Operation of the superconducting ring cyclotron cryogenic system

H. Okuno,[*1] T. Dantsuka,[*1] M. Ohshima,[*2] H. Shiraki,[*2] H. Hazama,[*2] A. Mikami,[*2] H. Miura,[*2] H. Shiba,[*2] M. Kubota,[*2] H. Hirai,[*2] and M Haneda[*2]

The SRC (Superconducting Ring Cyclotron) cryogenic system, which consists of three compressors, a He refrigerator, and four He buffer tanks for cooling the 240-MJ superconducting magnets used for the SRC, has a cooling capacity of approximately 1 kW at 4.5 K and an inventory of 5000 L of liquid He. The cooling system was operated for approximately nine months in 2014, with a three-month maintenance shutdown in summer (July–August) and a shutdown to conserve electrical power in January.

We experienced some problems with in the operations, some of which required us to stop the operation of the He refrigerator and the compressor. The problems are listed in Table 1. We stopped the operation of the helium compressor during the He purification process on February 19, 2014 because heavy snow on that day stopped the fan in the cooling tower for cooling water. Some improvements were carried out to prevent the fans from stopping due to heavy snow. A temperature sensor in the He refrigerator also demonstrated unusual , and we presume that this was because the attachment between the pipe and sensor became loose. Unfortunately this sensor plays a role in the interlock logic, but we let it go because we had to open the cold box to improve the attachment. On October 29 the second and third turbines tripped suddenly due to the high speed of the third turbine. However, we could find no sign of their high speed from the trend graph. We suspect that this was caused by the noise of the control system. We will check the rotation speed monitor system using a signal generator during the next summer maintenance.

During the operation from April to June, the helium flow rate of the cooling channel for a small power lead gradually degraded. This suggests trapping of some impurity that decreased the flow rate. On November 22 the interlock system for the superconducting magnet required that the power supply of all the superconducting trim coils be shut down. We could find no signs of an increase in temperature. Thus we suspect that this comes from the noise of the control system. On December 25, the flow rate of the cooling channel for one small power lead suddenly increased: we suspect that the impurity dropped or a control valve in the line. We believe that we need to monitor the impurity and aging of the control system regulary.

Table 1. Lists of problems that occured in the He cooling system in 2014.

Subsystem	Date	Problems
He compressor	February 19	Fans in the cooling stopped working due to heavy snow
He refrigerator	April – June	A temperature sensor behaved unusually
	October 12	Mishandling of the pre-cooling valve (warm gas injection)
	October 29	Trip of the second and third turbines.
Sc. magnet	April – June	Gradual decrease of the flow rate for small current power leads
	November. 22	Discharge of the superconducting trim coils
	October 29	Sudden increase of the flow rate for a small current power lead

*1 RIKEN Nishina Center
*2 Nippon Kucho Service Co., Ltd