LCLS-II Cryomodule and Cryogenic Distribution Control

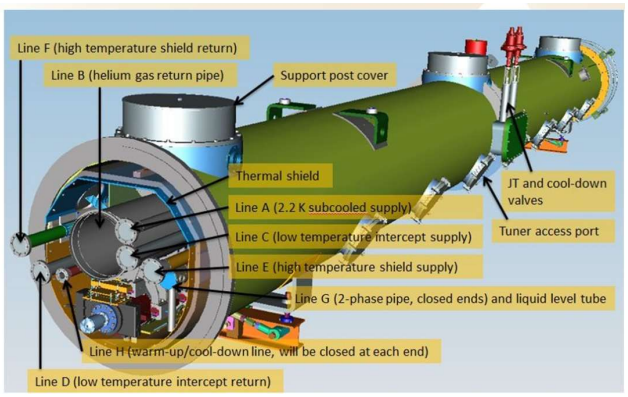
D. Robinson#, K. Mattison, C. Bianchini, D. Fairley, S. Hoobler, A. Benwell, C. Hovater
SLAC National Accelerator Laboratory, Menlo Park, CA 94025 USA

Abstract

The superconducting Linear Coherent Light Source (LCLS-II) at SLAC will be an upgrade to LCLS, a hard X-ray free-electron laser. LCLS-II is in an advanced stage of construction with equipment for cryogenic plants and more than half of the 37 cryomodules onsite. JLab is a partner lab responsible for building half of the LCLS-II cryomodules. The Low Energy Recirculation Facility (LERF) at JLab was used to stage and test cryomodules. The testing was done by setting up two cryomodules, cryocontrols instrumentation racks, PLC controls and EPICS. The LERF facility has fulfilled its mandate of providing an alternate cryomodule commissioning facility and providing a test-bed for pre-commissioning the LCLS-II cryogenic hardware and software controls.

What is a Cryomodule?

The LCLS-II cryomodule is 12 meters long and has 8 9-cell RF cavities. A total of thirty-five 1.3GHz and two 3.9 GHz cryomodules are being built and tested at FNAL and TJNAF. The JT Valve controls the amount of Helium into the tanks surrounding the cavities. Heaters under each cavity bath are used to offset the amount of heat generated by RF so the return pressure to the plant stays within expected parameters. The LCLS-II cryomodule is designed by FNAL and based on the previous designs with modifications to accommodate CW operation and LCLS-II beam parameters. The distribution equipment (6 feedcaps, 2 endcaps, 2 distribution boxes) are designed by FNAL.



Control System

Two cryogenic plants, designed by TJNAF, supply helium to the LCLS-II Linac Cryogenic Control system. SLAC is responsible for the linac controls and EPICS integration to the plant. The controls design is set for first light in 2020 and includes:

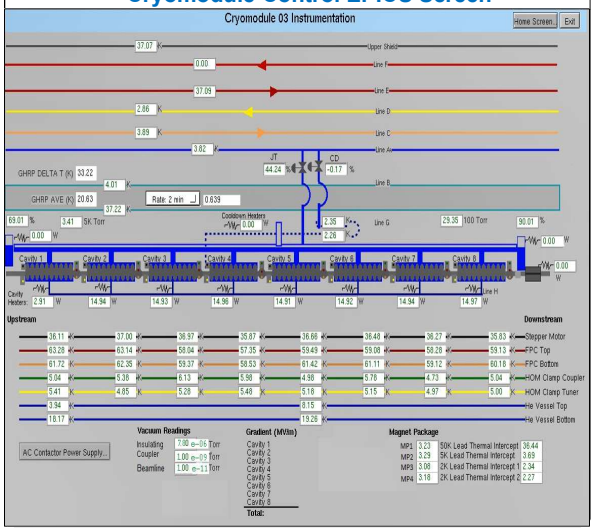
- EPICS Supervisory Control of Plant, Distribution, and Cryomodules
- Subsystem PLC processors
- 2 sets of centralized, redundant PLC processors and EtherNet/IP modules for cryomodule and distribution System
- PLC 1GB/s interface to EPICS
- LLRF to Cryo communications through Device Level Ring
- Device Level Ring communication with Distributed I/O and LLRF IOC Servers
- Profibus DP communication to temperature monitors
- Profibus PA communication to valve positioners
- Over 100 Devices on DLR
- Interfaced systems include: LLRF, Magnet, Vacuum
- Cryomodule and distribution control: cryogenic valves, pressure transmitters, liquid levels, and heaters

Cryomodule Signals (~x37)

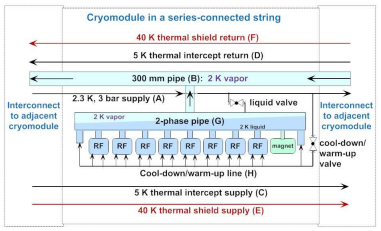
Instruments	Controllers	He Vessel	Couplers	Magnet	Vac Vessel	He Lines	He Level Cans	Total
Cernox	Lakeshore 240	4		2		2		8
Silicon Diode	Lakeshore 240		16	6		5		27
PT103	Lakeshore 240					3		3
Heater Control	Acopian PS	8		1		3	2	14
Pressure	MKS						2	2
Liquid Level	AMI						2	2
Voltage Taps	Conditioner			9				9
Flux (CMTF)	Bartington				*5			5
Valve Control	PS2				2			2
Total		12	16	18	7	13	6	72

First Light 2020

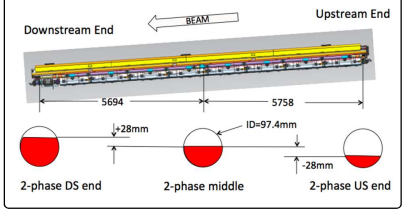
Cryomodule Control EPICS Screen



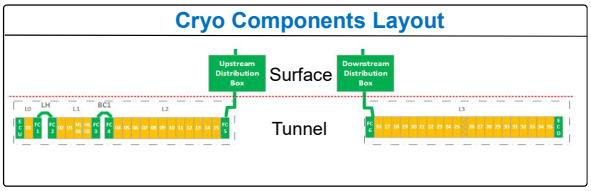
Cryomodule Helium Management

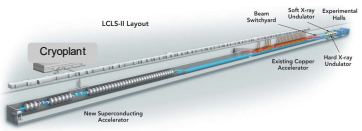


Liquid Helium Levels 0.5% slope

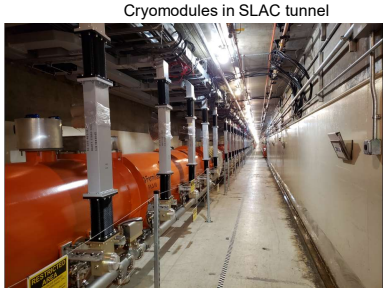


Cryo Components Layout

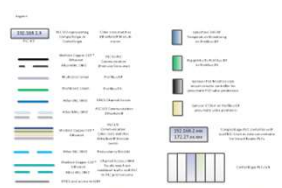




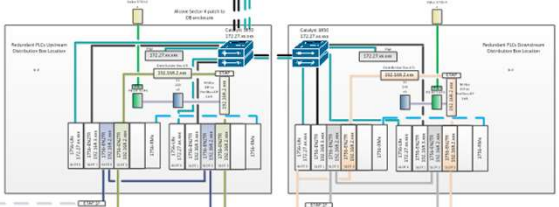
Cryomodules in SLAC tunnel



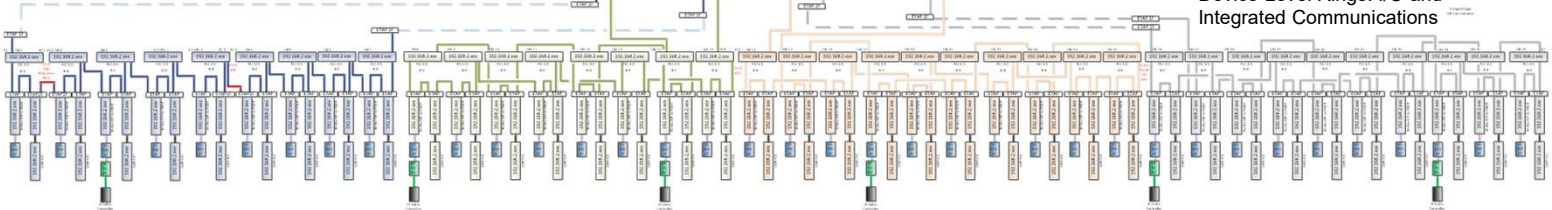
EPICS Servers



Centralized, Redundant PLC Chassis



Device-Level Rings: I/O and Integrated Communications



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