Residual resistance ratio measurement system for Nb_3Sn wires extracted from Rutherford cables

Authors: Algirdas Baskys, Michael Naus, Ian Pong

Abstract:

Conductor residual resistance ratio (RRR), a measure of the conductivity of copper within the wire, is an important parameter for superconducting magnet electrical stability [1]. Quality of wire, cabling deformation, heat treatment temperature, and heat treatment atmosphere can all affect the RRR of a conductor. Therefore, RRR measurement forms an important part of the electrical QC of Nb_3Sn Rutherford cables manufactured at the Lawrence Berkeley National Laboratory.

Here we describe a bespoke cryocooler-based measurement system, capable of measuring RRR of over 80 samples in a single cooldown. The samples are mounted on custom-designed printed circuit boards that accommodate for the shape of extracted strands from a Rutherford cable without added deformation, which is critical to ensure that the measured RRR accurately represents the RRR values of the conductor within the cable. Using this sample mounting solution, we routinely measure not just the overall RRR of the strand but also individual intra-strand sections corresponding to both cable edges, as well as the top and bottom faces of the cable. Such measurements provide valuable information if the degradation is localized to just part of the strand. Data measured for cables manufactured for the US contribution to The High-Luminosity Large Hadron Collider Upgrade project (“HL-LHC AUP”) [2] and Test Facility Dipole [3] are presented.

Abstract Acknowledgement

The work performed at Lawrence Berkeley National Laboratory was supported by the Office of High Energy and Nuclear Physics, U. S. Department of Energy, under contract No. DE-AC02-05CH11231.

References:

[1] Bordini, B., & Rossi, L. (2009). Self field instability in high-jc nb3sn strands with high copper residual resistivity ratio. IEEE Transactions on Applied Superconductivity, 19(3), 2470–2476. https://doi.org/10.1109/TASC.2009.2019086

[2] Apollinari, G., Carcagno, R., Ambrosio, G., Feher, S., & Ristori, L. (2019). US contribution to the High Luminosity LHC Upgrade: Focusing quadrupoles and crab cavities. Journal of Physics: Conference Series, 1350(1). https://doi.org/10.1088/1742-6596/1350/1/012005
[3] Pong, I., Hafalia, A., Higley, H., Lee, E., Lin, A., Naus, M., Perez, C., Prestemon, S., Sabbi, G., Hopkins, S., Ballarino, A., & Bottura, L. (2021). Cable Design and Development for the High-Temperature Superconductor Cable Test Facility Magnet. IEEE Transactions on Applied Superconductivity, 31(7). https://doi.org/10.1109/TASC.2021.3094410