

# Study on the performance of liquid helium re-liquefier for superconducting chip test

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**Abstract:** A liquid helium re-liquefier system has been designed for superconducting chip test. The cold source of the system is a PT420 GM type Pulse tube cryocooler. On this base, the precooling structure and recondensation structure has been designed. Besides, composite magnetic shielding structure was used to ensure the chip working in an extremely low magnetic environment. With a special designed mechanical interface and PID control system, the chip could be replaced when the cryocooler is on. Experiment shows that the cooling time of the system is about 8h, and the cooling capacity is 1.15W, which could ensure the working of superconducting chip with hundreds of channels. Residual magnetism of the working chamber is below 5nT. Automatic control module could ensure the system working without people. In order to extend the holding time when unexpected power outage occurred, a special cooling capacity recovered structure has been added to the system to utilize the cooling capacity of the cold helium gas.

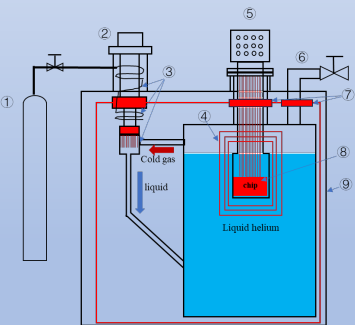
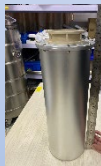


Figure 1. Schematic diagram of the system

- 1 Helium gas cylinder
- 2 PT420 Cryocooler
- 3 Heat exchanger
- 4 Magnetic shield
- 5 Coaxial cable
- 6 Gas vent
- 7 Precooling structure
- 8 Superconducting chip
- 9 Vacuum Chamber



(a) Precooling structure

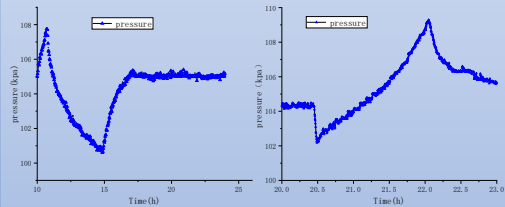


(b) Magnetic shield of the superconducting chip



(c) Signal transmission structure of the superconducting chip

Figure 2. Photos of the structures



(a) Cooling capacity testing curve of the system

(b) Liquefaction rate curve of the system

Figure 3. Performance Curve of the system

## Conclusion

1. Cooling time of the system is about 8h, and the cooling capacity is 1.15W.
2. Liquefaction rate of the system is 10.66L/day.
3. Residual magnetism of the working chamber is below 5nT.