UPGRADES TO CRYOGENIC CAPABILITIES FOR CRYOMODULE TESTING AT JLAB

Jefferson Lab

THP051

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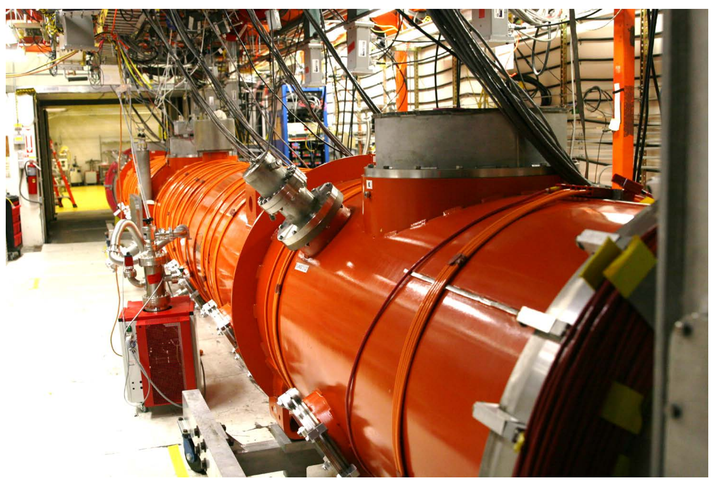
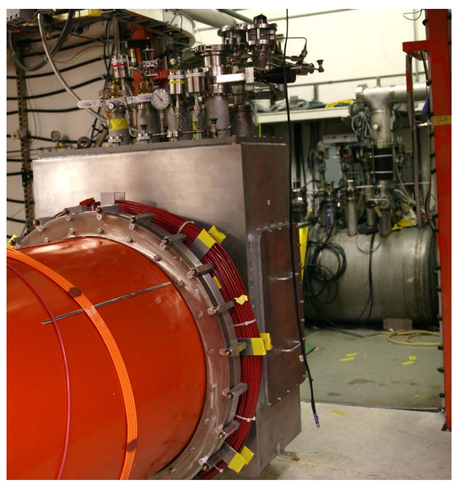
INTRODUCTION

The cryomodule test facility (CMTF) at JLab was initially unable to cool down LCLS-II cryomodules fast enough to properly expel magnetic flux, leading to depressed Q0 measurements. The CMTF cryogenic supply was modified in an effort to speed up the cooldown rate. The Low Energy Recirculating Facility (LERF) at JLab was also refitted to allow for cryomodule testing, supplied by the main Central Helium Liquefier (CHL)

BACKGROUND – CMTF & LERF

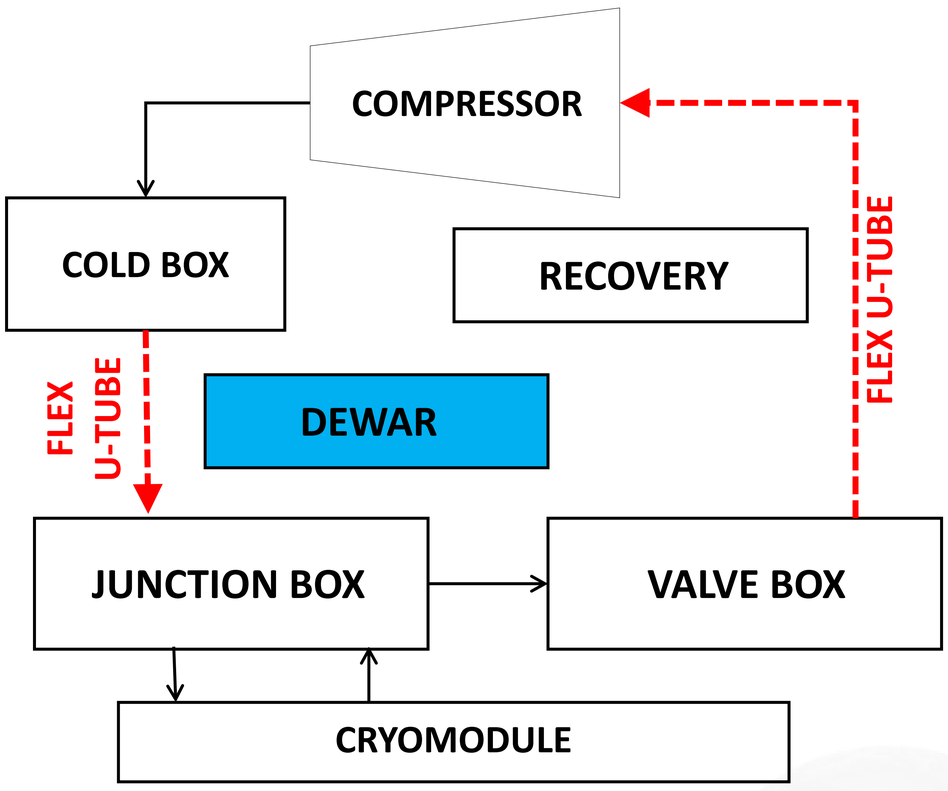
- CMTF was commissioned in 1988 to test the original CEBAF CMs
- The CMTF has tested CEBAF C20, C50 and C100 cryomodules; SNS High-β and Medium-β cryomodules; and LCLS-II cryomodules
- Cryogens are supplied by CTF, which has a 650W primary 4.5K refrigerator and a 1 kW 40K shield line
- The LERF (formerly the JLab FEL) was first used as a cryomodule testing facility in early 2019





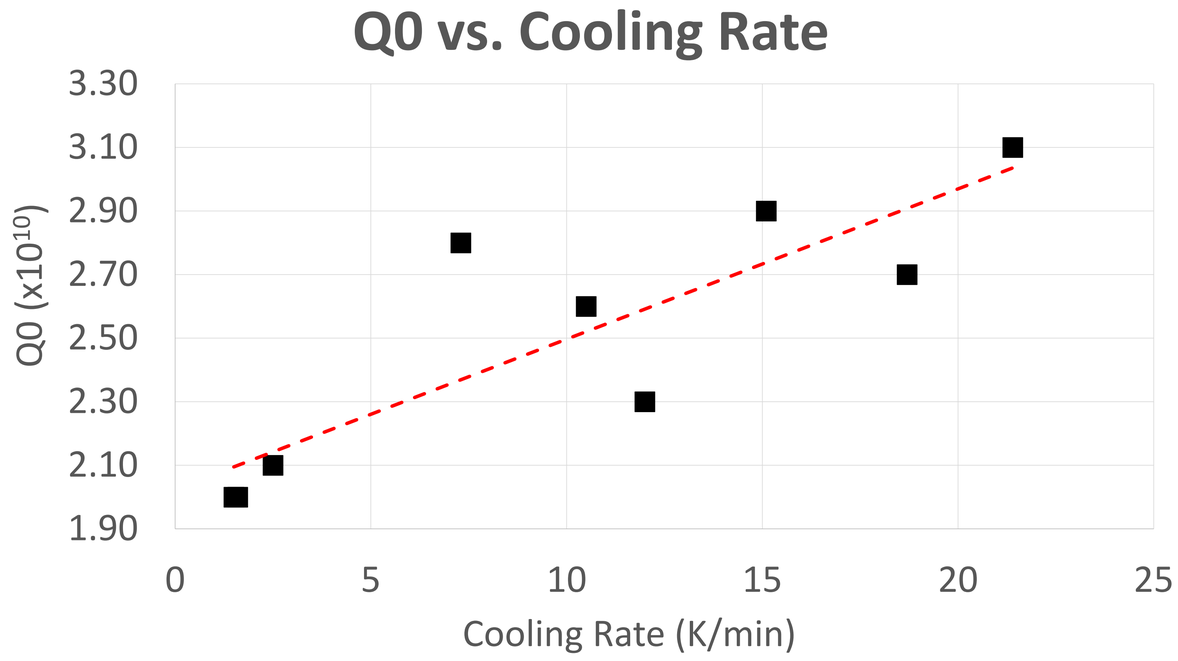
CMTF MODIFICATIONS FOR FASTER COOLDOWN

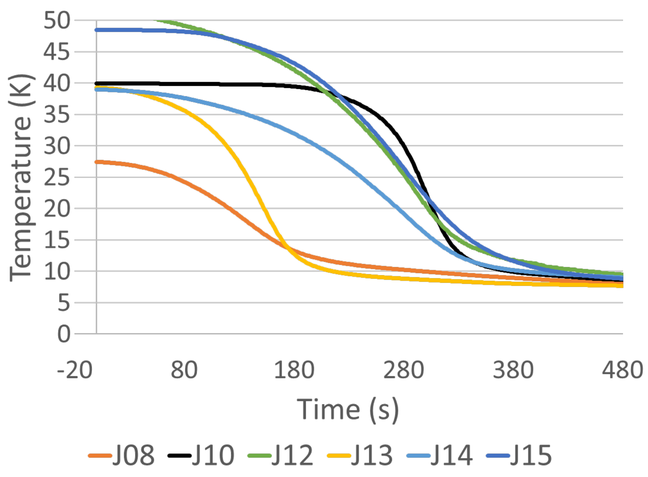
- The rate of cooling through the transition temperature of niobium was too slow to expel trapped magnetic flux, leading to Q values lower than spec
- Modifications were made to the equipment and procedures in the CMTF to allow fast cooldowns (FCD)
- Bypass lines were added to the 4K-2K heat exchanger to avoid pressure drop from flow going through coils
- Temporary flex u-tubes in the CTF bypass the 10,000 liter dewar, heat exchangers in the valve box, and the recovery system (image below).



COOLDOWN RESULTS

- Faster cooling rates have lead to higher Q values in both the CMTF and the LERF
- A correlation is apparent between the cooling rate and Q (graph below)
- Cooling rates at the LERF are limited by the CHL
- Temperatures are at HOM clamps on cavity end groups
- Cooling rates are between 20K – 15K; Nb cavity cells pass through transition in this period

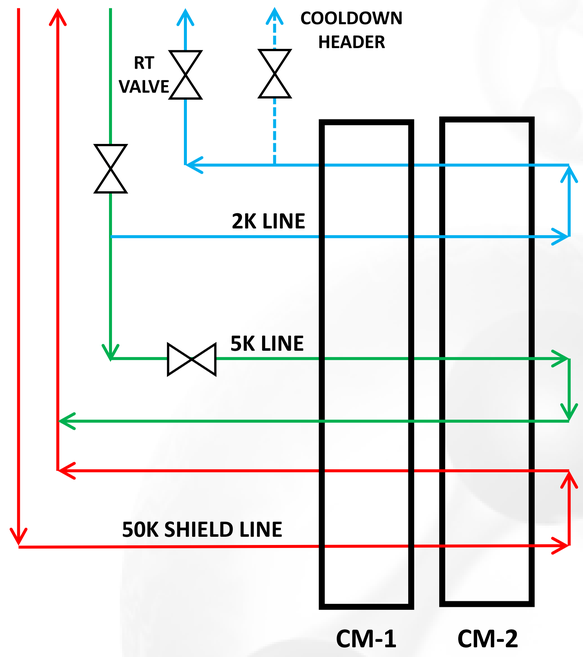




CM	Rate (K/min)	Q0
J1.3-04	1.5	2.0e10
J1.3-05	2.5	2.1e10
J1.3-07	1.6	2.0e10
J1.3-08	7.3	2.8e10
J1.3-10	21.4	3.1e10
J1.3-12	15.1	2.9e10
J1.2-13	18.7	2.7e10
J1.3-14	10.5	2.6e10
J1.3-15	12.0	2.3e10

LERF CRYOGENIC DESIGN

- Existing cryogenic connections in the LERF are used to test two LCLS-II cryomodules at the same time
- The cryogenic system is shared with the CEBAF south linac, and helium is supplied by the CHL
- The high capacity of the CHL negates the need for a heat exchanger
- The 5K line and 2K run in parallel; the 5K return is mixed with the 50K shield return



SUMMARY

The temporary and permanent modifications made to the CMTF has allowed for faster cooling of LCLS-II cryomodules, and resulted in higher measured Q0 values. The LERF has been successfully used to test cryomodules, with the added capacity of the CHL allowing for faster cooldowns and high-energy testing

Acknowledgements

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