

LCLS-II CRYOMODULES PRODUCTION EXPERIENCE AND LESSONS LEARNED TOWARDS LCLS-II-HE PROJECT



T. T. Arkan, D. Bice, J. Blowers, C. Grimm, B. Hartsell, J. Kaluzny, M. Martinello, T. Nicol, Y. Orlov, S. Posen, K. Premo, R. Stanek

Fermilab delivered the last LCLS-II cryomodule to SLAC in March 2021. LCLS-II-HE cryomodule production started at Fermilab with the assembly and testing of the verification cryomodule (vCM). With the goal of preserving the momentum for the experienced teams and for the proven functional facilities/infrastructure from LCLS-II, vCM assembly was done without a duration gap right after the last LCLS-II CM. At Fermilab, production of series cryomodules will start in the Fall of 2021. Fermilab will assemble, test, and deliver 13 cryomodules to SLAC.

LESSONS LEARNED & CONTINUTIY FROM LCLS-II

Description	LCLS-II	LCLS-II-HE	Key Take-aways
CM Design & Change/Configuration Control	-Started with E-XFEL 1.3 GHz Pulsed CM design, many changes for the CW requirements -Change control board focused mainly on the scope change and effects on the budget and schedule	-Proven Success with LCLS-II 1.3 GHz CW CM design, absolutely no design changes unless it is essential for the performance specifications -Technical change control board and systems engineering structures	-Substitution of parts thought to be equivalent must be reviewed and approved; small changes matter, and both can have ripple effects and make a big difference on the performance of the CM
Facilities/Infrastructure	Improved throughout the lifecycle of the project based on the recommendations from audits	Additional upgrades are done for the high gradient specification mostly to minimize the risk of field emission degradation	-Minimize pump and purge cycles for the beamline
R&D/Prototyping	R&D and prototyping durations were short due to aggressive project schedule. Design changes continued well into the 7 th production CM	5 months of cold test time for the vCM to adequately address cavity performance, multipacting processing optimization, Q-factor degradation during quenches, plasma processing, unit test and extended range tuner test.	-Do not cut off R&D too early. This is especially true when state-of-the-art performance is required
Quality Assurance & Process Controls	-Learning curve from R&D quantities to CM mass production -Stricter use of travelers real-time	-Stricter Work planning & control (off normal, FMEA) -Quality culture is heavily embedded in the Fermilab team thanks to LCLS-II	-Non routine operations such as disassembly, repair require special work panning and control
Personnel	Core team was augmented with contract new hires, high turnover rate	Proven, experienced, stable workforce from LCLS-II is working on LCLS-II-HE	-Training duration for SRF technicians is long. It is important to retain a steady state qualified workforce

VERIFICATION CM ASSEMBLY & TEST

vCM is assembled using best performing cavities fabricated with the new processing protocol. R&D to develop the new processing protocol, transfer the technology to industry, test and qualify the cavities processed with the new protocol is the first part of the equation to declare success. Phase-II is to assemble these cavities into the cryomodule and prove that the performance of the cavities can be preserved. vCM is assembled very soon after completing the last LCLS-II CM. vCM is currently being cold tested.



