



Operation Experience of SRF system for the PLS-II

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ABSTRACT

The SRF system of the Pohang Light Source-II (PLS-II) storage ring is operating at the 3.0 GeV/400 mA with three superconducting RF (SRF) cavities. PLS-II SRF system was upgraded to 3.0 GeV/400 mA beam storage from 2.5 GeV/200 mA of PLS in 2011. Each high power RF (HPRF) station is composed of a 300 kW klystron with a Klystron Supply Unit (KSU), transmission components including a 350 kW circulator and load, and water cooling system. The TH2161B 300 kW klystrons are stably operated as an RF power source with KSU of 55 kV/12 A at PAL as well as some light sources. Also PLS-II SRF system are included three digital type low level RF (LLRF), RF operation diagnosis, three Cryomodules made by RI and a Cryogenic system of 700W capacity made by Air Liquide. This poster describes the present operation status and experience of PLS-II SRF system as well as 300 kW HPRF system.

Operation Parameters of PLS-II SRF System

Parameters	Commissioning (2011/9~2012/7)	PLS-II (2012/9~)
Energy [GeV]	3.0	3.0
Current [mA]	~100, decay	~400 Topup
Emittance [nm-rad]	-	5.9
Harmonic number	470	470
No. of Insertion Devices	14	20
Electron energy loss / turn		
- Dipoles [keV]	1042	1042
- Insertion devices [keV]	140	200
Beam loss power by synchrotron radiation [kW]	145	500
RF frequency [MHz]	499.973	499.973
Cavity type	NC (PF type)	SC (CESR-III)
No. of RF cavities	4	1→2→3
Accelerating Voltage [MV]	1.8	4.5
RF Voltage per cavity [MV]	0.4~0.5	1.5
Klystron amplifier	75 kW amps x 2 300 kW amps x 1	300 kW amp x 3
Cryogenic Cooling Capacity @4.5 K [W]	-	700

Brief History of PLS, PLS-II & PAL-XFEL



- PLS Project started Apr.1 1988
 - Ground-breaking Apr.1 1991
 - 2-GeV Linac commissioning Jun.30 1994
 - Storage ring commissioning Dec. 24 1994
 - User's service started Sep. 1 1995
 - Energy ramping to 2.5 GeV Sep.1 2000
 - 2.5-GeV injection, Operation Nov.1 2002
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- 3 GeV PLS-II Upgrade Project 2009 ~ 2011
 - PLS operation ended (2.5GeV) Dec. 2010
 - PLS-II upgrade completed operation to 250mA / 3GeV ~May 2014
 - Operation to 400mA / 3GeV June 2018 w/ 34 beamlines in operation
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- PAL-XFEL Project approved Jan 2010
 - PAL-XFEL Started construction May 2013~
 - Beam commissioning started April 2016
 - User service 10GeV/0.1nm FEL June 2017~

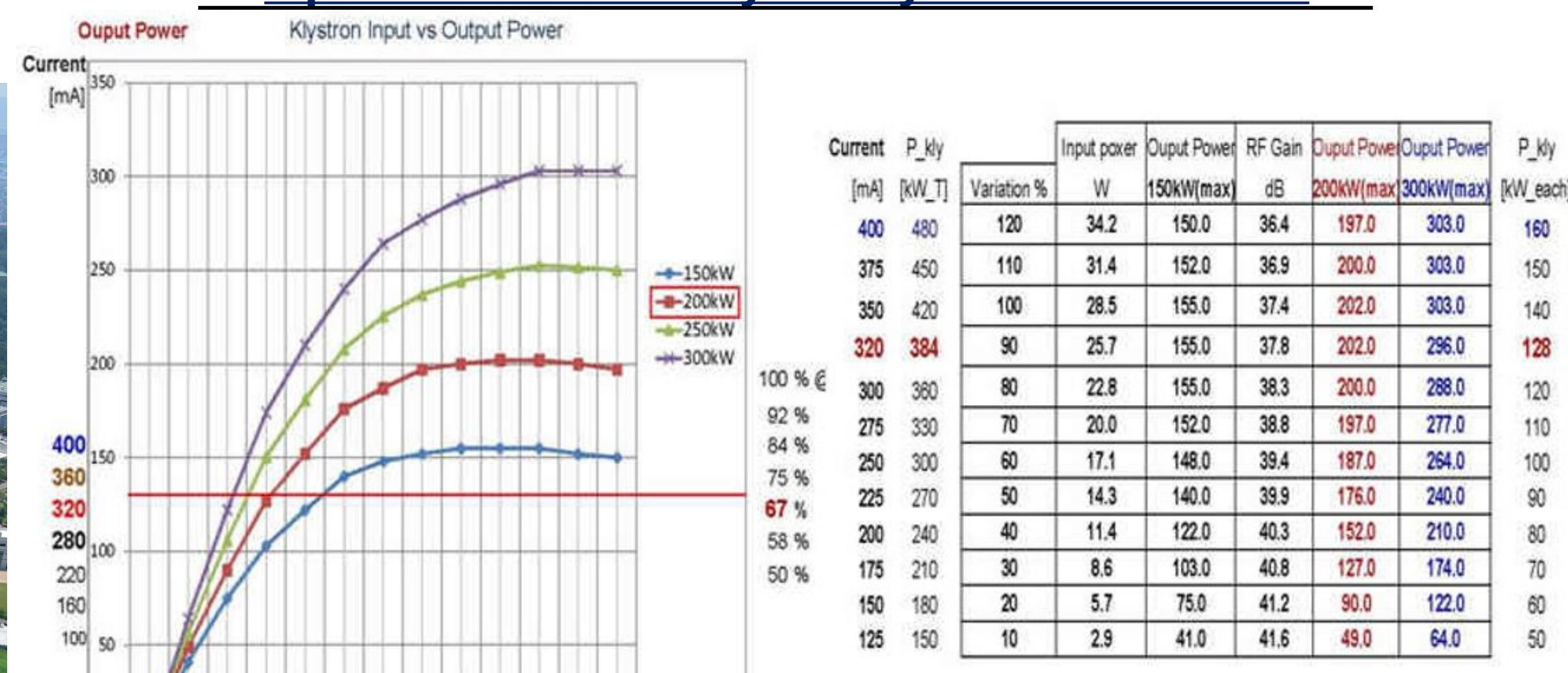
Klystron TH2161B(Thales) & KSU(Ampegon)



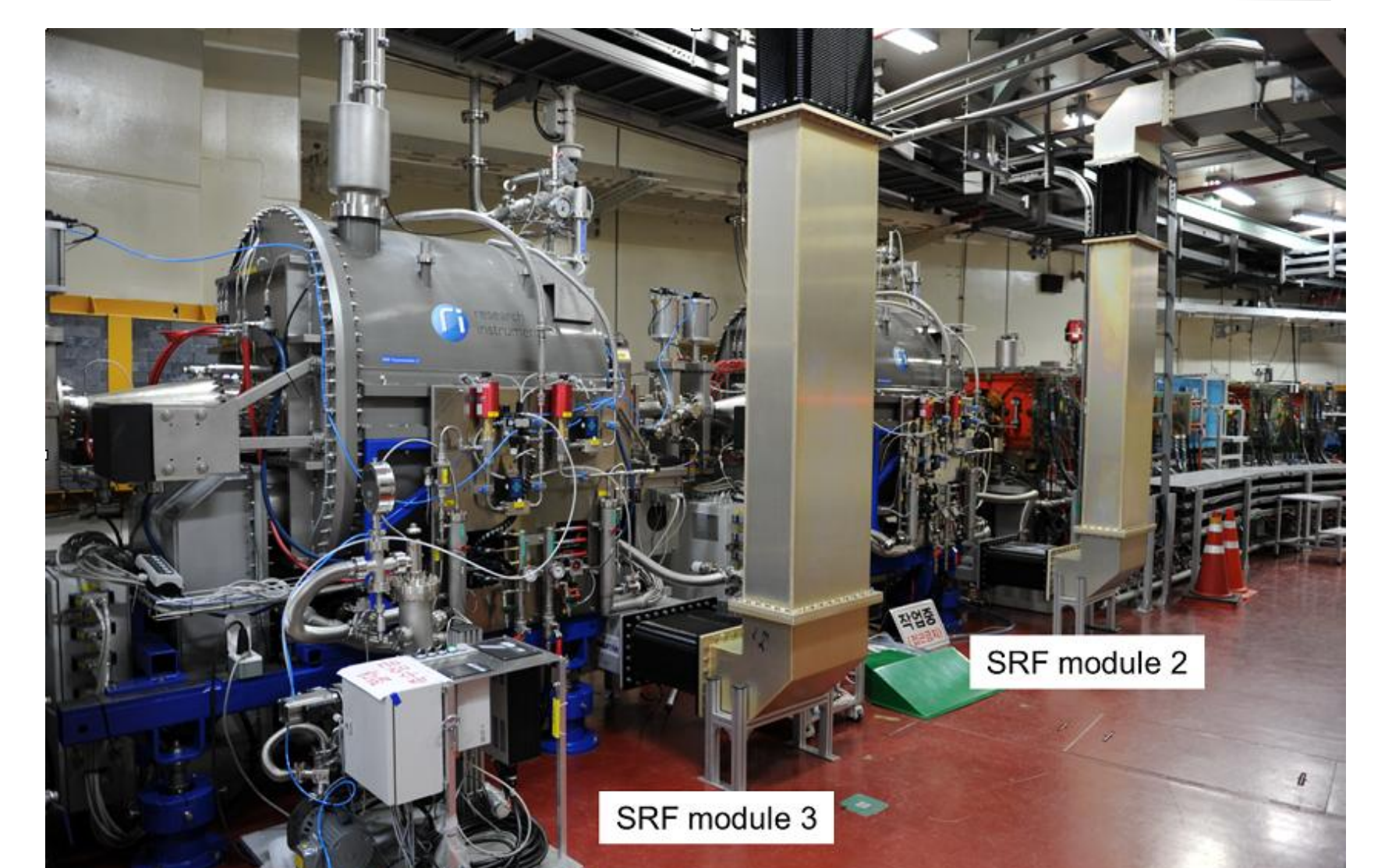
Overview of PLS-II & PAL-XFEL



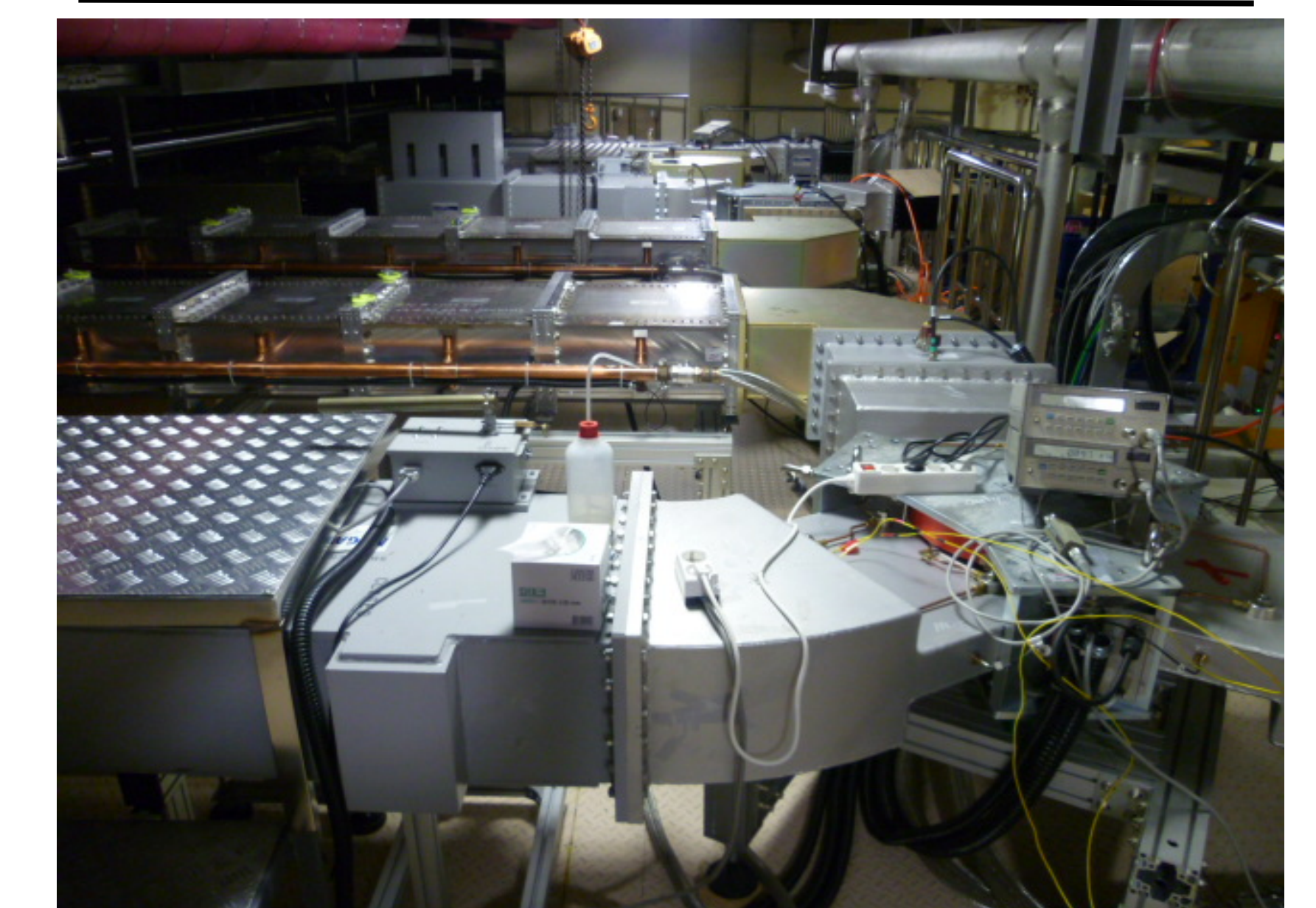
Operation Efficiency of Klystron RF Power



Cryomodules @ Tunnel with Waveguides

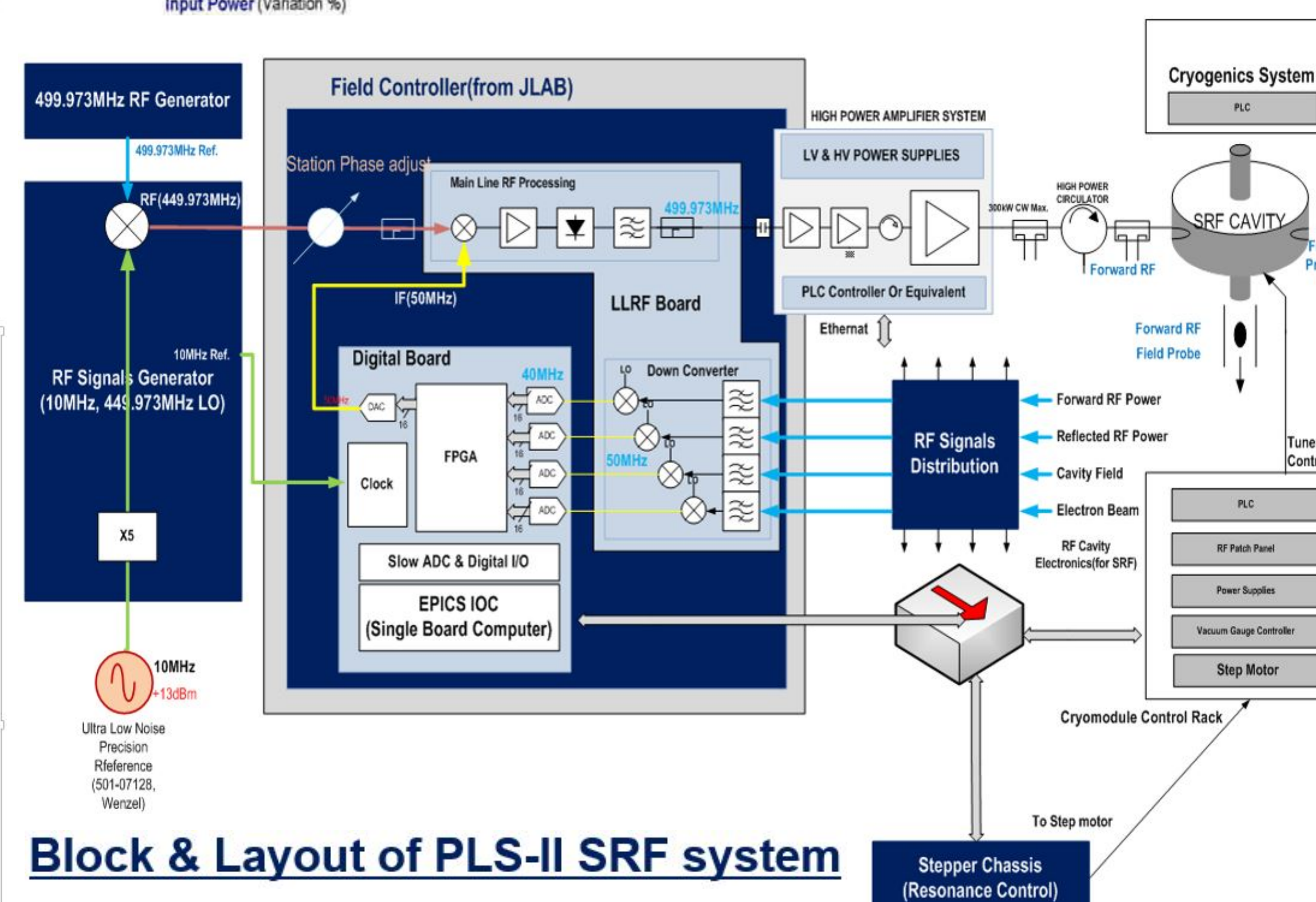


WR1800 Waveguide w/ Circulator, Load

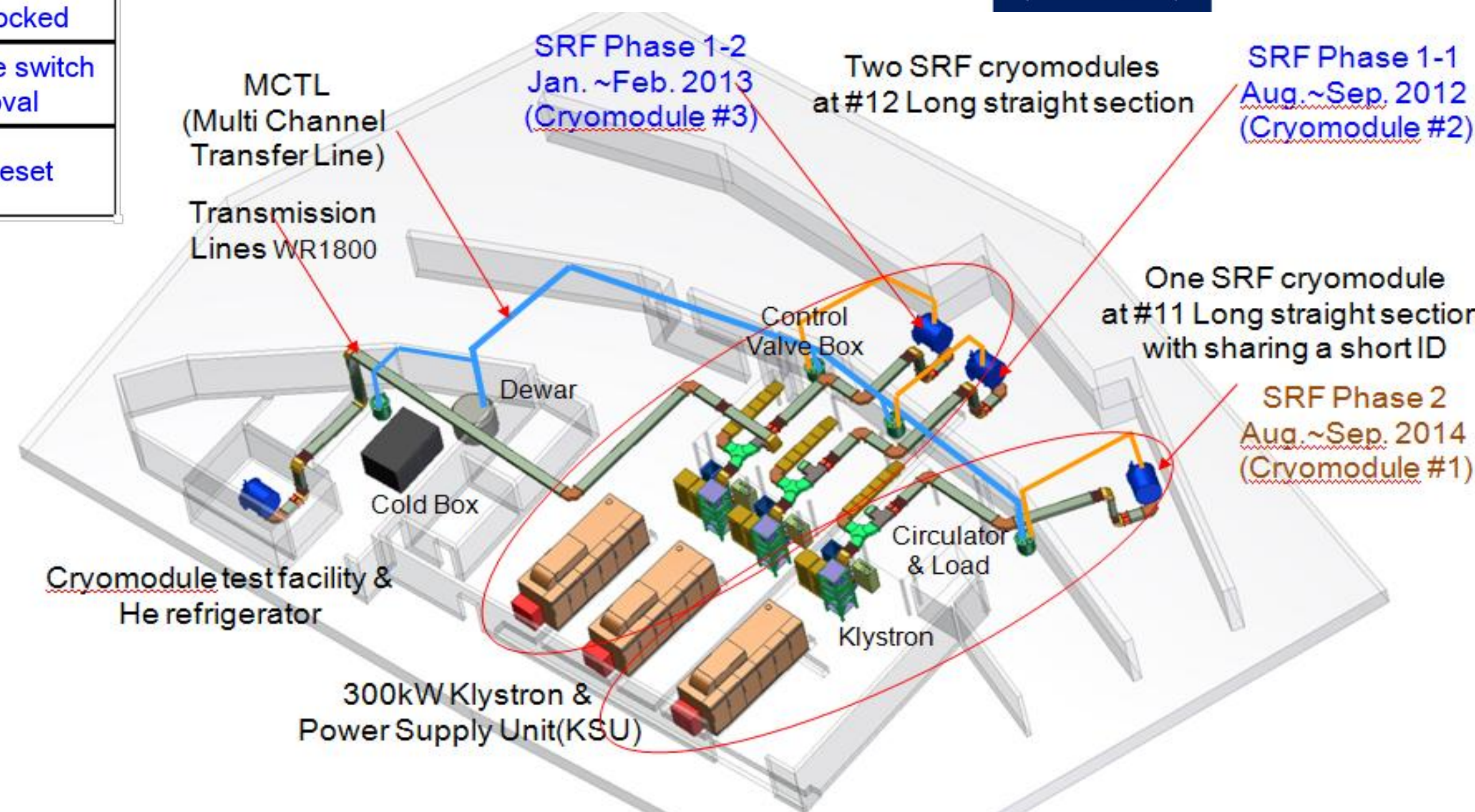


FAULT List of HPRF (2015~2018.6)

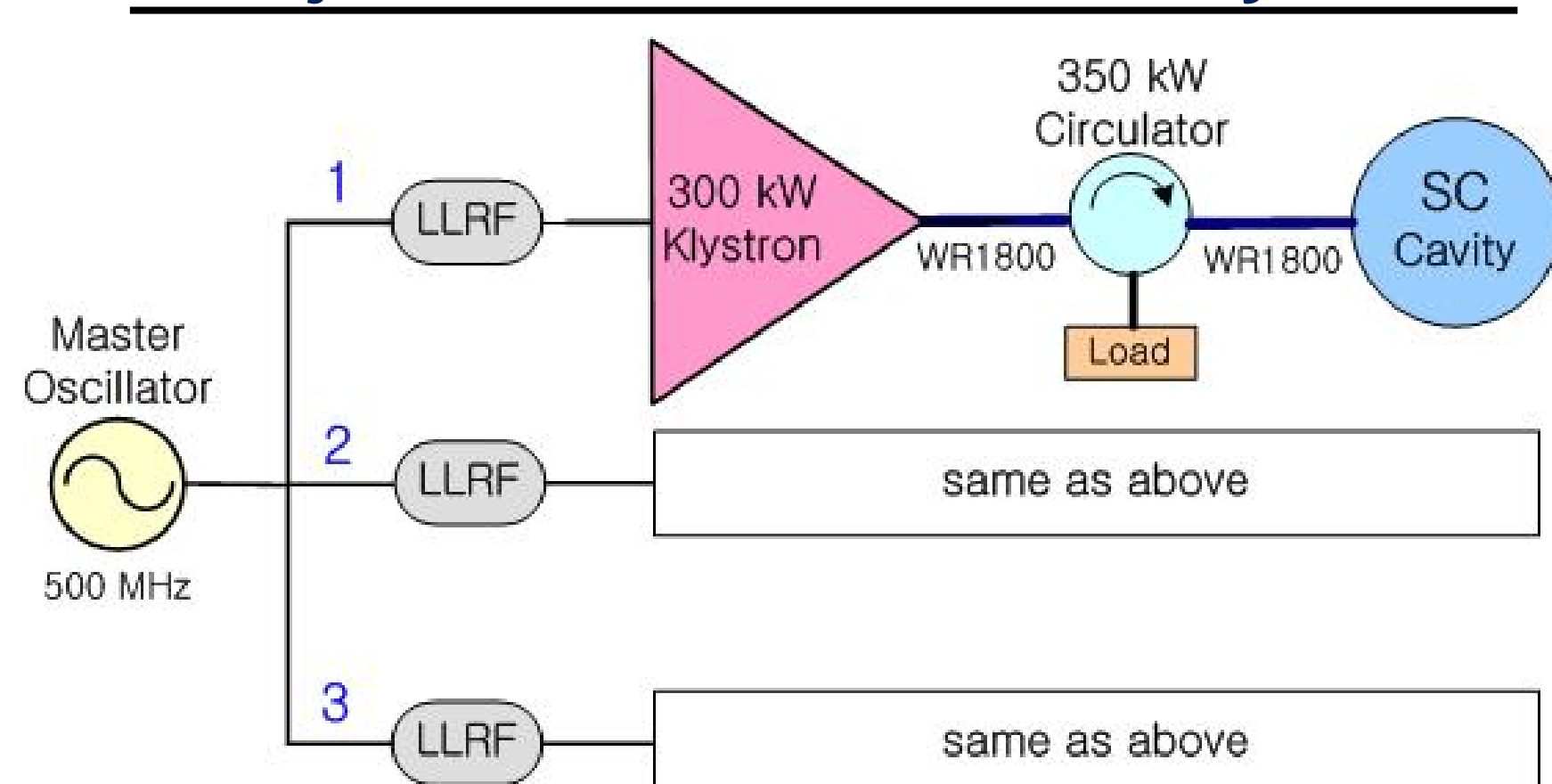
Fault Parts	Fault Message (count)	Fault Date	repair times	Causes	Maintenance
KSU	PSM P/S Fault (8)	2~3 times/year	No effect	Electric parts IGBT, Fuse	Replacement & repair (86/KSU)
KSU#2	KSU2 HVPS Water Leak (2)	2016/09/19 2017/12/18	2 hour	Deterioration (cooling pipe)	welding
KSU #2,#3	KLY Ion pump current too high (8)	2016. 5~6 (4) 2017. 7 (1) 2018. 5~6 (3)	39, 35 min 29, 39 min ~ 40 min	poor monitoring of control PCB (Deterioration ?)	auto Reset auto Reset P/S Replacement
KSU #2, #3	KSU_KLY Focus current too high (4)	2015/11/23 2016, 2017	10 min 2 hour	deterioration (control board)	Re-trial Replacement
KSU#1	KSU HVPS water flow Low (2)	2015/3	29 min	deterioration (Auto Reset)	water flow meter Replacement
KSU#1	total Pr too high (3)	2017/3/2	RF→BEAM	noise, control	re-interlocked
W/G	Circulator Arc (3)	2015/12/10	2 hour	WG switch poor Contact	waveguide switch Removal
Klystron	Kly. Window Arc (2) Win. Temp. high (2)	2017/7, 2018/5	RF→BEAM	Multipacting (?) RF & cooling	Auto Reset



Block & Layout of PLS-II SRF system



Major Blocks of PLS-II SRF system



SUMMARY

Operation status and experience of PLS-II SRF system are introduced. The 360 or 400 mA beam at 3 GeV has been operated with top-up mode for 34 beam-line users in 2018.

PLS-II HPRF system is reliably operating with some faults every year. Most faults are caused by KSU's minor problems such as PSMs, Ion pump current, focus power supply, cooling water, fan, and so on. The klystrons operating hour is about 34,000 hours average without any severe problem. Klystron efficiency is adjusted 65% for electricity saving and lifetime, but limited by linearity with LLRF control. Study on the proper operations of SRF system will be continued with makers and other similar light sources.