OPERATIONAL STATUS AT PLS: RECENT IMPROVREMENTS AND CHANGES

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Abstract

Pohang Light Source (PLS) has been operated since 1994. Last year few improvements have been made to stabilize the reference orbit drifts caused by insertion devices and other sources: The control system has been upgraded to 20 bit capability from 12 bit. The slow global orbit feedback is employed routinely in the user run times. These improvements and the operational status change is presented in this paper.

INTRODUCTION

PLS is a 2.5 GeV, third generation light source operated for users since 1995. At the beginning of PLS operation the 2.0 GeV electron energy was injected into the storage ring. In 1999, the stored electron beam energy was raised to 2.5 GeV by the ramping process to satisfy many X-ray users. Before ramping process the stored beam had to be dumped, and the magnets were degaussed in order to refill the electron beam in the storage ring. These operational procedures had introduced drifts of the closed orbit. In 2001 it was made to deramp the energy of the stored beam from 2.5 GeV to 2.0 GeV downwards and refill the stored electron beam without dump and without degaussing of magnets. With studies and upgrades done to PLS linear accelerator as a 2.5 GeV injector, the full energy injection started and the ramping/de-ramping process was eliminated since October 2002. This improvement in operational procedures could reduce the closed orbit drifts from about 160 µm to 20 µm in the horizontal plane over the 10 days of user operation period. In the vertical plane the orbit drifts couldn't be bounded to the orbit stability requirements of 0.1 % photon intensity fluctuation at PLS beam lines. But reducing the orbit drifts caused by the energy ramping/de-ramping process, other sources of the closed orbit distortion could be focused more effectively. Here we will review the overall improvements and the recent operational status.

IMPROVEMENTS

Though the original control system was used until August, 2004, 10 years from the start, the system was too robust to accommodate the growing demands of controls. The ramping/de-ramping operation process, the global orbit feedback and the beam based alignment should be implemented to provide more stable light to beam line users. So the PLS control system began to change and evolved into its present status with ongoing success of EPICS based control system in the world.

Magnet Power Supply Control System

The storage ring has 42 uni-polar type MPSs and 146 bipolar type MPSs. In the old system the uni-polar type MPSs were controlled through serial communication and the bipolar type MPSs were controlled through parallel communication. The Ethernet port was added to the new power supply control hardware to communicate with TCP/MODBUS protocol. By standardizing this protocol the number of IOC device drivers was diminished. The new control hardware can communicate with the old control system as before.

At the first stage of the development of the IOC, Windows NT based personal computer was chosen as the IOC server [1]. Low prices, abundant applications and the convenience in development were the favoured merits. The isolated local area network scheme was adopted not to be intruded by a harmful command.

In September 2004, the IOC for corrector magnet power supplies was replaced with 12 IOC's each of which was consisted of the VME CPU module and VxWorks real time OS and distributed around the storage ring shed area to speed up the data acquisitions.

EPICS based Beam Position Monitoring

The beam position monitor (BPM) ADC board was integrated into the same VME64x Crate where the EPICS IOC for the corrector magnet power supplies was implemented using the Motorola Power PC MVME5100. the ADC board was upgraded from 12-bit module to 16-bit module having a resolution of less than 1µm. In the board the Finite-Impulse Response (FIR) digital filtering algorithm was employed to digitize the analogue outputs from the Bergoz BPM processors more precisely.

New BPM electronics

The incredible behaviour of reading of some BPMs was mitigated by using second harmonics (375 MHz) for the BPM processors. Some sectors of vacuum chambers in the storage ring have the proper vibration of near 500 MHz, which affects the BPM electronics processing the dominant 500MHz frequency. Replaced with new Bergoz BPM processors processing second harmonics (375 MHz), the readings have been improved. And the beam current dependency of position readings can be measured more correctly after eliminating this kind of reading errors.

Machines realigned at the Scheduled Shutdowns

The floor of accelerator tunnel is still moving upwards and downwards. The amount of deformation is about 2 mm a year. The total accumulated deformation is about 25 mm for 11 years from hill to valley. Fig. 1 shows the settlement history of the storage ring floor from 1993 to 2004, during 11 years.

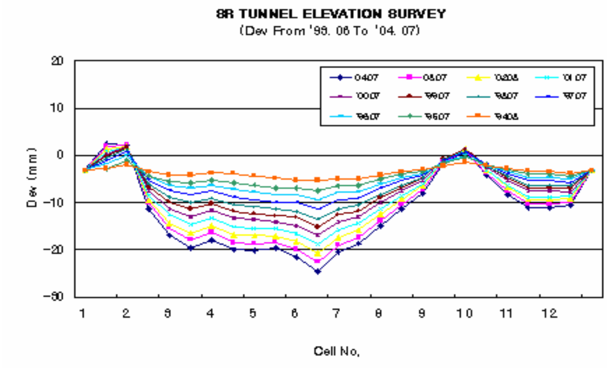

Figure 1: Settlement of the storage ring floor since 1993 (From '93. 06 to '04. 07).

The maximum adjustable range of the storage ring girders is 50 mm. The machine including insertion devices was completely realigned in August 2004 during the scheduled machine shutdown. We added an additional alignment policy that the insertion devices should not have a step with the upward streams. The inclination of the insertion devices was not considered and ignored in the past re-alignments.

OPERATIONAL STATUS

A closed orbit used to be lost annually after the realigning of the machines. The amount of alignment done to the machine positions makes the previous operational setup be almost useless. The closed orbit should be found again with the experienced trial and errors

Optimizing a Reference Orbit

To be a reference orbit in the user operation, this closed orbit should be optimized. The global orbit correction is carried out iteratively by the application tool COCU [2], developed in CERN, and modified in PLS to accommodate the EPICS based control environments. The MICADO algorithm is preferred. The TWISS parameters calculated at the beginning of the machine operation is still effective, when iteratively applied, in minimizing the large rms orbits and the orbit difference between the undesired orbit and the reference orbit. To meet the requests of local orbit correction from PLS beam lines, the 4-BUMP algorithm is used. But somewhere in the storage ring where we have not so good BPM readings, the local orbit correction should be negotiated and the beam line itself would be realigned in turn.

User Operation

There are 24 working beam lines in PLS. Three beam lines will be completed by the end of 2005. The electron beam is refilled twice a day and the user operation goes on 10 days normally. Table 1 shows The PLS operation parameters of these days.

Table 1: Basic operation parameters

Beam Energy	2.5GeV
Injection Current	190mA
Lifetime @ 100mA	33.7hr
Number of Bunches	300 (harmonic number : 468)
Tune	14.28/8.18
Injection Period	12 hour

After replacing the 65 kW klystrons with 75 kW ones the injection current of 190mA is offered to beam lines. The bunch filling pattern have been changed from 1111-mode to 1110-mode in order to generate the second harmonics of 375 MHZ, which is utilized by the new BPM electronics as mentioned above. In 1111-mode, 400 bunches were filled without a blank and 68 bunches were remained empty in order to prevent ion beam instability. In 1110-mode the first 3 bunches are filled and the next one bunch is empty and the 400 bunches are filled in that way. The 68 bunches are empty as before. Fig. 2 shows the 1110-mode bunch pattern in the PLS storage ring. Each bunch is addressed using the upgraded timing system progressing with a synchronous universal counter (SUC) [4].

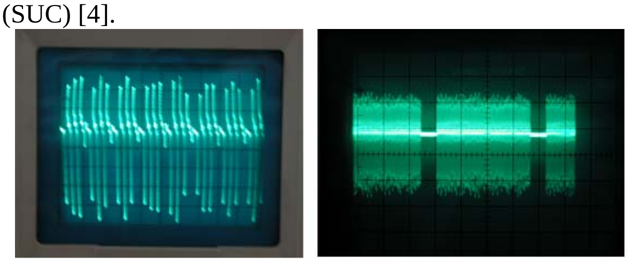

Figure 2: Filling pattern 1110-mode in the storage ring.

Closed Orbit Stability

With the full energy injection employed in the operation, the rms orbit drifts of a few hundred micrometers has been reduced to 20 μm [3]. Fig 3. shows the difference between the reference orbit and the closed orbit over a course of 10 days user operation. The motion of six IDs was the dominant source of orbit errors.

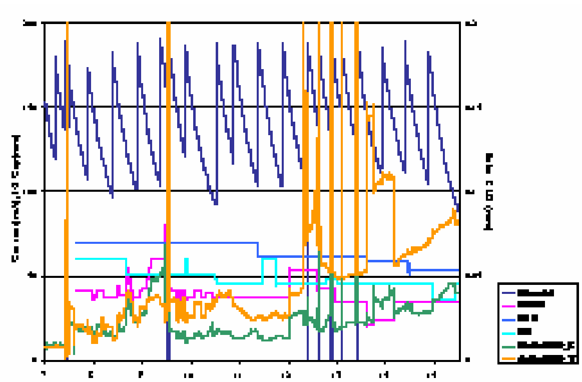

Figure 3: Rms change over the course of a user operation.

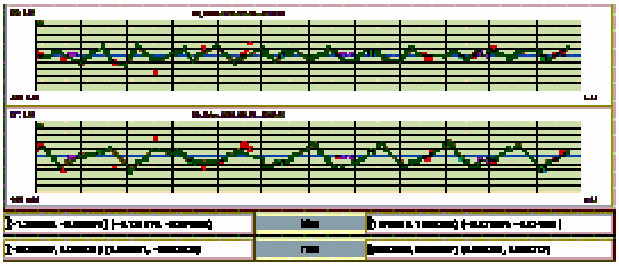

Figure 4: Snapshot before SOFB working.

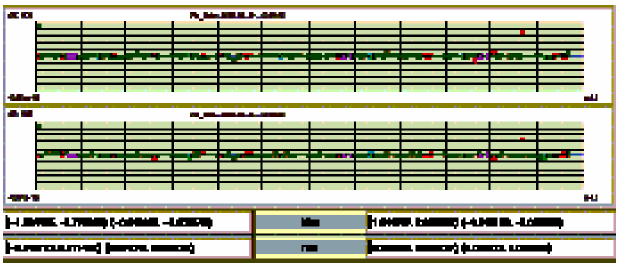

Figure 5: Snapshot after SOFB working.

The slow global orbit feedback (SOFB) system was developed [6] and has been used in routine user operation since November 2004. Figures 4 and 5 show the performance of the SOFB system. On May 9, 2005 the storage ring had to be dumped in order to cure the LCW problem occurred in the ring. When the beam was stored to 40 mA again after the beam dump, the rms errors were 60 µm and 100 µm in the x and y direction respectively. These rms errors were reduced to about 10 µm at the stored current of 150 mA at once. The response matrix was measured at 140 mA. The SOFB details will be presented in this conference [5].

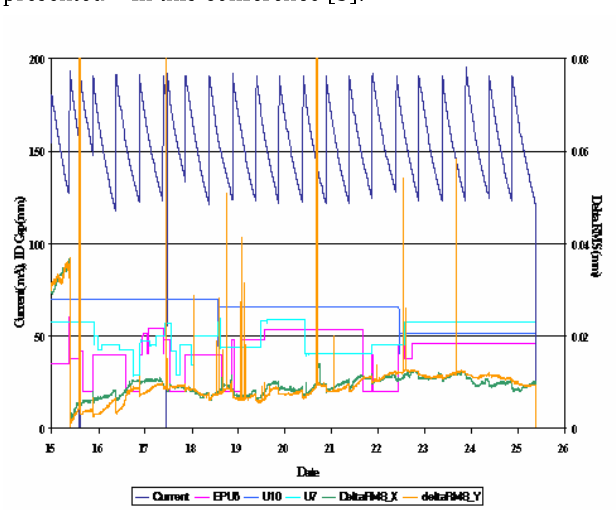

Figure 6: Rms orbit errors over a user run.

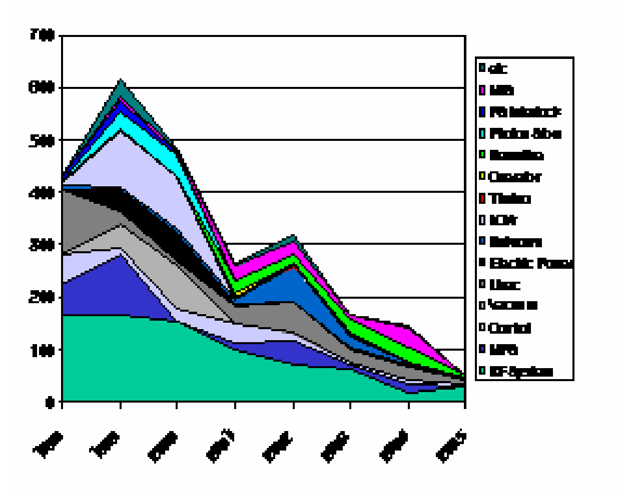

Figure 7:Operational fault statistics over 10 years.

CONCLUSION

In PLS, the closed orbit stability could be smaller than 2 or 3 µm by employing the SOFB system with upgrades mentioned. The history of rms errors was shown in the Fig. 6. There are plans to improve the SOFB performance. In the near future the fast orbit feedback system will be implemented. Figure 7 shows the fault statistics of the PLS operation over the last 10 years. The number of faults has been reduced by a part of tenth. PLS will be a better synchrotron radiation facilities in the near future.

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