C2Po1G-05 [42]

COMMISSIONING PLAN FOR LCLS II 2 K COLD BOX

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Abstract

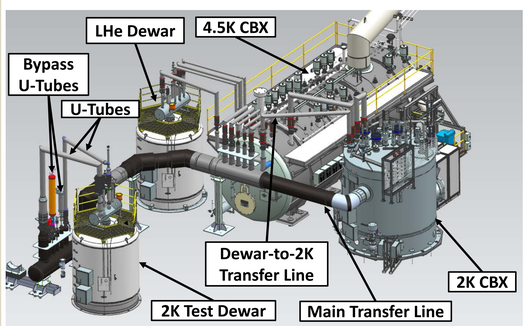
Commissioning of the LCLS II cryogenic plant has been planned with respect to electrical and mechanical systems checkout, equipment cleanup, cool-down, and individual performance evaluation. This plant consists of warm and cold storage, helium compressors, 4.5 K and 2 K cold boxes, and all auxiliaries typical for helium refrigeration processes. The 2 K cold box, consisting of five cold compressors in series to produce the flow and pressures necessary for 2K operation , will be the last equipment installed and, along with an additional 10,000 L helium Dewar, will allow the entire plant to be commissioned as a single entity. The pre-commissioning stages, commissioning plan for 2 K cold box without connecting to the LCLS II LINAC, additional test equipment needed to simulate the loads, all process studies and associated results are described herein.

Introduction

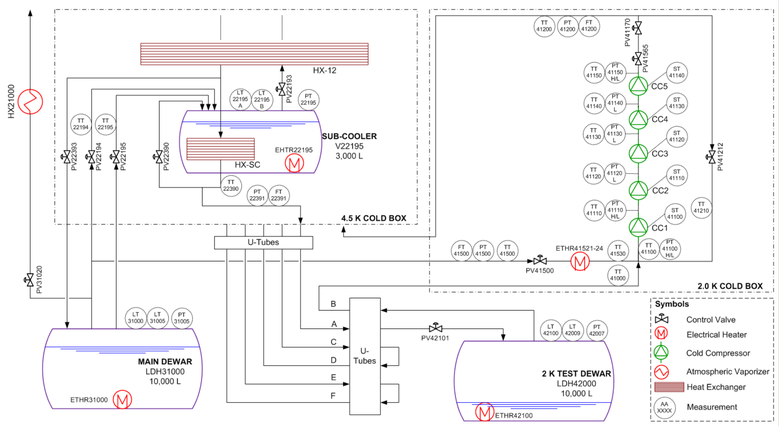
- LINAC Coherent Light Source –II (LCLS II) project requires 2.0 K Cold Box as part of the Cryoplant.
- LCLS II 2.0 K Cold Box consists of a series of six cold compressors, in which first five cold compressors are required to meet high flow condition.
- Commissioning plan for cold compressors with high flow condition has been developed in present work

System Definition

- The commissioning plan has been developed isolating the LINAC at the Interface Box by removing u-tubes.
- Test Dewar of capacity 10 m³ is used to simulate the pump-down volume.



3-D Model for 2.0 K Cold Box Commissioning



Process Flow Diagram for the 2.0 K Cold Box Commissioning

Process Design and Calculation

- The process model has been developed considering the following scenarios as in below table

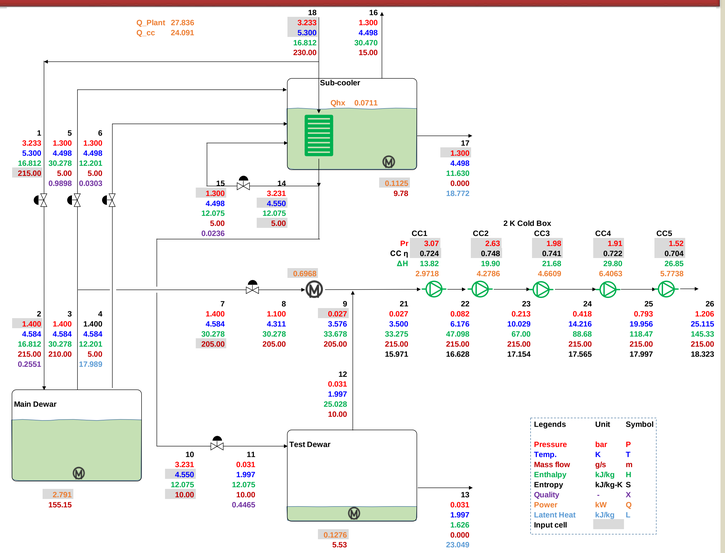
Modes	Mass Flow	Suction	Discharge
Maximum Capacity	≥ 215 g/s	3.5 K, 27 mbar	< 30 K, 1.2 bara
Nominal Capacity	≥157 g/s	3.6 K, 28 mbar	
Minimum Capacity	≤150 g/s	3.6 K, 28 mbar	

- Entire pump-down has been divided in to 10 discrete points and each point has been simulated to evaluate the operation of cold compressor. Two pump-down paths have been simulated for the present work.

Pumpdown-1: Most of pump down flow originated from Test Dewar [Test Flow : Main Flow = 29 : 1]

Pumpdown-2: Part of pump down flow originated from Main Dewar [Test Flow : Main Flow = 0.46 : 1]

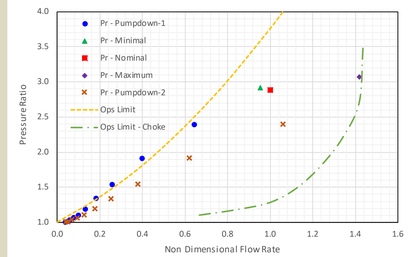
- It is assumed to maintain the liquid helium level at Test Dewar less than 20% in order to get 8.0 m³ of saturated vapour volume for the stable pump-down. In particular, the process model shows the result of calculation for the maximum capacity operation.



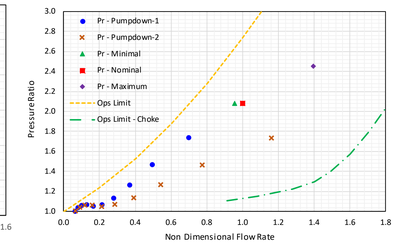
Process Model for the 2.0 K Cold Box

Cold Compressor Simulation Results

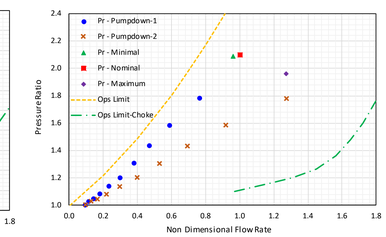
Cold Compressor - 1



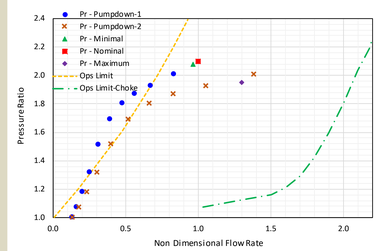
Cold Compressor - 2



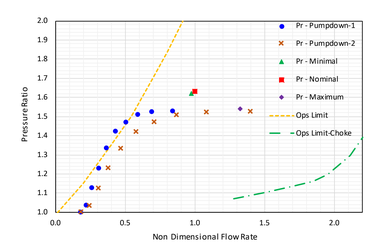
Cold Compressor - 3



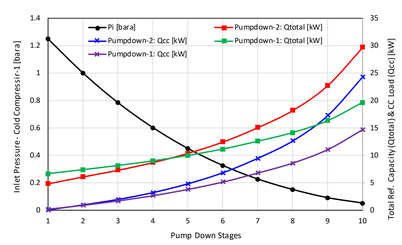
Cold Compressor - 4



Cold Compressor - 5



Pump Down Comparison



Manufacturing Status of 2.0 K Cold Box

Sub-Contractor -1

Sub-Contractor -2

Outer Vacuum Jacket and Internal Piping for two LCLS II 2.0 K Cold Boxes at Supplier Facilities

Conclusion

- Detailed commissioning plan for 2.0 K Cold Boxes including cold compressors has been developed.
- Process model has been developed and used to verify the operation of cold compressors within the limits.
- Process model has been used to develop the pump down paths, in which second pump down path has been selected for better stability.
- Both the 2.0 K cold boxes have been delivered to SLAC, Menlo Park, USA for installation.
- Commissioning of 2.0 K cold box will be performed at SLAC one-by-one scheduled at summer 2020.

Acknowledgement

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References

1. V. Ravindranath et. al., "Process simulations for the LCLS-II cryogenic systems", IOP Conf. Series: Materials Science and Engineering 278 (2017) 012106.
2. S. Yang et. at., "Mechanical Design and Analysis of LCLS II 2 K Cold Box", IOP Conf. Series: Materials Science and Engineering 278 (2017) 012091.
3. V. Ganni et. al., "Design, fabrication, commissioning, and testing of a 250 g/s, 2-K helium cold compressor system", AIP Conference Proceedings 613, 288 (2002); https://doi.org/10.1063/1.1472033.
4. R. Bhattacharya et. al., "Control methodology and test modes during the qualification test of ITER Cold Circulator", Physics Procedia 67 (2015) 288 – 293.

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