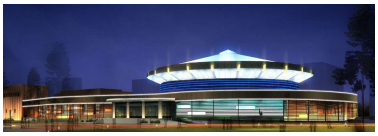

High Level Applications for Hefei Light Source

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Abstract

This paper first discusses the hardware and software structure of the Hefei Light Source (HLS) control system. Based upon the HLS control system, we developed a number of high level applications for machine commissioning and operation. This dissertation reports some critical applications, including the energy matching between the injector and the storage ring, lattice calibration and optical parameter correction for the storage ring, lattice compensation for the insertion devices (IDs), and the storage ring orbit feedback.

Physical quantity based control system

The physical quantity based control system developed for the HLS directly controls the physical quantities of the accelerator elements, including the magnetic field of various magnets and the beam energy, etc., leading to direct controls to the parameters of the accelerators and the electron beam. The physical quantities and related engineer quantities are automatically converted inside of the control system, and can be shared by different high level applications. This significantly improves the feasibility and effectiveness of the system. This system have been well serving the commissioning, machine study and operation of the HLS.

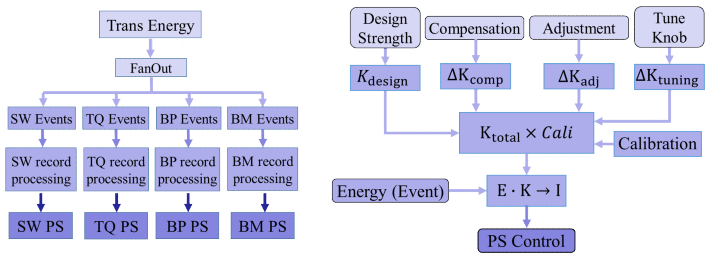
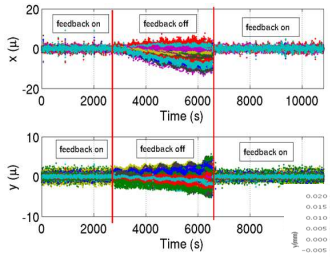


Diagram of the Physical quantity based control system of the HLS

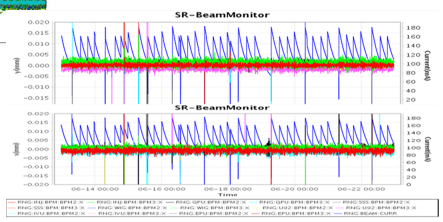
Orbit feedback

High orbit stability is required by synchrotron radiation users. Developing an orbit feedback software for achieving high orbit stability is one of our tasks.

- The BPM system employs button type electrodes. Electronics processing modules manufactured by Libera are used for the signal processing.
- The BPM system and corrector power supplies are capable of performing up to 10Hz feedback correction.
- The gold orbit is defined using the quadrupole centers measured using beam based alignment method.
- The Orbit feedback system can be used for global orbit correction and local bump adjustment.
- The long-term RMS orbit fluctuation is less than 10% of the beam size in both horizontal and vertical directions.



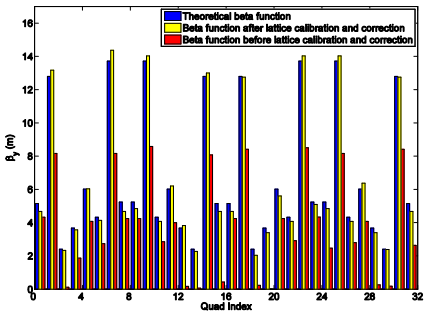
The HLS storage ring beam orbit stability with and without feedback, respectively. The values of each BPM are plotted using a designated color.



Long term beam orbit stability (10 days)

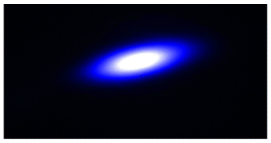
lattice calibration

The response matrix measured using BPMs and orbit correctors is used for the lattice calibration, optical parameter correction and lattice compensation for various IDs of the HLS storage ring. Some modifications are performed from the traditional fitting methods to meet the standard of the HLS control system. LOCO is used for the lattice correction and ID compensation.



Vertical beta function before and after lattice correction.

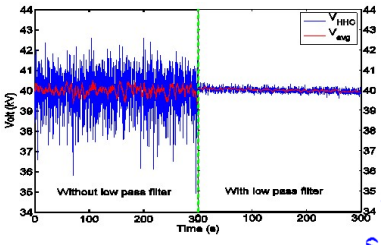
Synchrotron radiation before IDs compensation



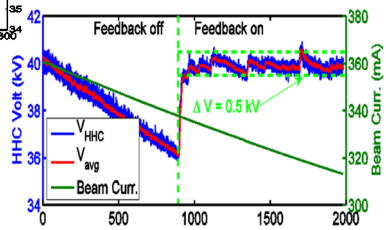
Synchrotron radiation after IDs compensation

The cavity control system

An antenna is used to out-couple a small potion of the energy from the cavity. This energy signal is then feed to the control module to process the voltage across the high harmonic cavity (HHC). The voltage signal, which is an analog DC signal, from the control module is measured by an analog-to-digital module in a Omron PLC. The digitalized voltage signal is then read by an AI record inside an EPICS input/output Controller (IOC). The measured voltage signal is turn out to be very noisy, which puts serious impact on the voltage control. To eliminate this effect, a set of EPICS records are used to filter out the noise. A number of COMPRESS and AI records are employed to build up the digital filter. The filtered voltage signal is used as the input of a PID record. The PID record calculates the distance the motor need to move for maintaining the high voltage of the HHC at a particular setpoint. This distance value is then set to the control module to control the servo motor system and drive the tuning pole of the HHC.



The HHC voltage signal measured using the PLC ADC: (Left) Without LPF, and (Right) with LPF. Both are measured with a beam current about 210 mA.



The HHC voltage stability with and without feedback. (Left) Feedback off; (Right) feedback on.

Summary

The physical quantity based control system of the HLS can be used to direct control the physical parameters of accelerators. The high level applications developed based upon this system play important roles in the light source commissioning, and are providing strong supports for stable and high performance operation of the light source.