Exploring 19 years of use of a superconducting wiggler at the Canadian Light Source.

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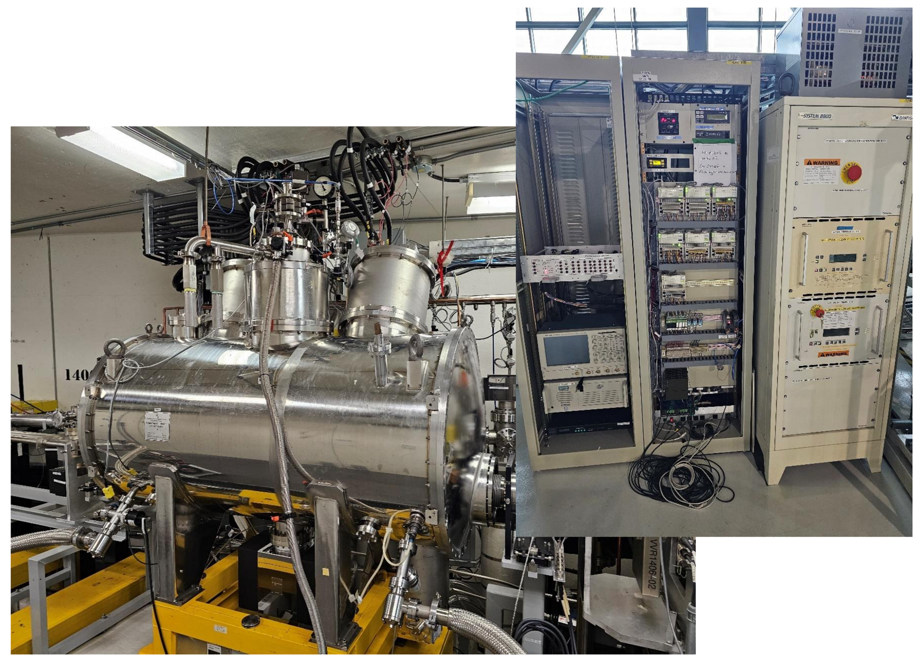
(Tue-Po-1.4)

Abstract: Canadian Light Source, a 2.9 GeV 3rd generation synchrotron located in Saskatchewan Canada, has had a superconducting wiggler since 2005. Commissioned in July 2005, the wiggler and associated systems have been serviced and upgraded throughout the years. This will look at system design, operations use and upgrades. A look at the quench count and some contributing factors for the high number. What is CLS doing to reduce the frequent quenches and how this could affect operations.

Background: HXMA (Hard X-ray MicroAnalysis) is one of the most subscribed beamline at CLS. HXMA uses a 2.0 tesla wiggler to produce X-rays for the beamline. The wiggler is able to be run at 2.2 tesla, but typically is set to 1.9 tesla to reduce the risk of damage when quenched. The field produced impacts the success of the beamline and its science program. It is important to maintain the operation of the wiggler and beamline to continue the science effort for so many researchers.

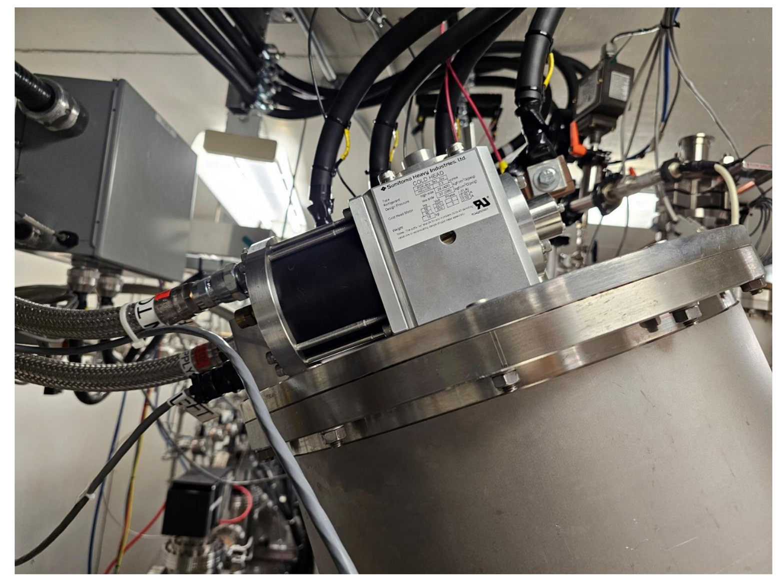
Design:

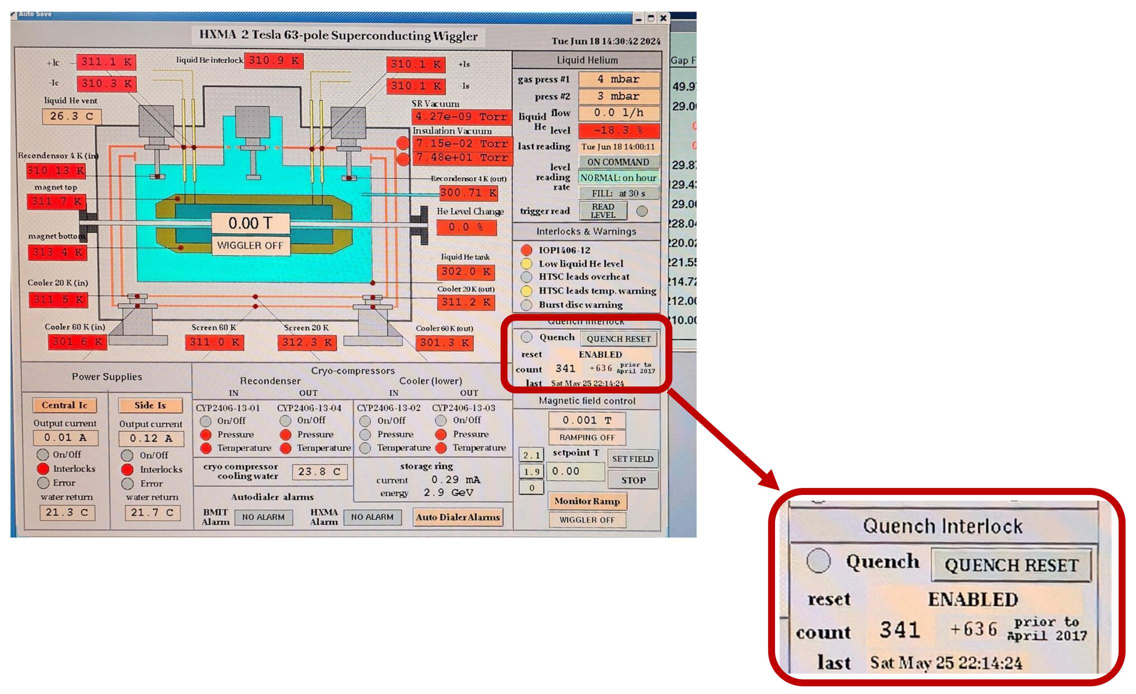
- Contracted to BNIP (Budker Institute of Nuclear Physics), created in 2004, commissioned in 2005
- The wiggler is made of 63 poles producing a 2.0 Tesla field constructed of niobium tin wires [1]
- The cryostat volume is 330 liters of liquid helium
- The power supplies provided by Danysik are able to produce 400A at 9V
- The compressors and cold heads provided by Leybold



Upgrades:[2]

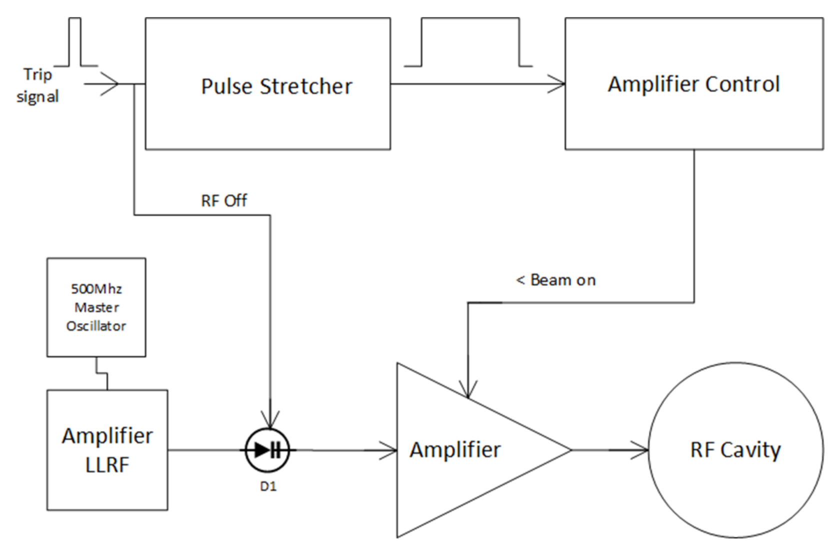
- **In** 2010 the power supply upgrade to 500A to provide an increase of average magnetic field to reach 2.2 tesla
- 2017 cold head upgrade (Sumitomo RDK415) and compressor replacement (Sumitomo F-50) were used to reduce helium consumption to near 0%
- Ice buildup of the filling port was resolved by adding heaters to the area.





Quenching:

- Count at **977** + Quench training [3] of 7 counts
- Quenches are known to be caused during a fast shutdown of the Storage ring RF system
- No beam kick out available during a fast shutdown, resulting in beam spiral inward as energy is lost [4]
- Slow RF shutdowns with a beam kickout do not result in HXMA wiggler quench.



Quench Resolution Effort:

- A pulse stretcher was added to the Accelerator Control Interlock System (ACIS) to prevent short intermittent interlock faults from tripping only some of the RF systems.
- This created an inherent trip signal and a delayed trip signal
- The un-delayed signal is now used to start a slow RF amplifier shutdown, this is followed by the delayed signal that causes a fast shutdown.
- The result is many trips that would normally cause a HXMA quench will now have a 2 stage trip and prevent a quench.
- Further effort has been made to reduce the number of nuisance trips using plastic fibers in place of glass for RF arc detection.

Conclusion:

The HXMA wiggler has seen an excessive number of quenches. With each one the wiggler pushes into a dubious title. Although it has seen far too many quenches, CLS takes the issue seriously and will continue working to resolve this. Several questions remain unanswered; are the quenches real? Does the power supply higher current upgrade put the wiggler windings at greater risk? but none bigger than how many more quenches will the wiggler take before failure?

References

[1] K.V. Zolotarev, et al., Superconducting 63-pole 2 T wiggler for Canadian Light Source, ISSN 0168-9002
[2] L Lin, SRI 2018, CLSI HXMA 2.0 Tesla Superconducting Wiggler Upgrades
[3] Report, On CLS superconducting wiggler test in bath cryostat In Budker INP July 12-15,2004
[4] W.A.Wurtz, et al. IPAC2014, PREVENTING SUPERCONDUCTING WIGGLER QUENCH DURING BEAM LOSS AT THE CANADIAN LIGHT SOURCE, ISBN: 978-3-95450-132-8

Acknowledgments

Much appreciation for my collogues at CLS for the background information support and a special thank you to De-Tong Jiang of University of Guelph.

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