CONTROL INTEGRATION FOR THE INJECTOR IN SRRC

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Abstract

In order to provide more efficient and stable light source operation, the injector control system needs to be upgraded and integrated into the SRRC main control system. The existed injector control system is not convenient enough due to its separation from the storage ring control system. The control system integration will make the operation and data access easier. The integrated control system shall improve the reliability and provide faster response than the existed one, It can decrease drastically the maintenance resource needed. One of the major goals for this project is to improve the control performance and its flexibility. Configurations of the new control environment for the injector, both hardware and software are described in this report.

1. INTRODUCTION

A new injector control interface will be integrated into SRRC storage ring control system. It has improvement on more reliability and stability than the existed injector control system. The new control environment for the injector operation of the Taiwan Light Source is an ongoing processing, including engineering redesigns and subsystem studies. These plans will improve the operation performance, decrease drastically maintenance resource needed [1][2][3], and carry the Taiwan Light Source forward to an excellent performance accelerator in support of an aggressive research environment.

2. SYSTEM DESCRIPTIONS

The injector is a turnkey system equipped with three layers distributed control system and was commissioned in 1991. New control system environment has the same structure with improved reliability and stability.

2.1 Existed Injector Control System Structure

The existed injector control system has three layers structure. The first layer is a powerful VAX workstation which is used to provide operation interface, be a system supervisory, alarm management, communicate to the second layer computer system, create and maintain the system data base. The second layer is a PC running iRMX III operation system which serves as a master for the BITBUS network, communicate with the PLC system, and processes the data. There are two types of subsystem in the third layer, BITBUS network and PLC system.

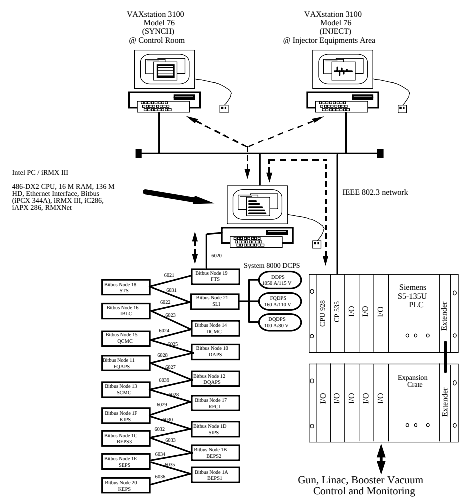

Figure 1. Existed injector control hardware configuration

2.2 New Injector Control Architecture

In new injector control system, a VME crate system is used to replace the second layer PC/iRMX III. It also acts as a master of the BITBUS network and communicating with the PLC system. The first layer and third layer are almost same as the existed injector control system.

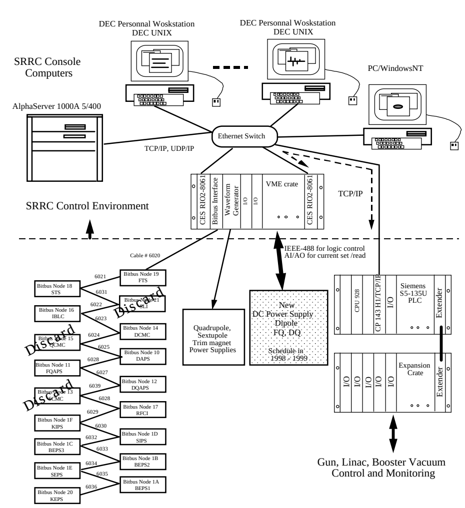

Figure 2. New injector control hardware configuration

3. CONTROL INTEGRATION METHODOLOGY

The injector works at high voltage mode when the storage rings injection about every week 6 to 8 hours currently. Because there is not any long period time for shutdown the injector to test the integration function, and not any major hardware change in this integration plan. Hence, all these tests are done in the duration of the injection shift. It is impossible to replace PLC system and any BITBUS node currently due to budget and manpower limitation. However, PLC system and BITBUS nodes upgrade will be investigated in the further upgrade plan.

3.1 PLC System Integration

PLC is the core of the linac control system. It coordinates signals to and from injector subsystem when it starts up and shut down the linac. It communicates to the VME crate system with Ethernet. The VME crate system runs a program to access the data of the PLC system.

3.2 BITBUS System Integration

The BITBUS network is a hierarchical system that a single master communicates with a number of slave nodes. For the integration purpose, a BITBUS controller was installed on VME crates system acting as a master. The BITBUS network application is running with 375 Kbit/s asynchronous mode in the SRRC.

3.3 Database Accommodation

The database structure of the injector control system is not fully compatible with the SRRC standard control environment. However, the VME crate will play as a protocol translator, which transforms devices level data format to main control system format. Consequently, the impact on the control database is negligible.

3.4 Control Level Integration

There is not any change on console level computer. It updates the I/O channel information into the styptic database and develops the graphical user interface for the injector normal operation. However, these functions will be integrated into the storage ring control system.

3.5 Graphical User Interface

The operation interface is a graphical mode interface, it is designed to provide easy operation and adjustment interface. Normal operation page is used to read and monitor status of the injector, and the detail information and setting are in the next page.

3.5 The Other Upgrade Activity

Injector integration and upgrade is a long-term and continuing program. These include DC power supply replacement, 1.5 GeV upgrade, diagnostic system installation, and utility upgrade. All these activities will be taken place in the next one to two years.

4. PERFORMANCE OF THE INTEGRATED SYSTYEM

Some typical examples of monitoring and signal polling of the injector by using the integrated control system are giving in the following paragraph.

Figure 3 shows the klystron modulator high voltage changing history in on/off transition during the normal operation. This operation includes the procedure of changing off/standby mode, HV on and trigging procedure.

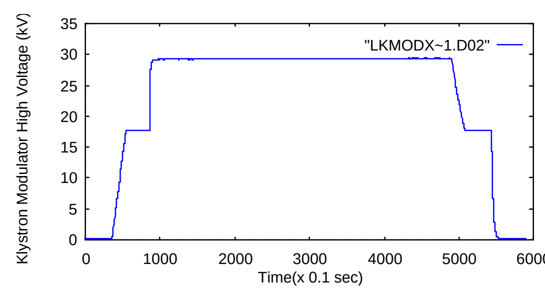

Figure 3. Klystron modulator high voltage

In the figure 4, a zoom portion of figure 3 show that the klystron modulator high voltage increases gradually was observed. In the further upgrade plan, studies and modification will be an important project for the klystron modulator.

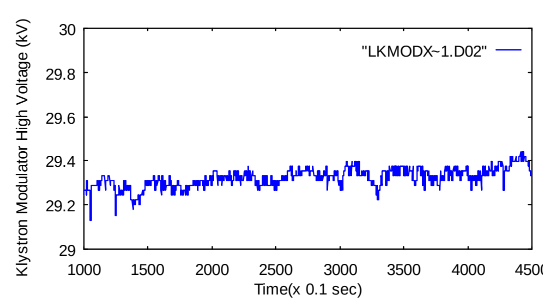

Figure 4. Zoom portion of figure 3

With the information provided by the diagnostic system installed, signal of the booster subsystem can be easily monitored. In the new control environment, a several of injector related application program will be developed and installed. In the figure 5, it shows the relation between the excitation current of dipole and quadrupole magnet power supplies (sinusoidal waveform). The spike like curve is the ratio of the excitation current of quadrupole and dipole, it inherits tracking information. Square wave like waveform is the stored beam current of the booster. During this test, the beam current is about 2 mA.

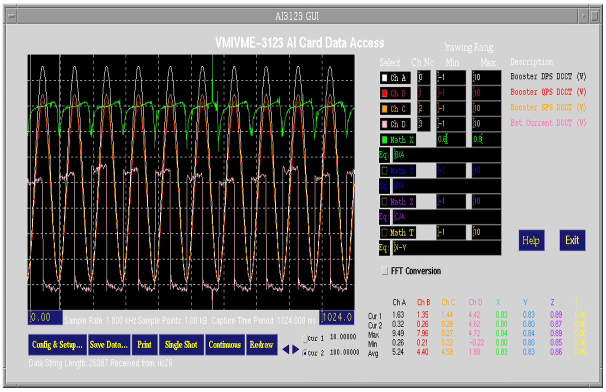

Figure 5 Booster magnet PS current (sinusoidal wave)
QD current/Dipole current (spike like wave)
Beam current (square like wave)

5. HIGH LEVEL APPLICATION

In order to modify and simplify the injector operation, there are several high-level application programs developed to support lattice file loading, machine cold start, shutdown procedure, and automatic operation.

5.1 Lattice File Loading

The main purpose of this application program is to download a set of nominal parameters for the injector operation and set to the corresponding subsystem. The change of these parameters can be saved and reloaded.

5.2 Machine Startup and Shutdown Procedure

A script file can be run for the injector startup and shutdown procedure. In the new injector control environment, an injector operation procedure can be edited to a script file and then be run for normal operation or other purpose of machine operation.

5.3 Injector Operation Automation

An automatic operation machine is a target of this machine upgrade plan. To achieve this goal, a series of upgrade projects have been studied and developed to improve the performance of various subsystems. Automation has considerable advantage in terms of efficiency, stability, and manpower saving.

6. FUTURE PROSPECTIVES

To improve the operation performance, efforts have been devoted on the study of timing, magnet power supply phasing, klystron modulator performance improvement, …etc. Feedforward technique for linac control is under development.

Due to the heat load effect on the beamline optics and the short lifetime due to small gap insertion devices, the topping up mode injection for the storage ring was considered. The first topping up mode injection test was done in 1994. Since the injector control system is separated from the storage ring control system at that time, the experiment was done by some manual intervention. The injector control system was expected to integrate with the storage ring control system in later of this year. Fully automatic topping up mode injection test will then become possible.

To keep ambient temperature stable inside the storage ring tunnel and to reduce the effect of the heat load problem, 1.5 GeV upgrade project is under serious consideration. In order to achieve the goal in the coming years, some old hardware should be replaced by new design, which uses different control interface. Saving the time for the preparation of 1.3 GeV injection is a another benefit of this integration plan.

Since the response time of PLC system and BITBUS network are relatively slow. In the next step upgrade plan will consider to replace the PLC system and BITBUS network by updated the hardware and software. Improvement in efficiency and stability is another important goal in the further upgrade planning.

7. CLOSING REMARKS

Performance of the injector control system will be improved substantially. The integration keeps most of the field level devices to reduce expense and manpower. Integrating the control system is one of the most important issues among the injector upgrade plans.

8. ACKNOWLEDGMENTS

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