Future Plans for the CLS Storage Ring LLRF

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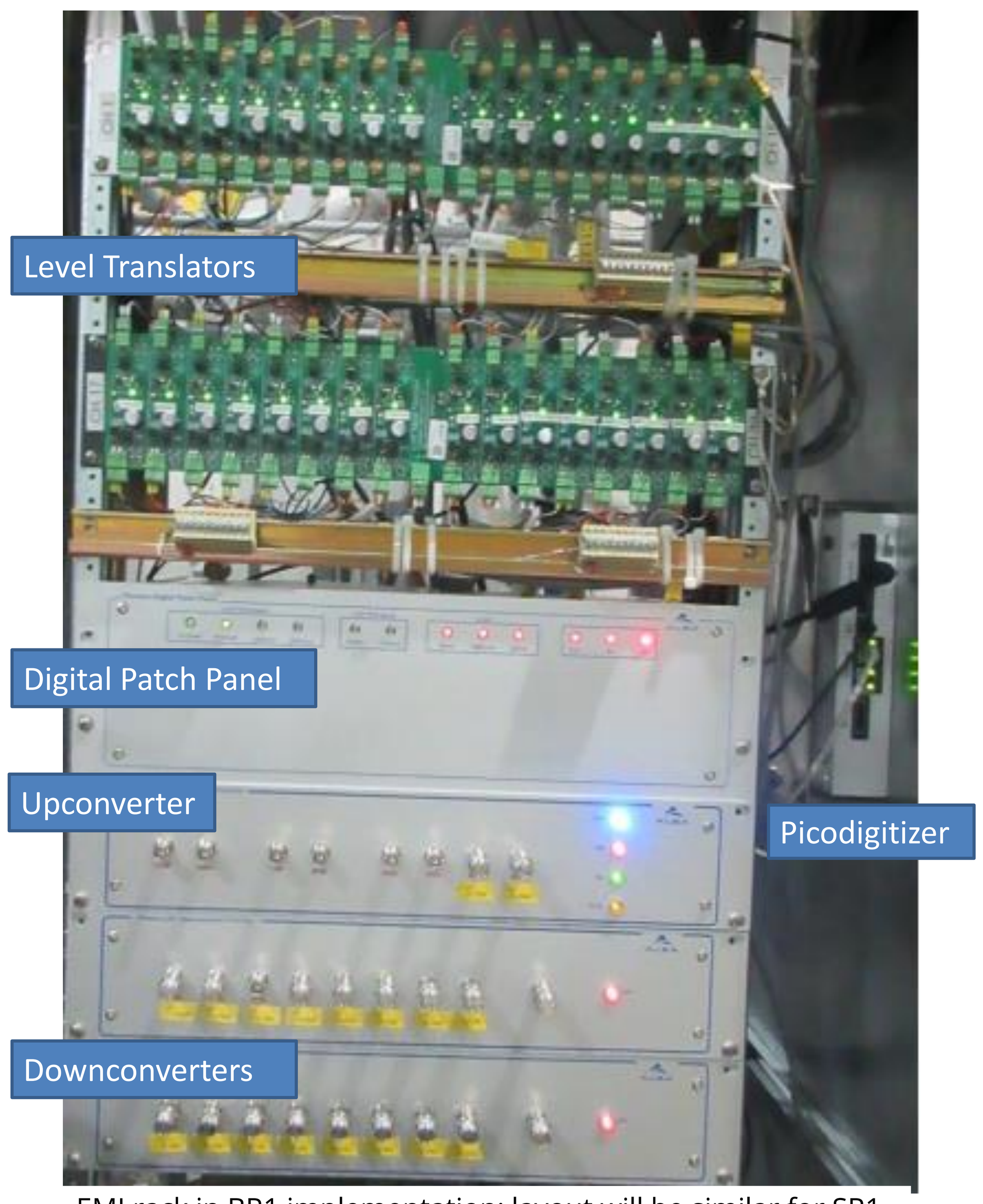
ABSTRACT

The Canadian Light Source (CLS) operates a single-cell CESR-B superconducting RF cavity system in the 2.9 GeV storage ring, powered by a 310 kW klystron. After the successful implementation of ALBA's digital low-level radio frequency system (DLLRF) in the dual cavity booster ring at CLS [1], plans are in place to test the same system in the storage ring RF. The DLLRF also leaves open future possibilities for migrating from klystron to solid state power amplification, as well as adding a second superconducting cavity to the storage ring RF. We will discuss the design of the control system, operational parameters, and comparison to the existing LLRF system.



EMI rack in BR1 implementation; layout will be similar for SR1.

DLLRF HARDWARE

- Nutaq Picodigitizer 125 FPGA + FMC boards + mezzanine GPIO bus
  - 16x ADCs and 8x DACs
  - 1x internal + 32x external digital GPIO
- RF Up/Down conversion frontends with MO reference to phase lock loop
- Level Translators for signal voltage conversion and electrical isolation

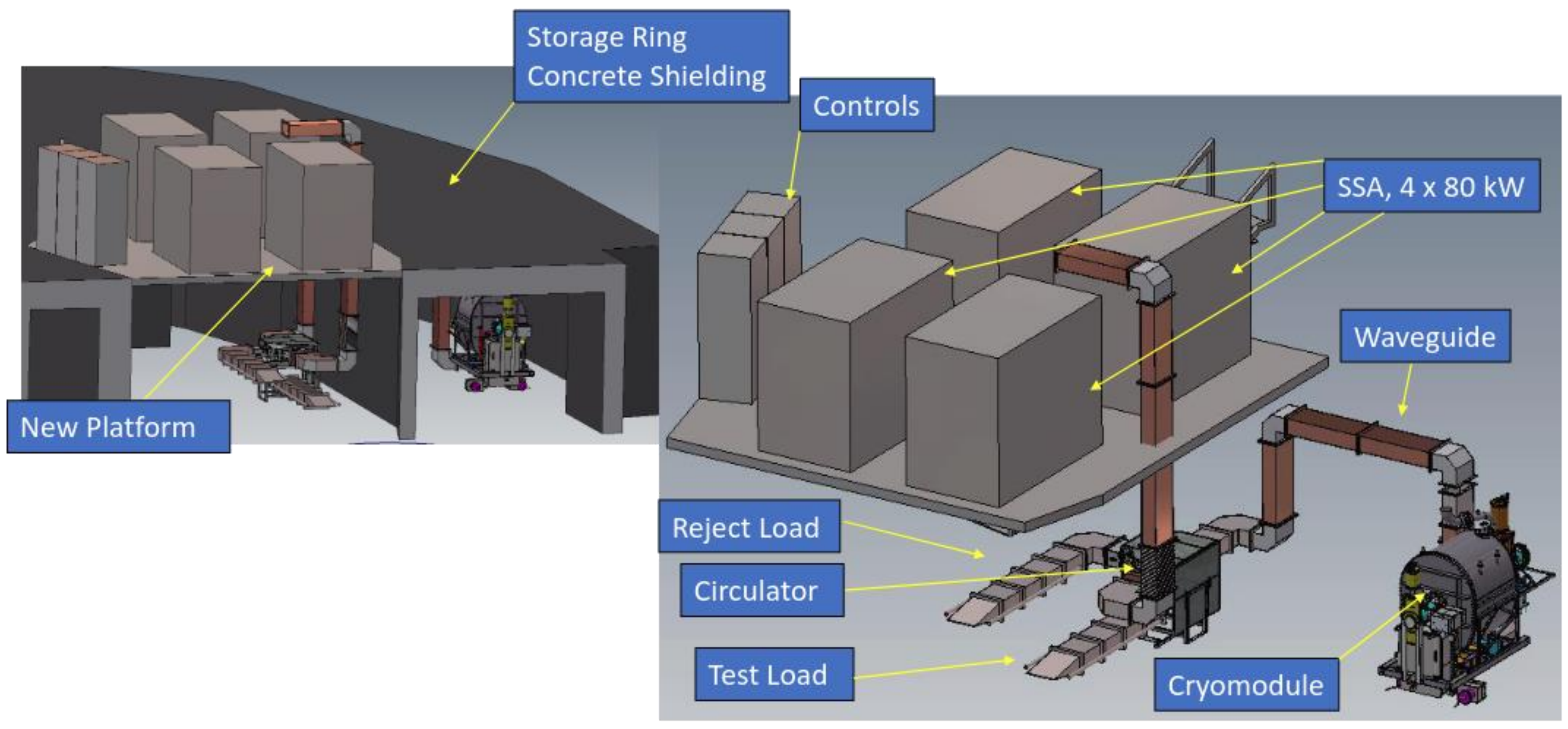
DLLRF FIRMWARE

- Shall be configured to run as two single-cell cavities, though initial testing will attempt to use the same RF signals as the existing DLLRF (e.g. forward and reflected power of pre-amp output and reject load signals).
- Through the operator GUIs, or via a GPIO input, the system may be slowly interlocked to avoid high reflected power at LLRF shutdown.
- Integrates into the CLS control system using EPICS IOC driver initially developed at Diamond Light Source.
- Further FPGA developments are in progress to add RF threshold interlocks, pin diode hold-open in Standby states, and live fast diagnostics for archival.

RF in #	klystron + 1x Cavity	klystron + SSA + 2x Cavity
1	VCav	VCav A
2	Fwd Cav	Fwd Cav A
3	Rev Cav	Rev Cav A
4	MO	MO
5	Fwd Klystron	Fwd Klystron
6	Rev Klystron	Rev Klystron
7	Fwd Circ	Fwd Circ A
8	Rev Circ	Rev Circ A
9	Fwd Rej Load	VCav B
10	Rev Rej Load	Fwd Cav B
11	Fwd RF Drv Out	Rev Cav B
12	Rev RF Drv Out	Fwd SSA
13	*tbd*	Rev SSA
14	*tbd*	*tbd*
15	*tbd*	*tbd*
16	DACs IF Out	DACs IF Out

2nd SUPERCONDUCTING CAVITY

- Research Instruments contracted in 2019 to deliver 3rd CESR-B Cryomodule.
- Allows CLS to operate with two cavities and one spare.
- Consideration to implement 4 x 80 kW solid state amplifier, due to higher reliability and redundancy [2].
- Goal is to operate at 250 mA in the SR at current insertion device capacity.
- May continue operating at 220 mA in the event of RF or cavity failure.
- More infrastructure is required for larger footprint of SSA, as well as supporting cryogenic systems [2].



CONCLUSION

With the new Booster Ring DLLRF expected to be put into operation this Fall, our attention is now turning towards upgrading the RF systems in the CLS Storage Ring. Part of the plans include integration of a second superconducting CESR-B cavity by 2024, which will also require additional infrastructure. Preference is towards solid state amplification for the RF source due to availability and the inherent reliability of such systems. The Storage Ring DLLRF will initially be tested in a monitoring mode with the existing hardware in 2023.

REFERENCES

[1] P. Solans et al., "Digital LLRF for the Canadian Light Source", in Proc. IPAC'22, Bangkok, Thailand, Jun. 2022, pp. 1538-1541. doi:10.18429/JACoW-IPAC2022-TUPOMS049
[2] C.N. Regier, "Superconducting RF System Plans at CLS", in Proc. MEDSI'16, Barcelona, Spain, Sep. 2016, pp. 293-298. doi:10.18429/JACoW-MEDSI2016-WECA05

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