

KEKB Accelerator Review Report

Andrew Hutton

Chairman

KEKB Accelerator Review Committee

Committee Membership

- The Eleventh KEKB Accelerator Review Committee meeting was held on March 20-21, 2006.
- John Seeman from PEP-II was unable to attend and was replaced by Yunhai Cai, an accelerator physicist working on PEP-II
- Dave Rice, Flemming Pedersen, and Shin-ichi Kurokawa were also unable to attend this meeting

KEKB Accelerator Committee Members

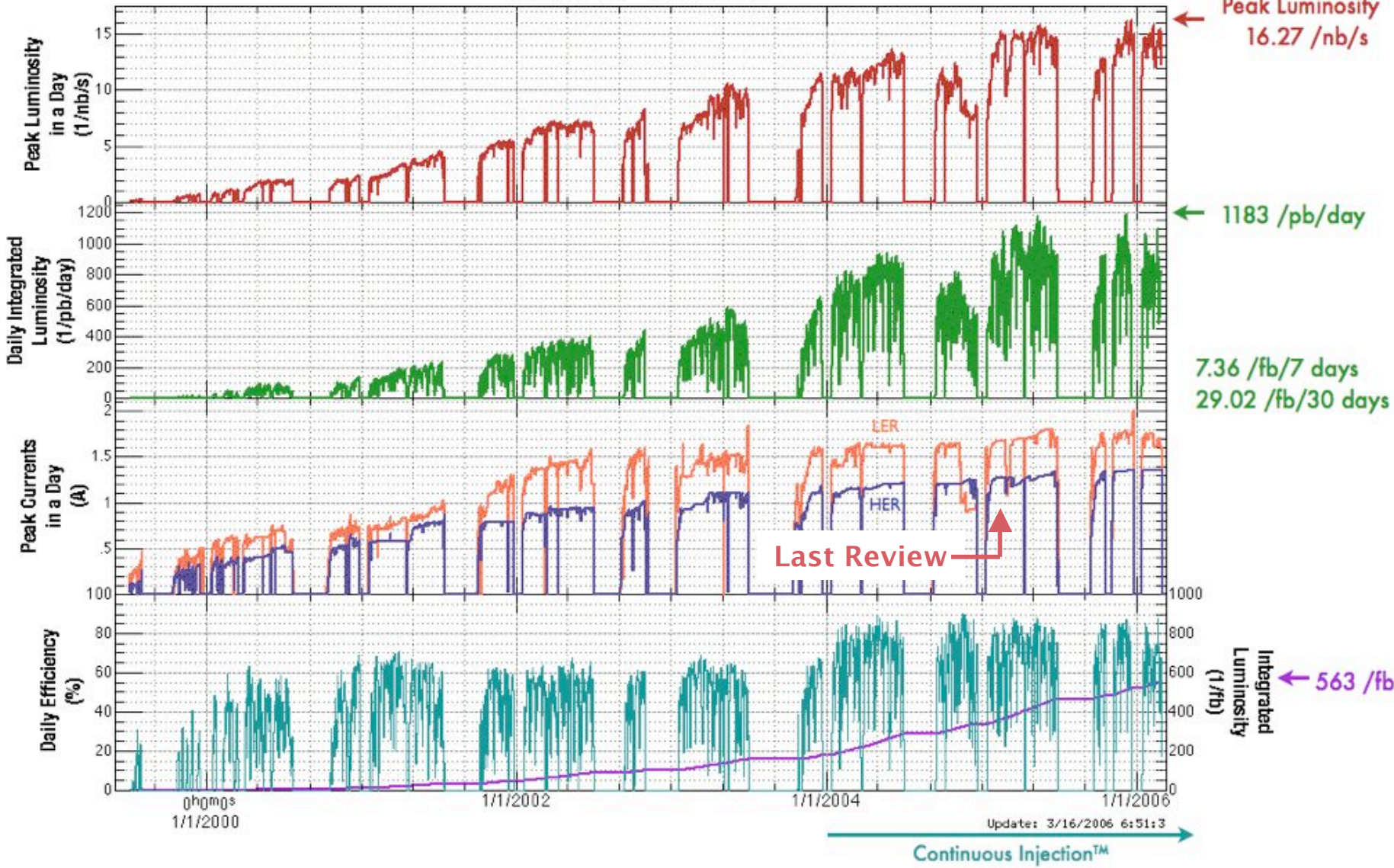
Andrew Hutton	JLab	Chairman
Yunhai Cai	SLAC	(replacing John Seeman)
Alexander Chao	SLAC	
Warren Funk	JLab	
Oswald Gröbner	CERN	(retired)
Georg Hoffstaetter	Cornell	
Won Namkung	POSTECH	
Flemming Pedersen	CERN	
Eugene Perevedentsev	BINP, Novosibirsk	
David Rice	Cornell	(unable to attend)
John Seeman	SLAC	(unable to attend)
Wang Shuhong	IHEP, Beijing	
Katsunobu Oide	KEK	Secretary
Shin-ichi Kurokawa	KEK	Secretary (unable to attend)

Overview of Performance

- KEKB has made excellent progress since the last Committee meeting
- Peak luminosity has increased to a new world record of **$1.627 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$**
 - At this time last year it was $1.52 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
- Maximum integrated luminosity was **1.183 fb^{-1} in 24 hours**
- KEKB was and was awarded the S-Equivalent rating by the Council for Science and Technology Policy – the top rating
 - This rating was awarded both for the Physics output and also explicitly for the machine performance

KEKB History

Luminosity of KEBK
June 1999 - Mar. 2006



Luminosity

- KEKB continued to make steady progress
- KEKB holds all of the worldwide luminosity records:
 - highest peak luminosity: $1.627 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$
 - highest daily integrated luminosity: 1183 pb^{-1}
 - highest weekly integrated luminosity: 7.36 fb^{-1}
 - highest 30-day luminosity: 29.02 fb^{-1}
- The luminosity has improved only by $\sim 10\%$ since last year
 - Probably close to saturation

No major improvement likely until crab cavities are installed

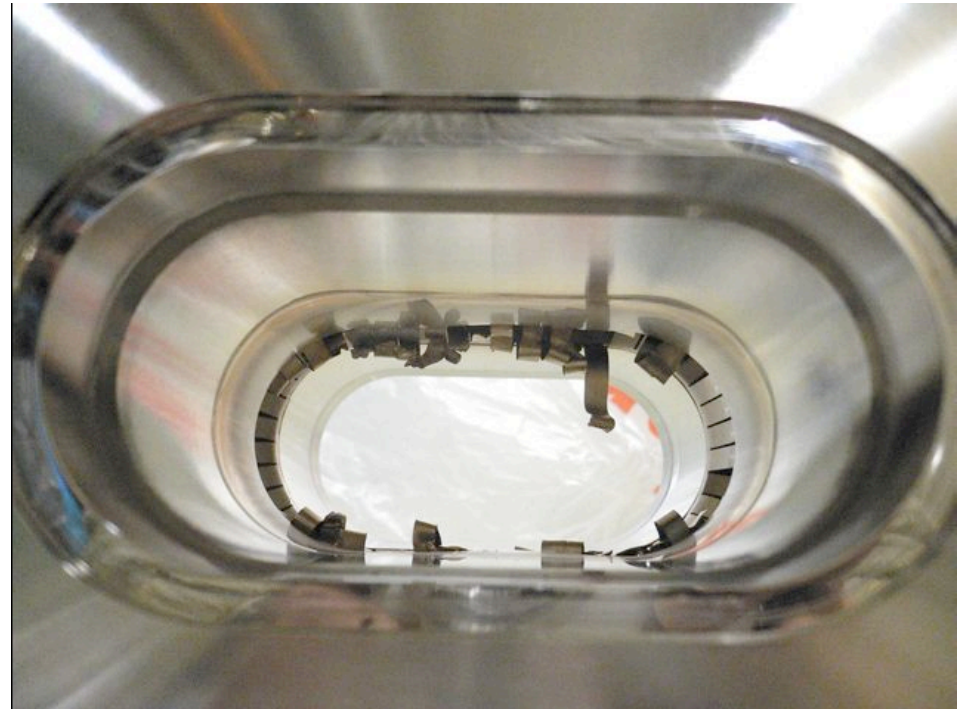
May take many months to tune crab cavities to see full benefit

Detailed Look at Luminosity

- KEKB operated perfectly up to summer shutdown
- New crab lattice was installed in summer shutdown
 - Optics change to prepare for hardware installation
- This did not go well, took several months to recover peak luminosity
- Luminosity still much more variable than before
 - Weekly and monthly luminosity still not recovered
- Committee believes this is due to crab lattice
 - Probably less tolerant to off-momentum particles

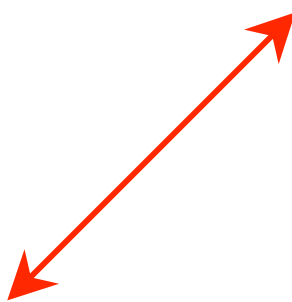
Hardware

- First evidence of damaged “standard” components
 - Significant cause for worry
- Accelerator availability was lower in 2005
 - Caused by bad recovery from summer shutdown
 - More downtime in October 2005 than entire 2004!

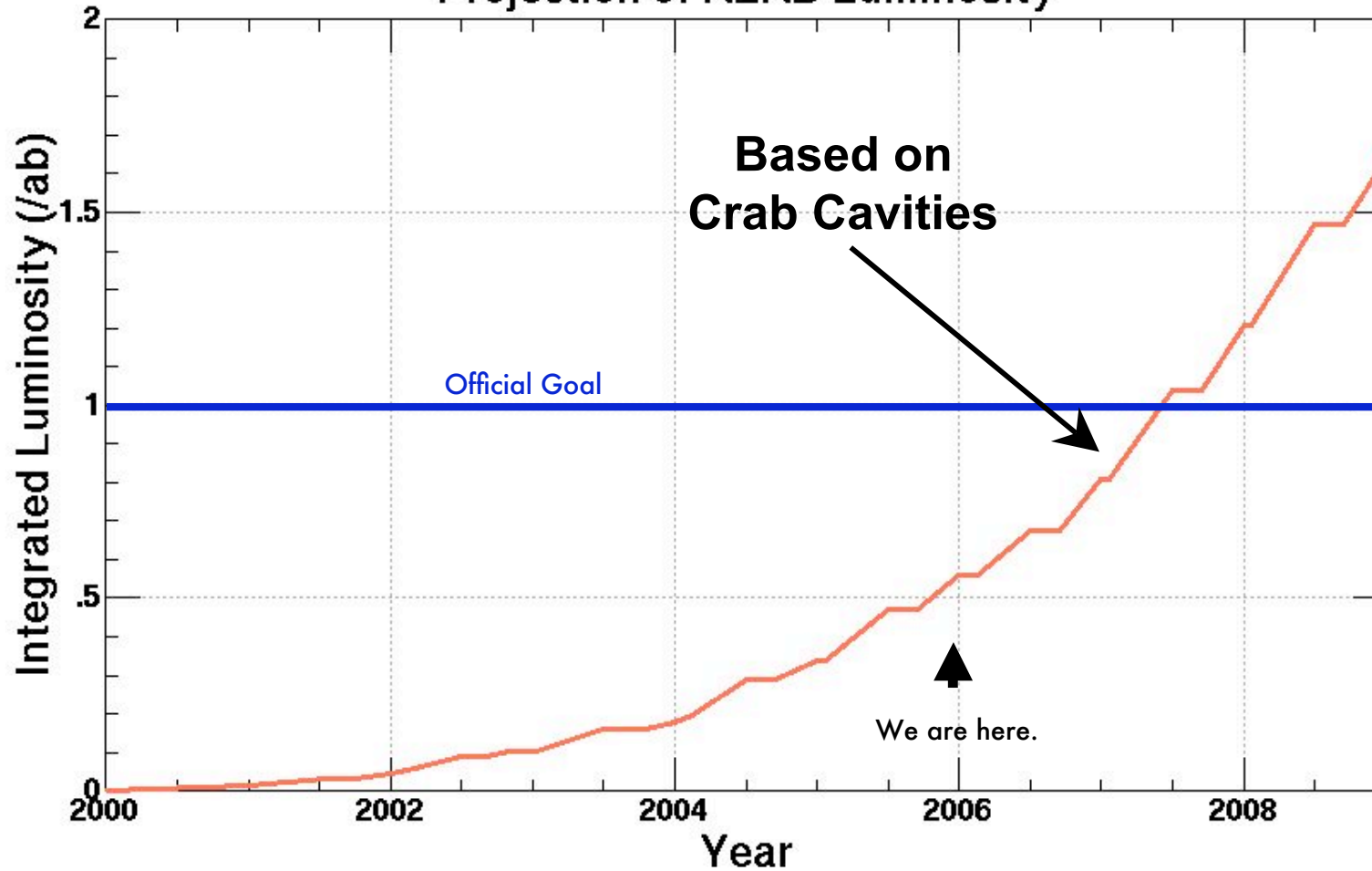


The Committee is concerned about the damaged standard components but does not believe that this is an immediate problem

Belle Detector

- The Belle detector has accumulated **563 fb⁻¹**, another world record
 - 365 fb⁻¹ last year
 - “Oide Scenario” predicted **550 fb⁻¹** at this time
 - Extraordinarily accurate prediction!
 - The Belle detector is working extremely well except for a period after the operating system was updated
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Projection of KEKB Luminosity



- 550 /fb will be reached before the Crab Cavity Installation.
- The Official Goal (=1 /ab) will be achieved before Summer 2007.

Crab Cavity

- Progress in crab cavity has been excellent
 - Most components ready to go
 - Minor “bump in the road” recently
- Problems with assembly of coaxial coupler
 - Heavy piece (~100kg)
 - Must be inserted with sub-millimeter tolerances
- The Committee examined the process in detail and endorses the present design
 - Made suggestion for improved fixtures



Repeat Recommendations (3rd time)

1. The Committee strongly endorses the plan to assemble, test, install and commission one crab cavity in each ring in the summer shut down of 2006

Reminder – this will be the first time that crab crossing has been attempted

2. The Committee endorses the studies to design a major luminosity upgrade (SuperKEKB) aimed at a luminosity of $2-4 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and recommends that they be continued

Repeat Recommendations (2nd time)

3. The Committee strongly endorses the plans for simultaneous injection in all four rings
4. The Committee recommends continuing the studies of a movable mask which is 'electrically invisible' (rod with ceramic support) and has a much lower loss factor
 - A significant amount of R&D remains to demonstrate a reliable, operational movable mask with a reduced loss factor
5. The Committee feels that HOMs is one of the limiting factors in increasing the current. Detailed studies of the vacuum components including proper damping and component cooling should be continued

New Recommendations

6. The Committee supports the present approach to coaxial coupler assembly, and recommends that continued efforts be made to improve the alignment fixtures, rather than searching for a new assembly approach
7. The Committee is agreed that the cavities should be installed in the rings at the earliest possible time, and commissioned, so that the benefits and limitations associated with them can be determined
8. The Committee recommends that both cavities should be cryogenically tested with the complete RF system before any installation is started

New Recommendations

9. While the Committee believes that the crab cavity program will be successful, it requests that the KEK management create a road map for KEKB operations under two different scenarios:
- The crab cavity is successful and KEKB operations continue at $\sim 400 \text{ fb}^{-1}$ per year
 - If after considerable effort, the crab cavity is unsuccessful, KEKB operations continue at $\sim 200 \text{ fb}^{-1}$ per year.

It would also be extremely helpful for planning and optimizing operations if the KEK management could provide an indication of the kind of information that would influence a decision on SuperKEKB (e.g. new physics found at Upsilon 3S or 5S)

New Recommendations

10. The Committee recommends studying carefully the tolerances of the new crab lattices to check if they are more susceptible to errors, such as the orbit drift and identify the causes of the luminosity fluctuation
11. The Committee recommends measuring the nonlinear dispersion as an additional check of the optics model
12. The Committee recommends that a close follow-up of the failures of the standard vacuum components should be made to establish critical operating parameters and to put limits on them

New Recommendations

13. The Committee recommends studying the effect of C-type magnets mounted on the antechamber, the solenoid field, and of a reduced secondary electron yield (SEY) (by coating or surface treatment) in simulations of the electron cloud densities on the beam axis

This is for SuperKEKB

14. The Committee expresses strong support for further studies of low SEY coatings and for testing these coatings under machine conditions

New Recommendations

15. The Committee recommends that an effort be made to understand the mechanism of the sidebands, their role of being a signature of the electron cloud instability onset, and their apparent correlation to the luminosity
16. The Committee supports the proposal by the KEKB team to directly measure the photo-electrons in the quadrupoles; it may give clearer information on the electron cloud in the quadrupoles. Refined simulations of this effect should also be continued
17. The Committee recommends that efforts should be made to estimate the power deposited at the joints between different parts of the coaxial coupler using the presently understood mechanical tolerances

Personal Viewpoint

- KEKB has made excellent progress
 - Luminosity is almost saturated now
 - Expect crab cavities to give large improvement – never been done, not easy
- SuperKEKB is still the long-term goal of the KEKB accelerator physicists
- KEKB should lay out a roadmap for the future of KEKB
 - I am concerned that in a few years, LHC and BEPC will be the only operating HEP colliders
 - ILC is a long way away

Summary

- KEKB is still the world leader
 - Great team, motivated and dedicated
- KEKB can expect to maintain lead for several years
 - Crab cavities should ~double luminosity
 - But - may reduce luminosity for several months before improvement is seen
 - Little improvement without crab cavities
- SuperKEKB would be an excellent match to the KEKB staff if the physics case justifies it