

Operation Readiness Clearance (ORC) of SpinQuest (E1039) Target Fridge Electronics

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Target Fridge Electronics

1 Introduction

The target fridge in the SpinQuest experiment is a device that is used to control the temperature of the polarized target. It is made as a module which is inserted to the magnet and to which the target stick is inserted. The electronics of the target fridge are independent of those of the magnet and the target stick.

Figure 1 shows the target fridge that is hung over the magnet. It can be lowered into the hole of the magnet for installation. Figure 2 shows heating plates, where two plates are located to sandwich the expected position of the polarized target and each plate is made with one Copper plate, one electrical heating pad (orange) and one supporting Aluminum plate.

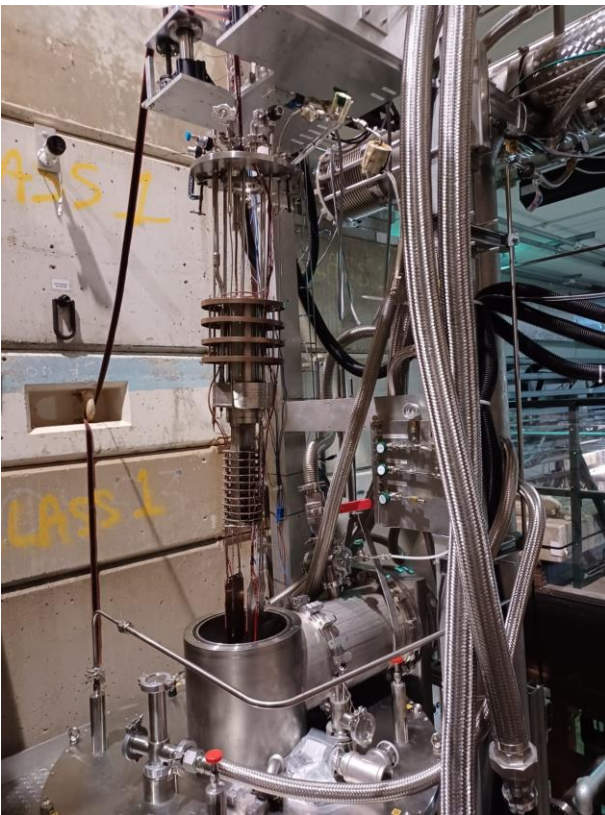


Fig. 1: Photo of target fridge.



Fig. 2: Photo of heating plates.

2 Scope

This document describes the specifications for the electronics that are implemented in the target fridge. The target fridge is equipped with liquid and gaseous lines for Helium, but they are out of the scope. The external devices for the fridge are placed at the slow control rack and connected to the target fridge, but they are out of the scope as well.

3 System components and parts

The target fridge includes the following electronical components:

- Resistive temperature sensor,
- Electrical heating plate,
- Thermocouple temperature sensor, and
- Pressure sensor.

The resistive temperature sensor is to measure the temperature at multiple positions on the target fridge. Eight sensors are distributed with a roughly equal vertical distance. As the liquid Helium is filled in the target fridge, the temperature is expected to be lower from bottom to top. A quad-twist wire is used to connect a sensor to a common Fisher-type connector at the top of the target fridge. The eight sensors are read out by LakeShore218 in the slow-control rack [1]. Below are the parts used in this component:

- Sensor: Vishay 1K Ohm resistor; <http://www.vishay.com/docs/31011/rcwp.pdf>
- Wire: Lake Shore Quad-Twist wire, 36 AWG (WQT-36)

The electrical heating plate is to raise the temperature of the target material during the annealing process. Two Copper plates are located to sandwich the target material. An electrical heating pad is attached to each plate. A pair of two wires is connected to the pad to supply a low voltage. The two wire pairs are connected to a Fischer-type connector at the top of the target fridge. The heaters are controlled by the annealing control box in the slow-control rack [1]. Below are the parts used in this component:

- Omega KH-303/5-P Flexible Heater: https://www.omega.com/pptst/KHR_KHLV_KH.html
- Wire: AWG16

The thermocouple temperature sensor is to monitor the temperature of the target material. One sensor is attached to each electrical heating plate. The two sensors are connected to the Fischer-type connector that houses the wires of the electrical heating pad mentioned above. The sensors are read out by one DAQ device (MCC E-TC) at the slow control rack [1]. Below are the parts used in this component:

- Omega Type-T thermocouple

The pressure sensor is to measure the pressure of gaseous Helium-3 that is encapsulated in a long thin Aluminum tube inside the target fridge. The measured pressure is used to monitor a small change in temperature below 4 K. The tube sticks out of the target fridge and is attached to a pressure sensor head. Two triaxial cables are attached to the sensor head, which are connected to an external preamplifier (MKS 615). Below are the parts used in this component:

- Pressure sensor head: MKS 615A
- Triaxial cable: Equivalent to RG-58A/U
- Triaxial connector: Amphenol 031-2675-1

4 Safety Precautions

The voltage and the current on each resistive temperature sensor is controlled by LakeShore218. The current is kept at 1 mA and the voltage varies with the resistance of the sensor (which changes by temperature). The voltage is 1 V at maximum. All the sensors and wires have been insulated.

The heating pad (Omega KH-303/5-P) in the electrical heating plate is capable of holding 115 V with 5 W/inch² at maximum. We apply about 20 V at maximum manually, while monitoring the surrounding

temperature using the thermocouples. The temperature is kept below 100 K during the annealing process. All the sensors and wires have been insulated.

The thermocouple temperature sensor is given no external voltage. The induced voltage is an order of 1 mV. All the sensors and wires have been insulated.

The pressure sensor is given no external voltage. The induced voltage varies with the pressure to be measured, but never exceed 1 mV. All the sensors and wires have been insulated.

References

[1] ORC-1895: E1039 Slow-Control Rack for the SpinQuest experiment at NM4