THE REASSEMBLY OF THE SIAM PHOTON SOURCE

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Abstract

The full commissioning of the accelerator complex of the Siam Photon Source is about to start. In this report, the substantial part of machine reformation is briefly described. Then the machine reassembly work and various problems found during the course of the work are described. The contents are useful for planning the utilization of the second hand machine.

1. INTRODUCTION

Recent development of the accelerator technology is very fast and remarkable. In accordance, physicists plan to carry out new sophisticated experiments by the full use of advanced techniques. When a new accelerator is build, the building or the tunnel for the old one is preserved and used for the new one, but the old machine is abandoned. In the case of an accelerator complex for a synchrotron light source, the realization of a 3rd generation accelerator complex makes a 2nd generation source unnecessary. However the accelerator can be used in a country where making the experience of the construction of a large-scale scientific research facility and training scientists and engineers by the use of the accelerator are still very important missions.

The Siam Photon Source is previously owned by the SORTEC Laboratory in Tsukuba, Japan. Since the laboratory had been closed, the light source accelerator complex was dismantled and transferred to the National Synchrotron Research Center (NSRC) of Thailand. Then, NSRC reformed the machine structure and reassembled the accelerator complex. Since a similar project is planned in other countries and more plans still may come out in the future, the experiences we had in the Siam Photon Project will be useful for other similar projects. This is the motivation to present this report.

2. MACHINE REFORMATION

The structure and simulated performances of our accelerators have been reported many times [1-3]. The structure and characteristics of the injector linac after the reassemby are reported in this conference [4]. The characteristics of the machine control system are also reported elsewhere [5].

Among component accelerators, the injector linac, and the low energy beam transport (LBT) line connecting the linac to the booster synchrotron are not reformed and the same as those used in the SORTEC Laboratory.

The storage ring was reformed. The structure of storage ring is described in some separate reports [2, 6]. The reformed parts are described below.

(1) The injector linac, the LBT line, the synchrotron and the high energy beam transport (HBT) line are installed in the room underground. The electron beam is brought up to the storage ring room on the ground floor and injected into the storage ring from the inside of the storage ring.

(2) The magnet lattice structure of the SORTEC ring, the quadruple doublet lattice similar to the FODO lattice, is changed to the double bend achromat (DBA) lattice. The natural beam emittance is reduced to one seventh as small as that of the SORTEC ring. The numbers of quadrupole magnets, sextupole magnets and steering magnets were increased. The mechanical structures of the magnets built newly are the same as those of the SORTEC ring. The power supplies to the magnets have some new features

(3) Four long straight sections for insertion devices were inserted. Because of this and the lattice reformation, the vacuum system including vacuum chambers was renewed. The vacuum chambers are made of aluminum. Four gate valves separate and divide the ring into four sections. The gate valves are closed and the isolated a quarter of the whole chambers was baked successively. For the beam position adjustment, four button-type beam position monitors are installed in the vacuum chambers. The automatic operation of the vacuum system is not carried out by the computer in the machine control system. The vacuum state data are sent to the computers in the control system.

(4) The machine control system was renewed. The machine control system is composed of personal computers (PC's) and programmable device controllers (PLC's). In the machine control room, three PC's, one for the control server (CNT-SRC) and others for the data acquisition server (ACQ-SRV), are installed along with four PC's used as operational terminal equipment. Two of the additional computers are used to control the admittance to the controlled access areas and to record the personal histories of stay in the controlled access areas.

Pairs of PLC and the device control stations (DCS's) are installed in the synchrotron room, the electric substation room, the storage ring room and the machine control room. LAN connecting the computers and DCS's is made with the ordinary Ethernet. A hub is located in the control room. PC's and PLC's are connected to this hub with optical fibers and with 100 Base-T cables.

The six PLC's observe the states of individual instruments and control them independently of each other. The language for PLC's is the ladder for the programmable logic control. OS used in the two servers PC's, and the three PC's as terminal equipment is Windows NT 4.0. CNT-SRV observes the conditions of individual component instruments through PLC and memorizes as the database. The operation and the state observation are carried out by the graphical user interface.

(5) Because of the reformation (1), the HBT line was newly built. A distinctive feature of the HBT line is that the electron beam is not much deflected in the horizontal direction, first by 4° clockwise then by 2° counterclockwise. The small deflection angles keep the beam profile in a good shape. A few magnets and the associated power supplies are from the SORTEC system.

3. REASSEMBY

The machine assembly work proceed as follows:

(1) The building where the accelerators are installed was surveyed to mark reference points [6]. Since the reference points were found to move, the survey was repeated just before the accelerator alignment. After the settlement of the reference points, one of which is in the synchrotron room and the other is in the storage ring room, component accelerators were installed and accurately aligned using the reference points. Allowable errors were ±0.1mm.

(2) The installation and alignment were first carried out on the booster synchrotron and then on the injector linac followed by the LBT line. The storage ring was installed and aligned after the other component accelerators and the LBT line in the underground rooms were aligned.

(3) The HBT line was aligned after all the component accelerators were aligned.

(4) For the alignment of the storage ring, magnets were installed first. Then each magnet was decomposed into two pieces and the upper part was removed. Then the vacuum chambers were installed and aligned. The important positions of the vacuum chambers are those of the beam position monitor. The reference planes, both horizontal and vertical, are settled by surveying and adjusting. The vacuum chambers are so aligned that the beam position monitors come onto the proper sites. When the alignment of the vacuum chamber is completed, the upper half of each magnet was setup in its original position and magnets were aligned. This was carried out using the reference point marked on each magnet.

(5) The alignment of the synchrotron magnets was made more or less similarly to the case of the storage ring. In this case, the alignment of the vacuum chambers was not important.

(6) Almost at the same time as the installation work was underway, the performance of various power supplies and controllers were inspected. Broken components were either repaired or replaced.

(7) The wiring work and the water tube connection work were carried out after the alignment work had been over.

(8) The baking of the vacuum chambers of the storage ring was carried out after all the work of the machine setup had been over. At present, the pressure inside the vacuum chamber is in the range of 10^{-11} Torr.

(9) The installation of the new machine control system was implemented after other assembly work had been finished [5,7]. The new machine control system contains both hardware and software. Some of the interfaces of the power supplies and controllers on the sites were those used in the old SORTEC machines.

(10) In the very last stage of the reassembly work, radiation monitors were installed and their performances were examined. This system is connected to the global interlock in the machine control system through the computer connection.

Up to the present, the proper operation of the linac and the LBT line was confirmed. The performance test and characteristics measurements have been carried out on the RF acceleration systems of the accelerator complex including that of the linac [4,8]. The complete investigation with the electron beam load has not yet been accomplished, but the performance and characteristics measurements made so far indicate that beam filling will be achievable.

4. TROUBLES

Before the assembling work started, machine components had been stored in packages in a large storehouse room for about 5 years. The SORTEC facility was not operated over one year. Thus, the system had not been in operation over about 6 years. Semiconductor elements die while they are kept unused for a long time. This occurred in the Siam Photon Source.

Here some interesting cases of troubles we have had so far are described.

(1) Breakdown of the cooling water temperature controller. If the cooling water temperature is not properly controlled for the power supplies for the injector linac, the microwave output is not stable and the beam intensity as well as beam energy is not stable. We found the current control units in the temperature controller did not work. Although such a unit is commercially available usually, we were not able to obtain the same unit since the model is too old and not sold any more. We replaced the broken unit with a new unit. However, additional work had to be made to reform the circuit around this.

(2) The power supply to the kicker magnet was out of order. One board installed in it was found to be dead. The board was renewed.
(3) The breakdown of two ion pump controllers. We found that this was caused by the breakdown of the transformer installed in the controller. Since the new transformer could not be found, we had to replace the whole evacuation systems including ion pumps. The new pump controllers are not equipped with the automatic recovery system against a short period power failure. The possible measure for this is to use more pieces of UPS.
(4) The breakdown of the synchronous pulse generator in the machine control system. One obvious cause of this was the drying up of a battery supplying power to circuit boards. By this, the memories in the board disappeared. As the cure of the lost memories, the dead battery was replaced with a new one. Then, the memories were input again. Another cause is the breakdown of the software storage part of a computer installed in the synchronous pulse generator. However, it seemed hat the trouble of the computer installed in the synchronous pulse generator could not be repaired. Thus, the SORTEC timer system was abandoned and a new timer system has been made. The work will be completed soon. At present, the repaired part of the old synchronous pulse generator and a part of the newly built system are combined together to generate synchronous pulses switching the beam injection system.
(5) The breakdown of the 5th harmonics filter for the power supply line to the booster synchrotron. The apparent symptom of this was the burning down of a part of a circuit board. The cause has not yet been clarified. At present, we bypass the line and do not use this filter.
(6) The blowing out of two fuses in a static condenser unit in the power supply line. This occurred twice. Various measurements are underway to find the cause and the measures. At present, we do not know if these accidents are related to the accident (5), though it is possible. The enhanced 5th harmonics component can be contained in the power from the primary line.
(7) In some power supplies to the synchrotron, fans to cool the circuits did not work. The cause was the deterioration of lubricating grease. The work to replace the fans was slightly complicated because of the complicated design of the system.
(8) Mobile parts attached to the water flow line such as valves did not work properly. This was caused by rust. The parts were decomposed and cleaned. This cured the troubles.
(9) Almost all of the flow meters and pressure gauges indicated incorrect values. They were all replaced.
(10) Welded parts of the tubes of the pure water supply were corroded. Rust was found at many welded parts. The causes were the use of improper welding rods and poor workmanship. All the welded parts were cut off and welded newly. About three months were spent for this repair work.

(11) Bellows of the automatic frequency tuner showed leak. The bellows was replaced. For this work, three months were lost.
(12) Some of aluminum vacuum chambers were cracked during transportation. They were not fatal and welded again.
(13) Another serious problem is the heterogeneous floor settlement in the machine room. In the case of the synchrotron room, the difference of the synchrotron magnet level that moved in 4 months amounted up to 5 mm. The synchrotron was realigned. The similar heterogeneous floor settlement was found in the storage ring room, although the amount of the floor shift was smaller. As a measure for this, the electron beam location adjustment by the use of steering magnets is considered. In spite of repeated inspection work, the cause of the heterogeneous floor settlement has not yet been clarified.

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