

Modification of SORTEC RING and the Associate Machine Control System

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Abstract

Guidelines for building the control system of the first synchrotron radiation source in Thailand, named the Siam Photon Source, are described. Central computers used for Man-Machine Interface Stations (MMIS) are four personal computers, three of which are usually used for indicating status data transmitted from or to several Devices Control Stations (DCS) through Ethernet. One unit of DCS handles a group of equipment belonging to the major component pieces of apparatus in the accelerator system. Some details of the I/O connection will be mentioned along with the descriptions of MMIS and DCS.

The Ministry of Science, Technology and Environment (MOSTE) of Thailand is now promoting the synchrotron radiation research project named the Siam Photon Project. The content of project has been reported in various places [1-4]. The details of the Siam Photon Source are also found in other articles [6-8].

The Siam Photon Project is summarized as follows:

- (1) A 1.0 GeV electron storage ring shall be constructed. The storage ring shall be equipped with four long straight sections for insertion devices.
- (2) Beam lines and experimental stations for advanced spectroscopic studies on gases, solid materials, surfaces and interfaces shall be built. In the first phase stage of construction, a complex beam line for angle-resolved photoemission and soft x-ray fluorescence measurements shall be constructed.
- (3) The installation of superconducting magnet wigglers is considered. Beam lines for x-ray experiments using light from the wigglers shall be built. The experiments considered in the first phase stage is protein crystallography.
- (4) In the second phase stage of construction, beam lines for other experiments shall be built. They include those for some advanced photoemission spectroscopy, x-ray microscope, routine photoabsorption and photoreflexion experiments, radiation biology, basic researches on metrology using synchrotron radiation as an intensity standard of light, the study of micromachining, basic

researches on microlithography, and ordinary x-ray crystallography.

The synchrotron radiation source built in the Siam Photon Project is the modified SORTEC storage ring that was owned by the SORTEC Corporation in Tsukuba, Japan. The SORTEC storage ring as well as the associated injector linac, booster synchrotron and beam transport lines were dismantled and the components were transported to the National Synchrotron Research Center (NSRC) that is carrying out the practical work for the Siam Photon Project under MOSTE.

For the machine structure, we ask the readers to refer the previous reports [1-7] in which the details of the modification of the SORTEC storage ring as well as the results of the beam dynamics calculations are presented. Concerning the machine control system that is completely renewed, a report describing an aspect different from the present report is presented in this conference [8]. In that report, descriptions of the cause of the renewal of the control system, the hardware and the software are described.

The outline of the control system is as follows:

The control system forms a sort of local area network. Sets of apparatus to be controlled are various instrument controllers and power supplies broken up into groups associated with the injector linac, the synchrotron, the storage ring, beam lines and the pieces of equipment in the control room. Data flow is made from the Man-Machine Interface Stations (MMIS) to Ethernet and then to Devices Control Stations (DCS), Remote Input-Output station (RIO), Subsystem Units (SSU), and Component Units (CU). Obviously, the opposite data flow occurs also. MMIS's are the stations where operators make dialogue with the control system in a way as inputting the order and operation parameters or obtaining the information on a deal of status of the machine components. DCS's are units where order or information signals to and from various groups of equipment are relayed. SSU's are panels such as power supplies and controllers. CU's are terminal units of the machine such as magnets, the RF cavity, and beam monitors. Central

computers to be used for MMIS are four personal computers, three of which are usually used for status indication. Only one computer is used for controlling the whole system. They shall be of the defacto standard. IBM-PC is an example of this type. Information data are transmitted from or to several DCS's through Ethernet. One unit of DCS handles a group of equipment belonging to the major component pieces of apparatus in the accelerator system. The DCS units to be set up are those for the linac and the low energy beam transport line, the synchrotron and the high energy beam transport line, the storage ring, the electric substation, and the system in the control room. The input and output connection of a DCS unit with various panels is made by computer link devices. They are RIO. The use of RIO drastically reduces the numbers of wires connecting on-site panels with system interfaces. Nine interface panels shall be newly built.

The personal computers, the sequencers, and component parts for maintenance that are obtainable in Thailand shall be used. As practical work, the following design work and manufacturing work shall be carried out:

- (1) The machines control equipment equivalent to that of the SORTEC apparatus shall be designed and built newly. The corresponding pieces of equipment are as follows:
 - (a) Interface panels for the power supplies to the low energy beam transport (LBT) line system.
 - (b) On-site interface panels for the beam monitors in the LBT system
 - (c) Interface panels for power supplies in the synchrotron
 - (d) Interface panels for various power supplies in the storage ring
 - (e) On-site interface panels for beam monitors in the storage ring
 - (f) Computers for controlling the whole system
- (2) Interfaces for I/O connections for sets of equipment added newly in the high energy beam transport (HBT) line system and those of the storage ring apparatus shall be newly produced.
- (3) Wires connecting computers for controlling the whole system with various pieces of equipment shall be provided.
- (4) The timing controller, the clock generator, the pattern memory, the beam monitor control panel, the interface panel for the beam monitor and the interface panel for the beam monitor that are from the SORTEC apparatus shall be used in the present work.
- (5) The signals from beam position monitor electrodes in the storage ring shall be put in the signal processors. The beam position monitor data out of the signal processors shall be put in DCS.
- (6) Processing of the signals for the OPEN/CLOSE status of the beam shutters, however, shall be included in the global interlock of the safety system.

Some more additional explanations of the elements of the control system are presented below.

(1) MMIS

Four personal computers at MMIS shall be driven by Windows- NT 4.0. This is of the defacto standard. The operation of the synchrotron radiation apparatus and the observation of the machine state shall be performed with MMIS provided here. The main functions of MMIS are as follows:

- a) The computers exhibit the operational state, setting up of parameters and the start/stop operation. The relevant operation and exhibition are implemented independently for individual component equipment.
- b) Instruments requiring the sequence control are controlled by the computer at MMIS.
- c) The MMIS computer makes and preserves the operation pattern for the equipment that must be operated by means of the pattern control. It reforms the operation pattern, if necessary.
- d) Three computers at MMIS are ready to show the alarm notice all the time. This is implemented by indicating the status whether important pieces of equipment are in the normal operating states or out of order.
- e) The three computers illustrate the aspect of the change in the machine state.
- f) The computers preserve the data of pressure in the vacuum chamber and the magnitude of the stored current for a period of 24 hours.
- g) The computers preserve necessary operation parameter data for all sets of equipment.
- h) The computers perform the global interlock control.

(2) Interlock

The global interlock control shall be carried out. The global interlock is the system that interlocks various operation units using notice signals from various safety devices so as to make the accelerators run safely. The pertinent notice signals are as follows:

- (a) OPEN state signal from the beam stopper in the HBT system
- (b) ON signal from the fast kicker magnet power supply of the synchrotron
- (c) ON signal from the septum magnet power supply of the synchrotron
- (d) CLOSE state signals from the doors to the machine rooms and the experimental hall
- (e) OFF state signals from the manual switches for energy stops
- (f) CLOSE state signals from beam line shutters

- (g) NORMAL state signals from the access control equipment
- (h) NORMAL state signals from the radiation safety control equipment.

(3) RIO

The I/O connection of MMIS with various power supplies and interfaces on the site are made through RIO. RIO's are installed near the upper or side parts of the panels. A number of RIO's on different panels connect in series by means of Computer Link (direct connection between computers with wires) and data are transmitted through this line. The Computer Link line connects ultimately with DCS described in (3). The interface system for the I/O connection shall be provided for magnet power supplies, synchrotron beam monitors, LBT line beam monitors, storage ring beam monitors, HBT line beam monitors, the vacuum system, the RF acceleration system, the clock generator, the timing controller, and the pattern memory.

(4) DCS

- (a) DCS handles a group of equipment belonging to a layer through a number of RIO. DCS's contain Programmable Logic Controllers (PLC's) that control RIO's. Data from RIO's are transmitted to Ethernet through DCS.
- (b) The DCS's to be built are shown below. If necessary, further integration or division shall be made.

Control Room DCS; Linac DCS; Synchrotron DCS; Electrical Substation DCS; Storage Ring DCS

(6) Preservation of Data

Data to be preserved are pressure in vacuum chambers, the stored current, and necessary equipment operation parameters.

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In conclusion, we summarize the functions of the present control system below. The functions are almost the same as those of MMIS.

- (1) Monitoring Operations of Individual Sets of Equipment
Status indication, setting parameters, and making a start or a stop are made individually for various pieces of equipment.
- (2) Sequence Operation Control
The sequence control of the start/stop operations of the magnet power supplies and the RF power supply are made.
- (3) Production, Alteration, and Preservation of Operation Patterns
The production, alteration and preservation of the operation pattern of the magnet power supplies and the RF acceleration system of the synchrotron are made.
- (4) Indication of Alarm Notice
The alarm notice shall be indicated if a sets of equipment is in trouble.
- (5) Indication of the History of the State Change
The history of the state change of a set of equipment are illustrated.