SuperKEKB MAIN RING POWER SUPPLY SYSTEM

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Abstract

The power supplies for magnets of KEKB main ring were recycled into SuperKEKB main ring. Several tests were performed for all of the power supplies to check the soundness. Some of the power supplies were improved to satisfy the requirements of optical design, and some of them were replaced by new power supplies. Most of the trim-coils were arranged with one of power supply per a coil in SuperKEKB. The total number of the power supplies is over 2000.

INTRODUCTION

SuperKEKB [1] have been started to upgrade aiming 40 times higher luminosity than KEKB had achieved the peak of 21.083 × 10^{33} cm^{-2} s^{-1}. New components and reused ones are installed in the KEKB tunnel or in the buildings during 5 and a half years. The installation has finished and then a beam commissioning of Phase-1 has started in February 1st [2].

Huge number of power supplies for electro-magnets was used in KEKB and almost the same number of ones is used in SuperKEKB continuously. The oldest power supplies are replaced, and a part of the others are overhauled. The number of power supplies which are new ones or reused ones is shown in Table 1.

Table 1: The Number of Power Supplies

	new	reuse
BM, Wiggler (0.4 - 1 MW)	13	0
QM: large (0.1 - 0.5 MW)	0	18
QM, SM: medium (2 - 105 kW))	204	335
Steer., etc.: small (0.3 - 2.4 kW)	138	1681
QCS steering magnets (70 A, 10 V)	49	0
QCS main magnets (<2 kA, <15 V)	11	0
total	415	2034

POWER SUPPLIES

Power Supplies for BM and Wiggler

Power supplies for bending magnets, which are named B2E for HER and B2P for LER, are replaced new ones. The old power supplies of B2E and B2P used in KEKB were manufactured for TRISTAN. Most part of the cables connecting the power supply and magnets are reused and a part of the connection is cabled in this upgrade because of the change of the setting of the magnets.

Arrangement of the wiggler magnets in SuperKEKB are different from that in KEKB. The number of magnets is increased and the variety of the wiggler magnet is also increased. Then the new power supplies for the wiggler magnets are manufactured. The cables for new magnets have to be installed. Stored cables are carried and installed from power supply building to KEKB tunnel. The cabling for new wigglers are very heavy work; complicated, but little working space owing to the established cables and magnets as shown in Fig. 1.

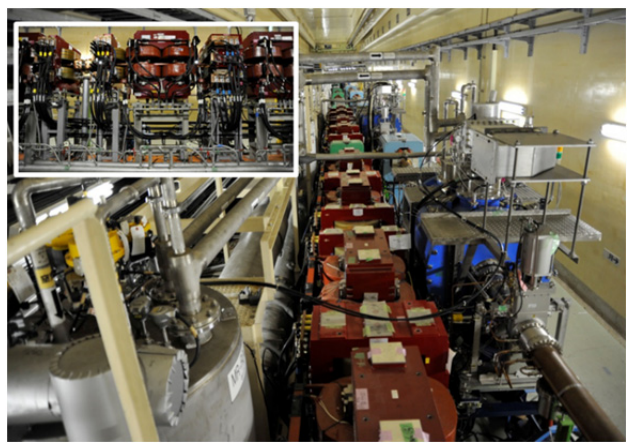

Figure 1: New wiggler magnets in NIKKO and its cabling.

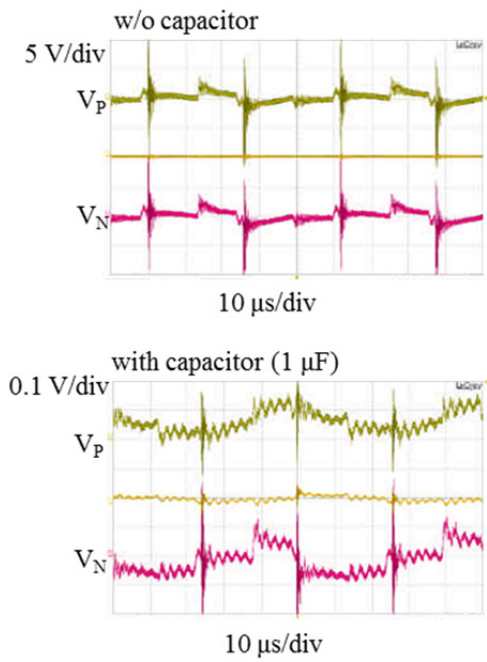

Figure 2: Switching ripples of the medium class power supply.

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Large Class Power Supplies for QM

Large class power supplies for quadrupole magnets in arc section are reused. They are repaired and modified. A resolution of DAC for current setting becomes high from 16 bit to 20 bit. High precision current setting has been performed by this modification. Cabling of a current output monitor in the power supply is modified to reduce a noise in the monitor signal. Running test with the real magnets has been done and there were no failure.

Medium Class Power Supplies for QM and SM

The kind of the magnets is increased. Then new power supplies are manufactured for them. Old power supplies are overhauled to reduce a failure rate. Replacements of chemical capacitors, AC-DC converters, circuit breakers and IGBTs are performed. The components are chosen by failure reports in KEKB operation.

Ceramic capacitors are added at the output terminal of the power supplies to suppress switching ripples. The switching ripples have been 20 times smaller after the modification as shown in Fig. 2.

Mass measurement of the power supplies have been done. Figure 3 shows histograms of current ripples of 50 Hz and 300 Hz. The current ripple is relative value normalized by rated current of the each power supplies. The current ripple of 300Hz of the power supplies manufactured in 1998 is significantly worse compared with that of them manufactured in 2014. New power supplies are improved to reduce such current ripples.

Small Class Power Supplies for Steer., etc.

Only 138 power supplies are manufactured, while 1681 power supplies are reused in SuperKEKB. Some of the reused power supplies are overhauled. The number of overhauled power supplies is only 256, limited by budget. We have replaced chemical capacitors, DC-DC convertor board and so on. Running test with dummy load, however, has been performed for all of the reused power supplies. Fault was found in 3 % of the power supplies.

Most of the trim-coils in quadrupole magnets and sextupole magnets are driven by this power supply in SuperKEKB. Although about 500 power supplies are assigned, the load impedance of a part of the trim-coils is smaller than that required from specification of the power supply. Then additional coils are inserted between the output of the power supply and the trim-coil.

OUTPUT CURRENT MONITOR

Every power supply has an output of current monitor signal. These signals are connected to a switch-board installed in a Monitor panel. The monitor panels are set into the each power supply building. The switch-board is controlled by a swither, KEITHLEY 7001. The monitor signal is measured by a high precision digital multimeter,

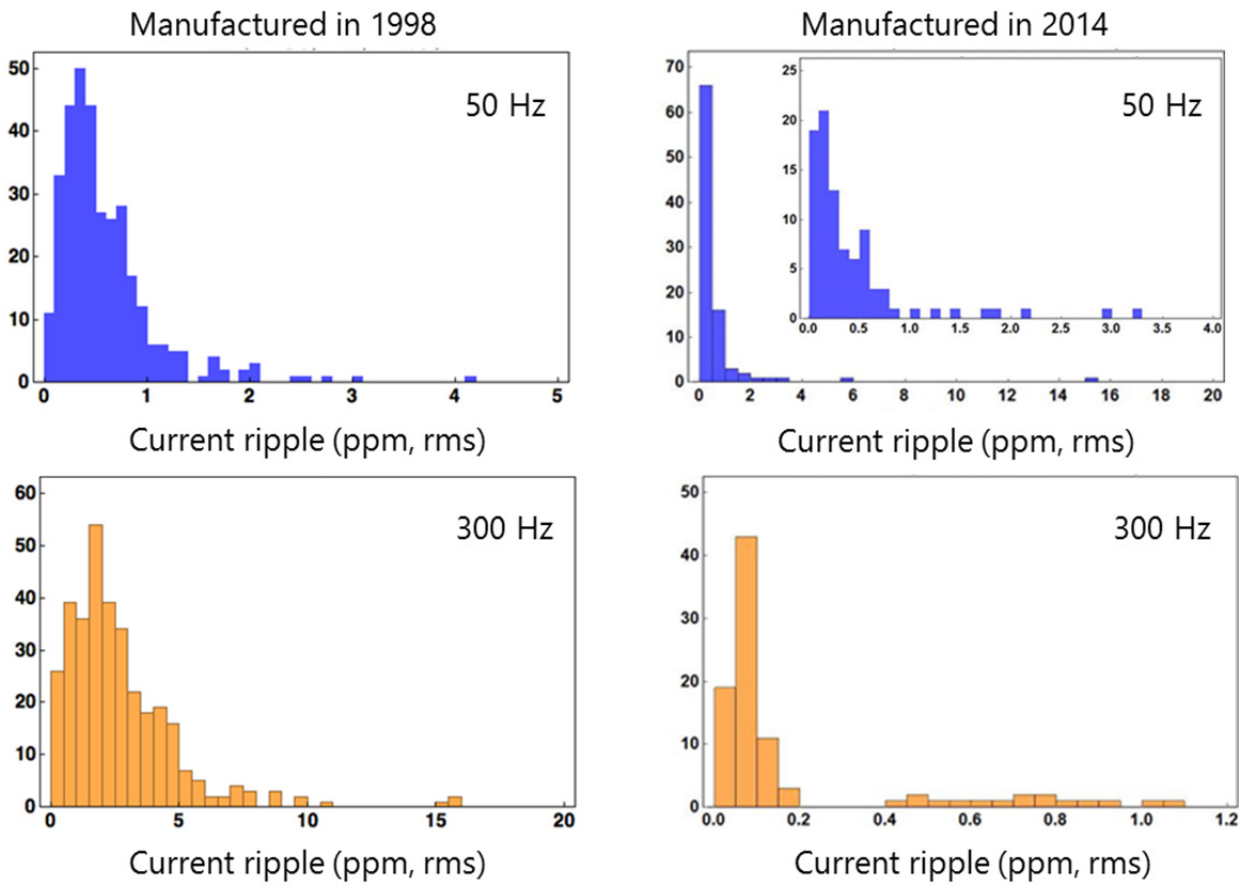

Figure 3: Histograms of current ripples of 50 Hz and 300 Hz. The current ripple is a relative value normalized by rated current of the each power supplies.

KEITHLEY 2001 or 2002. They are controlled with GPIB connected to control LAN.

CONCLUSION

The new power supplies and reused ones are installed and several tests are performed. The new power supplies are performed expected ability. The reused power supplies are repaired and modified to increase their performance and to decrease their failure incidents. Then the operation of the power supplies are moving along quite smoothly.

REFERENCES

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