UPDATE OF THE CONTROL SYSTEM AT SRRC

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Abstract

The control system of accelerator complex at SRRC work well since its dedication in 1993. Several major upgrade projects will finish in the early of next millennium to improve performance of the light source. Injector of SRRC will run in 1.5 GeV in 2000 with rejuvenated control system that has been integrated to main control system recently. Orbit feedback system is developed to improve orbit stability. The RF control system will upgrade to accompany with superconductivity RF cavity project that is expected finish in 2001-2002. These developments in control system of SRRC are summarized in this report.

1 INTRODUCTION

The storage ring of SRRC has been run near seven years. Several major upgrades will be done within 1999-2002 to improve performance of the storage ring. Control system is a two-level hierarchical system [1]. The upper layer consists of two process computers; several console workstations and PCs. Process computer are used as control server. Consoles are mainly used for user interface. The lower layer consists of many VME crates field level controllers which routinely perform the local data acquisition, interlock generation and carry out devices control requests from the control consoles or process computers. Flexible and openness makes control system upgrade easily.

2 STATUS IN SRRC CONTROL SYSTEM

Old VAX/VMS consoles has been migrated to Alpha/Unix environment in 1996. PC/WindowsNT console was implemented in mid-1997. Porting control environment to PC/Linux environment has been done in early of 1999. Control applications are increasing its demands to the bandwidth of control network. To transmit large data block, image and video information via control network without degrade performance, upgrade backbone to gigabits Ethernet is under way. Routing and segmentation of 10 Mbits/sec nodes, which cannot upgrade in control system, is a provisional solution to increase overall network performance. Many new control applications was developed based on X-Windows and Motif widgets. Various commercial tools (PV-WAVE, LabVIEW, MATLAB, …etc.) adopt to reduce development efforts. VME crate system equips with transient digitizers to acquire waveform and spectrum.

Injection kickers and RF cavities occupy two long straight sections. The remained four long straight sections are available for insertion devices. Four insertion devices include a wiggler (W20), and three undulators (U5, U9, and EPU5.6) have been installed. A 3-poles, 6 T superconductivity wiggler is in implementation phase. Orbit is sensitive to the operation of undulators in low energy machine like SRRC. Usually, a pre-defined table stored correctors setting value as function of gap, update end-correctors setting are done during gap change. However, several undulators move simultaneously or gap accompanies with phase change is a big challenge in orbit control. It's seemed orbit feedback system is a better solution than feed-forward manner.

Efforts was devoted to simplify and to re-engineering the control system. These activity are multi-purpose, includes performance improvement, avoid obsolete and reduce maintenance difficulties. Re-engineering of the injector control system is an example of these efforts.

3 HIGHLIGHT OF SOME NEW DEVELOPMENTS IN CONTROL SYSTEM

3.1 Insertion Devices Control

IDs control in SRRC is in heterogeneous manner [2]. Local controller of wiggler W20 is in PC/LabVIEW environment. The U5 local control software running in PC/MS-DOS environment. Both local controllers of W20 and U5 connected to VME crate via IEEE-488 bus. Undulators U9 and EPU5.6 control are compatible with SRRC control environment which are based upon VME crate equip with PowerPC CPU running LynxOS. The U5 system executes gap move request within a few seconds for mm range move. Control system overhead contributes about half of the elapse time for the operation. This is due to the slowly response in local controller through IEEE-488 interface. Overhead of the control system is almost negligible in EPU5.6 and U9. Re-engineering of W20 and U5 control is under planning to improve its performance. Software of EPU5.6 is shown in Figure 1. All IDs will share similar hardware and software structure in near future.

Residue field compensation scheme has "fixed" and "follow" gap operation mode. Feed-forward control in orbit is used to reduce orbit excursion. Eliminate orbit change during IDs motion by using orbit feedback that combines global and local are also available. It is shown that orbit feedback system is effective to lock orbit in dynamic operation of IDs during user shift. A few microns in RMS orbit displacement control achieve during multiple IDs motion either in gap or in magnetic phase. Further improve in orbit control performance is under way.

Beamline user can send command to control server or VME crates to perform limited gap/phase setting and stopping. Status of IDs is always available for query in control system. Synchronized ID operation with monochromator in beamline is supported.

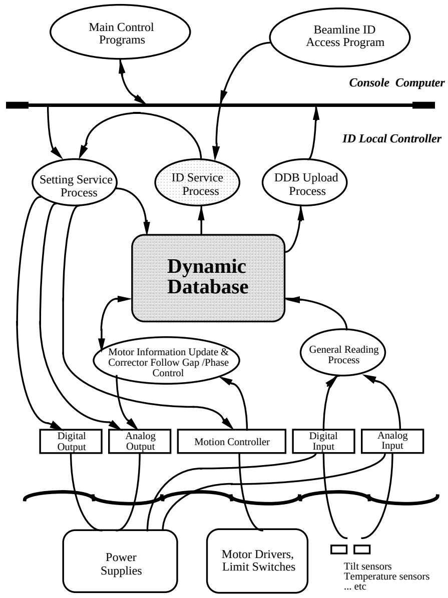

Figure 1: Structure of the EPU5.6 control software.

3.2 Orbit Feedback System

Global orbit feedback system operates routinely [3]. Present system composed VME crates to handle orbit acquisition, correctors control, and photon beam position monitor data acquisition. These crates share orbit information with reflective memory network. Orbit acquisition VME crate systems host PowerPC running LynxOS and support various operation modes. The orbit sampling rate is 1 kHz currently. The corrector control VME crate is also in PowerPC/LynxOS environment. The feedback DSP modules are located on corrector crate. Current efforts are focus to improve the performance of the feedback loops on various operation conditions. Local orbit feedback loop using electron and photon beam position monitors is under intensive test. Upgrade DSP system to new generation board equips with TMS320C6701s is in implementation phase. Fast DSPs provide flexibility to include more BPMs and correctors in feedback loops and flexibility in control rule selection.

3.3 Phase Space Monitor

Phase space monitor was implemented by using 500 MHz log-ratio detectors and VME based transient digitizers. One transverse plane composes two BPMs with appropriate phase advance to measurement position and angle. Transient digitizers installed in VME crate are used to acquire turn-by-turn beam position. A server program hosted on VME crate manages the operation of measurement. Client program on console provides operation interface. Time-domain and frequency-domain raw data display is supported. User interface to operate phase monitor display is shown in Figure 2. Digitizer configuration, kicker firing and related parameter change can be done by the aid of this user interface.

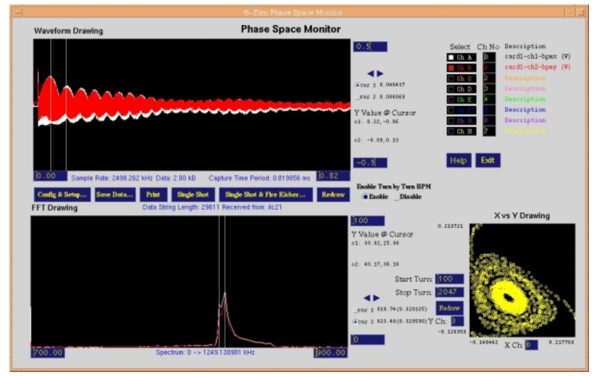

Figure 2. Phase space monitor user interface, $3\nu_x \sim 22$.

3.4 New Control System of the SRRC 1.5 GeV Injector

The turnkey injector system composed a 50 MeV linac and a 1.3 GeV electron booster synchrotron. The control system consists a Bitbus network and one PLC in field level. Both systems are connected to a PC running iRMX III operation system. A VAXstation uses as control console. It is difficult to maintain and to operate the injector control system due to its close nature, out-of-date in hardware and software.

Re-engineering of the old injector control system finished in June 1999 [4]. PC/iRMX III system and VAXstation was obsolete. New control system kept PLC and most of the Bitbus nodes to save money. VME crates system access injector devices as shown in Figure 3**.** The operations of the injector are done on standard control console in renewed system. The integration was performed during the injector in standby mode after every storage ring fill cycle. This live upgrade strategic minimized interferes to the normal operation of the storage ring.

Upgrade booster to operate at 1.5 GeV is scheduled in January 2000. Power supplies and chokes of the White circuits should be replaced. New IGBT based switching power supplies provide superior performance compare with old ones. Magnet of the booster excite by 10 Hz sinewave, PID controller are used to regulate amplitude and phase of the booster AC power supplies. This regulation is essential to compensate thermal effects of magnets and chokes. The White circuit control environment is shown in Figure 4.

3.5 Control Environment of the Superconductivity RF System

Two existing DORIS cavity will replaced by a CESR B-cell superconductivity RF (SRF) cavity in year of 2001-2002. The goal is to increase stored beam current to 500 mA and eliminate coupled-bunch instabilities. Low beam coupling impedance due to strong HOM damping will increase beam current threshold drastically. The SRF cavity will install in CESR B-cell cyromodule. Existing low level RF system will modify to accommodate new SRF system in high beam loading condition.

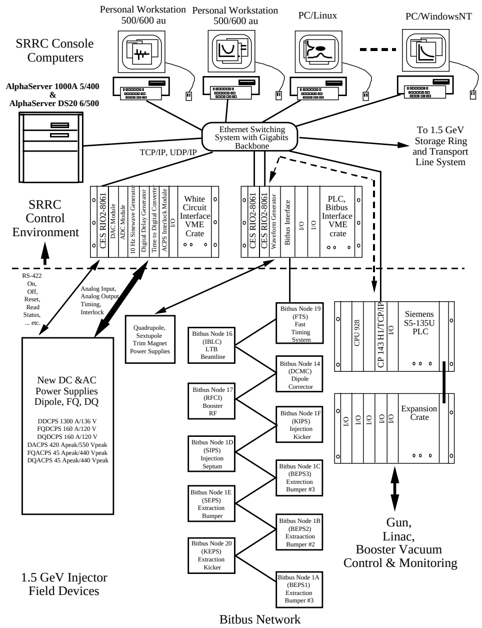

Figure 3. 1.5 GeV booster control system

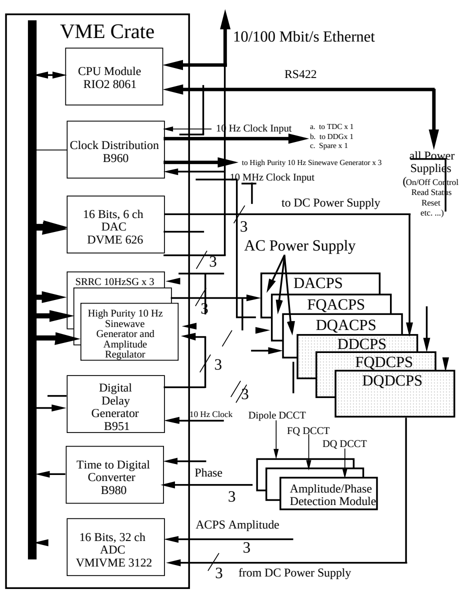

Figure 4. 1.5 GeV booster power supply control interface

Upgrade RF transmitters to increase output power are also scheduled. Intelligent controllers are used to regulate crucial parameters, such as temperature, liquid helium (LHe) level, pressure, … etc. These controllers connect to VME crate by serial links. Various signals are also acquired with multi-channels ADC module to monitor the operation of SRF system. Transient digitizer will record relevant events to aid the operation and debug the SRF system. The conceptual of control environment is shown in Figure 5. Various high level applications will aid RF conditioning, cold start, shutdown, and normal operation.

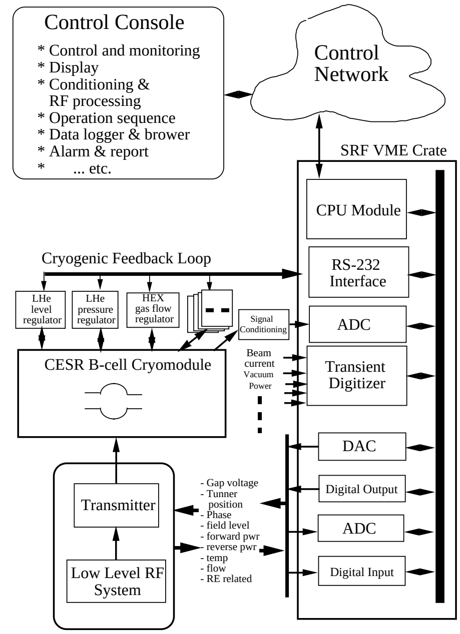

Figure 5. Superconductivity RF system – control environments

4 SUMMARY

Control system in SRRC is enhanced to support several major upgrades in accelerator system. Improvement in openness of the control system made the system more flexibility. Unify control environment in accelerator system are helpful to improve efficient of resource usage. Various activities in control system include hardware upgrade and adopt modern software technology are essential to improvement the performance of the accelerator system.

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