INJECTION TRANSIENT MOTION AT PLS-II

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Abstract

PLS-II is an upgraded third generation synchrotron which includes many insertion devices with improved beam properties. Top-up or top-off operation is short time-interval injection to make roughly constant current and is essential to provide high intensity beam. When the electrons are injected to synchrotron, the stored beam is disturbed by small error of the injection system and the beam quality at the beamline can be decreased. We present this injection transient motion at PLS-II.

INJECTION SYSTEM

Pohang Light Source (PLS) has been built with a full energy linac and a storage ring at 2 GeV of electron energy [1]. After the upgrade project called as PLS-II, 20 insertion devices are provided with improved beam properties such as 3 GeV of electron energy [2].

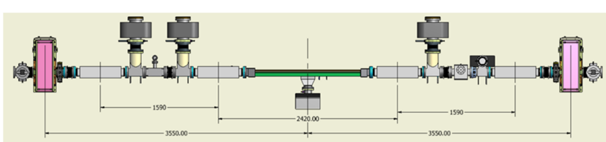

Figure 1: The injection system consists of a Lambertson septum and four kicker magnets.

The detail specifications are changed but the basic injection scheme from the 3-GeV linac into the storage ring is the same. Figure 1 shows the straight section including a septum and four kicker magnets. The kicker system composed of four kicker magnets make horizontal orbit bump up to 15.9 mm height. The lambertson septum deflects the linac beam from underground while the stored electron beam is not disturbed.

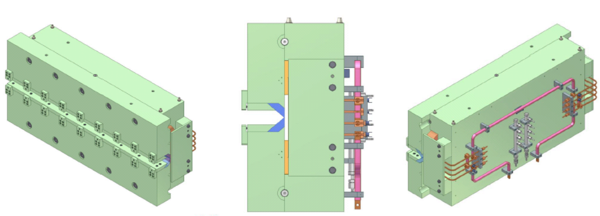

Figure 2: New septum magnet is designed with smaller gap, longer length and especially reduced leakage field at 3 GeV [3].

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NEW LAMBERTSON SEPTUM

In the PLS, the Lambertson septum was designed for 2.0 GeV injection and reused for 2.5 GeV. As the Lambertson septum was operated over original range, the leakage field in stored beam area became larger. The main effect on the stored beam was a vertical kick by the horizontal leakage field which induced about 1 mm vertical oscillation. Therefore leakage reduced Lambertson septum was prepared for 3.0 GeV injection [3].

PLS-II COMMISSIONING

Turn-by-turn BPM

In the beginning of the PLS-II commissioning with new Lambertson septum, the leakage field decreased and vertical transient oscillation is suppressed as 0.2 mm. But horizontal transient motion increased up to 2 mm. The orbit is measured by using turn-by-turn function of LIBERA Brilliance. Figure 3 shows a injection transient motion in both planes. The orbit of the stored beam is distorted by the kicker magnets during 7 turns and the electrons motion decoheres within 1 ms [4].

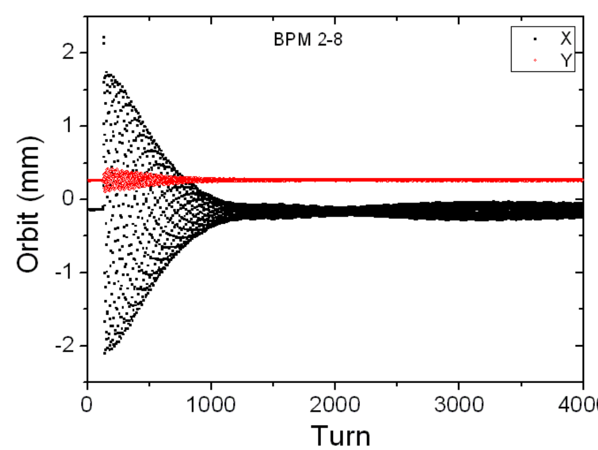

Figure 3: Turn-by-turn signal shows injection transient motion at 8th BPM of 2nd cell. In the commissioning stage, the stored beam oscillates with 2 mm amplitude in horizontal while 0.2 mm in vertical.

Because the vertical transient motion was five times larger than the horizontal one, the upgrade issue was focused on the septum. The kicker magnets and its power supply are installed as before. An example of the horizontal transient motion in all BPM is shown in Fig. 4.

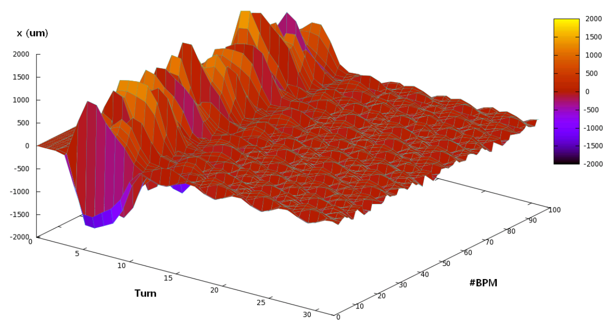

Figure 4: Turn-by-turn signal from all BPM. Horizontal residue can be reduced to 0.4 mm while 2 mm during injection kick.

Delay Between Kicker Magnets

Only one thyratron supplies 6.8 us-pulse current for the kicker magnets which are connected as two serial groups. Consequently, there are two knobs for control of injection bump. One is the strength of the kicker magnets without individual adjustment, and other is the time delay between two kicker groups. The minimization of the injection transient motion is limited with these knobs, and the horizontal transient after kick is suppressed as 0.4 mm while 2 mm during injection kick.

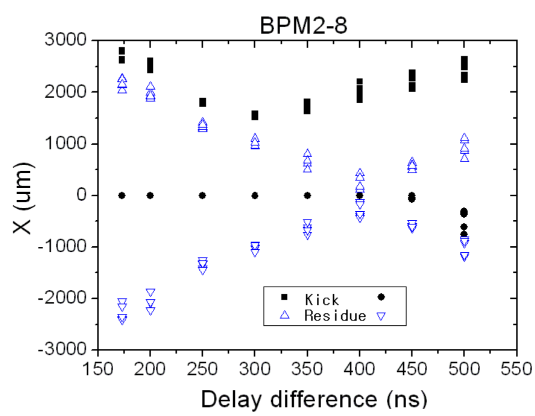

Figure 5: Delay adjustment between two kicker groups. Horizontal residue is minimized with 400 ns delay.

Figure 5 shows the horizontal transient motion at a certain BPM with different delay between the kicker groups. This summary from one BPM is not enough to describe transient motion during injection kick but it is good to see the motion after kick. It is weird that the optimal delay for minimal residue is about 400 ns which is much larger than the time-of-flight between the kickers.

Single Bunch

There are various effects on turn-by-turn signal from the filling pattern and the kicker pulse. In order to observe individual effect clearly, only one bucket is filled and the delay is varied as shown in Fig. 6. In this case, the optimal delay

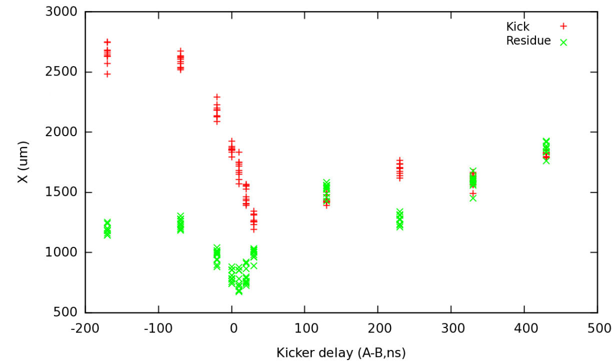

Figure 6: Kicker delay adjustment when a single bunch is stored. Horizontal residue is minimized with 10 ns delay.

is about 10 ns which is similar to the time-of-flight between the kickers. When a single bucket is filled and no electron comes from the linac, the transient motion is dependent on the bucket position as shown in Fig. 7.

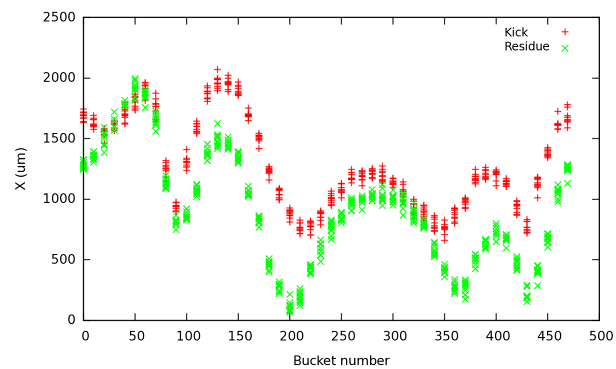

Figure 7: Variation of kick timing when no electron comes from the linac and a single bunch is stored.

CONCLUSION

In the PLS-II, the vertical transient motion was reduced but the horizontal oscillation became larger. The kicker delay was adjusted to suppress the transient as 2 mm during kick and 0.4 mm after kick. Large and complicated transient motion requires further study.

REFERENCES

[1] Tong-Nyong Lee, "An overview of the PLS project," PAC'93, Washington, DC, May 1993, p. 1457-1459 (1993).

[2] S.H. Nam, "Major Upgrade Activity of the PLS in PAL: PLS-II," PAC'09, Vancouver, Canada, May 2009, TH4PBC03 (2009).

[3] Dong-Eon Kim, K. H. Park, H. G. Lee, H. S. Han, Y. G. Jung, H. S. Suh, Y. D. Joo and K. R. Kim, "Status of PLS-II Magnet Design and Fabrication," Journal of Korean Physical Society, 56, p. 1964-1970 (2010).

[4] Alexander Wu Chao and Maury Tigner, "Handbook of Accelerator Physics and Engineering," p. 93-94, World Scientific Publishing, Singapore (1999).

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