MT 26
International Conference
on Magnet Technology
Vancouver, Canada | 2019

Contribution ID: **1107** Type: **Contributed Oral Presentation**

Wed-Mo-Or12-04: Self-Protecting HTS Current Lead - Demonstration of a new technology

Wednesday 25 September 2019 12:00 (15 minutes)

A straight forward solution to reduce the heat load of Current Leads to superconducting magnets operating at 4 K is the use of high temperature superconductors (HTS) thereby eliminating the ohmic heating at the 50-77 K range. The heat input from the current leads is then determined by heat conduction in the HTS section only, leading to some factor 10 reduction in the heat load in comparison to fully normal conducting conventional leads. Modern HTS conductors demonstrate extremely high current density and further decrease of the current lead heat load is limited not by the material properties but by the requirement of robustness and reliable protection of the leads in the case of cryogenic failures in order to avoid lead burnout.
While accelerator magnets are designed for a fast dump at quench events within a fraction of a second, larger stored energy magnets like detector magnets may have discharge times of tens of seconds or even more. In this case the HTS part of the lead has to withstand the ohmic heating for a relatively long time and this requirement then determines the heat input at operation conditions. A new idea to reduce the heat load while keeping full reliability of the HTS leads is using an automatic thermo-mechanical switch that is thermally connected to, and electrically connected in parallel to the HTS lead section. In the case of a quench in the HTS lead section, by using the differential thermal expansion between materials, the switch turns on and the overheated section is bypassed by the high cross-section of the conductive part in the switch.
We wish to use this new technology for the first time for the BabyIAXO detector magnet.
In this paper the design and test of the first and unique Self-Protecting HTS Current Lead with a current rating of a few kA is presented.

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Session Classification: Wed-Mo-Or12 - Flux Pump and Cryostats