

§12. First Cooldown of Subcooled He II Cryostat

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Subcooled superfluid helium (He II) has been widely used as a coolant for large scale superconducting magnets. It is well known that the superconducting magnet which is operated with He II shows higher stability margin than that of normal helium (He I). Helical coil system of the LHD will be cooled with subcooled He II for the Phase II operation. Research and development of He II refrigeration system, as well as study the heat transport mechanisms of He II are essential for the successful LHD upgrade. We designed and fabricated a subcooled He II cryostat at the cryogenic laboratory.

The cryostat consists of an upper reservoir, lower reservoir, a saturated He II heat exchanger and a lambda plate as shown in Fig. 1. The upper reservoir contains He I

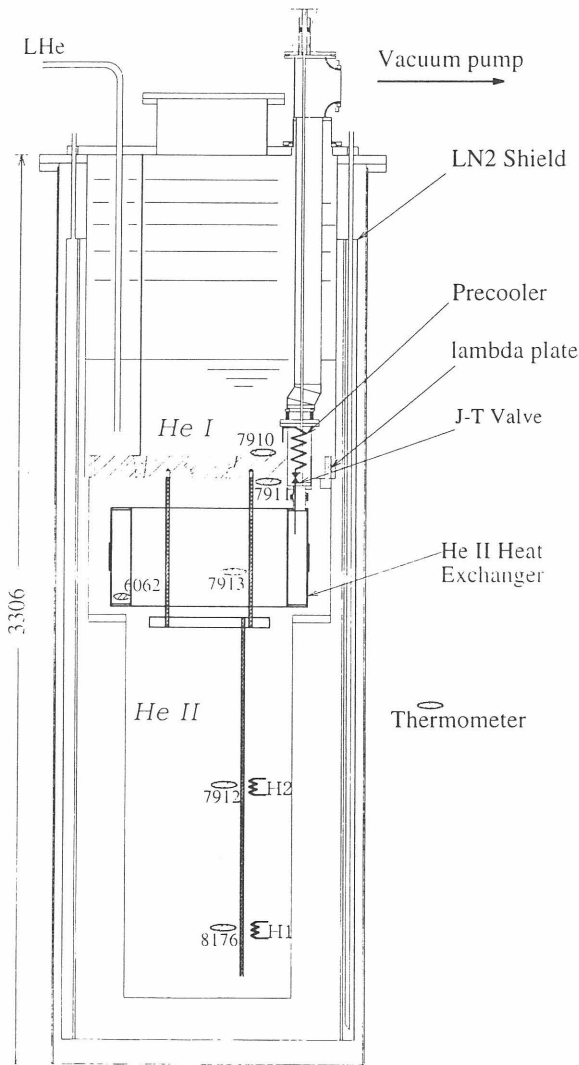


Fig. 1 Schematic of Subcooled He II Cryostat.

which intercepts conduction heat leak from the room temperature to the subcooled He II region and provides saturated He II through the J-T valve. The hydraulic communication line between two reservoir is used to feeding He I to the lower reservoir during the first cooldown and maintaining the subcooled He II pressure close to atmospheric pressure.

The He II refrigeration is obtained in terms of pumping a He II heat exchanger with roots blower backed up by a rotary pump. The pressure within the saturated He II heat exchanger is maintained at desired value by regulating the pressure with control valve. The refrigeration power is controlled by adjusting J-T valve and the He II level within the heat exchanger.

I. Cooldown Result

Cryostat was pre-cooled with exchange gas in the cryostat and liquid nitrogen filled in the thermal radiation shield. It took approximately 48 hours to cooldown to 220 K. Then, the liquid helium was transferred to the cryostat. Fig. 2 shows a cooldown curve from 220 K to 4.4 K. It took two days to fill the liquid helium in the cryostat and start pumping down the system. He I in the lower reservoir reached at the lambda point after pumping down for 8 hours. The whole system reached its lowest temperature 1.6 K after 12 hours of pumping process as shown in Fig. 3.

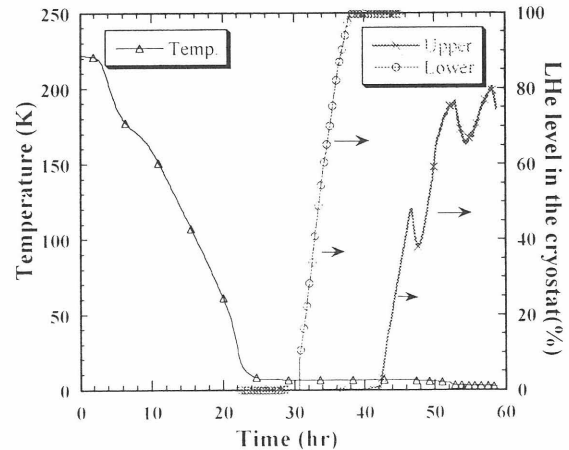


Fig. 2 Cooldown curve of Cryostat to 4.4 K.

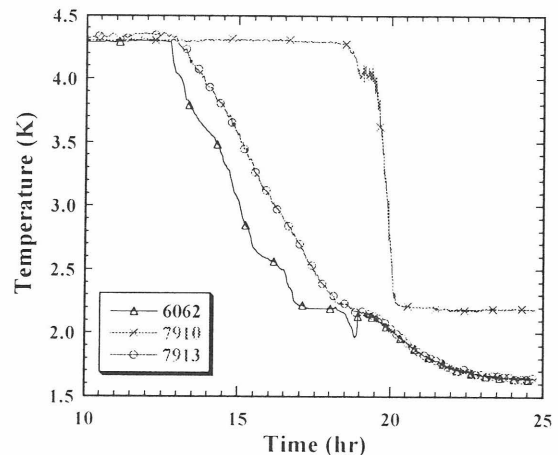


Fig. 3 Cooldown from He I to He II.