An Overview of the PLS Project*

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Abstract
PLS (Pohang Light Source) is a synchrotron radiation facility currently under construction in Pohang, Korea. It consists of a 2-GeV full energy injector linac, a storage ring, and three initial beam lines. The PLS belongs to a third generation machine with an expected beam emittance of 12 nm rad. The commissioning of the PLS is scheduled to take place toward the late fall of 1994. The facility will be opened to users by mid-1995 and will eventually provide high brightness source of radiation in the wide spectral region from bending magnets and insertion devices.

I. INTRODUCTION

Construction of the Pohang Light Source (PLS) in Pohang, Korea is well in under progress since the ground-breaking of the site in April of 1991. The main part of the accelerator facility consists of a full energy injector linac and a storage ring optimized at 2-GeV of electron energy [1]. The PLS belongs to a third generation light source with an expected emittance of 12 nm rad. Ten 6.8-m long straight sections are available for installation of insertion devices. Two initial bending magnet beamlines and a superconducting wiggler are under construction. The PLS conventional facility which includes the linear accelerator buildings with a total floor space of 38,678 m^2 have been completed 87% of its total schedule as of April, 1993. Figure 1 shows a general layout of the PLS facility. The machine installations for both the injector linac and the storage ring are under progress. The commissioning of the injector linac and storage ring will be taken place respectively by beginning and fall of 1994.

II. INJECTOR LINAC

The electron linac consists of 60-MeV preinjector and 2-GeV main linac which are located 6 meters below the ground level. Total of 42 SLAC-type accelerating columns are powered by 11 klystrons and 10 pulse compressors. A nominal beam energy is 2-GeV and total length of the linac is 150 m. The linac will be operated at 10 Hz when the beam is injected into the storage ring injection system via 98 m long beam transfer line which will bring the beam above the ground level. A detailed description of the PLS injector linac can be found in this proceedings [2].

III. STORAGE RING

A. Lattice and Magnets

The storage ring lattice has a Triple Bend Achromat structure with 12 superperiods and total circumference of the ring is 280.56 m. Table 1 summarizes major storage ring parameters. There are 3 flat dipole magnets, 12 quadrupoles, and 4 sextupoles in each superperiod. Figure 2 shows the PLS magnetic lattice of one superperiod. A large number of quadrupoles provides flexibility and diversity. Two pairs of sextupoles, one focusing and one defocusing are used for chromaticity correction. The required strengths of these sextupoles are considerably smaller than those for other third generation light sources, resulting in smaller nonlinear effects and somewhat larger dynamic aperture. The sextupoles have additional horizontal and vertical trim windings to correct the closed orbit distortions and to control the skew quadrupole components. The closed orbit is monitored by total of 108 beam position monitors. Correction of the orbit is accomplished by 82 horizontal and 82 vertical dipoles distributed around the ring.

Table 1: Major storage ring parameters

Nominal energy	2 GeV
Circumference	280.56 m
Harmonic number	468
Radio Frequency	500.082 MHz
Critical photon energy	2.8 keV
Maximum current	
Single bunch mode	7.0 mA
Multi bunch mode	100 mA
Natural emittance	12 x 10^{-9} m rad
Available straight section for insertion device	10
Time structure	20 ~ 50 psec
Beam lifetime	> 5 hours
RMS beam size at insertion device center	
σ_x	330 μm
σ_y	70 μm
Energy loss per turn from bending magnet	225 keV

The injection system of the storage ring consists of four bump magnets and one Lambertson septum magnet. The beam from the linac is vertically bent 8° by means of Lambertson magnet in order to make the beam level the same as the storage ring orbit.

Prototype magnets for the storage ring dipole, quadrupole, sextupole, and correction dipoles (all supplied by Hyundai Electrical Engineering Co.) have been examined and the field measurements have been performed. The magnetic field error multipole components are found to be within allowable tolerances. All 36 bending magnets have now been delivered and the field measurements have been performed. The delivery of the remaining quadrupoles, sextupoles, and correction dipoles will

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be completed by the beginning of 1994. Prototype power supplies for the magnets have been designed and tested successfully. The main products are now being delivered by POSCON Co. and Daewoo Heavy Industries Co.

B. Vacuum Chamber

The storage ring vacuum chamber is made of aluminum alloy 5083-H 321. Each superperiod has two sector chambers (7-m and 10-m long) and one straight section. Each sector chamber consists of a top and a bottom pieces and these are machined separately and welded together. Three beam line ports per superperiod are provided, one from insertion device and two from a middle bending magnet. The vacuum chamber is divided into two regions, a beam channel and an antechamber in order to reduce vacuum problem in the beam channel caused by photon induced desorption. A number of water-cooled photon stops are positioned to prevent the synchrotron radiation striking the chamber wall directly, except the beamline ports. The storage ring vacuum system is pumped by sputter ion pumps (SIP) and combination pumps consisting of lumped non-evaporable getter pump (NEG) and SIP. The combination pumps are located directly below each photon stops. So far, three main sector chambers which are mounted on supporting girders have been evacuated to the order of 10^{-10} torr and installed into the storage ring tunnel.

C. Survey and Alignment

Since the PLS is a third generation machine, its components should be placed as accurately as possible within the respective allowable tolerances. In order to control the absolute position of the PLS components, a global reference network is formed based on the PLS coordinate system. There are total of ten global reference points: four on the surrounding hill tops, two on the linac and four on the storage ring tunnel floor. These ten geodetic points are to be sighted directly each other to form a surface network. This is done by penetration hole right above the geodetic points and the platform built at the roof top of the storage ring building. Based on the 10 geodetic points, the storage ring control network is formed, which consists of 48 monuments fixed at inner wall brackets of the tunnel.

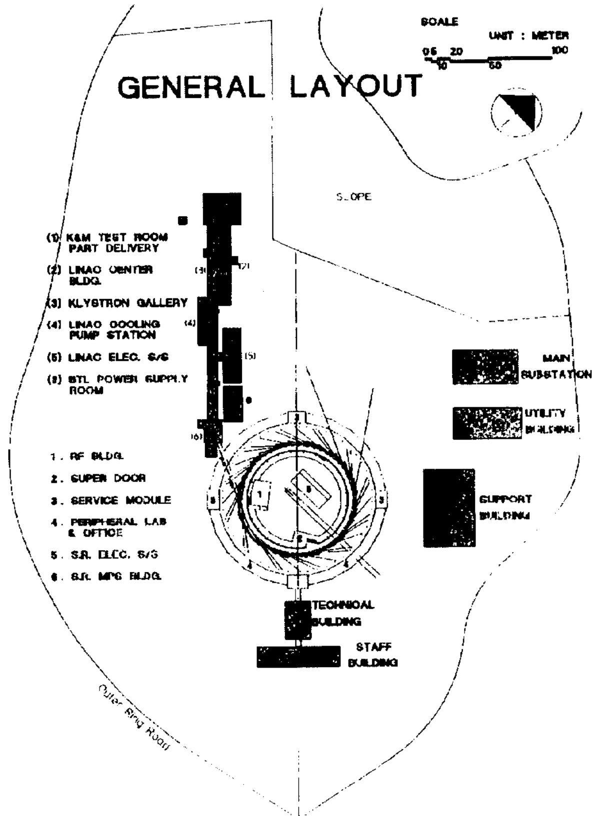

Fig. 1: PLS layout

D. Storage Ring RF Cavity

The storage ring RF cavity system will have four single cell cavities all installed in the dispersion free straight section just before the injection straight. The storage ring RF system has a provision to increase the stored beam current to 400 mA at electron energy of 2-GeV. For the initial phase of commissioning however, only two cavities will be used. Accelerating fre-

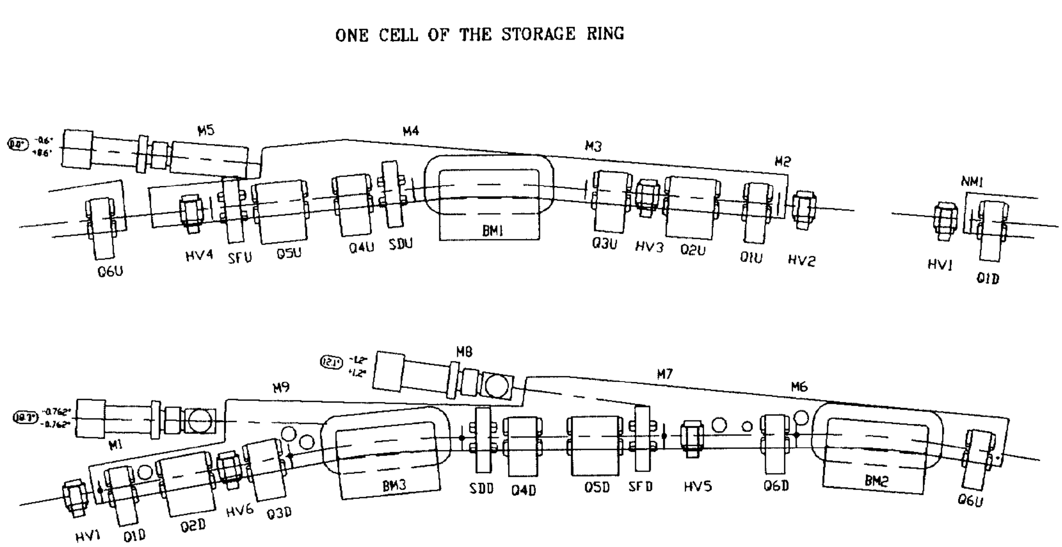

Fig. 2: PLS lattice of one cell

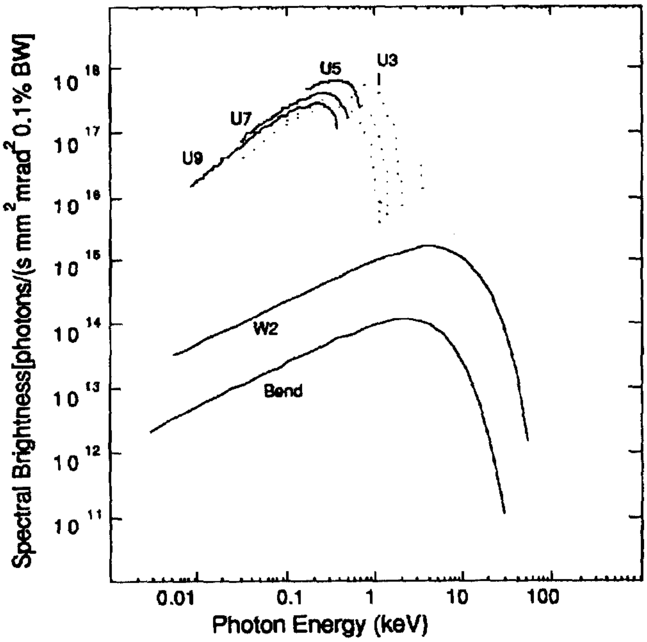

Fig. 3: Spectral brightness of the PLS photon beam

quency of the storage ring is chosen to be 500.082 MHz. High power test of the prototype cavity (fabricated by Toshiba Co., Japan) powered by a 60-kW klystron (Harris TVT Co., England) has been made successfully and the second cavity will be delivered by the end of 1993.

E. Instrument and Control

The PLS control system consists of a host computer, an expandable set of console computers, and VME-bus based Data Acquisition and Control Systems (DACS). The DACS consists of Subsystem Control Computers (SCC), Machine Interface Units (MIU), and low level communication networks. It performs many control and monitor functions, such as reading and setting parameter values of machine components, feedback control, alarm handling, and raw data processing, etc. A number of beam diagnostic monitors are used in the storage ring in order to obtain essential beam parameters, such as beam position, beam current, beam intensity profiles, betatron tune, etc. These includes 108 beam position monitors, a DC current transformer, two photon beam position monitors, two striplines, six screen monitors, and a scraper.

IV. BEAMLINES

PLS bending magnets with a field strength of 1.058 T and a beam energy of 2-GeV operation, the critical photon energy is 2.8 keV. Figure 3 shows spectral brightness as a function of photon energy and Table 2 indicates some parameters for possible PLS insertion devices. There will be two experimental beamlines from the bending magnets, in the initial phase, each for vacuum ultraviolet (VUV) and X-ray, respectively. For the VUV beamline, a spherical grating monochromator which accepts 10 mrad of the radiation are being constructed with a set of five gratings. It will deliver photon energies between 13 and 1,250 eV mainly for photoemission studies. This beamline is also designed to accommodate another branch for Seya-Namioka optics for lower energy photons.

Table 2: PLS insertion device (ID) parameters

ID*	Period (cm)	No. of period	Field (T)
U3	3.0	140	0.22
U5	5.0	80	0.56
U7	7.0	60	0.90
U9	9.0	48	1.18
W2	15	20	2.0
W6	110	1	6.0

* U for undulator, W for wiggler.

For the x-ray beamline, a mirror will accept 4 mrad of radiation and a double crystal monochromator with a fixed exit beam position is used to give focused photon beam at photon energies between 3 and 12 keV. This beamline will be mainly used for X-ray diffraction and XAFS experiments. In addition to the two bending magnet beamlines, a 7.5 Tesla, 3 poles superconducting wiggler is also under construction in collaboration with the Budker Institute of Nuclear Physics, Russia. This beamline will provide hard X-ray region by general broad band radiation up to 30 keV of photon energy. In the normal operation mode, the time structure of the synchrotron radiation will comprise pulses with a FWHM of 20 ~ 50 ps with a minimum separation of 2 ns between pulses.

V. SUMMARY

The PLS project officially started in April of 1988. The PLS conventional facility is near completion, and the machine installation for the injector linac and the storage ring is at its peak. The commissioning will start toward the end of 1994. The project is funded jointly by Pohang Iron and Steel Company and the Ministry of Science and Technology of the Korean government. The PLS will be the national user's facility and will eventually provide high brightness radiation up to 30 keV of photon energy.

VI. REFERENCES

[1]. *Design Report of Pohang Light Source*, Revised ed.(Pohang Accelerator Laboratory, POSTECH, January 1992).

[2]. W. Namkung, et al., "Progress of PLS 2-GeV Linac," these proceedings.