ORBIT FEEDBACK IN TAIWAN LIGHT SOURCE

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Abstract

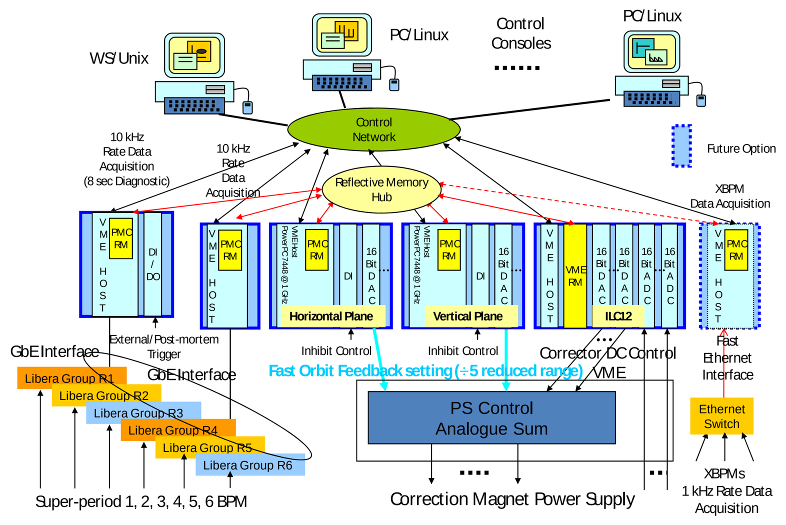
The global orbit feedback system is indispensable for the Taiwan Light Source (TLS) operation. The existing orbit feedback system has been deployed for a decade to stabilize electron closed orbit. This orbit feedback system is used to suppress various perturbations include orbit excursion due to insertion device operation. To take advantages of advanced technologies in BPM and power supply, the feedback system is upgraded recently accompany with BPM electronic and corrector power supply upgrade; infrastructure of new system has also been modified and rebuilt. Efforts of digital BPM (Libera Brillance), PWM power supply, orbit feedback system, on-line system modeling, diagnostic access, and control rules upgrade with reduced ill-conditioned response matrix will be presented.

Introduction

- Orbit stability is more and more emphasized for a modern synchrotron light source. Beam motion should be less than 10 % of its beamsize or even smaller.
- To improve orbit stability and reduce the ambient environment influence of Taiwan Light Source (TLS), the orbit feedback system is adopted.
- The fast orbit feedback system was proposed later to release the limited loop bandwidth of the system.
- The upgrade progress and performance of the BPM system will be presented. Measurement of the system response and latency are discussed next. Finally, the infrastructure and performance of fast orbit feedback are summarized.

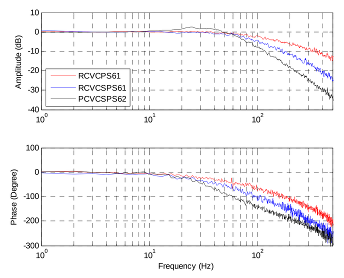
Infrastructure of Orbit Feedback System

Infrastructure



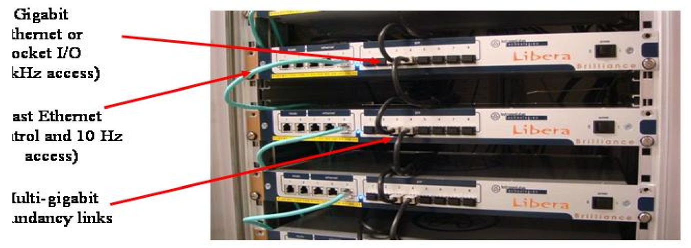
- The orbit controls for the horizontal and vertical plane are separated.
- The reflective memory is employed to shares fast orbit data without consuming extra CPU resource and support data acquisition for other subsystems.
- Since there are no dedicated fast correctors at TLS, setting of the DC closed orbit control and the fast correction signal will be sum by an in-house made interface card.

Power Supply Upgrade



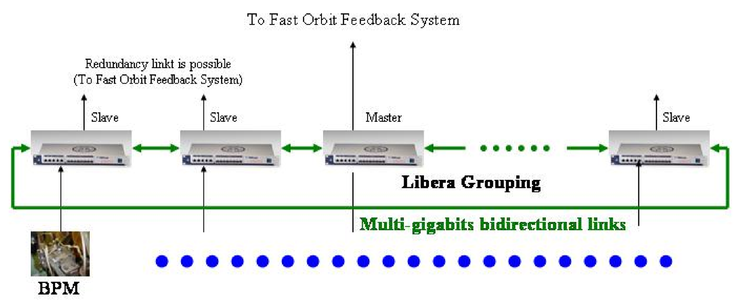
- The linear type corrector power supply is replaced by MCOR 30.
- The MCOR3 power supply is 5 times better in noise level and has large small signal bandwidth.
- The bandwidth determined by power supply, corrector and the vacuum chamber is increased from a few Hz to around 80 Hz and 30 Hz in vertical and horizontal respectively.
- Left figure shows the measured overall response of the three vertical correctors in section R6 used for orbit feedback system.

BPM Upgrade



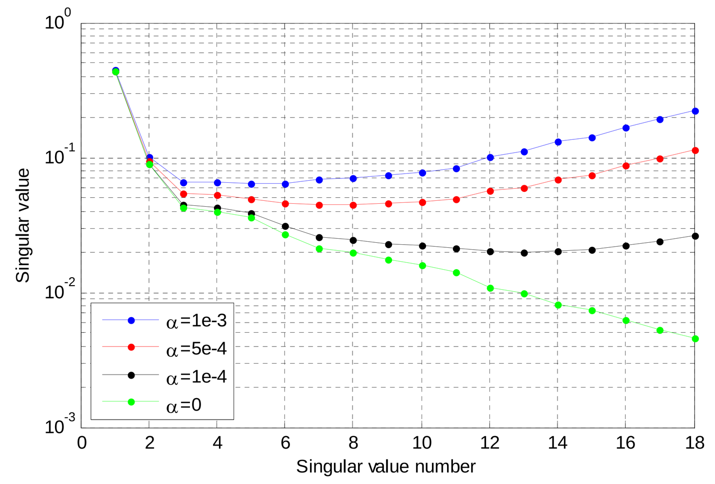
- The Libera Brilliance is employed to replace the BPM electronics for the TLS as the upper figure.
- All of Libera Brilliances in the storage ring are grouped together to produce a packed GbE UDP packet and reduce the number of IP packets receiving jitters for CPU.

Libera Grouping



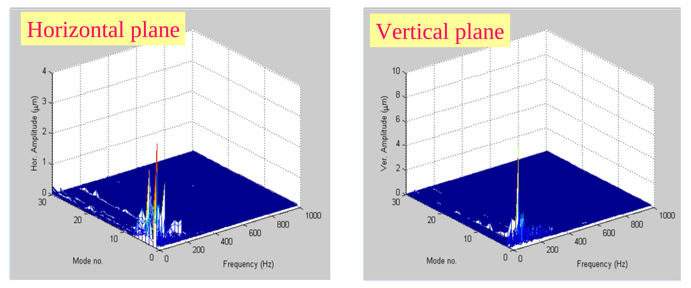
- The upper figure shows the structure of Libera grouping.
- All of Libera Brilliance units are connected to a ring by a redundant multi-gigabit links via the LC optical links and/or copper "Molex" cables.
- This link can exchange the data among the all units done by FPGA inside Libera.

SVD and Tikhonov Regularization



- Singular value decomposition (SVD), as a most commonly correction algorithm, is employed to invert the response matrix.
- To obtain a stable solution, Tikhonov regularization is adopted.
- The upper shows the scaling singular value versus different regularization parameter α of the TLS.
- This regularization method can solve ill-conditioned problems and less sensitive to measurement errors.
- After applying this method, the loop gain can be automatically adjusted when the higher mode with less weightings and lower bandwidth..

BPM Data in Mode Space

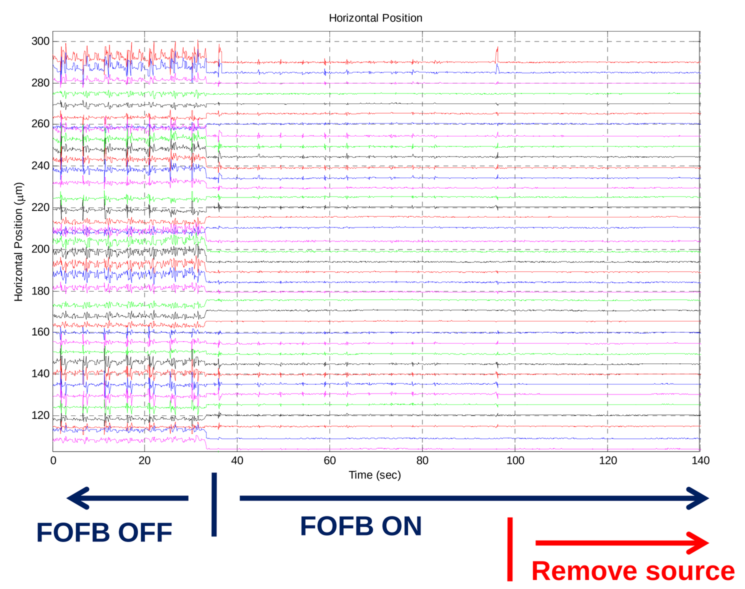


(a) (b)

- Upper figure shows BPM spectrum in mode space in the horizontal and vertical plane respectively.
- The higher mode has less weight for both of two planes and vice versa.

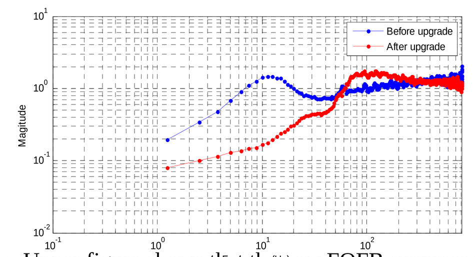
System Performance Measurement

Orbit Stability for User Operation

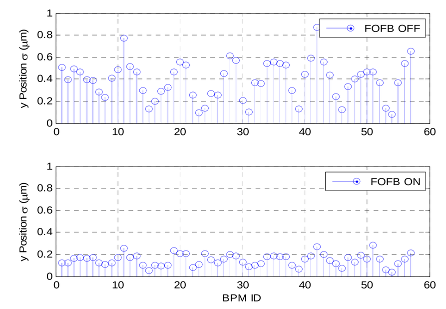


- Upper figure shows SA data for FOFB OFF before 32 sec and ON after 32 sec.
- The peak to peak displacement in the horizontal plane may be over 10 μm in some BPM position while it can be reduced less than 1 μm after applying FOFB system.
- The stability is better when removing the perturbation source from quadrupole power supply.

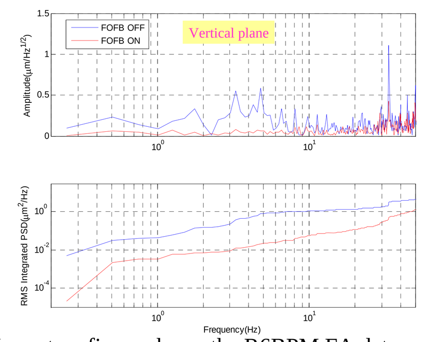
Noise Sensitivity Function Measurement



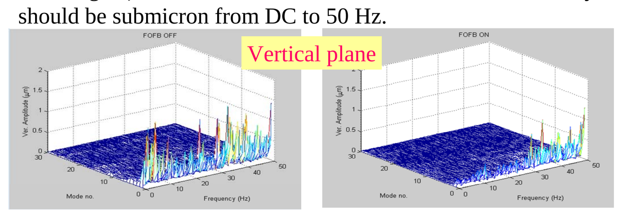
- Upper figure shows that the new FOFB suppress noise of bandwidth to 50Hz from old 5Hz system.



- Figures show σ of orbit displacement between FOFB on/off.
- All BPM reading can be reduced to 0.2 μm from the largest 0.8 μm between feedback on and off.



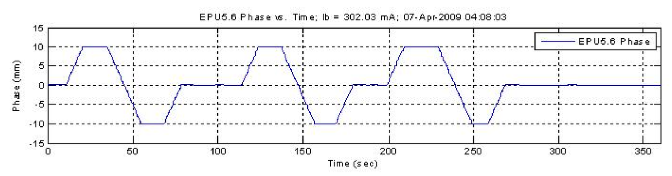
- Upper two figure shows the R6BPM FA data spectrum when FOFB on and off.
- The orbit stability is suppressed to one micron at this location with larger β function therefore the overall RMS orbit stability should be submicron from DC to 50 Hz.

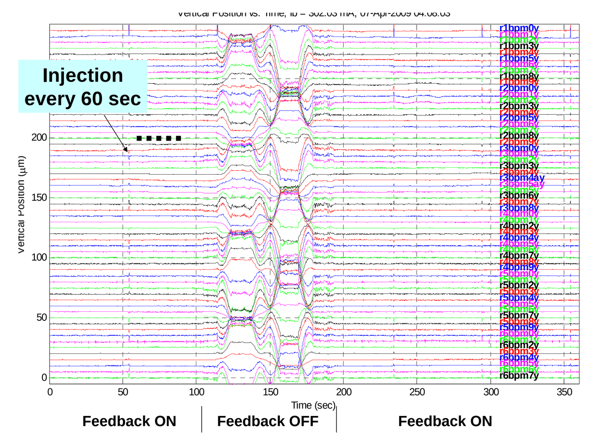


(a) (b)

- Upper figure show Modal spectra for feedback on/off.

Effects of FOFB for Insertion Device Operation





- The wider bandwidth of the new orbit feedback loop can promote the motion speed. Upper figure shows the 1 mm/sec phase move of the EPU5.6.
- It is clearly observed that the feedback loop can eliminate the orbit excursion.

Summary

Infrastructure of the FOFB for TLS has been revisited. Commissioning of the FOFB system is on going. Various R&D including modelling, measurement, control rules, and etc. are going on. Various results and many exercises confirmed that the FOFB system effectively improve orbit stability.

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