PRESENT STATUS OF THE SIAM PHOTON SOURCE

P. Klysubun #, S. Rugmai, S. Cheedket, P. Sudmuang, G. Hoyes, M. Oyamada, W. Pairsuwan,
NSRC, Nakhon Ratchasima, Thailand

Abstract

The Siam Photon Source (SPS) is a 1.2 GeV synchrotron light source situated in Nakhon Ratchasima, Thailand. It is currently in the fourth year of routine operation for synchrotron radiation users. In order to address the increasing demand from users for increasing beamtime, better beam position stability, and improved machine reliability, several machine improvements and upgrades have been undertaken during the past year. This report first briefly gives the overview of the light source, and then describes the current operation status and operation statistics during 2007 - 2008. Recent machine improvements, for instance, modernization of injector components, improvement of vacuum system, recalibration of beam position monitors, and orbit correction, are presented together with the initial synopsis of the successful installation of the first insertion device, a permanent magnet planar undulator.

INTRODUCTION

The Siam Photon Source [1,2], a dedicated 1.2 GeV synchrotron radiation source located in Nakhon Ratchasima, Thailand, is the central part of a national research facility called the Siam Photon Laboratory (SPL), which is operated by the National Synchrotron Research Center (NSRC) under the guidance of the Ministry of Science and Technology. The accelerator complex consists of a 0.5-Hz, 1.0-GeV injector and a 1.2-GeV electron storage ring, the configuration of which is based on a four-fold symmetric double bend achromat (DBA) lattice. At present, regular operation requires energy ramping in the storage ring since the beam is not injected at full energy. It is planned that the energy of the injector will eventually be upgraded to 1.2 GeV for full energy injection in order to simplify the injection process. The electron storage ring has four 7-m long straight sections, two of which are partly occupied by an injection septum and an RF cavity. The third straight section has a permanent magnet planar undulator [3,4], which was installed in January 2008. The final straight section will be occupied by a 6.4T superconducting wavelength shifter [5], which is scheduled to be installed in 2009. Currently, there are three photon beamlines in operation and three more under construction. Fig. 1 shows the SPS spectral flux densities.

STATUS OF OPERATION: 2007 – 2008

In the year 2007 the SPS continued to operate in user mode of operation. The weekly operation schedule was the same as that of 2006, that is, Monday morning was reserved for weekly preventive maintenance, while Monday afternoon and every other Tuesday were scheduled for machine study as well as installation and testing of new equipments. The rest of the week until 2 PM Friday was dedicated for user experiments. Beam injection was performed four times a day, as in 2006. The time it took for each round of injection was approximately half an hour. The injection process consists of dumping of the circulating beam, standardizing the magnets, injecting the beam, and ramping up the beam energy in the storage ring.

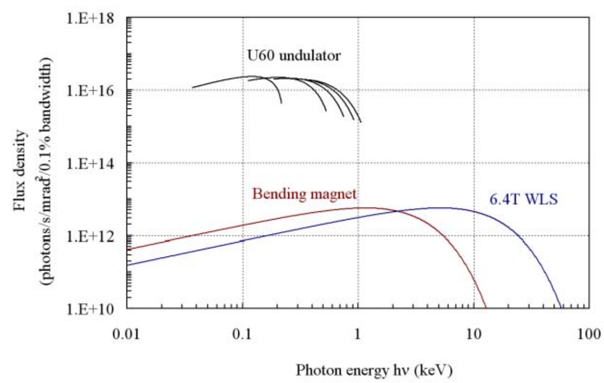

Figure 1: SPS spectral flux densities.

The total number of scheduled user beam hours in 2007 was 1631 hours, out of which 1541 hours were delivered, resulting in the user beam availability of 94.5%. This figure is up significantly from last year where the machine uptime was merely 84.2%. Several factors contributed to this improvement, the most important of which was the construction and commissioning of a new, dedicated 115-kV electrical substation for the SPS. Prior to the substation becoming operational a large number of machine trips (~ 40%) was caused by electrical instability of the 22-kV line previously supplying the facility.

In January 2008 after the storage ring beam position monitors were recalibrated and COD correction were performed, the beam lifetime markedly improved from previously 4.5 hours at 100 mA to 9 hours at the same current. As a result the number of beam injection was reduced to 3 times per day in 2008. The overall operation schedule was changed as well. Now the first week of each month is reserved for machine study and equipment installation while the rest of the month is dedicated for user experiments. In a particular week user beamtime starts from 5PM Monday and lasts until 4PM Friday. The total number of scheduled user beamtime for the year 2008 is 2370 hours.

#pklysubun@nsrc.or.th

RECENT MACHINE IMPROVEMENTS AND FUTURE UPGRADES

Modernization of Injector Components

Beginning last year efforts have been focused on modernizing various electronic components of the injector in order to improve its reliability and stability. Several aging and degrading electronics of the injector, some of which were more than fifteen years old, have been replaced with modern counterparts. Following the upgrade of the pattern memory system of the booster with a new PXI-based digital I/O waveform generator, a high-frequency switching high-voltage power supply was installed to replace the old HV PS for charging the pulse-forming network (PFN) of the linac klystron. After the installation the linac performance, especially its stability, improved noticeably due to better voltage regulation of the klystron PFN.

Figure 2: High frequency switching PS for the linac klystron under testing (left) and after installation atop the old HV PS (right).

Additionally, all of the old manually-controlled analog DC power supplies of the linac magnets were replaced with programmable digital power supplies, resulting in more reliable and stable operation. In 2008 machine shutdown the HV PS charging the electron gun PFN was also replaced with a high-frequency switching HV PS. In addition, the vacuum tube (triode)-based RF oscillator and amplifier feeding the klystron were replaced with solid-state counterparts. After these upgrades are completed the reliability and stability of the injector both improve considerably.

Figure 3: New solid-state RF oscillator and amplifier.

Installation of Soft X-Ray Undulator U60

In January 2008 the 2.5 m-long, 60 mm-period length pure permanent magnet undulator U60 [3,4], has been successfully installed into the storage ring straight section between bending magnets BM2 and BM3. The undulator has been found to cause only small perturbations on the electron beam. It was found that the undulator field has no apparent effect on injection efficiency. The vertical tune shift was measured to be 0.005 at the undulator minimum gap of 26 mm. The perturbation on the beam orbit was found to be within ±10 microns (rms) while changing the undulator gap. Correction of these small perturbations is well within the capacities of the existing magnet system in the storage ring. A soft x-ray beamline utilizing radiation from the undulator is now under construction. Characterization of the U60 radiation is planned to be carried out using optics of the beamline.

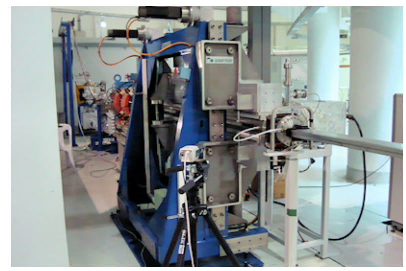

Figure 4: Undulator U60.

Vacuum System Improvement

During the 2007 machine shutdown two all-metal gate valves were installed in the storage ring. One replaced an existing Viton valve to improve the ring vacuum condition. The other was added for better vacuum sectioning. Two more all-metal GVs were installed during the 2008 machine shutdown together with new vacuum chambers, i.e. wavelength shifter upstream and downstream chambers. As for the booster synchrotron, all of the old nude ion gauges (NIG), some of which are broken, were replaced with cold cathode gauges (CCG), along with associated controllers.

Improvement to the Storage Ring Beam Position Monitors

During the 2007 shutdown period all of the storage ring BPM electronics were removed for recalibration using a signal generator. In addition, signal averaging DSP has been installed to reduce electronic noises in the BPM signal readouts.

Implementation of a New Low-Level RF Electronics

The low-level RF (LLRF) electronics for both the booster synchrotron and the storage ring will soon be replaced with modular NIM modules. The current LLRF systems, which are more than fifteen years old, are composed of several obsolete electronic components, many of which are impossible to find replacement. In May 2007 the attenuator in the booster synchrotron LLRF electronics failed and a replacement could not be found. Fortunately with the help from the SPring-8, which has an unused equivalent low-level controller board, the malfunctioned board was replaced with the new board after some modifications. To prevent similar problem from happening in the future the LLRF electronics needs to be upgraded.

Additional Storage Ring RF System

The installation of the 6.4T WLS in the storage ring will introduce an additional 8 keV energy loss per turn to the circulating beam, resulting in the reduction of the overvoltage factor of the RF system from presently 1.82, which is already relatively low, to 1.62. This in turn limits the maximum stored beam current and greatly reduce the beam lifetime. A second RF system will be installed to rectify this situation. The second cavity will have a gap voltage of 120 kV similar to the existing cavity; however, the associated 30-kW RF amplifier will be all solid-state instead of vacuum tube (tetrode)-based currently in use. At the time of writing the procurement process for the amplifier is being carried out.

ACKNOWLEDGEMENT

The authors wish to thank all members of Accelerator Technology Division for their devoted contribution and tireless support.

REFERENCES

[1] P. Klysubun et al., “Operation and Recent Developments at the Siam Photon Source”, APAC’07, Indore, February 2007, p. 607.

[2] P. Klysubun et al., “Operation and Improvement of the Siam Photon Source”, Nucl. Instrum. Meth. A 582 (2007) 18.

[3] S. Rugmai et al., “Soft X-ray Undulator for the Siam Photon Source”, AIP Proceedings 879 (2007) 335.

[4] T. Dasri et al., “Characterization of Soft X-ray Undulator for the Siam Photon Source”, Nucl. Instrum. Meth. A 582 (2007) 40.

[5] P. Klysubun et al., “A 6.4T Superconducting Wavelength Shifter for the Generation of Hard X-rays at the Siam Photon Source”, Nucl. Instrum. Meth. A 582 (2007) 47.