HB650 CRYOMODULE DESIGN: FROM PROTOTYPE TO PRODUCTION*

V. Roger, S. Chandrasekaran, C. Grimm, J. Holzbauer, O. Napoly, J. Ozelis, D. Passarelli
FNAL, Batavia, IL 60510, USA

SRF 2023 GRAND RAPIDS

INTRODUCTION

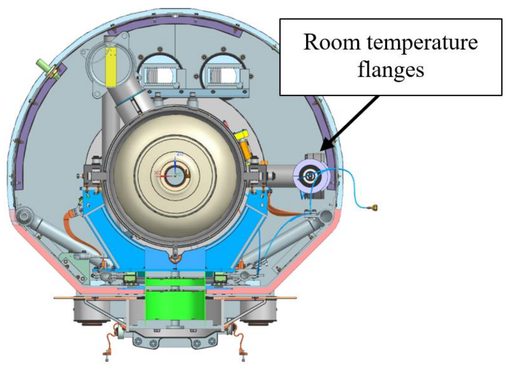
In early 2023, the assembly of the prototype HB650 cryomodule was completed and cold tests started to evaluate its performance. The lessons learned from the design, assembly and preliminary cold tests of this cryomodule played a fundamental role during the design optimization process of the production HB650 cryomodule.

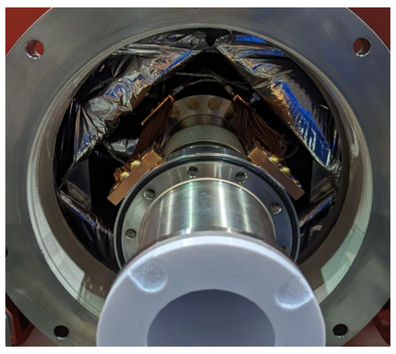
TEST RESULTS AND HEAT LOADS ANALYSIS OF THE 1ST COOL-DOWN

The static heat loads measurements are clearly out of tolerance especially the 2K heat loads including a 20 W difference by running the cavities at 4K or 2K.

	Estimated heat loads	Measured heat loads
High Temperature Thermal Shield (HTTS)	150 W	250 W
Low Temperature Thermal Source (LTTS)	26 W	30 W
2K (with cavity at 4K)	11.2 W	33 W
2K (with cavity at 2K)	11.2 W	52 W

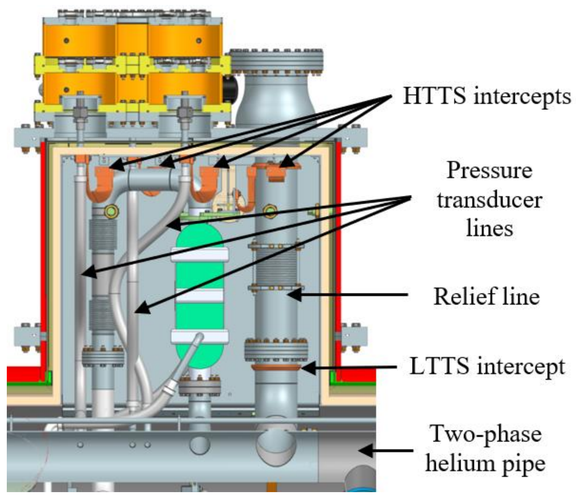
Investigations have shown that the heat loads by radiation from the room temperature coupler parts which are inside the coldmass were not accounted for and MLI on the thermal shield was not close enough to the coupler. This radiation contributed to around 15 W to the 2K heat loads, up to 60 W on the HTTS. To a lesser degree, an effect on the LTTS heat loads is also expected.

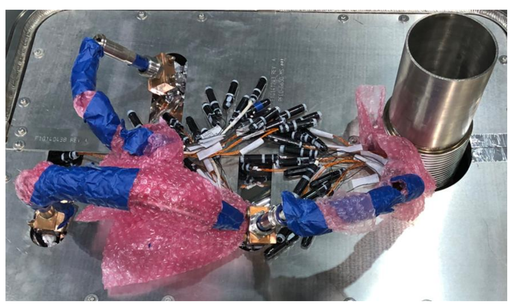


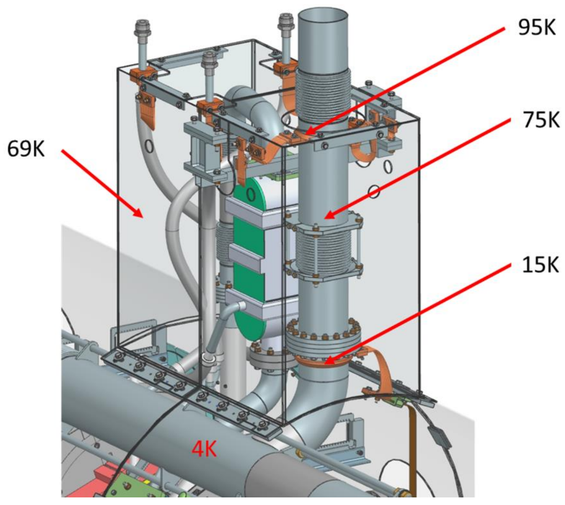


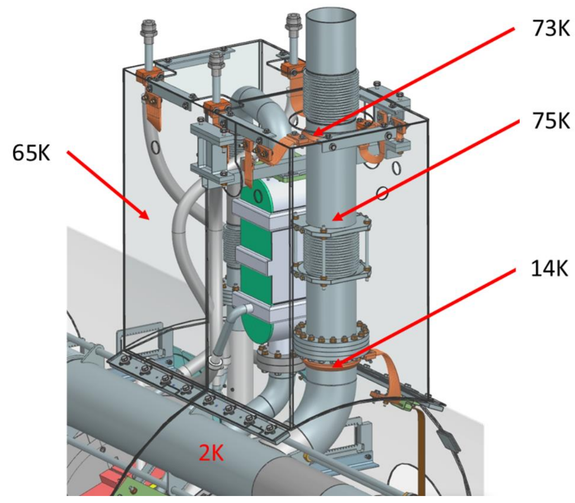
Another 5W were coming form microphonics in the cool-down valve.

Temperature sensors located on the top part of the HTTS shows a temperature drop switching cavities from 4K to 2K which tends to prove that “Rollin films” are going up against the walls of the pressure transducer lines and makes shorts with the thermal shield. 20 W due to “Rollin film” seems important but this phenomenon could be facilitated by more than 50 wires present inside each of these tubes.



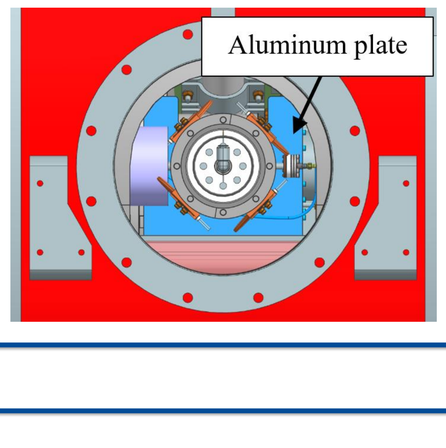


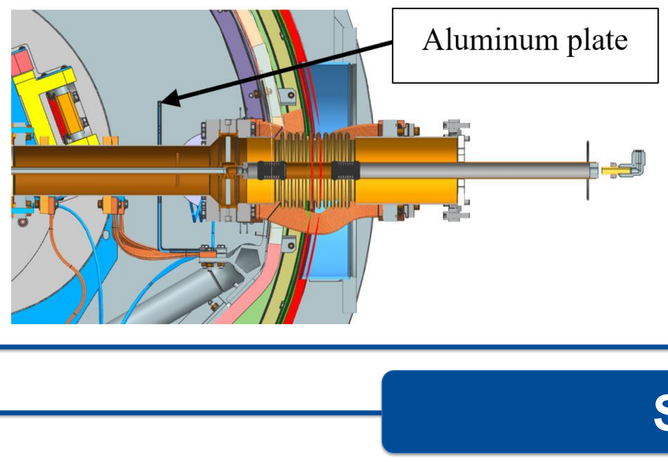




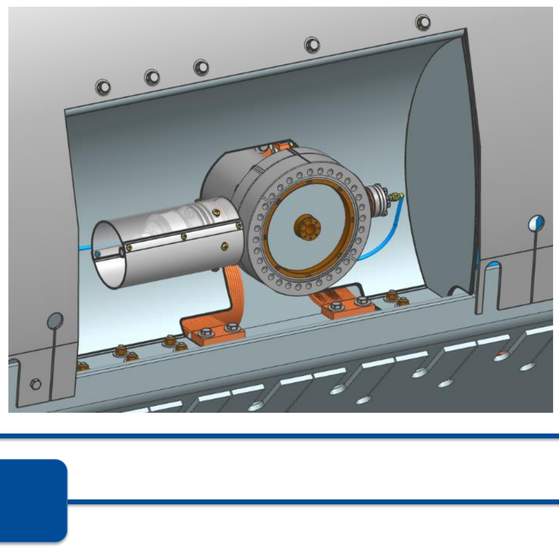
IMPROVEMENTS PLANNED AFTER THE 1ST WARM-UP AND PATH FORWARD

To reduce the heat loads by radiation on this prototype cryomodule, the plan is to add MLI and to connect a plate to the HTTS to shield more this radiation: expected effect 5 to 10W. Heaters will be placed on the pressure transducer lines to reduce the effects of the “Rollin film”





On the production HB650 cryomodule, the HTTS has been redesigned to move the room temperature flanges outside the coldmass.



SUMMARY

The potential sources of the heat loads discrepancies in between the calculations and measurements have been identified. A path forward has been defined to improve the prototype cryomodule during the 1st warm-up and to validate this heat loads analysis during the 2nd cool-down by adding heaters and temperature sensors. Based on this analysis & the lessons learned, the design of the production HB650 cryomodule has been optimized with all the room temperature parts outside the coldmass.

*Work supported by Fermi Research Alliance, LLC under Contract No. DEAC02- 07CH11359 with the United States Department of Energy