Operational status of the superconducting SAMURAI magnet

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Operation of the superconducting SAMURAI magnet was started in June 2011, and experiments using the SAMURAI spectrometer was started in March 2012.[1)] So far, a commissioning and five experiments have been performed.[2–6)] During this period, we had maintained the operation of the cryogenic system of the magnet and overhauled the cryocoolers in October 2012.[7)] However, the operation policy for the magnet was changed from "continuous cooling" to "irregular cooling" in order to save the operation time of the cryocoolers, where "irregular cooling" means that the magnet will be cooled down for every SAMURAI campaign experiments and warmed up after the experiments. Thus, the operation of the magnet was stopped temporarily in September 2013. In this report, the alteration in the temperature of the magnet when it was stopped is shown.

The upper and lower superconducting coils are installed in two separate cryostats and cooled by the liquid helium bath cooling method.[7,8)] Each cryostat is equipped with one 4-K GM/JT cryocooler, which recondenses the evaporating liquid helium. The 20-K as well as 80-K thermal shields are cooled by two GM cryocoolers. Each cryostat is equipped with another GM cryocooler that cools the power leads made by a high-Tc superconductor.

The warming-up procedure was started by stopping these cryocoolers. In order to keep the recovery volume of the liquid helium within the load limit of the recovery compressor at RNC Liquid Helium Plant, the warming-up timing of the lower cryostat was delayed. As a result, the liquid helium was fully recovered, 215 L in 37 h and 227 L in 34 h from the upper and lower cryostats, respectively.

The temperature rise at the major points in the cryostats is shown in Fig. 1. In the figure, the structure is seen when the temperature of the coil vessels exceeded 77 K (Fig. 1(a)). This is because of the heat exchange between the coil vessels and other parts, which happened when the condensed residual atoms such as nitrogen at the outer wall of the coil vessels evaporated into the vacuum layer of the cryostat.

Figure 1(a) shows the temperature of the coil vessel, which corresponds to the cold mass of the cryostat. The cold-mass weight of each cryostat is about 3.5 ton, and it took about 48 and 41 days to reach room temperature for the upper and lower cryostats, respectively. The speed of the temperature rise for the lower cryostat was faster than that for the upper cryostat at all points, as shown in Fig. 1. This is assumed to be due to the difference of the heat load, which results from the difference of the length of the chimney pipe between the liquid helium reservoir vessel and the coil part of the cryostat (see Fig. 1 in Sato et al.[7)]).

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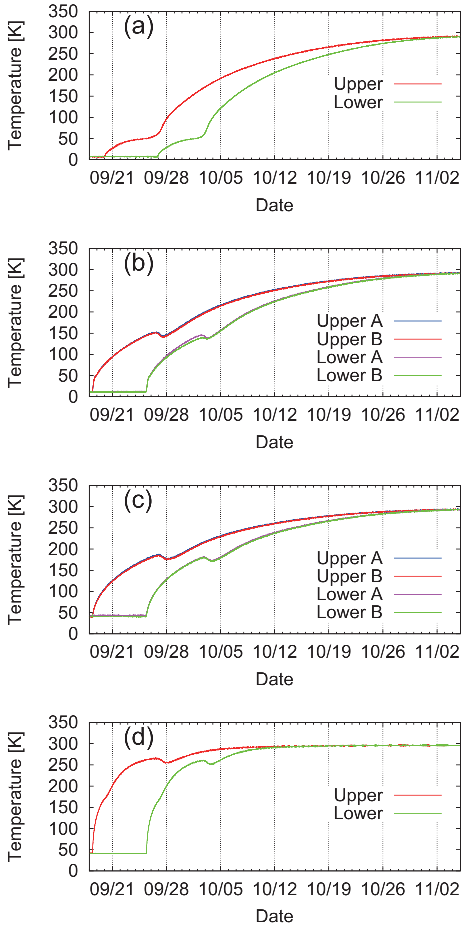

Fig. 1. Temperature rise at each point: (a) coil vessels, (b) 20-K cryocoolers, (c) 80-K cryocoolers, and (d) cryocoolers for power leads. The cryocoolers of the upper and lower cryostats were stopped on 9/18 and 9/25.

References

1) K. Yoneda et al.: RIKEN Accl. Prog. Rep. **45**, i (2012).
2) T. Kobayashi et al.: Nucl. Instrum. Meth. B **317**, 294 (2013).
3) K. Yoneda et al.: RIKEN Accl. Prog. Rep. **46**, 145 (2013).
4) Y. Kondo et al.: RIKEN Accl. Prog. Rep. **46**, 6 (2013).
5) T. Nakamura et al.: RIKEN Accl. Prog. Rep. **46**, 7 (2013).
6) H. Otsu et al.: In this report.
7) H. Sato et al.: RIKEN Accl. Prog. Rep. **46**, 147 (2013).
8) H. Sato et al.: IEEE Trans. Appl. Supercond. **23**, 4500308 (2013).