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Probability of premature quenching of HTS coil due to local reduction of critical current

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Growing interest for high-temperature superconducting (HTS) tapes, in particular the 2nd generation with functional layer of REBCO (RE = Y, Gd, Er,⋯), is motivated by an impressive progress in capability of such conductors to transport large currents. Nevertheless, this essential property, characterized by the value of critical current, Ic, quite often fluctuates along 100-1000 m lengths by more than 5%. Particularly dangerous are the „weak spots", with sudden reduction of critical current on the scale of few milimeters. At transporting the currents comparable to the Ic, determined on the "healthy"portion of conductor, this location will experience disproportionate heating. In some extent, the excess heat could be removed to its surroundings. Recently we developed an analytical prediction for the maximum of current that could be transported before turning the weak spot into a "hot spot", with rapidly increasing local temperature. One of the outcomes of this model is the prediction that, on parity of the locally reduced critical current, shorter weak spots will sustain higher currents than larger weak spots. On the other hand, testing of the critical current is usually performed on conductor lengths substantially exceeding the milimeter size of a weak spot. Then, smaller weak pots could easier escape attention during such inspection. A quantitative analysis including both these phenomena allowed to find the relation between the critical current, obtained in testing of the sample containing a weak spot, and the current causing its thermal runaway. It is then possible to draw recommendation for a minimum distance of voltage taps during the critical current check in a conductor intended for manufacturing of a HTS coil.

Primary author: GÖMÖRY, Fedor (Slovak Academy of Sciences)

Presenter: GÖMÖRY, Fedor (Slovak Academy of Sciences)

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