LCLS-II CRYOMODULE PRODUCTION AT JLAB: SUMMARY AND LESSONS

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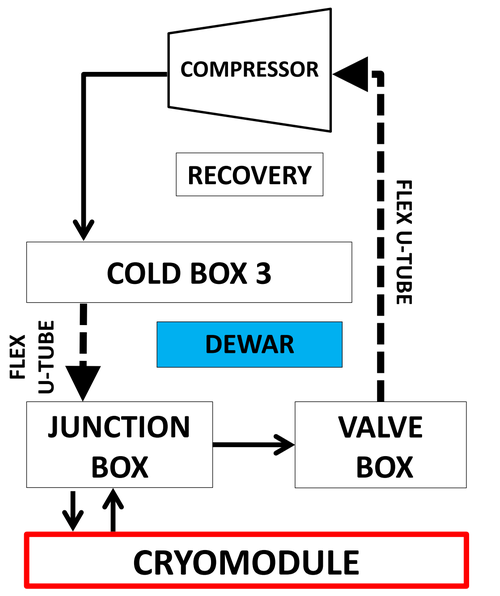
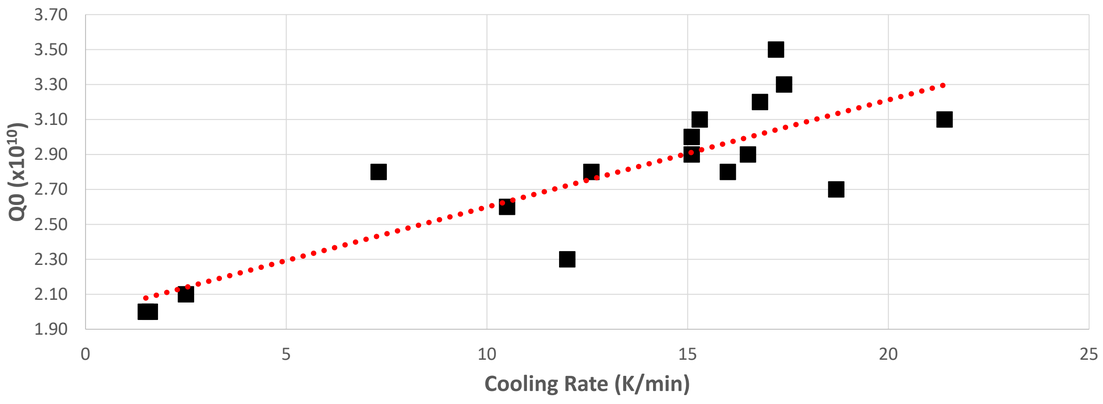
INTRODUCTION

- Twenty-one LCLS-II Cryomodules (CMs) were assembled at JLab and delivered to SLAC
- Issues with CM transportation and acceptance testing were solved to allow for the completion of the project
- Other lessons from LCLS-II will be implemented in LCLS-II-HE, as well as other CM production projects at JLab

CRYOGENIC TESTING IMPROVEMENTS

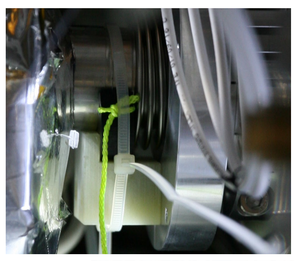
- LCLS-II cavities require a fast cooldown (FCD) in order to expel trapped magnetic flux and achieve high Q_0s
- A process was developed to increase the cooling rate in the JLab CMTF
- Flex-tubes in the cryo plant were used to temporarily bypass certain components (e.g. the dewar) to increase flow
- CMs were brought up to 40K and then cooled down fast with the new process
- The relation between cavity cooldown rates and average Q_0 is shown in the plot below





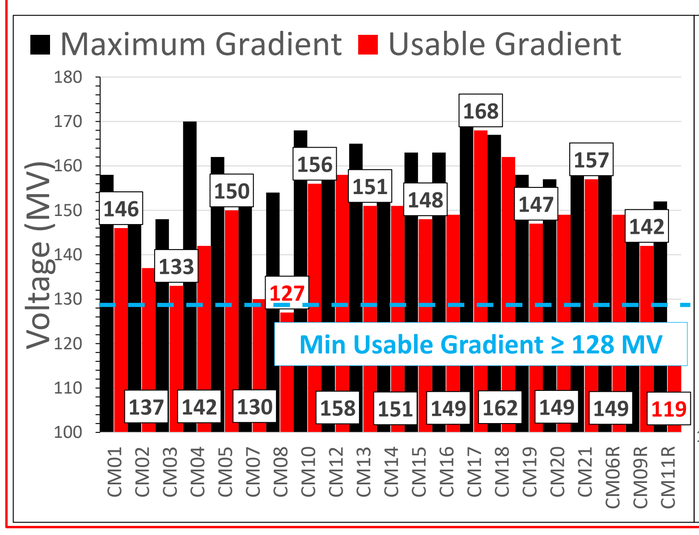
CRYOMODULE TRANSPORTATION

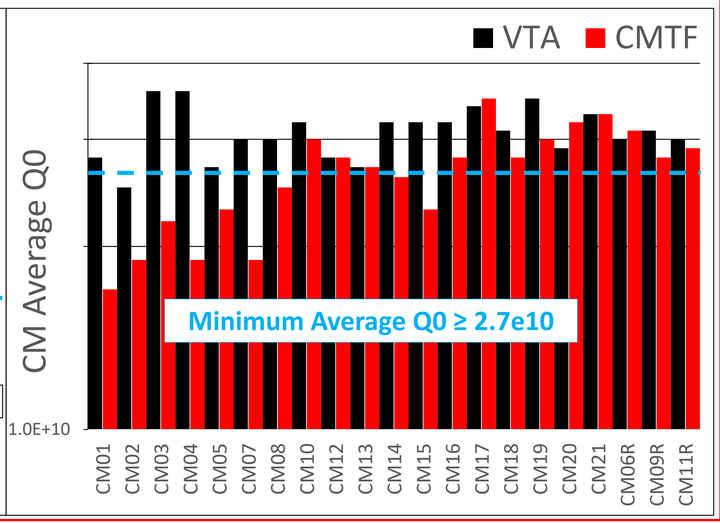
- Two CMs suffered vented beamlines during transport from FNAL to SLAC
- Bellows on the cold FPCs failed due to cyclic fatigue from excited resonant frequencies
- The spring configuration on the shipping frame was adjusted to be less stiff
- A restraint for the bellows was developed and tested on a trip from JLab to SLAC
- The new shipping system was used to ship all production CMs from JLab and FNAL to SLAC



CRYOMODULE PERFORMANCE

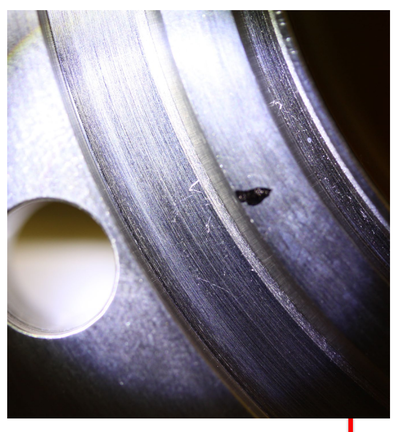
- The LCLS-II spec called for a usable gradient of over 128 MV and an average Q_0 of $2.7x10^{10}$ for each CM
- Plots below show the CM gradients (left, usable gradient value in boxes) and average CM Q_0 (right)
- Improvements to cleanroom and VTA procedures increased FE onset (and hence usable gradients) in later CMs, and upgraded cryogenic capabilities allowed for higher Q_0 measurements after CM08



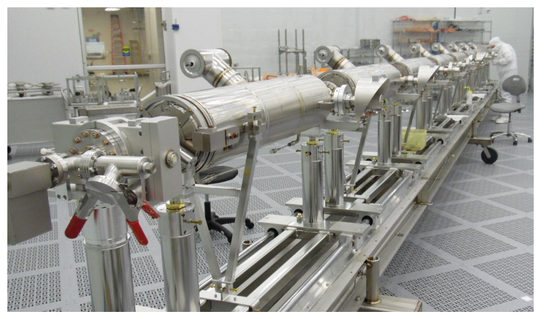


LESSONS LEARNED

Parts in Circulation (PICs): The procurement plan called for shipping and processing fixtures to be returned to vendors for reuse. Delays in inspection and installation meant vendors often did not have enough PICs to continue production. The preference for future CM projects will be to purchase 100% of these parts with no circulation



Non-Conformance Reports: A large number of NCRs were written for the LCLS-II project. Half of these involved scratches and rework on various types of flanges. The inspections and rework could be completed more efficiently if the rework operations were made a standard part of procedure, to happen prior to inspection



Cavity Replacement: A small leak was found in a cavity's helium vessel bellows on CM11R. Due to schedule constraints, it was decided that the single cavity would be replaced in the cleanroom. The remaining cavities would not be disassembled and reprocessed in the regular manner. Though the cavity replacement was carried out successfully, contamination from the outsides of the string entered the beamline space. During testing in the CMTF, five cavities had field emission onsets lower than spec and three of them did not meet the minimum gradient criteria. Replacing a cavity in this manner should be avoided for future projects

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