COMPUTER CONTROL SYSTEM FOR THE SIAM PHOTON SOURCE

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Abstract

A new computer control system is being developed for the accelerator complex of the Siam Photon Laboratory, which is the first synchrotron radiation facility under construction in Thailand. Basic ideas for the new control system consisting of PCs and PLCs are described.

1 INTRODUCTION

The synchrotron radiation (SR) facility named the Siam Photon Laboratory is being constructed at Nakhon Ratchasima, which is about 250 km to the northeast Bangkok, in Thailand [1]. The accelerator system for the Siam Photon Source, consisting of a 1 GeV electron storage ring and an injector, was donated by the SORTEC Laboratory in Tsukuba, Japan [2]. It was dismantled and its components have been transported to Thailand. The building for the Laboratory is now under construction and the accelerator system will be reassembled by the end of 2000. The storage ring is upgraded from a dedicated SR source for study of micro-lithography to one of the highest-performance second-generation SR sources in the world [3].

The hardware of the control system for the SORTEC accelerator complex consisted of a mini-computer in the control room as a control computer and several data stations at various locations in the accelerator complex, in which interface boards for controlled devices and a CPU board were installed [4]. The control computer and the data stations were linked with RS-232C lines. Since the data transfer between the computer and the data stations was slow, another control system using a UNIX workstation and the VME interface was developed for control of the storage ring during machine study, in which the fast response of the control system was required. The operating system (OS) for the mini-computer was special; it is a combination of the UNIX operating system and a real time operating system. The control software was written in special FORTRAN running on it. The mini-computer was more than 15 years old and the special OS has not been used any more, so that we cannot used even the control software. The interface boards are not standard ones and CPU chips used in the CPU boards are not available now. All these factors made us decide to replace the whole control system including the interface hardware. The old control system was abandoned and a new computer control system will be installed for the Siam Photon Source.

The new control system is now being designed. In this paper, we will report the basic idea of the new control system for the Siam Photon accelerator complex.

2 ACCELERATOR COMPLEX

The ground plan of the accelerator complex of the Siam Photon Laboratory is shown in Fig. 1. It consists of a 1 GeV electron storage ring for the SR source, a 1 GeV synchrotron, a 40 MeV electron linac, a beam transport line from the linac to the synchrotron, which we call LBT, and a beam transport line from the synchrotron to the storage ring, HBT. The synchrotron and the linac are installed in the underground room and the storage ring is on the ground floor. The electron beam accelerated with the synchrotron is extracted and transported through the underground tunnel, steered to the ground floor and injected into the storage ring from inside.

The main parameters of the accelerator complex are listed in Table 1. In the routine operation for user experiments, the accelerator system will be operated as follows. The electron beam will be injected into the storage ring typically twice a day since the lifetime of the electron beam is expected to be longer than 10 hours. The injection time will be 10-20 minutes and consequently the synchrotron, the linac and the beam transport lines stand by most of the time. The electron energy of the storage ring will be raised from 1 to 1.2 GeV in the future by replacing the power supply for the bending magnets of the storage ring. Since the maximum energy of the synchrotron can not be made higher, the electron beam will be accelerated in the storage ring after injection.

3 HARDWARE

The new control system should be cost effective. The very fast response time is not required because such time critical jobs are made by using hardware circuits. We, therefore, have decided to use personal computers as control computers and programmable logic controllers (PLC) as interfaces to controlled devices. The basic ideas of the hardware for the new control system are as follows.

- Defacto standard components.
- Distributed control system.
- Multi-layered structure.
- Device control station (DCS) for each subsystem.
- Cutting down wiring.

The control system is being designed based on these basic ideas. The structure of the hardware system is shown in Fig. 2. It has two layers. The accelerator complex will be divided into five subsystems; they are the devices in the control room, LBT, the synchrotron, the electrical substation for the synchrotron, and the storage ring. A DCS or a few DCSs will be installed for each subsystem. Four PCs at first and the DCSs are connected with Ethernet. We call this level the information layer. A DCS includes a PLC or some PLCs. The majority of the controlled devices are power supplies for magnets and they have parallel I/Os. In order to cut down wiring between controlled devices and DCSs, a remote input and output station (RIO), which converts parallel I/O signals to serial signals, will be installed near every controlled device. We plan to incorporate RIOs in power supplies to be newly made. A DCS and RIOs are serially connected with an optical cable, which is named the computer link. This level is called the device layer.

We plan to adopt IBM-type PCs with Windows and PLCs made by Allen Bradley, because not only they are defacto standards but also they are easily available in Thailand.

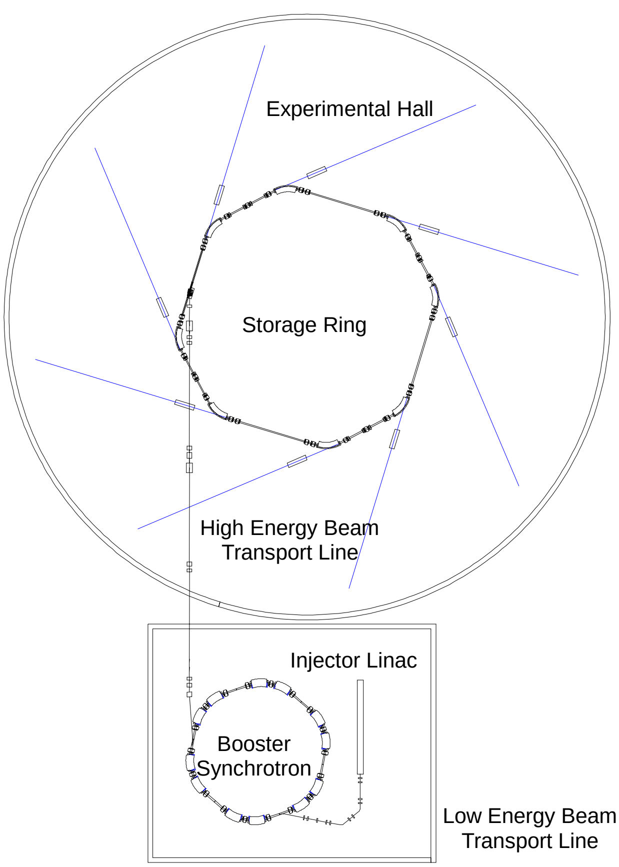

Fig. 1. Ground plan of the accelerator complex of the Siam Photon Laboratory.

4 SOFTWARE

The operating system for the PCs will be Windows NT 4.0 and the control software will be written in JAVA or C. The control software in the PLCs will be written in the standard ladder language.

The principal functions of the control system for the SR source are threefold; (i) automatic operation triggered by a single crick for routine operation to provide SR for user experiments, (ii) control of individual power supplies mainly used in the commissioning of the accelerator system as well as in machine study, and (iii) monitoring and logging of the accelerator status. Since the accelerator complex for the SR source will be operated in various modes to meet requirements of SR users, the control software should be flexible enough to meet these requirements, especially in the automatic operation mode. We will use a similar method developed at UVSOR facility of the Institute for Molecular Science [5].

In the automatic operation for user experiments, the accelerator complex will be operated as shown in Fig. 3. The accelerators can be divided into two groups in this case; the storage ring and the injector including the linac,

Table 1: Main parameters of the accelerator complex.

Storage ring		
	Energy	1.0 GeV
	Circumference	81.3 m
	Stored current (expected)	500 mA
	Magnet lattice	DBA
	Superperiodicity	4
	Long straight sections	7m×4
	Natural emittance	74 π nm rad
	RF frequency	118 MHz
	Harmonic number	16
Synchrotron		
	Energy	1.0 GeV
	Circumference	43.19 m
	Beam current	30 mA
	Repetition rate	1.25 Hz
	RF frequency	118 MHz
	Harmonic number	7
Linac		
	Energy	40 MeV
	RF frequency	2.856 GHz
	Beam current	60-80 mA
	Macropule width	1.7 µs
	Energy spread (FWHM)	1.3 %
	Emittance	0.7 π µm rad

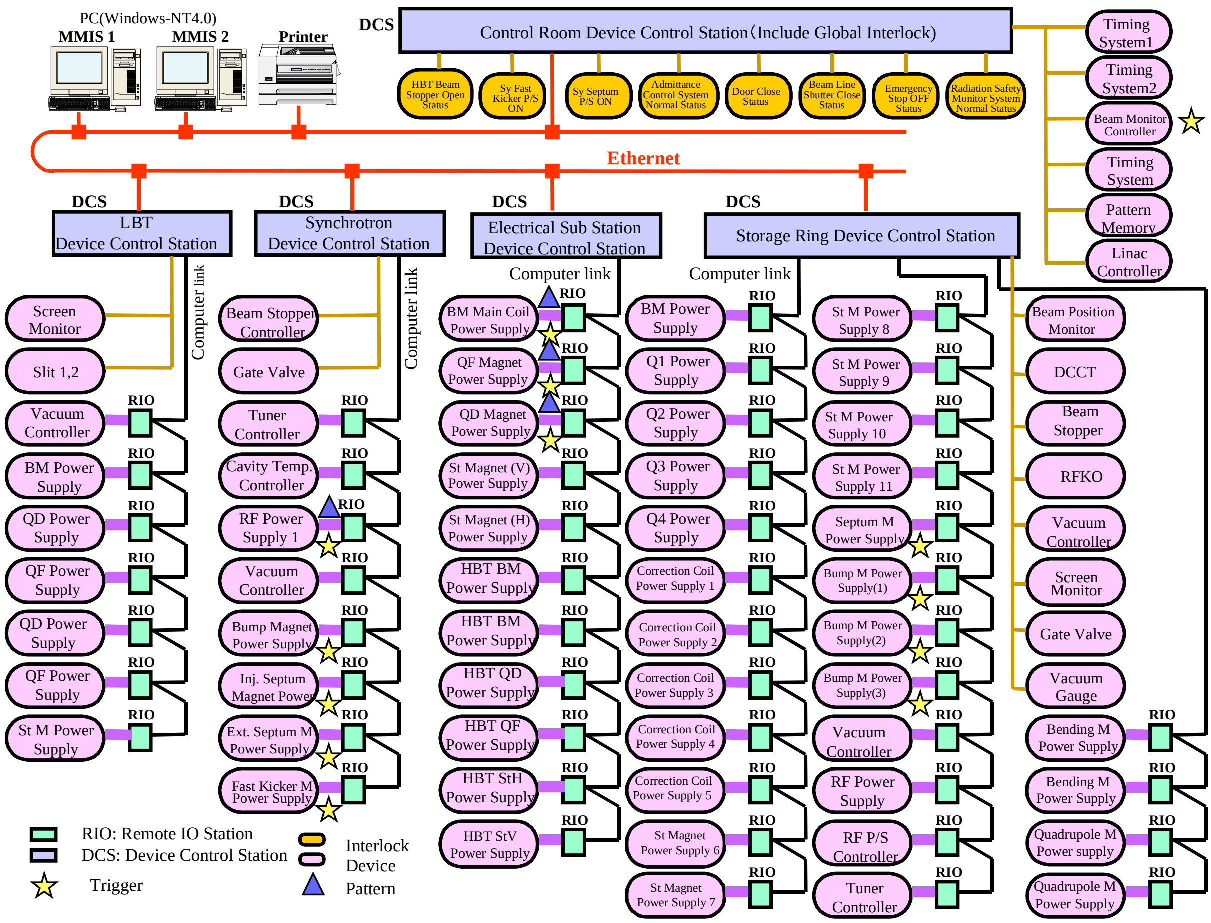

Fig. 2. Structure of the control system.

LBT, the synchrotron and HBT. In the shutdown mode, the storage ring and the injector are all switched off. In the ready mode, all the magnets in the both system except for pulse magnets for injection or extraction are excited but the electron beam is not accelerated by the injector. In the injection mode, the electron beam is accelerated from the linac and injected into the storage ring. Finally in the operation mode, the storage ring is operated as it is or the electron beam is accelerated in the storage ring in the future, but the injector is put in the standby mode, in which the power supplies in the injector system are switched on but the magnets are not excited. Accordingly the automatic operation should have the following commands; (a) start-up and shutdown, (b) injection start/stop, (c) acceleration/prepare for the next injection.

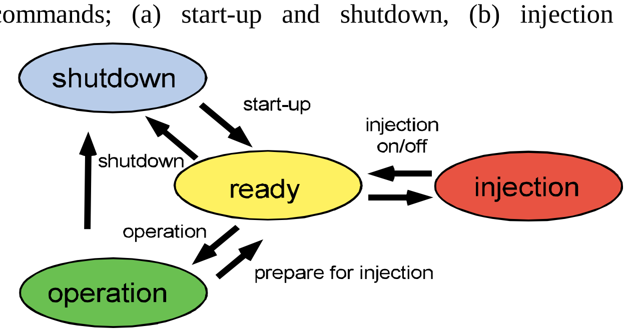

Fig. 3. Commands and statuses of the accelerator complex in the automatic operation.

In the control software, each command has an option number, specifying a data file in which names of data files for set vales are written. This makes it possible to operate the accelerator complex in various operation modes without changing the control software.

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