OPERATION IMPROVEMENT BY TUNING OF STORAGE RING AT PLS-II

Ilmoon Hwang*, Mungyung Kim, Tae-Yeon Lee, Chong-Do Park,
Pohang Accelerator Laboratory, POSTECH, Pohang, Republic of Korea

Abstract

After upgrade of the pohang light source (PLS-II), several problems reduced the quality of the top-up operation. Unbalance of the injection kicker system and it's lack of control had limited the efficiency of the injection from the linac to the storage ring. We tuned the storage ring to improve the injection efficiency and to stabilize the orbit during the injection.

PLS-II INJECTION

The Pohang Light Source has been upgraded and is providing user service since 2012 [1]. After the commissioning, the operation condition was changed and the performance of the storage ring was gradually improved. The electron injection from the linac is a part of the improvements.

The injection system from the full energy linac to the 3-GeV storage ring consists of a Lambertson septum magnet and pulsed orbit bump in a straight which is marked as black boxes in Fig. 1. The electron beam from underground linac is deflected by a lambertson septum while the stored beam is not disturbed. New septum was designed for 3 GeV with longer length, smaller gap and reduced leakage field which induces transient perturbation vertically [2].

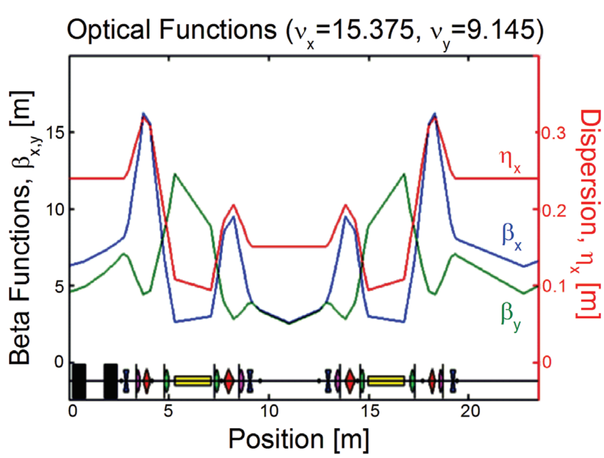

Figure 1: PLS-II lattice function of a half cell.

Two kicker magnets are serially connected with a time delay unit as shown in Fig. 2. For simplicity, individual adjustment was not prepared. In the original plan, four kickers can make 15.5 mm height bump with 6.8 us which is about 7 turns. The designed horizontal tune was 15.28.

* imhwang@postech.ac.kr

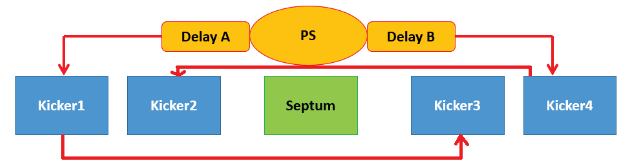

Figure 2: The injection system consists of a Lambertson septum and four kicker magnets. There are two timing-delay units and one strength knob.

LEAKAGE OF INJECTION BUMP

In the commissioning of the PLS-II, various conditions were tried to store the electrons. Different tunes, smaller kicks and many variations were tested. The kicker delay were set as weird values [4].

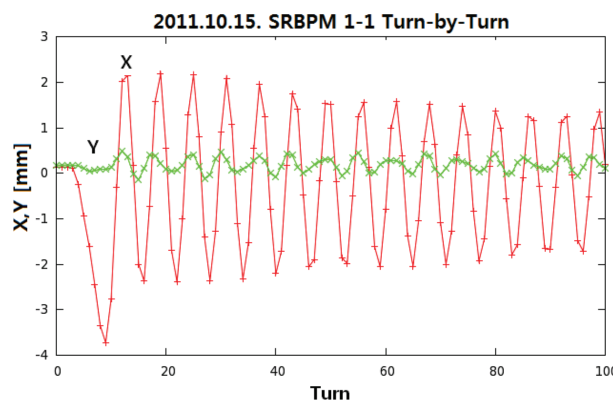

Figure 3: An example of the injection bump leakage at the first BPM in the commissioning.

Because no beam position monitor (BPM) was installed inside of the injection straight, the bumped orbit cannot be directly observed. The bump leakage is measured by using turn-by-turn data of LIBERA Brilliance. Figure 3 is an example of the injection transient in the commissioning.

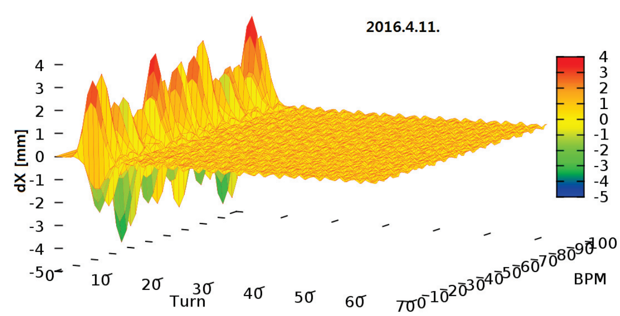

Figure 4: The injection bump leakage in horizontal plane after tuning.

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Figure 4 shows an example of tuned bump leakage. While the bump leakage in kicking is maximum 4 mm, the transient motion after kick is suppressed by adjust of the horizontal tune.

BBA AND LOCO

The beam-based alignment (BBA) which evaluates the offset of the BPM from the center of the quadrupole, and the linear optics correction (LOCO) were accomplished by using matlab-middle layer [5]. But these optimizations were not useful in the commissioning period because the operation condition including the tunes and the orbit were tweaked several times to improve the injection.

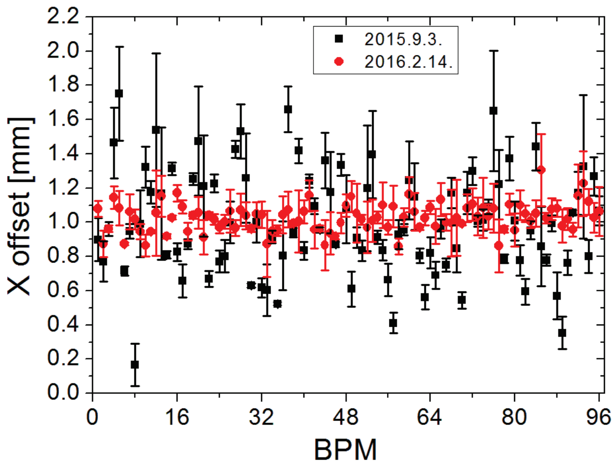

Figure 5: Beam-based alignment in horizontal plane. BPM's center set as 1 mm out of the quadrupole center.

The first problem was loss of the stored beam by 500 um of the vertical leakage when the gap of in-vacuum undulator is 6 mm. Therefore the injection kickers were operated with 70% of its planned strength. When vertical BBA was adopted with the operation tune in 2013, the vertical leakage was reduced below 200 um and the stored beam survived with the planned kick. After tune adjust and vertical BBA, the injection leakage did not limit the injection. In 2015, the horizontal BBA was performed as shown in Fig 5. Systematic and random offset were about 1 mm. The systematic offset can arise from C-shaped magnet.

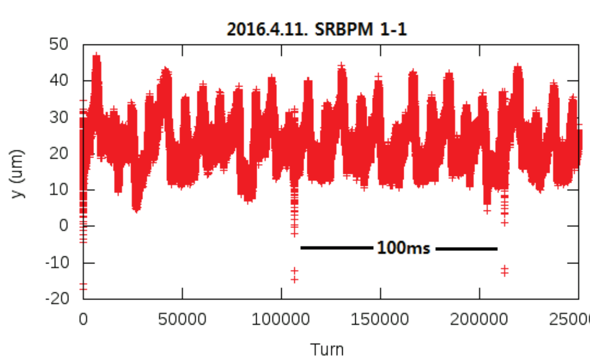

Figure 6: A vertical leakage at a beam service.

The second problem of the leakage is the interference in the orbit feedback vertically. Roughly, rms 20 um of the vertical leakage do not perturb our orbit feedback. After the BBA in both plane and the LOCO, the vertical leakage was suppressed as shown in Fig. 6 during a beam-service period.

INJECTION EFFICIENCY

The injection efficiency is defined as a ratio of incoming charge from the linac and increased charge in the ring. It is a major index of the PLS-II operation. As the ring is tuned well, the injection bump can be closer to the original height and the injection efficiency increased. Figure 7 shows the injection efficiency as a function of the kicker voltage in present configuration.

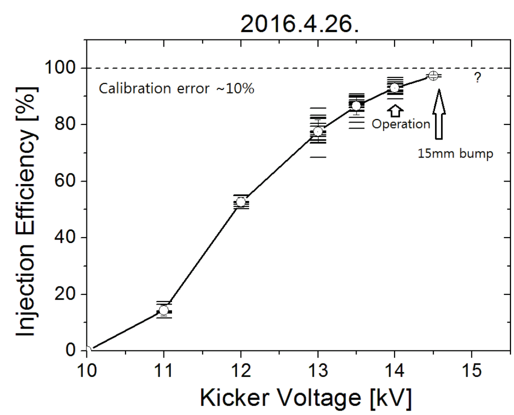

Figure 7: The injection efficiency as a function of the kicker strength.

CONCLUSION

The injection efficiency has been enhanced by increasing the kicker strength which is enabled by the BBA and the LOCO with the operation condition. The reduced vertical leakage minimized the orbit perturbation in presence the of the orbit feedback.

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