iBUMP FEEDBACK TUNING FOR KEKB ACCELERATOR

T. Aoyama, H. Iida, T. Kawasumi, T. Kitabayashi, Y. Satoh, H. Shimizu, M. Tanaka, K. Yoshii,
Mitsubishi Electric System & Service Engineering Co. Ltd.,
2-8-8 Umezono, Tsukuba, Ibaraki 305-0045, Japan
and
Y. Funakoshi, N. Iida, H. Koiso, M. Masuzawa, Y. Ogawa, K. Oide,
High Energy Accelerator Research Organization (KEK),
Oho 1-1, Tsukuba, Ibaraki 305-0801, Japan

Abstract

KEKB accelerator is an asymmetric electron-positron collider, which has been designed as a high luminosity machine. The iBump feedback system is one of the collision tuning tools. It turned out that the luminosity is very sensitive to the targets value of the iBump feedback. We report an operational history of the iBump feedback system with our trials to realize higher luminosity for the KEKB accelerator.

1 INTRODUCTION

Construction of the KEKB accelerator [1] was finished in November 1998 and physics experiments started in June 1999. Since then the luminosity has been successfully increasing. Up to now, we have 4.49×10^{33} $cm^{-2}s^{-1}$ as the peak luminosity.

To realize such high luminosity, we have applied many tuning methods for collision tuning. The iBump feedback system [2] is one of such tuning methods to control the HER beam orbits at the interaction point (IP): there are two rings in the KEKB accelerator; the high energy ring (HER) for electrons and the low energy ring (LER) for positrons. The iBump feedback system is working to keep an appropriate difference of the two beam positions, called *offset*, by making orbit bumps in the HER near the IP.

We have tried to find the best target value of the iBump feedback to reach high luminosity. However, there are many parameters that affect the luminosity, thus, the iBump target and the luminosity depended on each operator's tuning manner.

In this paper, we report a brief history of the iBump feedback tuning with our trials to realize higher luminosity for the KEKB accelerator.

2 EGURE AND HAZURE

Now, we introduce two terms, *Egure* and *Hazure*. Figure1 is the iSize feedback monitor [3] to control the HER beam size at the IP. This panel shows a correlation between the beam size and the specific luminosity (luminosity/number of bunches/bunch current product). By controlling the horizontal offset (H-offset) of the iBump feedback system, the LER beam size and the luminosity change. If we allow the H-offset to fall below a lower limit, the LER horizontal beam size (σ_x) and the vertical beam size (σ_y) uncontrollably increase and we lose luminosity. We call this phenomenon *Egure*. As an opposite case, if we allow the H-offset to exceed an upper limit, the LER σ_x and the σ_y uncontrollably decrease and the luminosity decreases again. We call this phenomenon *Hazure*.

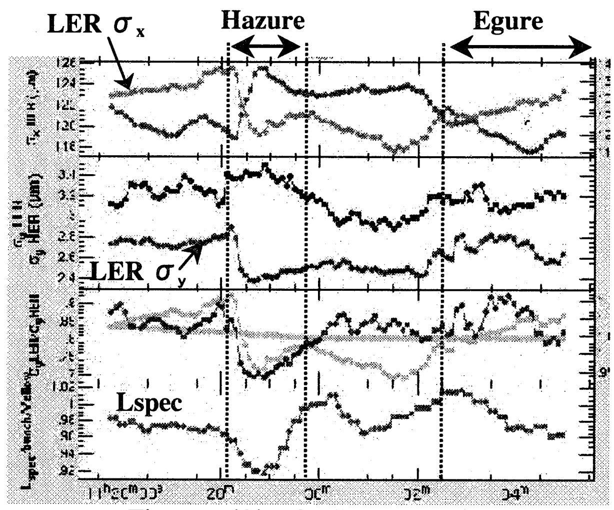

Figure 1: iSize feedback monitor.

3 HISTORY OF THE iBUMP FEEDBACK TUNING

3.1 iBump Target Tuning

Until December 2000, the H-target value was the main tuning parameter for the iBump feedback system. Figure2(a) shows a correlation of the H-target and the specific luminosity. We were tuning the H-target manually to get high specific luminosity by using this panel. Through this manual tuning, we found that an optimum value of the H-target unexpectedly changed with the beam current; we call this *the target-current problem.*

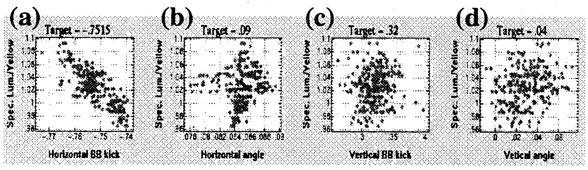

Figure 2: iBump monitor.

3.2 Programmable H-Target Changer

From December 2000 to May 2001, we used a programmable H-target changer (PHTC) to avoid the target-current problem. Figure3 shows the PHTC panel. The PHTC application refers to the LER beam current and changes the H-target value via an *H-target curve* semi-automatically: i.e., an appropriate H-target curve for each experiment was made by manually. Although, the PHTC was successful in keeping the high luminosity, we sometimes could not apply the previous H-target curve to the next run without some modifications. If we use the previous curve, the PHTC leads to Egure and/or Hazure, because the condition of the accelerator unpredictably change at each experiment. Thus, the PHTC needed a manual real-time modification for each run.

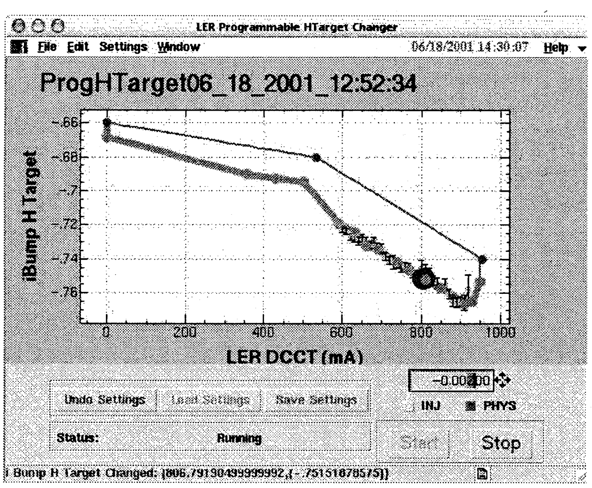

Figure 3: Programmable H-Target Changer.

3.3 H-Offset Direct Tuning

In May 2001, we started to tune the H-offset value directly instead of the H-target. Figure 4 shows the iSize feedback monitor panel. If we decrease the H-offset, the beam size increases and then the luminosity also increases. However, if we allow the H-offset to fall below the lower limit, an Egure occurs and we lose the luminosity. If we manually increase the H-offset, both the beam size and the luminosity decreases, and when the H-offset exceeds the upper limit, we will encounter a Hazure. Therefore, the best tuning point exists at very close to the Egure limit (lower limit), and we must try to set the H-offset near this threshold by using information on the beam size and the luminosity. This tuning is very difficult because we must set the H-offset very near to the dangerous Egure limit below which we encounter the unwanted Egure.

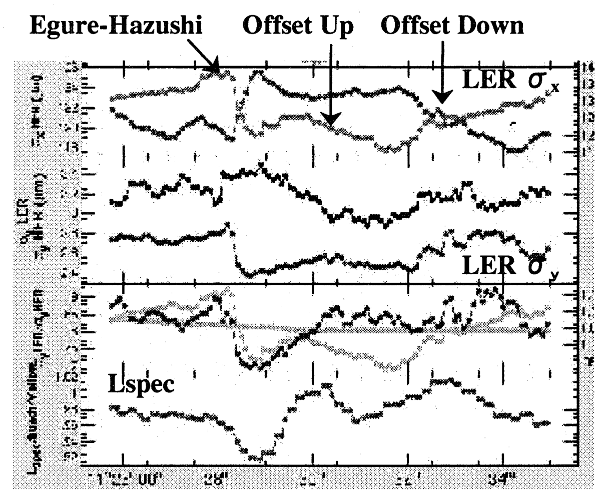

Figure 4: iSize Feegback Monitor.

If an Egure occurs, we usually intentionally make the Hazure state by setting the H-offset near the threshold to get the high luminosity again. we call this recovering method *Egure-hazushi*, see Fig.4. Figure5 shows the H-offset tuning panels. The entry field for H-offset at IP in the iBump FB Bump Height panel and/or the Suppress Egure buttons are available to set the H-offset directly.

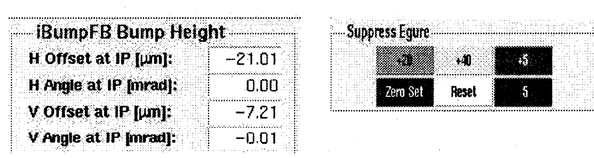

Figure 5: H-offset tuning panels.

By using the H-offset direct setting method, the number of Egure and Hazure phenomenon are successfully decreased. Although some operators could keep the H-offset near the threshold and could master the Egure-hazushi procedure, most operators were not able to do the good tuning. The main reason for this problem was a lack of a clear guideline for the H-offset tuning.

3.4 Guideline for H-Offset Setting

To improve the above problem, we sought better methods for the H-offset tuning. Finally, we found that a kick angle of the ZHQC2LE (KRB), which is one of the steering magnets near the IP, is related to the H-offset. The KRB of the ZHQC2LE is synchronously varying with the H-offset value. This steering magnet, ZHQC2LE, is controlled by the continuous COD correction system [4].

Figure 6 shows the KRB, the H-offset and the luminosity. This figure says that there is a possibility of the existence of the best ratio between the ZHQC2LE:KRB and the H-offset. Indeed, if the ratio is much different from an optimum value, Egure or Hazure usually occurs and we loose the luminosity. Here we note that the peaks of the H-offset in Fig. 6 came from beam injections.

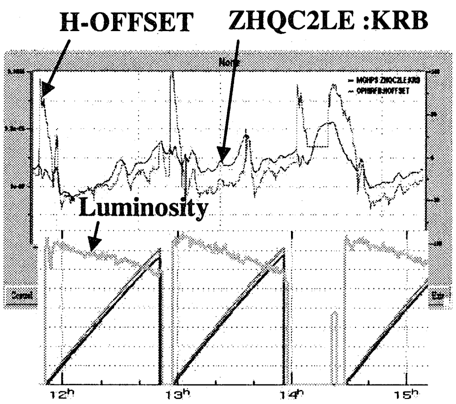

Figure 6: Relation between the KRB of the ZHQC2LE, the H-offset value and the luminosity.

3.5 H-Offset Easy Feedback System

Now we have a guideline for direct tuning of the H-offset. As we mentioned before, there is a correlation between the KRB and the H-offset. To realize high luminosity, an operator should change the H-offset according to the variation of the KRB: i.e., if the KRB is increasing then an operator should increase the H-offset. After we applied this guideline, the number of the Egure and the Hazure phenomena has been drastically decreased.

Although, this tuning guideline is quite clear and easy to understand for operators, it is not the best method because it requires operator's constant attention. The variation of the KRB is very fast so an operator must keep his eyes on the monitor panel and he must change the H-offset value very quickly. Thus, an operator had no way to tune the other accelerator parameters if he changed the H-offset manually. Figure7 shows the KRB-Offset relation monitor and the H-offset direct tuning panel.

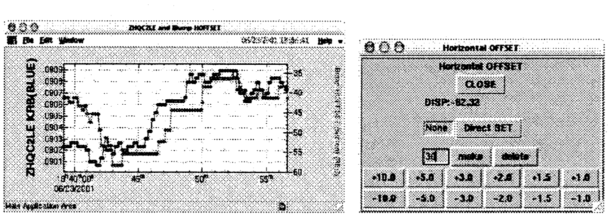

Figure 7: KRB-Offset relation monitor (left) and H-offset direct tuning panel (right).

To avoid such a bad situation, we have constructed a utility tool called *the H-offset easy feedback*. This tool keeps the appropriate ratio between the KRB and the H-offset automatically. The H-offset easy feedback control panel is shown in Fig. 8.

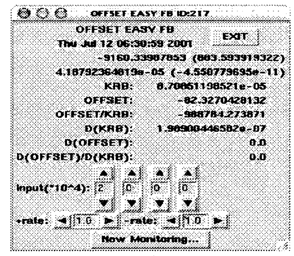

Figure 8: H-offset easy feedback panel.

Owing to this tool, the operator's task became very short for the H-offset tuning. After an operator tuned the appropriate H-offset value at the beginning of the experiment only once, the H-offset easy feedback tool changes the H-offset value to keep the very stable high luminosity instead of the operator. As a result, now we have time for tuning the other accelerator parameters.

4 SUMMARY

Higher luminosity of the KEKB accelerator has been possible with the progress of iBump feedback tuning. To realize a stable iBump feedback, we have continuously improved the iBump tuning method. Now, we have a guideline for the iBump feedback which is useful to keep the high luminosity without Egure or Hazure.

We continue to make efforts to reach the designed luminosity, 10^{34} cm^{-2}s^{-1}, for the KEKB accelerator.

5 ACKNOWLEDGMENTS

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