

Performance test of the cryogenic cooling system for the superconducting fault current limiter

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◆ Introduction

Background

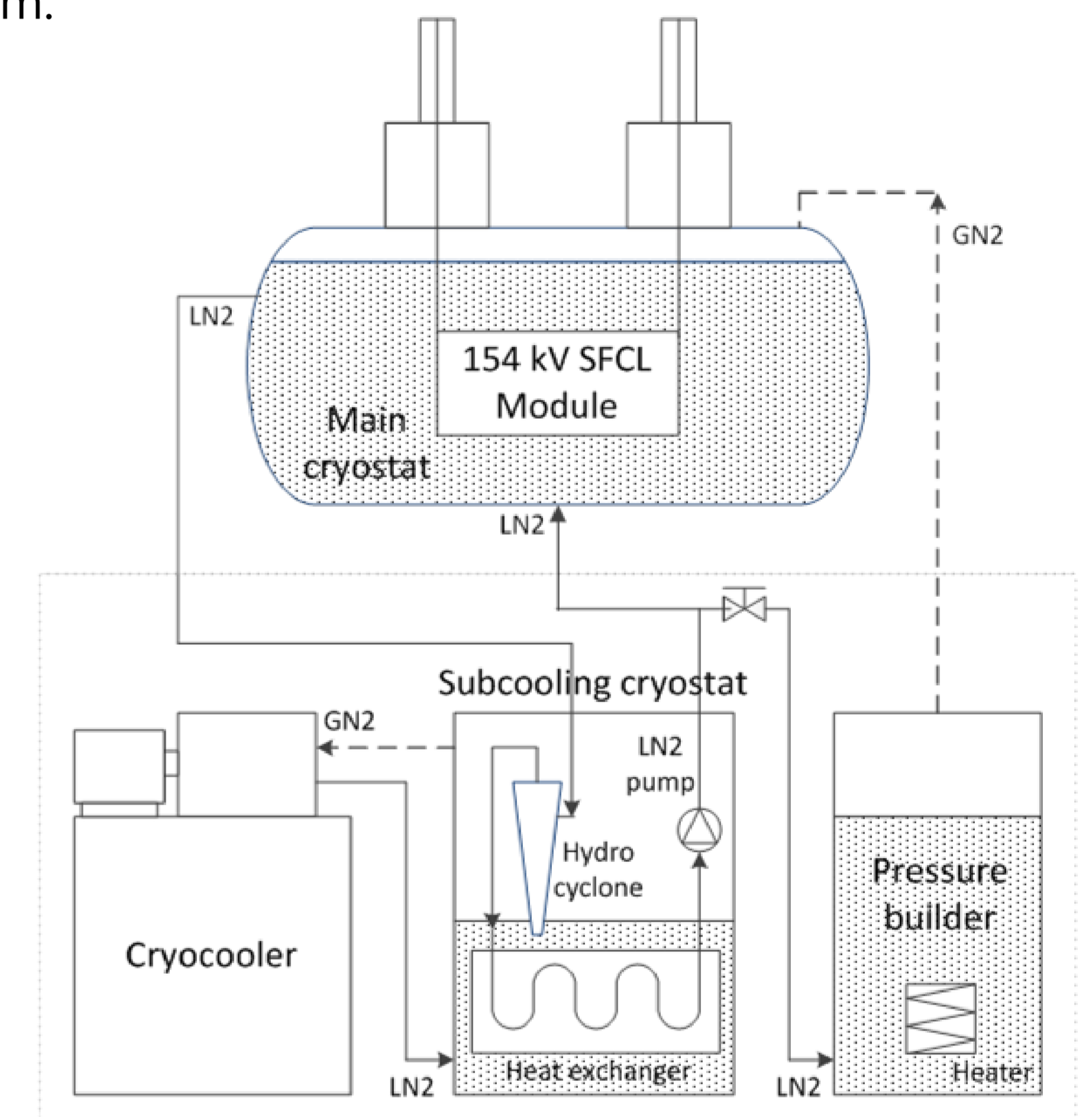
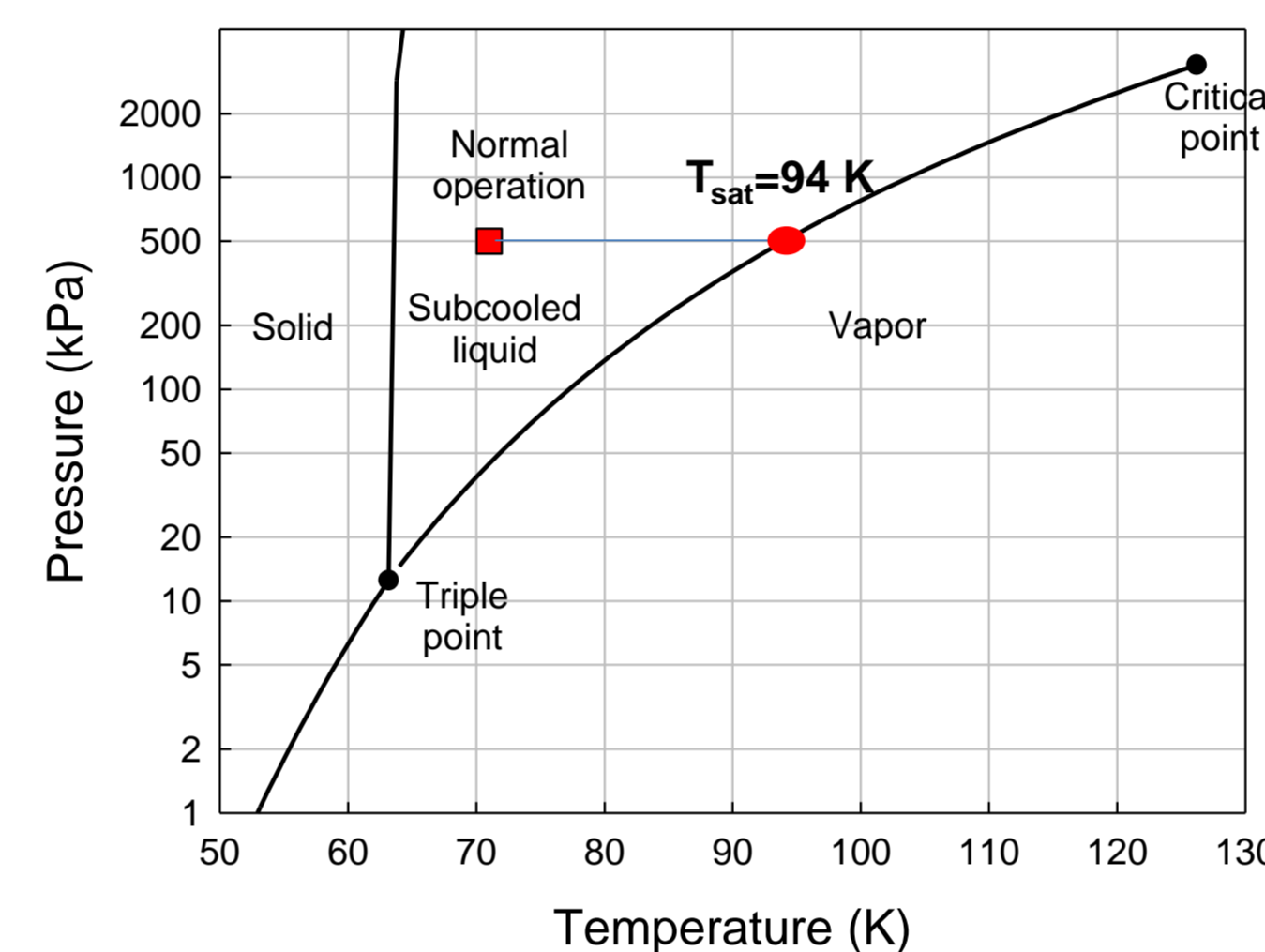
- ✓ SFCL is an electric power device which limits fault currents immediately in a power grid.
- ✓ Cryogenic cooling system are an essential prerequisite to safely operate HTS modules.
- ✓ When fault currents occurs, the heat is generated in a short time but the amount is very large.
- ✓ Liquid cooling using subcooled LN2 are widely used for the cooling of SFCL.
- ✓ Critical current of HTS modules is increased at low temperature, and an elevated pressure can suppress the generation of bubbles.
- ✓ Also, the LN2 in subcooled temperature and elevated pressure can evade the cavitation in cooling system.

Objectives

- ✓ In Korea, due to higher demand in a transmission level, 154 kV/ 2 kA SFCL have been developed.
- ✓ Verification of the design of the cooling system and cool-down process

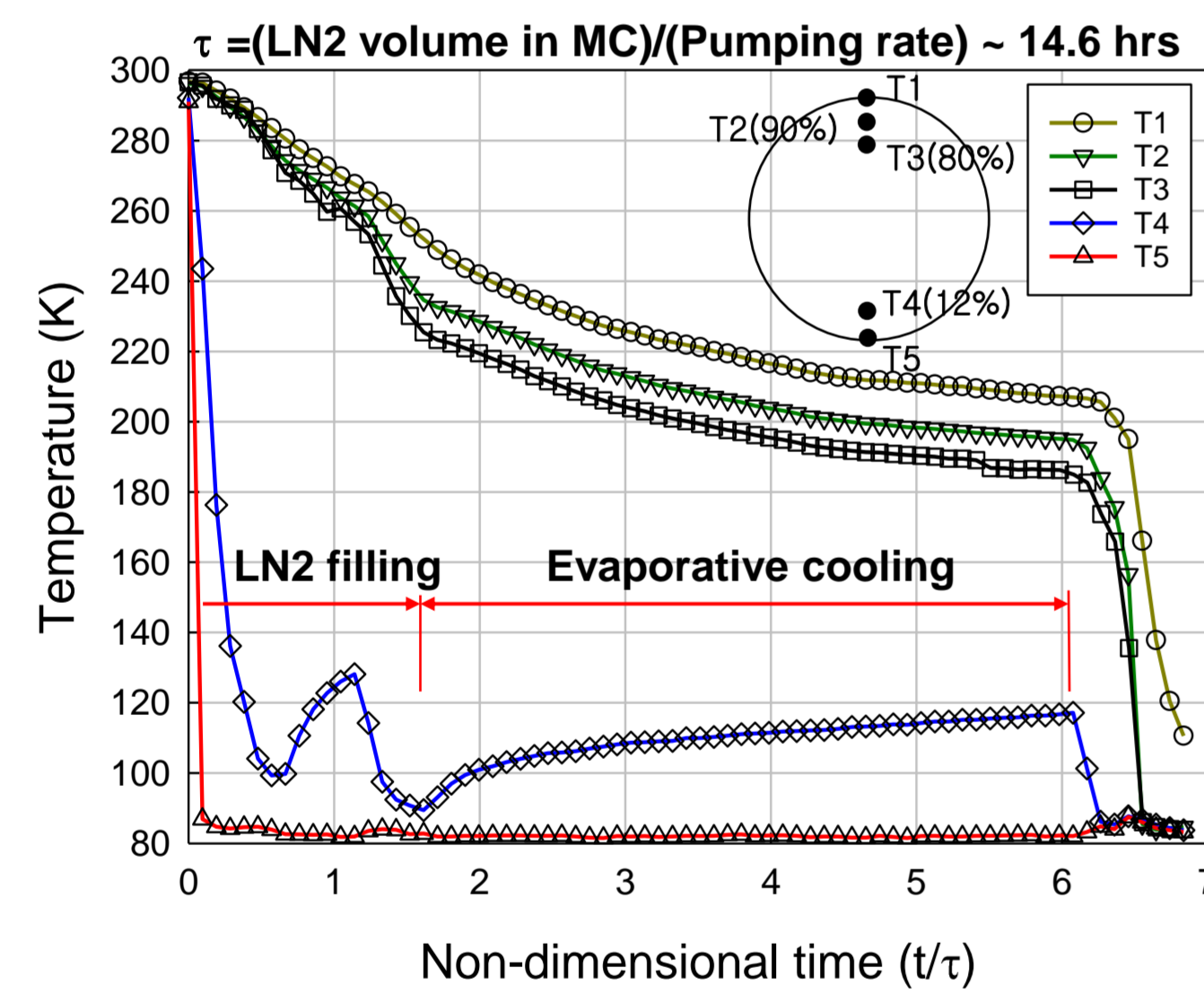
◆ Cooling system configuration

Cooling sys. component	Specification
Main cryostat (MC)	- 71 K (500 kPa), Heat load < 800 W
Coolant	- Subcooled LN2 (500 kPa, 71K, 23 Ton)
Pressure builder (PB)	- Automatic pressure control (500 kPa), Heater (2 kW)
Subcooling cryostat (SC)	- Hydrocyclone (50 μ m) / Heat exchanger (4 kW)
	- LN2 circulation pump (5700 RPM, 450W)
Cryocooler	- Stirling cryocooler (RL type ; 4.0 kW@77 K/ 48 kW _{max})

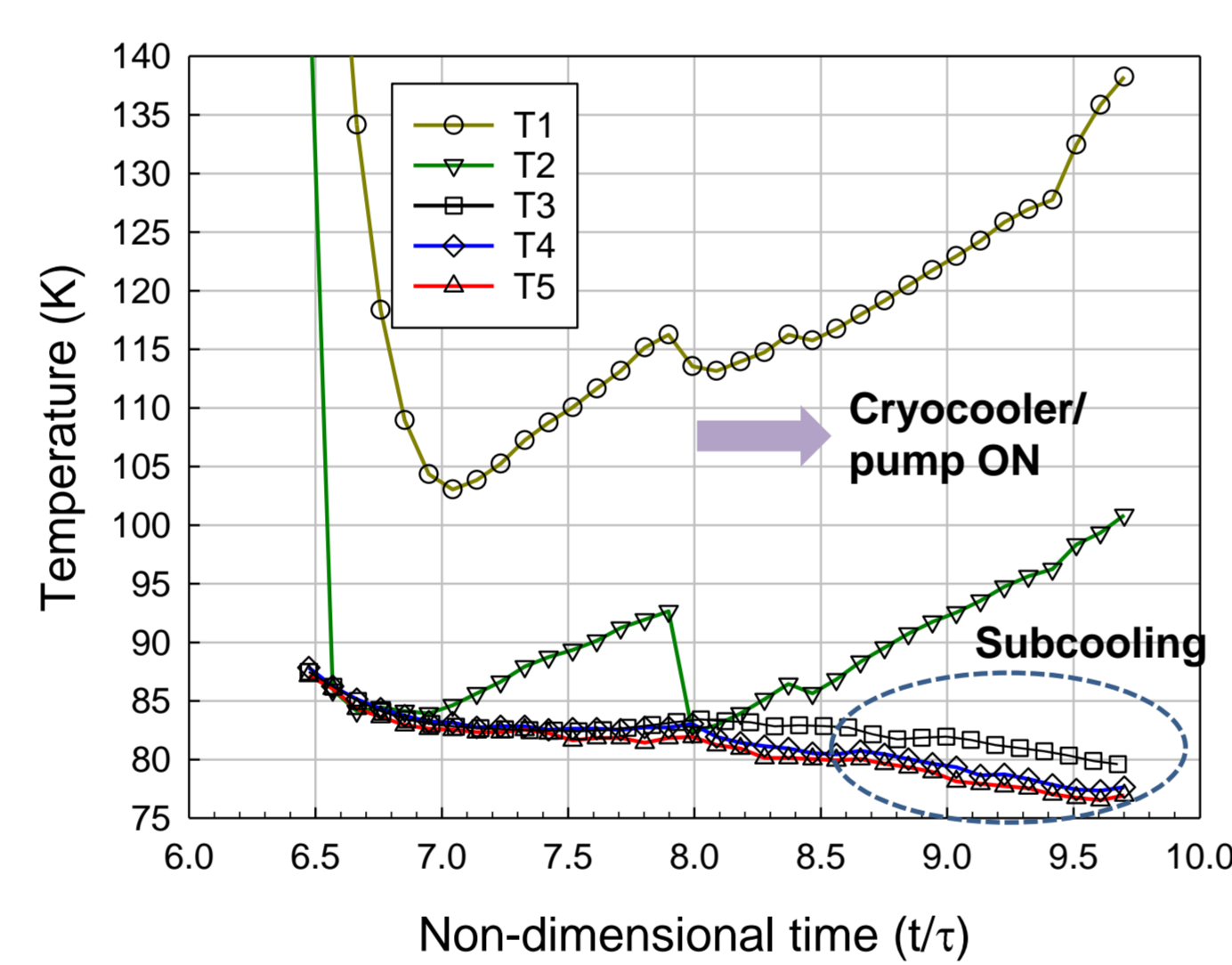


[Fig. Schematic diagram of cooling system]

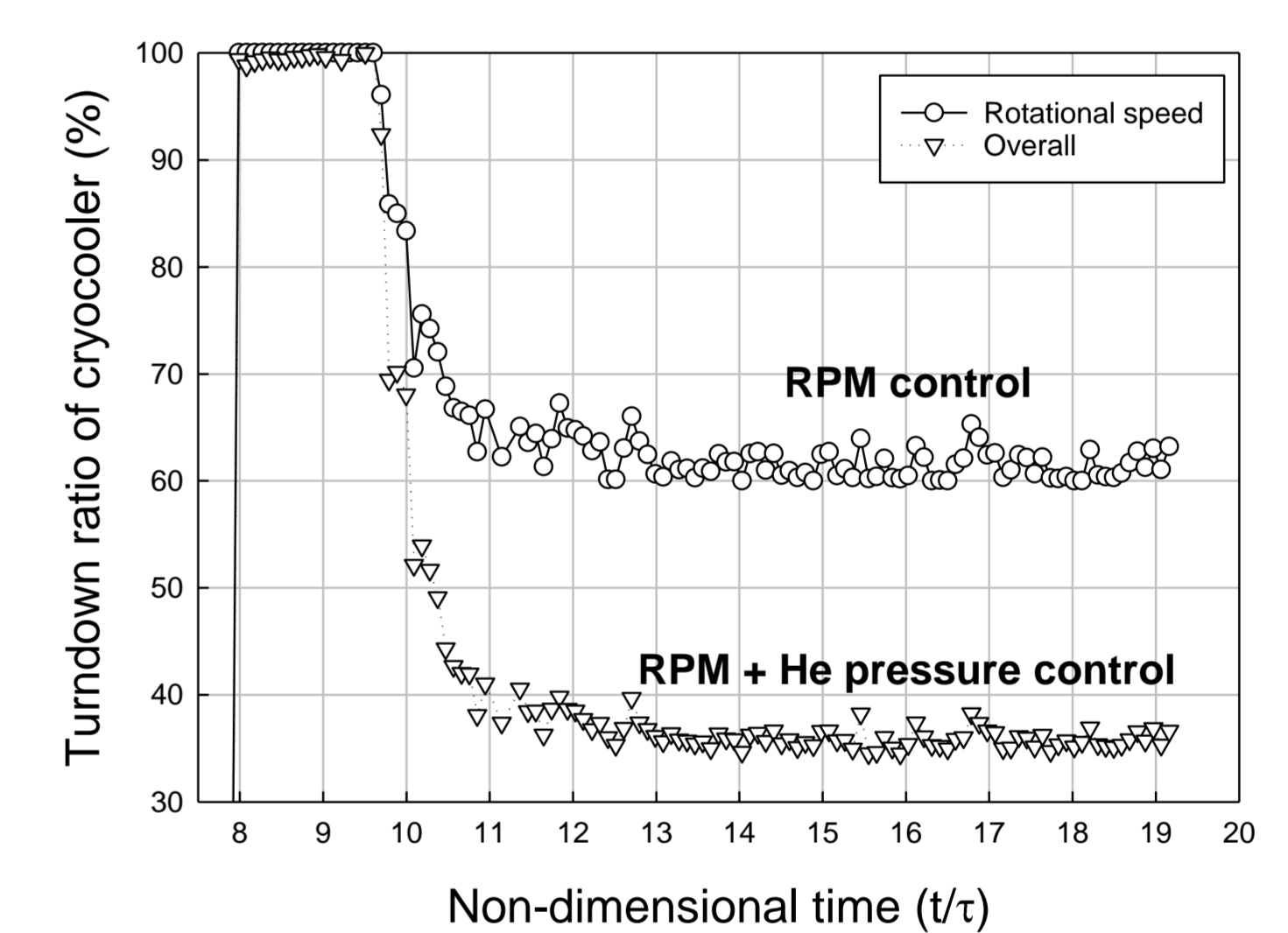
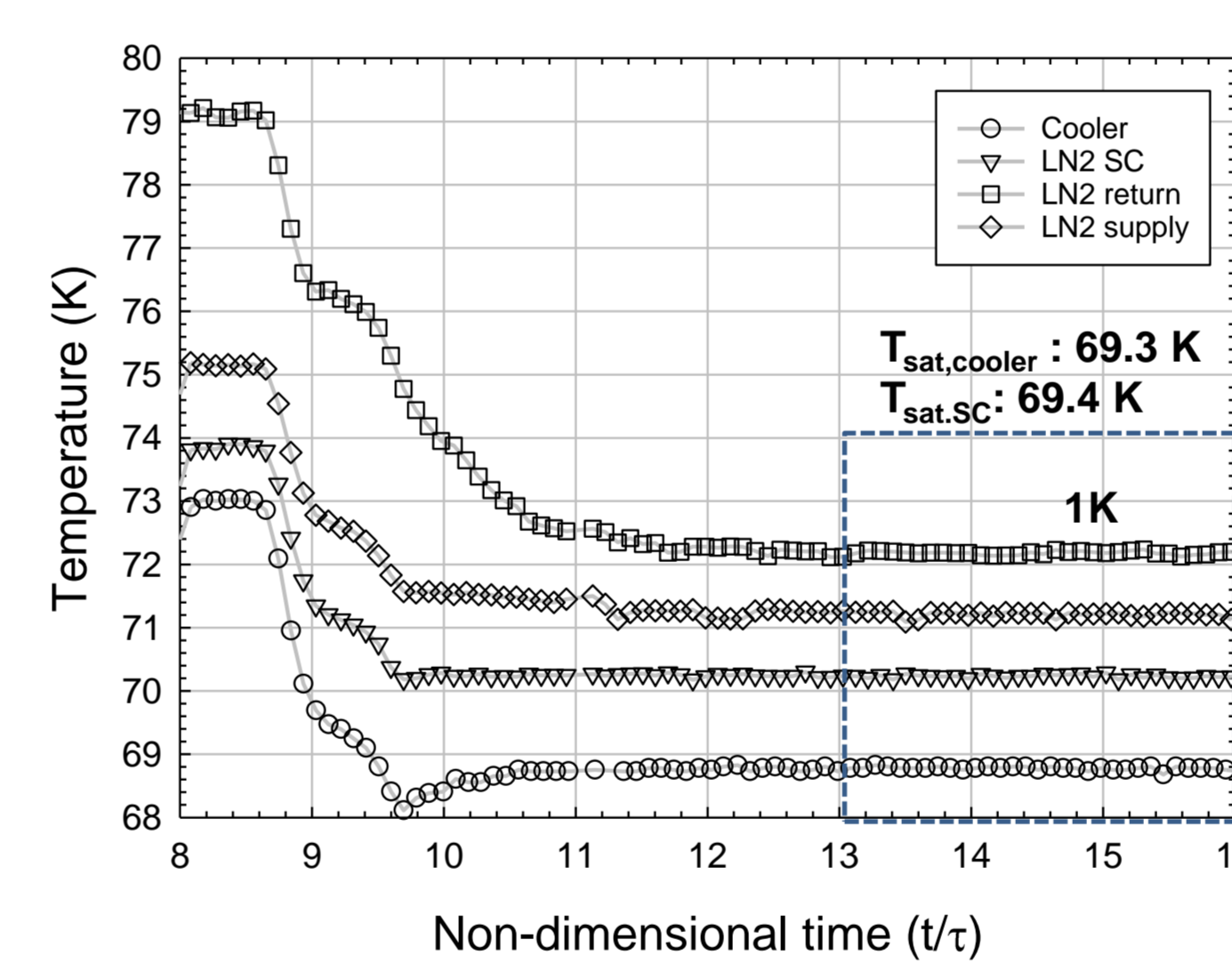
◆ Performance of the cooling system for 154 kV SFCL



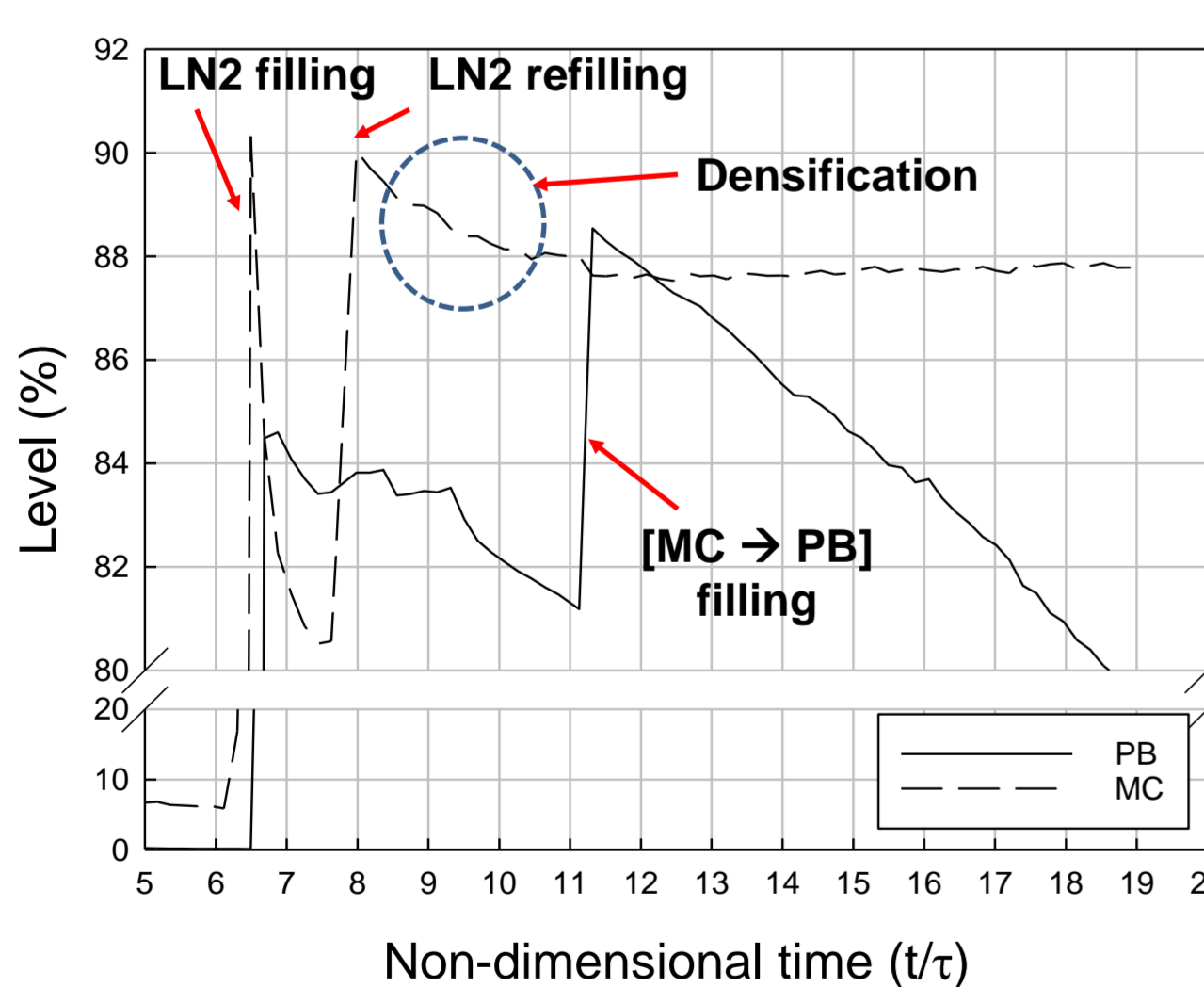
[Temperatures on surface of MC]



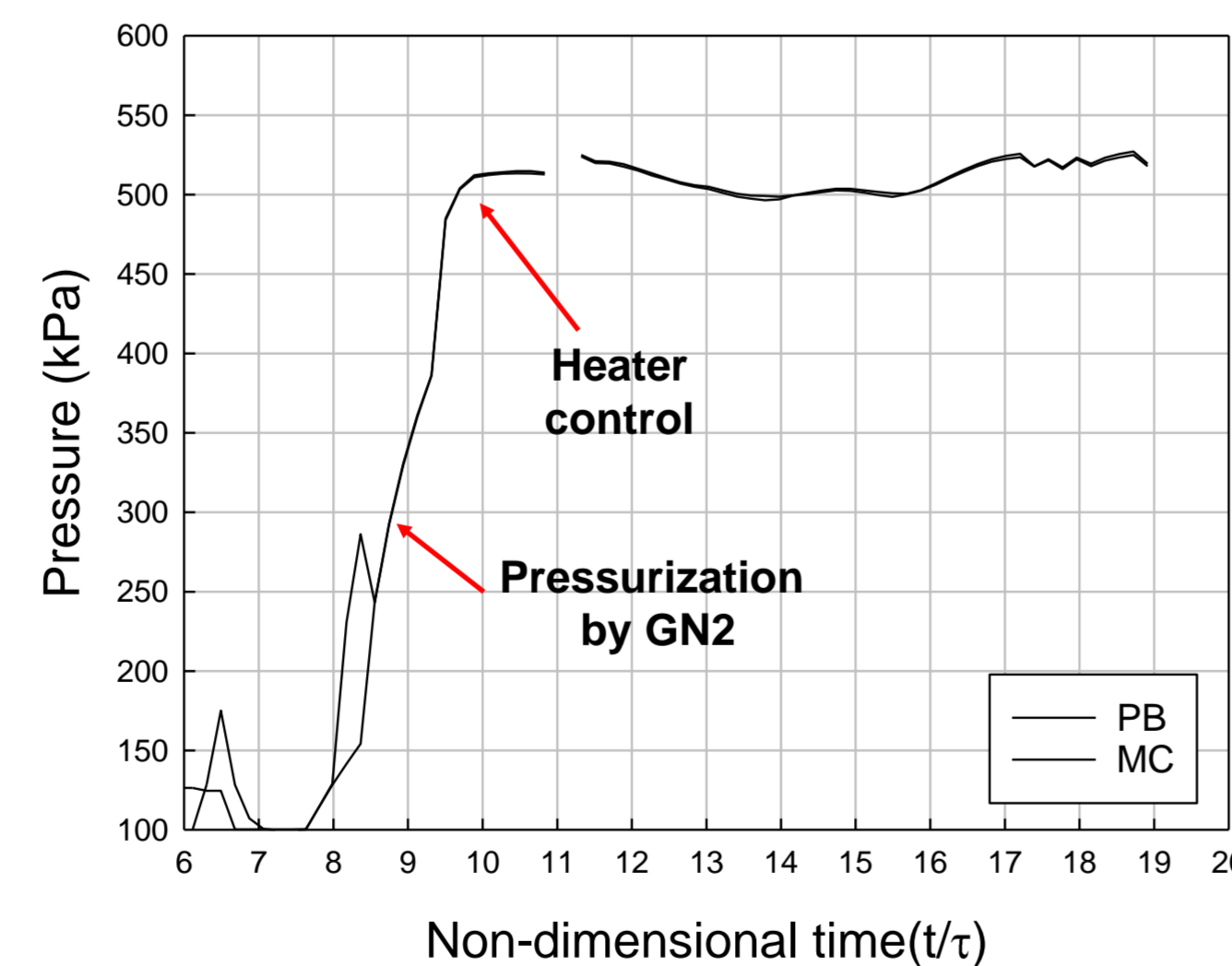
[Temperatures of LN2]



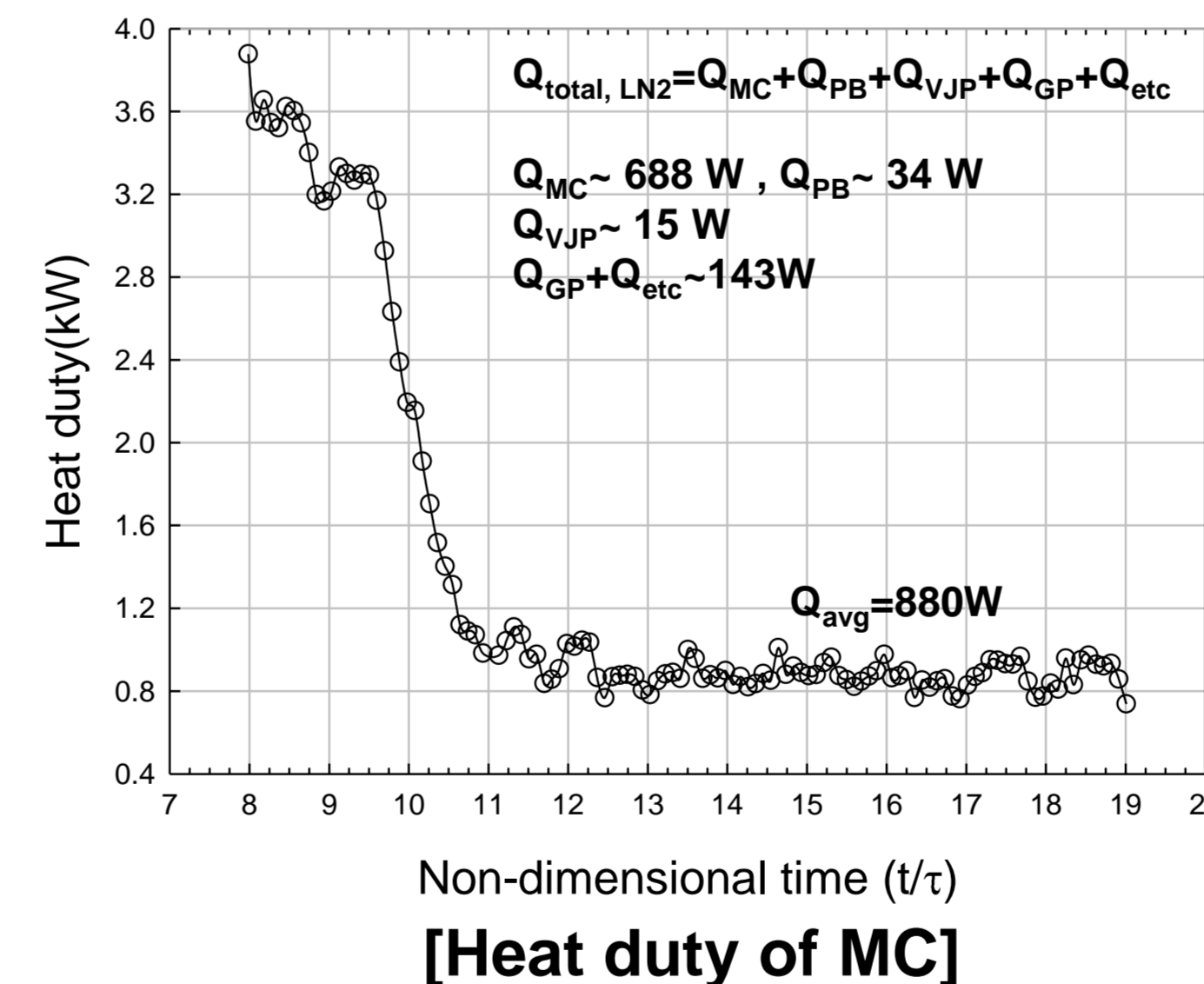
[Turn down operation of cryocooler]



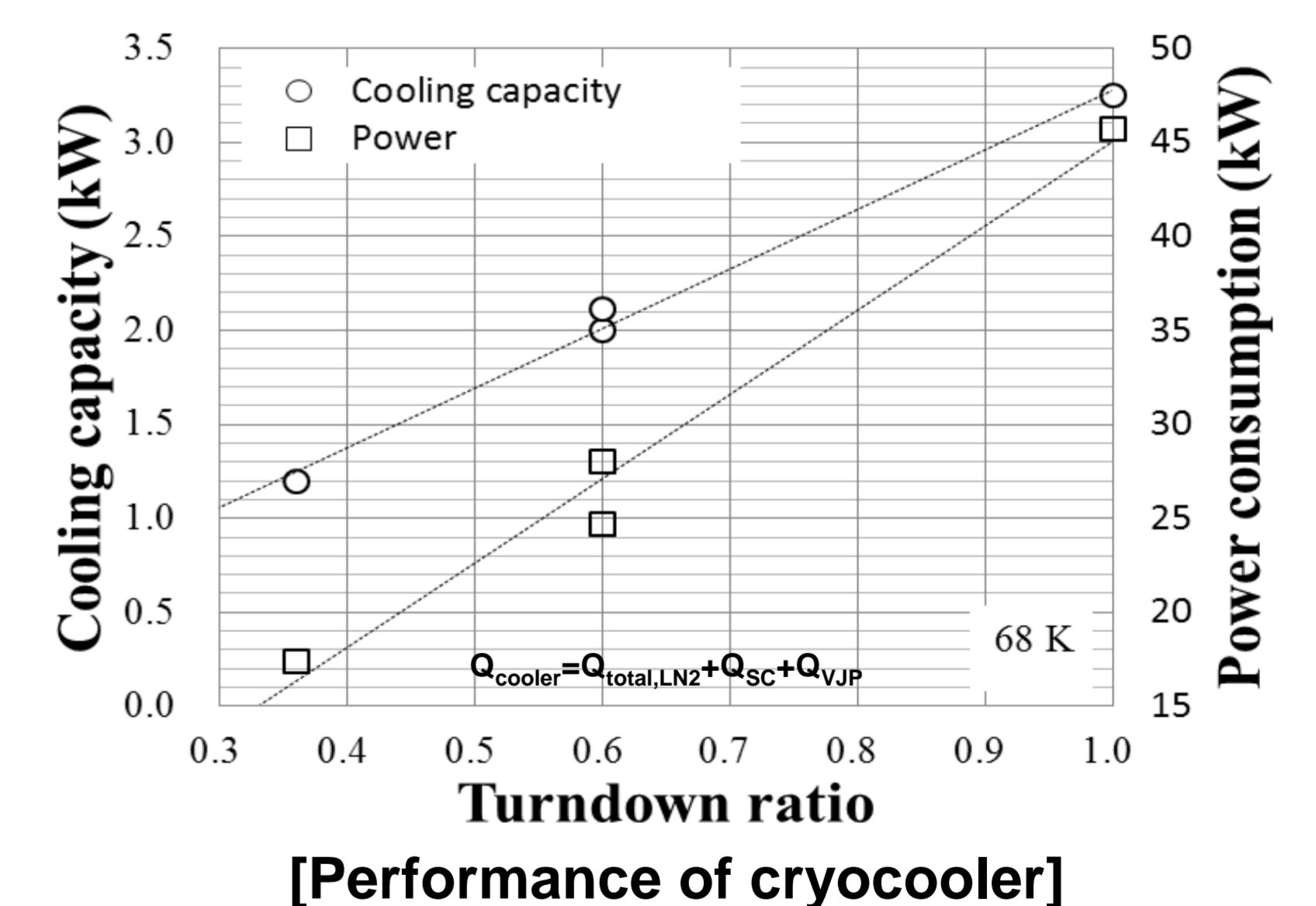
[Level of LN2]



[Pressure of MC & PB]



[Heat duty of MC]



[Performance of cryocooler]

◆ Summary

- In this study, we tested the performance of the cooling system for the prototype single phase 154 kV SFCL, which consist of a stirling cryocooler, a SC, a PB and a MC for the SFCL module, to verify the design of the cooling system and the cool-down procedure.
- Cooling processes are composed of a purging process, a cleaning and precooling process, a LN2 filling process, a subcooling process and a pressurizing process.
- The cooling system and process are designed to ensure the normal operation condition of 71 K, 500 kPa.
- Temperature variations of the LN2 in the MC are less than 1 K in normal operation.

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