§8. Stabilizing Large-scale and High-current Density Conductor Composed of Parallel Sub-conductors by Active Control of Current Distribution

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1. Purpose of study

Scales of superconducting magnets of next generation helical fusion system are estimated to be larger than the present LHD by two order of magnitude and current capacity of superconductors for the magnets reaches to several 100kA. Development of these large scale conductors may cause various problems which are considered difficult to slove by just extending present technology for conductors and magnets. To clear those problems, we proposed the parallel sub-conductor system in which the main conductor was composed of parallel sub-conductors.[1] Each sub-conductor is electrically insulated from other sub-conductors and connected to an individual power supply. A current of each sub-conductor is feed-back controlled to follow a given current reference. Thus, the current distribution in the main conductor is actively controlled. In this method, a current in a sub-conductor can be quickly transferred to the other sub-conductors by controlling the individual power supplies, while the main conductor current is unchanged. Therefore, the magnet can be actively stabilized by quick transferring a current in a quenched sub-conductor to the others.

The purpose of the study is to demonstrate effectiveness of the parallel sub-conductor system.

2. Results of study in 1998 fiscal year

We performed an experimental of two parallel wires system using a small model coil wound of NbTi wires to study on characteristics of sub-conductor current transfer control.

A schematic circuit of experimental arrangement is shown in Fig.1. Two bipolar power supplies, PS_1 and PS_2, were connected to the two sub-wires 1 and 2 separately. Fig.2 shows a quench event without the current transfer control. After the pulse heating, the sub-wire 2 was quenched and voltage v_2 across the subwire 2 increased until the quench was detected and the coil was disconnected from the power supply. Fig.3 shows that the coil was actively stabilized by current transfer control. The total current of the sub-wires was kept 70A during the whole process of the quench and the current transfer control.[2] Thus, it was demonstrated that the coil was actively stabilized by the current transfer control.

3. Studies in next step

Followings are to be studied in the next step. 1) To study algorithm to control the currents in the sub conductors for four parallel wires system in the case that a quench occurs in any of the sub-conductors, 2) To perform an experiment using a small model coil.

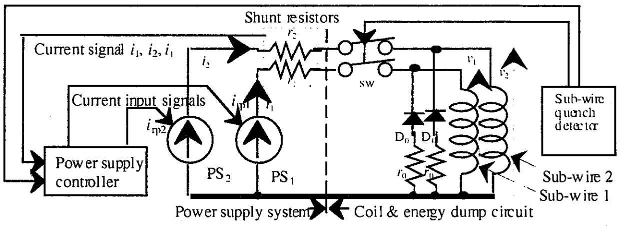

Fig. 1 Schematic circuit of experimental arrangement

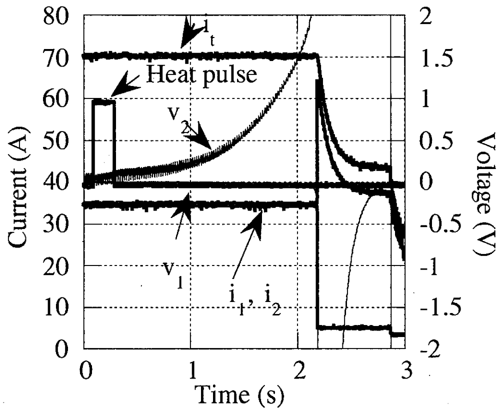

Fig. 2 Quench event without current transfer control.

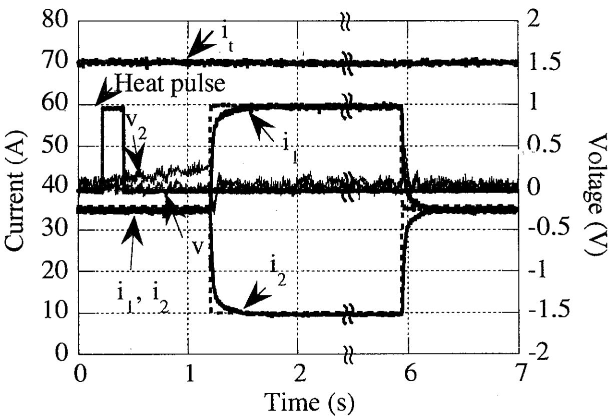

Fig.3 Active stabilization by current transfer control.

Reference

1) W.K.Yoo, O. Tsukamoto et al., *Adv. in Cry. Eng.* 39, (1993) 293

2) O. Tsukamoto et al., Proc. of *ICEC 17*, (1998) 579