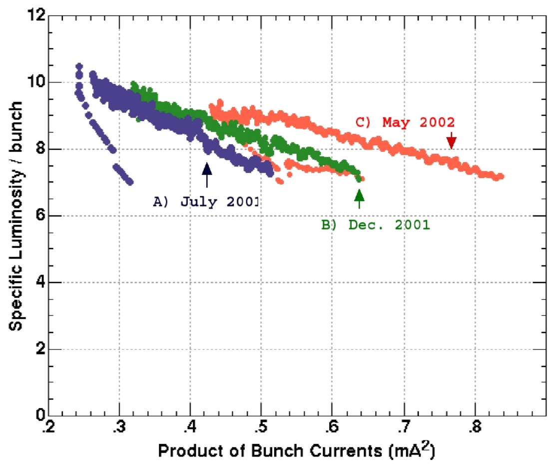

Figure 3: Improvement of specific luminosity in the regular 4-bucket spacing operation.

ing magnets when the difference exceeds a criterion limit.

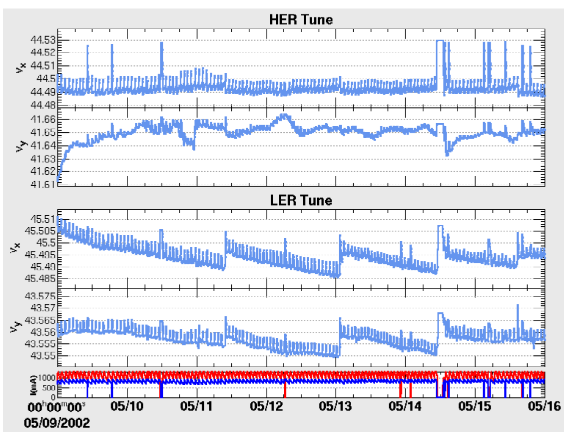

Figure 4: History of model tunes during the best 7 days.

6 NEAR-TERM ISSUES

To improve the injection rate of the positron beam, a 2-bunch/pulse injection scheme has been developed[5]. This methods came into practical use in mid April and indeed shorten the injection time by a half. To match the 2-bunch injection mode, the bunch fill pattern in the rings was changed to an irregular 4-bucket spacing with 49 bucket periodicity. Although the integrated luminosity was improved with the 2-bunch injection, the specific luminosity during that period was lower than the regular 4-bucket operation. That irregular pattern also made the detector background worse, so we abandoned the 2-bunch injection temporarily. The 3.5-bucket spacing that was tried to increase the number of bunches also matches to the 2-bunch injection, but that pattern has also achieved lower luminosity as shown in Fig. 6. The dependence of the specific luminosity on the fill pattern is now being studied intensively, and a relation to the HOM effects of the IR chamber and masks has been suspected. After solving a problems on the data taking system of Belle, continuous injection [5] to LER will be retried after the next summer shutdown.

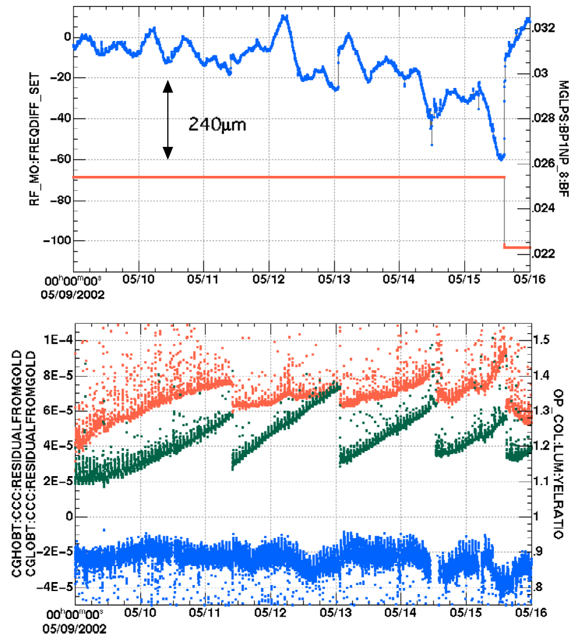

Figure 5: Orbit drift during the best 7 days during the best 7 days.

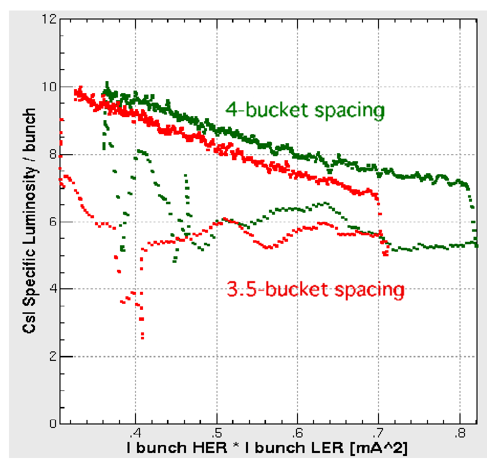

Figure 6: Specific luminosity in 3.5-bucket spacing operation.

7 REFERENCES

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