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

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Abstract

The RF system for the Pohang Light Source (PLS) storage ring was greatly upgraded for PLS-II project of 3.0GeV/400mA from 2.5GeV/200mA. The point of big upgrade is to adopt superconducting RF (SRF) cavities and digital low level RF (LLRF). The RF system is under operation with five normal conducting (NC) cavities for beam current of 100mA to provide user beams from March 2012 with two 300kW klystron and two 75kW klystron amplifiers [phase-I]. Two SRF cryomodules with cryogenic system are installed and testing during summer shutdown period in 2012 because of long delivery [phase-II]. And then user beam will be serviced with SRF system from 2013. The third SRF cavity installation plan in 2014 is also in preparation to increase the storage ring current up to 400mA with all 20 insertion devices [phase-III]. This paper describes the present installation, commissioning, operation status, upgrade progress and future plan of the RF system for the upgrade project of PLS-II storage ring.

INTRODUCTION

The PLS-II is a 3.0GeV, upgraded the third synchrotron light source from PLS of 2.5GeV, which has a full energy linac and a storage ring. The PLS RF system with five independent stands 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].

The phase-I RF system of PLS-II is operating for beam current of 100mA with five NC RF cavities with two 300kW klystrons, two 75kW klystron amplifiers and digital LLRF because of long delivery of cryomodules and limited project schedule and budget.

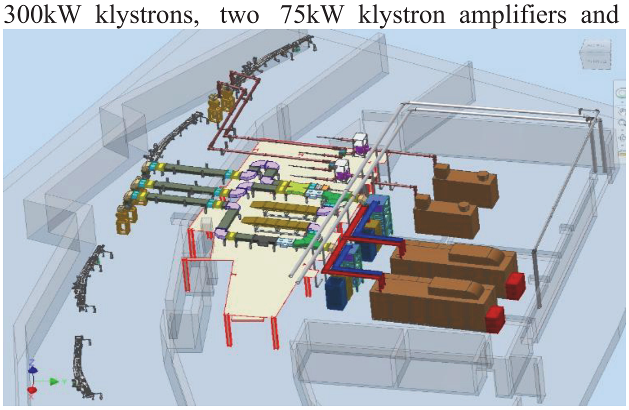

Figure 1: PLS-II RF system [phase-I].

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

Table 1: Major parameters of PLS and PLS-II

Specification	PLS(~2010)	PLS-II(2012~)
Energy/Current	2.5GeV/200mA	3.0GeV/400mA
Emittance	18.9 nm-rad	5.8 nm-rad
Circumference	280.56 m	281.82 m
Beam loss Power	142 kW	549 kW
RF Frequency	500.082MHz	499.654MHz
RF Power Sources	75kWx5	300kWx3
RF Voltage/Cavity	1.6MV/NC	3.3MV/SC

PRESENT OPERATION STATUS

After disassembled PLS RF system and remodeling a RF building, the phase-I RF system for PLS-II was installed and commissioned in 2011 [2] [3]. And the beam of 100mA has been serviced to beam-line users from March 2012. For the SRF system of phase-II, a cryogenic system of 700W was installed, and two cryomodules are installing to operate by the end of 2012. Table 2 compares the RF system of phase-I and II [4].

Table 2: Parameters of PLS-II RF system

Specification	Phase-I(~2012)	Phase-II(2013~)
Energy/Current	3.0GeV/100mA	3.0GeV/200mA
Losses with IDs	1,242keV	1,242keV
Beam Power	124kW	248kW
RF Cavities (Q'ty)	NC x 5	SC x 2
RF Power Sources	(75x2)+300kWx2	300kWx2
Cryomodule	installing	~1.8MV/each
Cryogenic	commissioning	~700W

Although five NC cavities used at PLS were installed and commissioned, four cavities are operating because one 300kW klystron is prepared to test a cryomodule soon.

Also all facilities at a test pit are installed for testing and conditioning a cryomodule.

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HIGH POWER RF SYSTEM

Main upgrade of PLS-II high power RF system is 300kW RF power sources from 75kW klystrons. A 300kW klystron amplifier 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, a heater and mod-anode supply, two magnet and ion pump supplies. The KSU and klystron have been proven to be reliable in the light sources such as SLS, CLS, IHEP, SSRF under continuous operating conditions for several years [5]. The KSU is controlled by a PSM HVPS controller, a fast interlock controller and a programmable logic controller which is mainly to connect with EPICS remotely.

Figure 2: 300kW klystron and KSU of RF system.

The other upgrade of PLS-II high power RF system is circulators, loads with WR1800 waveguide components. Table 3 shows main upgrade components of PLS-II high power RF system compared to PLS.

Table 3: Main upgrade of PLS-II RF system

Specification	**PLS**	**PLS-II**
Klystron tube	75kW(K3773BCD)	300kW(TH2161B)
High voltage P/S	Linear(27kV/6A)	PSM(55kV/12A)
Transmission line	6-1/8” Coaxial	WR1800
Circulator	75kW(AFT)	350kW(AFT)
Dummy Load	75kW(Water load)	350kW(Ferrite)
RF Cavities	Normal	Superconducting
Low Level RF	Analogue type	Digital type

Figure 3 shows PLS-II high power RF system of phase-I in 2012 and figure 4 shows phase-III which is a final status of SRF system for stable operation without any RF instabilities up to 400mA in 2014 with three SRF stations. The PLS-II RF system is on going from phase-I status to phase-II which will be commissioned with two SRF stations up to 200mA storage currents in 2013.

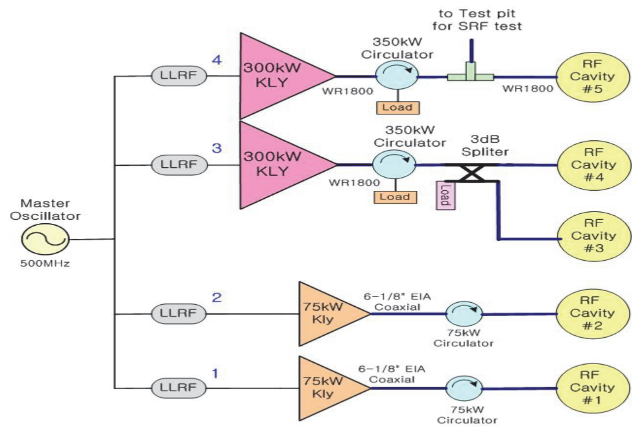

Figure 3: PLS-II RF system of phase-I (~2012).

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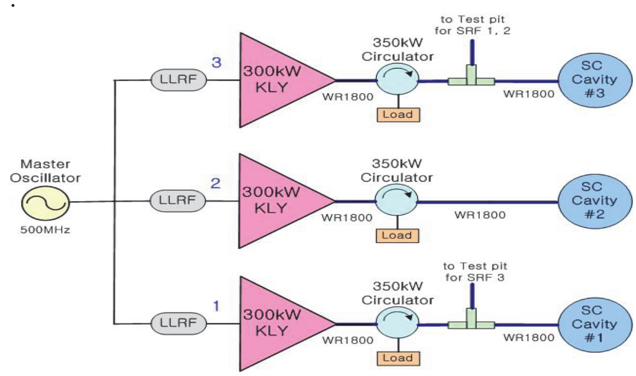

Figure 4: PLS-II RF system of phase-III, adding one more SRF station from phase-II (2014~).

LOW LEVEL RF CONTROL SYSTEM

A Low level RF (LLRF) system is upgraded with digital proven technology of collaboration with Jefferson Lab [6]. The LLRF system provides a RF field control for each RF station within good stability within ±0.1% in amplitude and ±0.1° in phase. The LLRF system includes an interlock control, a diagnostic function, and some measurement equipments. The cavity field control is maintained digitally using an FPGA for feedback algorithm. And RF control system operates in EPICS (Experimental Physics Control System) environments using compact PCI and embedded processor architectures. The KSUs, cryomodules and a cryogenic system can be controlled by Siemens S7-300 program logic controllers (PLC) in local or remotely with EPICS.

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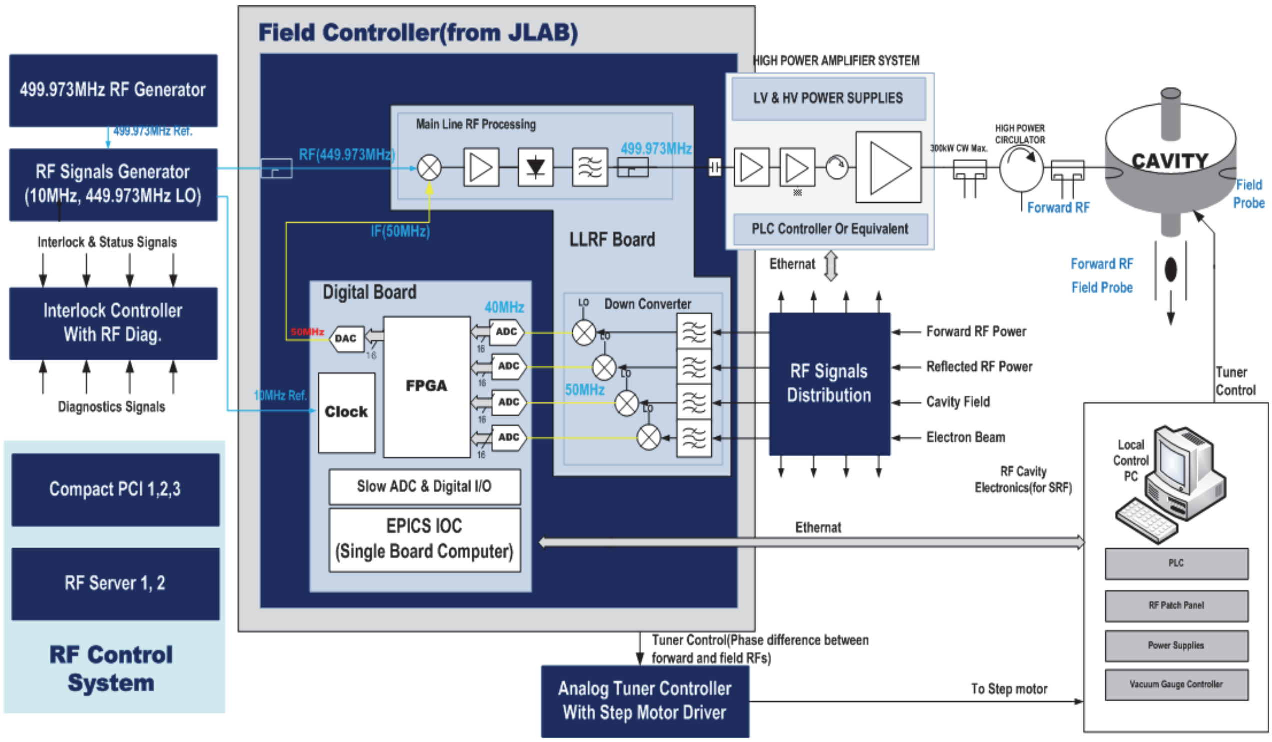

Figure 5: Block diagram of PLS-II RF system with LLRF control.

SUPERCONDUCTING CRYOMODULE

Two SRF cryomodules of CESR-III type is tested the performances after fabrication at RI (former ACCEL) factory and will be commissioned at PAL site by 2012. Two 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 first cryomodule was installed at a test pit of PAL and described in detail at this proceeding [7].

CRYOGENIC SYSTEM

A cryogenic system of 700W cooling capacity at 4.5K with LN2 pre-cooling of 27 liter/hour is commissioning at PAL site for the three cryomodules operation with main contractor of Air-Liquide. A cryogenic system is consisted of a helium (He) refrigerator, a compressor station, a LHe dewar of 2000 liters, a distribution valve box, a cold box, LHe multi-transfer lines, He tanks, N_2 tank, and so on. The cryogenic system is installed at three areas of the helium buffer tanks, a compressor room and a cold box room.

SUMMARY

Present status and progress of phase-I of PLS-II RF system is introduced. The 100mA beam at 3.0GeV has been operated in a decay mode. The high power RF system is operated very well, and the digital LLRF system is operating much better after precise PID control. For the phase-II status, two cryomodules is installed by 2012. Even the high power RF and LLRF system are prepared and operated with NC cavities, the systems will be commissioned more stably with SRF system. For the phase-III of PLS-II SRF system, one more 300kW high power RF system was ordered and will be replaced with two 75kW klystron amplifiers in 2013. Also one more cryomodule was ordered to RI and will be installed in 2014 for stable operation up to 400mA at 3.0GeV with all 20 insertion devices.

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