OPERATION STATUS OF RF SYSTEM FOR THE PLS-II STORAGE RING*

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Abstract

The RF system of the Pohang Light Source-II (PLS-II) storage ring is operating at the 3.0GeV/200mA with two superconducting RF (SRF) cavities. Each RF station is composed with a 300kW klystron with a power supply unit, transmission components, a digital LLRF and an SRF cavity. And a cryogenic system of 700W capacities is supplied the LHe and LN2 to three cryomodules of SRF cavities. The second SRF cavity is installed during at the beginning in 2013 and the third one will be installed during summer in 2014 for stable 400mA operation with all 20 insertion devices. Also the third high power RF station with a 300kW klystron, power supply unit and WR1800 waveguide components is prepared in 2013. The third LLRF system is already installed, but improved stabilities of amplitude, phase and tuner control. This paper describes the present operation status and improve plan of the RF system for the PLS-II storage ring.

INTRODUCTION

The PLS-II machine of 3.0GeV is the upgraded third synchrotron light source from PLS of 2.5GeV, which has a full energy Linac and a storage ring. The PLS RF system was five independent RF stations. Each one was consisted of a modified 75kW klystron amplifier as a power source, a circulator, a single-cell cavity with precise controlled water cooling system, all connected by 6-1/8” coaxial transmission lines and analogue type low level RF system [1] [2]. But the upgraded PLS-II RF system in 2013 is operating for beam current of 200mA with two SC RF cavities supplied by two 300kW klystrons, high voltage power supplies and digital type LLRF system. Figure 1 shows the block diagram of PLS-II RF system at phase-2 status in 2014 finally.

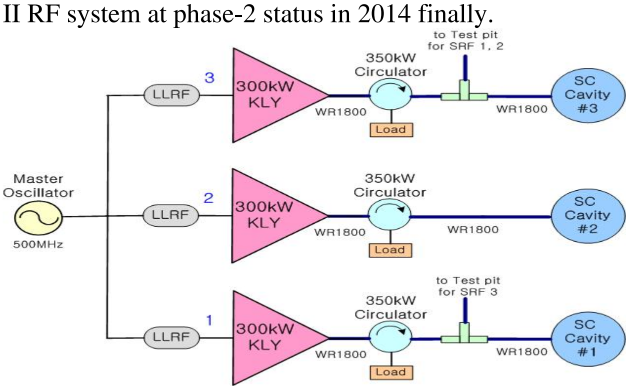

Figure 1: PLS-II RF system (phase2).

Also table 1 shows comparison parameters of PLS and PLS-II.

Table 1: Comparison of PLS and PLS-II

Specification	PLS(~2010)	PLS-II(2013~)
Energy/Current	2.5GeV/200mA	3.0GeV/200mA
Emittance	18.9 nm-rad	5.8 nm-rad
Circumference	280.56 m	281.82 m
Beam loss Power	142 kW	274 kW
RF Frequency	500.082MHz	499.654MHz
RF Power Sources	75kWx5	300kWx2
RF Voltage/Cavity	1.6MV/NC	3.3MV/SC

PRESENT OPERATION STATUS

After installing the second cryomodule, the phase-1 SRF system is operating up to 150mA top-up operation after decay mode [3]. And the beam of 200mA will be serviced to beam-line users from second half of 2013. For the SRF system of phase-2, 400mA beam operation will be carried the end of 2014 after installing another tthird cryomodule at summer of 2014. A cryogenic system of 700W is operating for two cryomodules. Table 2 shows upgrade progress of PLS-II RF system [4].

Table 2: Upgrade progress of PLS-II

Specification	Phase 1(2013)	Phase 2(2014~)
Energy/Current	3.0GeV/200mA	3.0GeV/400mA
Operation mode	Decay & Top-up	Top-up
Beam loss Power	142 kW	549 kW
RF Power Sources	300kWx2	300kWx3
Cryomodule	1+1 module	3 modules
Cryogenic LHe	300W/700W	450W/700W
RF Voltage-total	3.3MV/SC	4.5MV/SC

For the third cryomodule operation, one more 300kW klystron with KSU was prepared and tested with a load and a circulator at the beginning of 2013. As soon as disassembling two 75kW klystron amplifiers at the end of 2012, the third 300kW high power RF system was installed and tested well.

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ISBN 978-3-95450-122-9

HIGH POWER RF SYSTEM

A high power RF station is consisted of a Thales TH2161B klystron, Thomson klystron power supply units (KSU) and WR1800 waveguide components such as a circulator, a ferrite load. The KSU consists of a klystron cathode high voltage power supply up to 55kV/12A with 86 pulse step modulator (PSM) modules and a heater and mod-anode supply. Two magnet and ion pump supplies are separately assembled in a 19 inch cabinet with a 40W drive amplifier. Two KSUs for 300kW klystrons have been operating about 11,000 and 5,100 hours each without any severe problems.

Figure 2: Three 300kW klystrons and KSUs.

Minor problems of PLS-II high power RF system were driver amplifier faults, over-temperature at window of klystron due to insufficient air cooling flow rate, unnecessary arc sensing due to welding or bad shielding, water leakage to klystron or waveguides due to broken water pipe and flood damage, cleaning process due to soot of local fire. After a local fire at tunnel, some arc, smoke and over-temperature detectors are added inside of KSU. Table 3 shows main equipments of PLS-II high power RF system.

Table 2: Main Equipments of PLS-II RF System

Equipments	Specification	Maker
Klystron tube	300kW(TH2161B)	Thales
High Voltage P/S (KSU)	PSM type 55kV/12A	Ampegon (Thomson)
Transmission lines	WR1800	MEGA & domestic
Circulator & Load	350kW	AFT
Low Level RF	Digital type	J-Lab & PAL
Cryomodule	2.2MV(max)	RI (Accel)
Cryogenic	700W, 4.5K	Air Liquide

PLS-II HPRF system is operating very well because high power components have been proven to be reliable in the light sources such as SLS, CLS, IHEP, SSRF, under continuous operation for several years, and after improving some faults during commissioning at NSRRC [5]. The RF system of phase-1 status is going to phase-2 which will be commissioned with three SRF stations up to 400mA storage currents by 2014.

LLRF CONTROL SYSTEM

Low level RF (LLRF) system is upgraded with IQ digital technology of collaboration with Jefferson Lab. The LLRF system provides a RF field control for each SRF cavity's stable operation within ±0.3% (rms) by amplitude and ±0.3° (rms) by phase feedback control loops. The LLRF system also includes cavity tuner control, an interlock control, a diagnostic function, and some measurement equipments such as spectrum analyzer and oscilloscopes. The operation data of HPRF and cryomodule system as well as LLRF are controlled and monitored with EPICS IOCs remotely. Also integrated OPI RF control screen is prepared for easy operation, monitoring and fault resets at a beam operation centre.

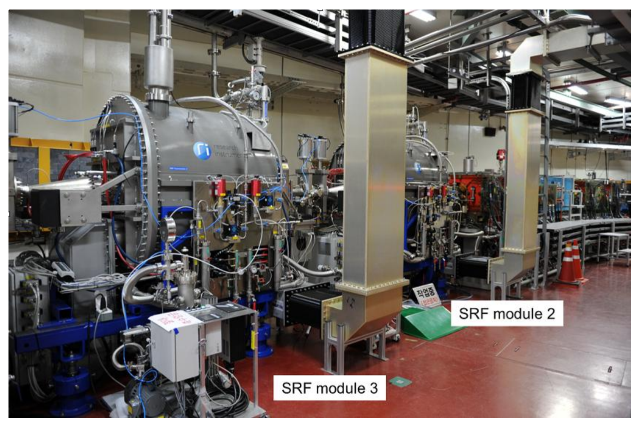

Figure 3: PLS-II RF system of phase-I (~2012).

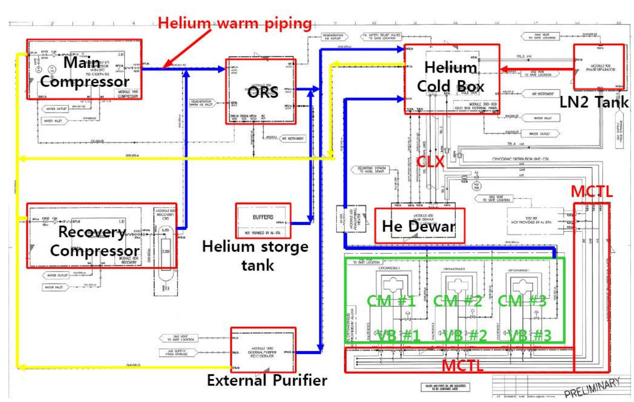

Figure 4: Block diagram of Cryogenic system.

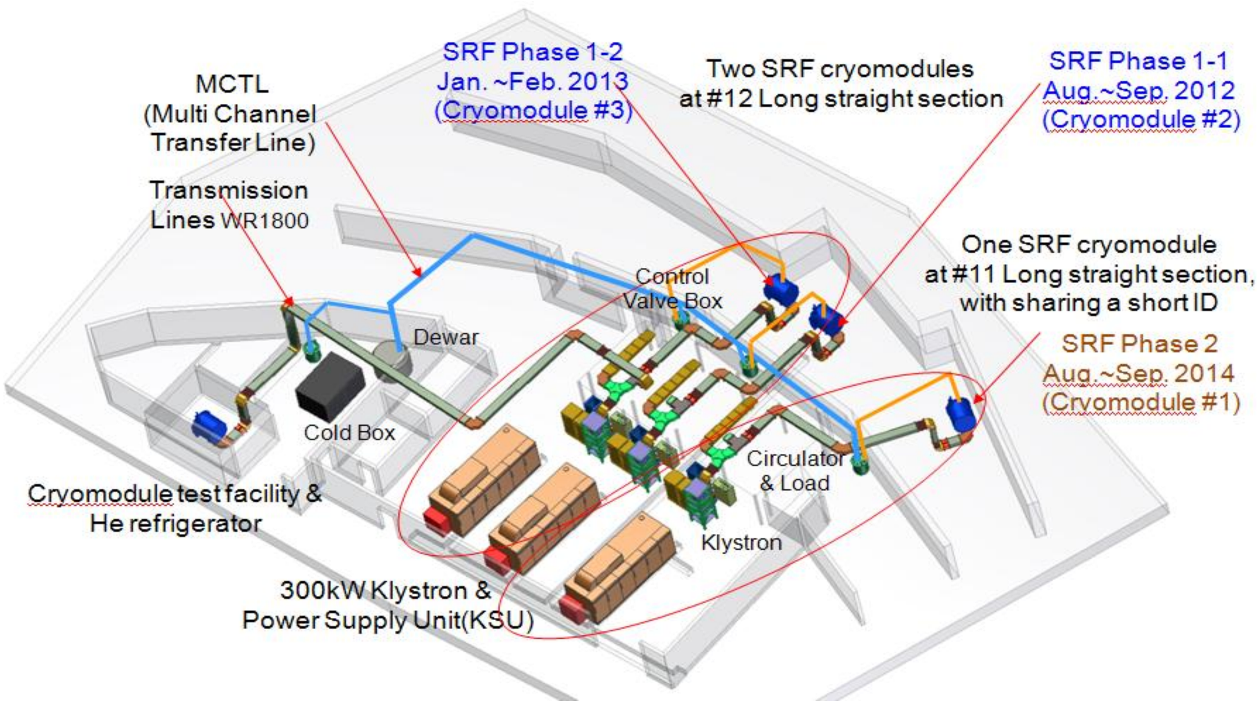

Figure 5: Layout of PLS-II RF system with three Cryomodules (phase-2).

CRYOMODULE SYSTEM

Figure 3 shows two SRF cryomodules with WR1800 waveguides at 12th straight section of tunnel. Two SRF cryomodules of CESR-III type was tested the performances after fabrication at RI factory and commissioned at PAL. Each cavity showed the performance with over 2.2 MV RF voltages with Qo of 8.7x10^{9} and 125kW standing wave power. Two SRF cryomodules are separately installed in Aug. 2012 and Jan. 2013 because of vacuum leakage accident of the first module. SRF cavities were measured for accelerating voltage up to 3.2MV at vertical test and RF windows were passed at the RF power test with 300kW travelling mode. The cryomodule is operating and partially warmed up to 40K and pulsed conditioned for better operation. More detailed commissioning and operation issues are described at this proceeding [6].

CRYOGENIC SYSEM

Figure 4 shows a block diagram of cryogenic system. The cryogenic system is consisted of a helium (He) refrigerator, a main and a recovery compressor of KAESER, a cold box, a LHe dewar of 2000 liters, multi-channel transfer lines, He tanks, N_2 tank, and so on. After commissioning by Air-Liquide in 2012, the stability of the He level in the dewar is still not so good status. The fluctuation of the level is more than 25% in a period of 20 hours. Therefore the fluctuation and low level less than 20% affect stable operation of cryomodules, and then results to fault interlocks. Also remote monitoring with EPICS will be delayed and performed at summer shutdown period in 2013.

SUMMARY

Present status and phase-1 progress of PLS-II RF system is introduced. The 150mA beam at 3.0GeV has been operated at top-up mode. The high power RF system is operated very well, and the digital LLRF system is operating much better after precise PID control with SRF cavity tuner. For the phase-2 status, the third cryomodule will be installed and operated by 2014. Even the third high power RF and LLRF system are prepared, the three RF stations will be operated more stably in 2014. Also cryogenic system will be serviced and improved with Air-Liquide. And then stable operation up to 400mA top-up mode at 3.0GeV will be performed by the end of 2014 with all 20 insertion devices.

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ISBN 978-3-95450-122-9