CLS Storage Ring RF System

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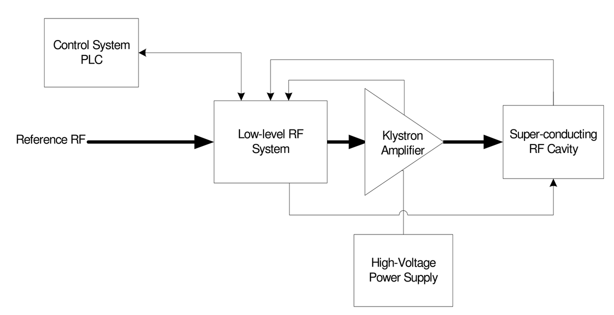
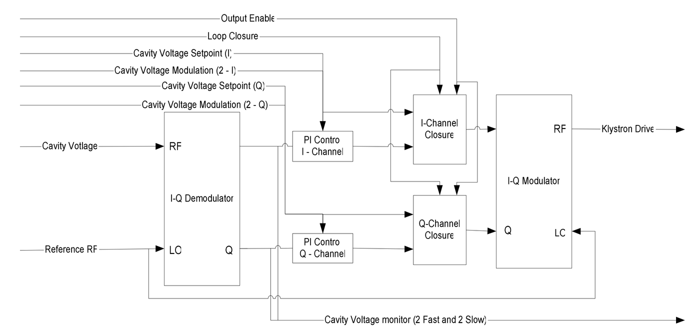
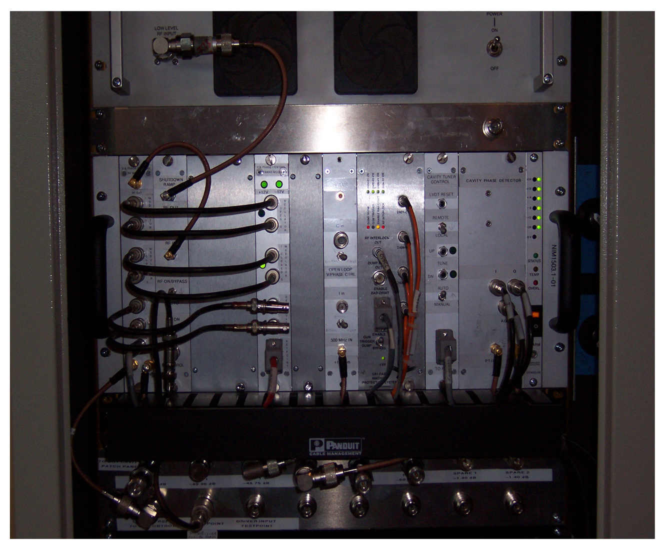
The RF System

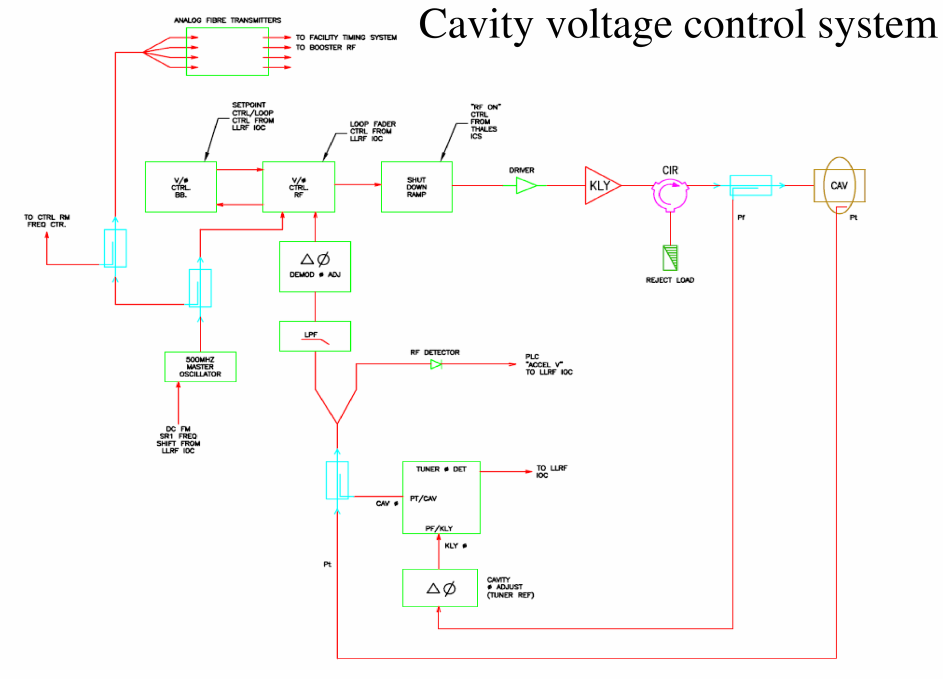


Low-level RF (LLRF) System Context

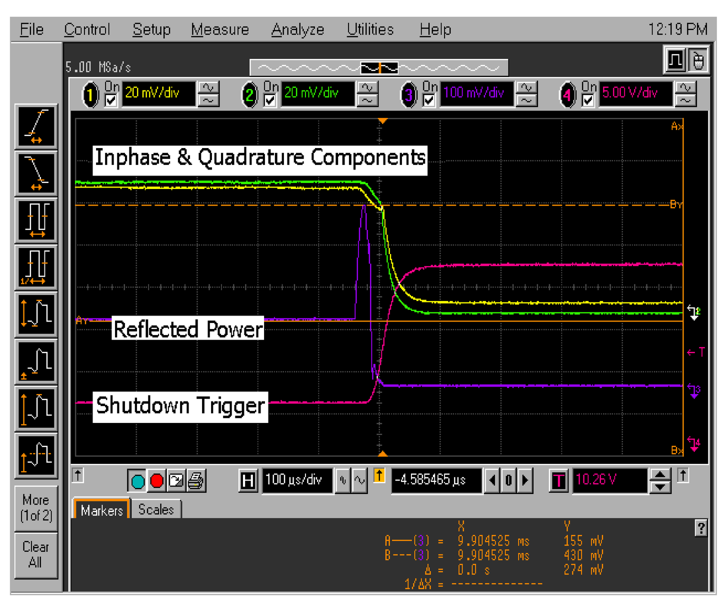


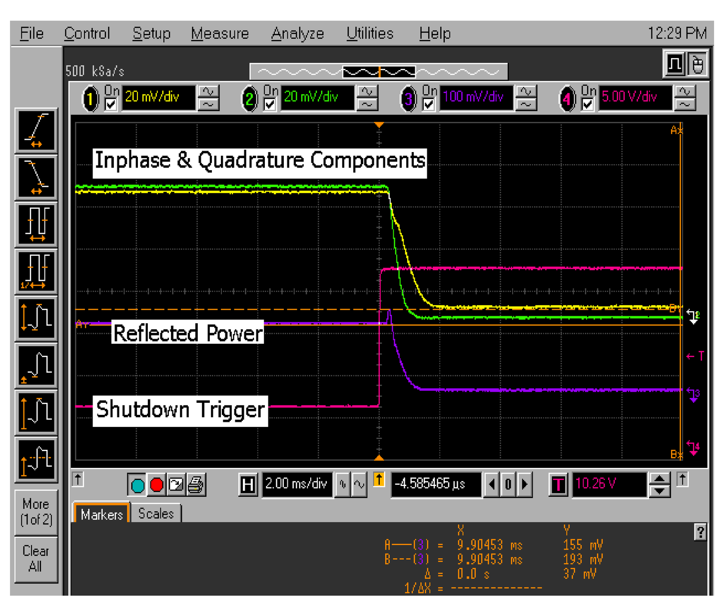
Cavity voltage control system



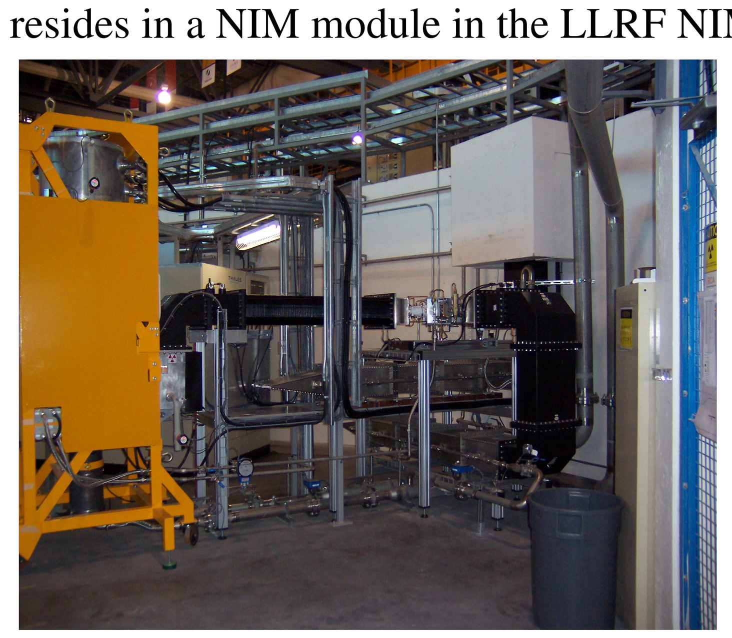


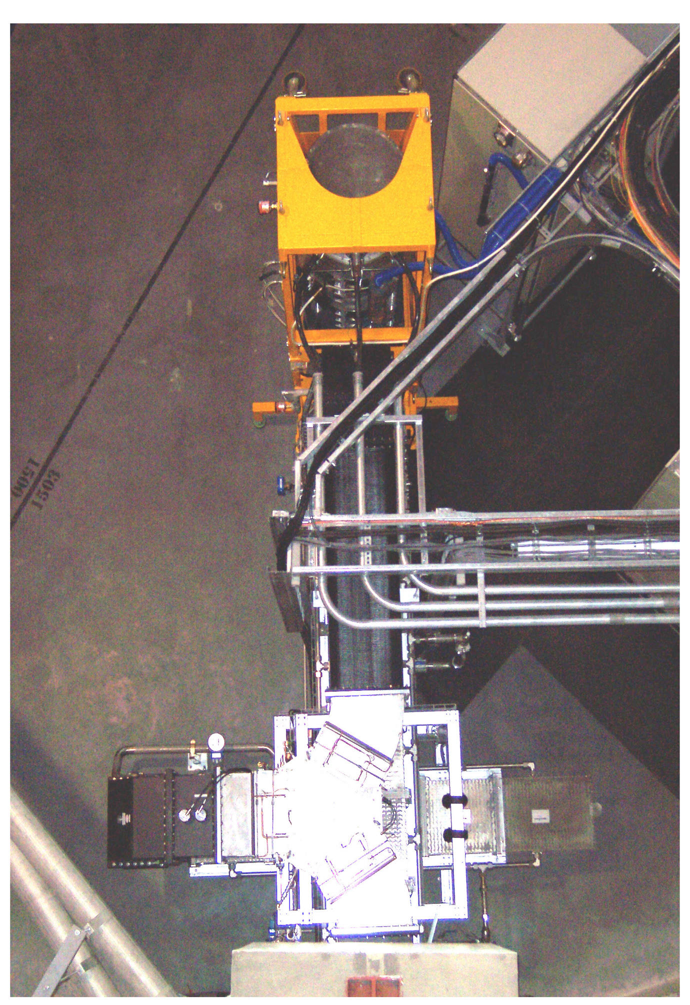
The LLRF was designed and constructed by the CLS [1]. It is an analog, I/Q-based voltage/phase control and I/Q phase detector/tuner control using PLC supervision. Testing determined that a similar I/Q-based system will be suitable in a redesign of the BR RF LLRF [2].





Implementation of a "slow shutdown" circuit significantly reduced reflected power (*Pr*) generated by sudden removal of the RF drive [3]. A 1ms, "ramped" shutdown prevents minor trips of the RF system from generating arcs in the waveguide and poor vacuum in the cavity; reducing secondary system trips and resulting in quicker system restarts. The "ramp" is implemented in hardware and resides in a NIM module in the LLRF NIM crate.

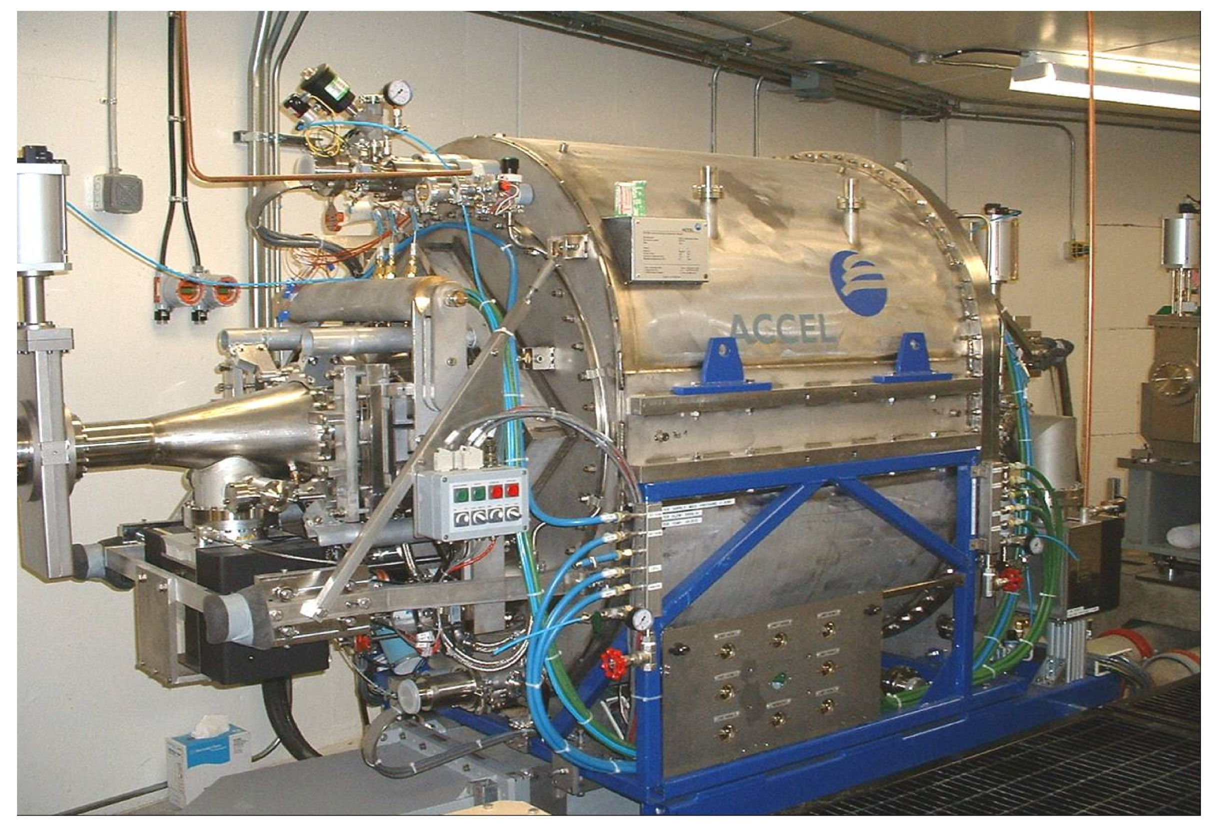




The layout of the RF amplifier, circulator, test and reject loads and the waveguides is particularly compact. Connecting the test load is accomplished by rotating the elbow (shown entering the SR chicane in the centre photo) 180°. Shown also are the AFT ferrite RF loads and the AFT circulator rated at 350KW fitted with external water cooling.

Abstract

The Canadian Light Source (CLS) selected a superconducting RF cavity based on the Cornell design for the CLS storage ring. The RF cavity, amplifier and cryogenics plant were purchased commercially while overall system integration was performed by the CLS. The CLS also took on the design and construction of the low-level RF (LLRF). This paper discusses the CLS experience including: the design of the RF cavity control system, obstacles encountered during integration and solutions implemented or proposed to address them.



Summary

Early integration of system process variables in to a facility's SCADA (Supervisory Control and Data Acquisition) system provides valuable information for the installation and particularly the commissioning phases.

Initial integration of the SR RF components has revealed areas that are well-suited to realization using conventional, commercially-available industrial devices.

Operational experience indicates that there are still varied opportunities for automating normal operational tasks and that more elegant control will simultaneously alleviate some of the onus placed on the operator and provide better protection to the installed systems.

References

[1] M de Jong, "Storage Ring Low-Level RF System Preliminary Design", CLS Ref: 5.4.32.3
[2] J. Stampe, "Passive I/Q Performance", CLS Ref: 7.5.48.1
[3] H. Padamsee, J. Knobloch and T. Hays, *RF Superconductivity for Accelerators*, John Wiley, New York 1998

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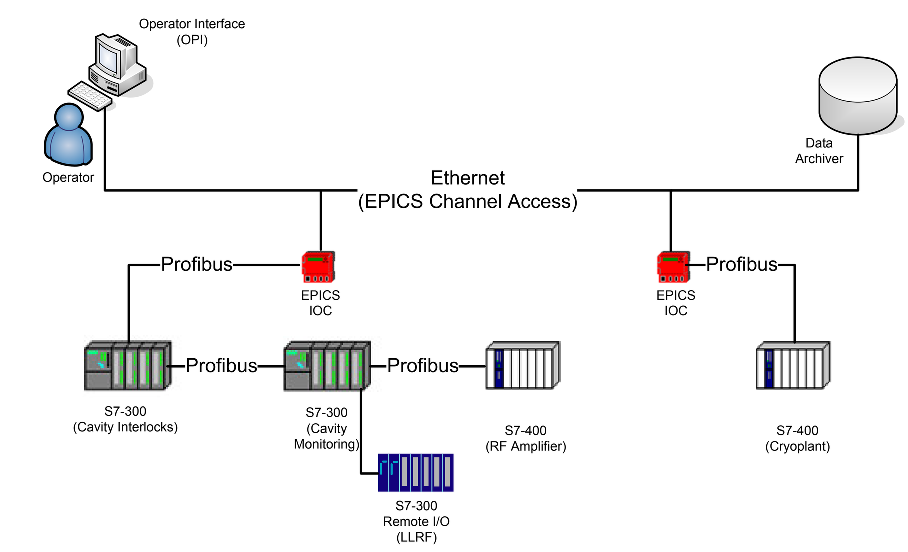
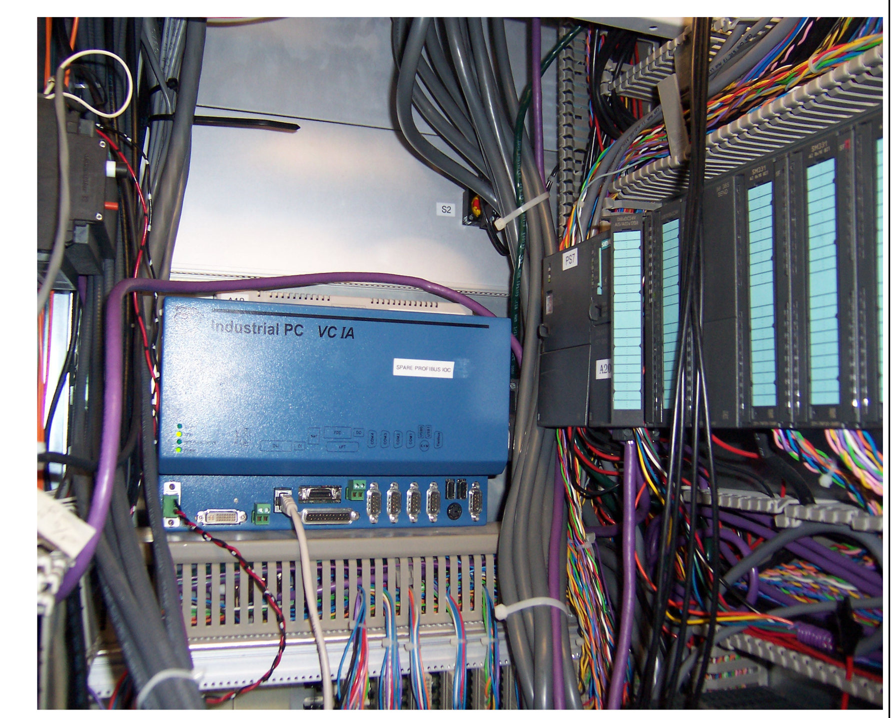
Controls Network

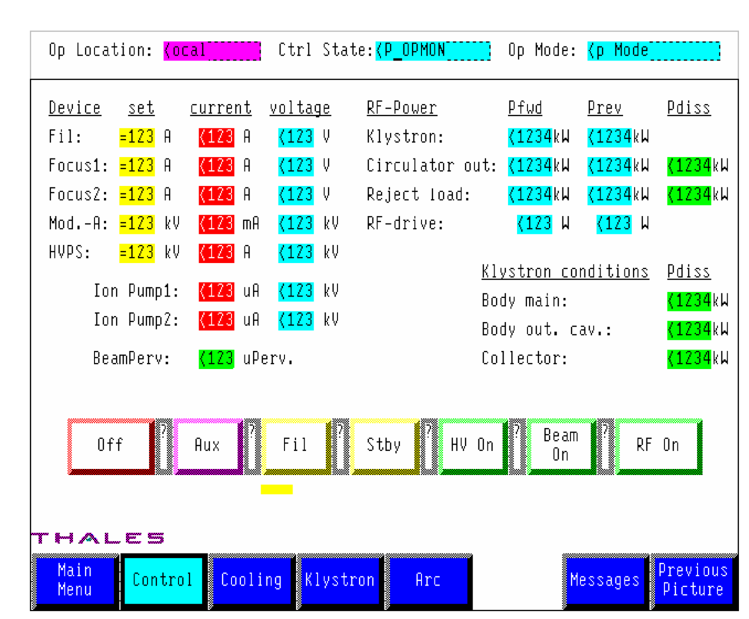


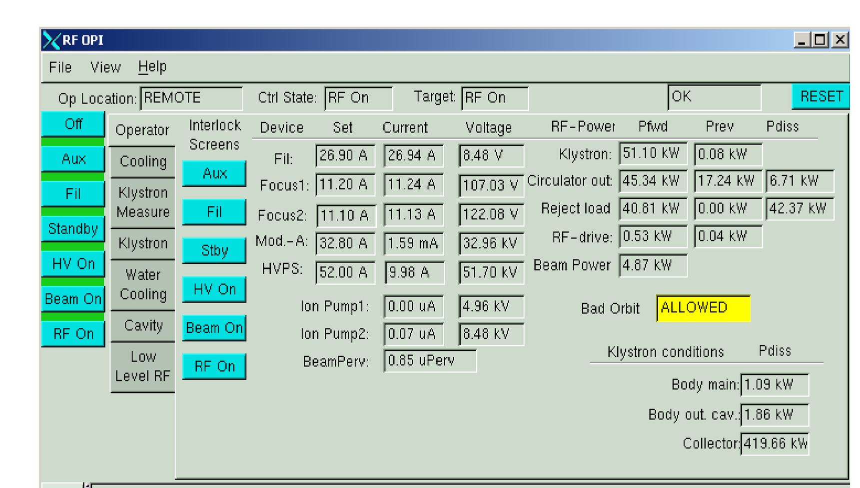
With the IOC hardware and software configuration currently in place, up to six PLCs can be integrated in to EPICS per IOC. Once the data is available to EPICS, it can be displayed on an OPI (Operater Interface), archived and plotted for analysis, allowing valuable insight in to system behaviour. The CLS is currently evaluating the use of PLC Ethernet modules to remove the dependency on proprietary, Profibus hardware required by the current configuration. An Ethernet solution promises to provide a more flexible network.

The PLC/LLRF interface is handled by a remote I/O rack, connected via Profibus communication processors (CP) to a CPU in the cavity control rack on the storage ring.



The IOC is connected via Profibus to the PLCs it is controlling and exposes selected process variables to EPICS via Ethernet. The IOC for the cavity and RF controls is located in the cavity rack.





The EPICS OPI developed at the CLS was modeled after the HMI delivered by Thales to enhance user adoption. Future versions will provide fewer unnecessary options to the operator and more automated control.