Minimum Quench Energy of Nb_3Sn Wires and Rutherford Cables with High Specific Heat

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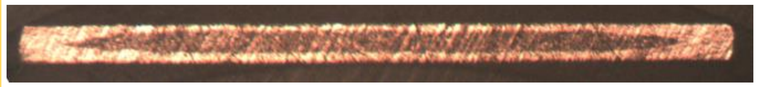
Abstract.

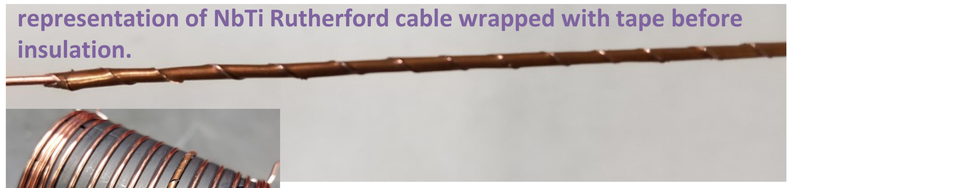
A major problem of state-of-the-art Nb_3Sn accelerator magnets is their long training due to thermo-mechanical perturbations. Increasing the specific heat, C_p, of the Rutherford cable would reduce and/or eliminate training by limiting its temperature rise. This paper studies feasibility of increasing the C_p of Rutherford-type cables by using thin composite Cu/Gd_2O_3 and Cu/Gd_2O_2S tapes produced by Hyper Tech Research, Inc. The tape can be either wrapped around the cable, placed on the cable wide faces under the insulation, and/or inserted as a core. Wire samples outfitted with these high-C_p ribbons, or tapes, were prepared and tested at FNAL for the Minimum Quench Energy (MQE). At 90%I_c and 15 T, the MQE gain average of the Nb_3Sn wire soldered to the Cu/Gd_2O_2S 55 μm thick ribbon was 2.5, and further increased at larger transport current.

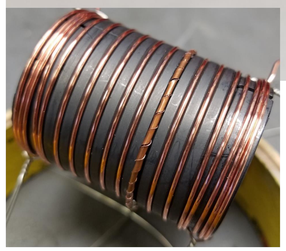
Experimental Setup.



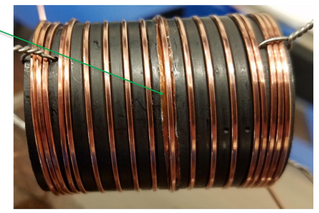
Hypertech high-C_p Cu tape w/30% vol. Gd_2O_3

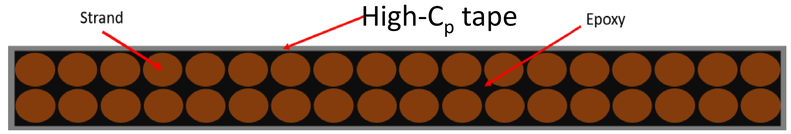
OPTION A – Tape wrapped around wire before heat treatment as representation of NbTi Rutherford cable wrapped with tape before insulation.



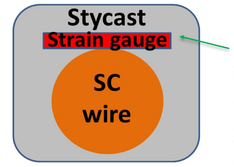


OPTION B – Tape placed **underneath** wire, and either soldered or not after heat treatment, as representation of Nb_3Sn Rutherford cable wrapped with tape and then heat treated, producing possible sintering.



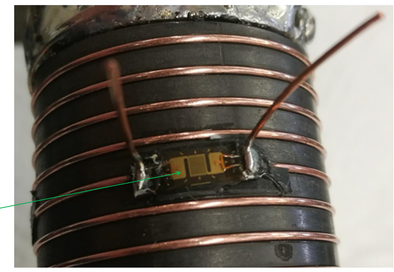


Possible Rutherford cable design with high-C_p tape



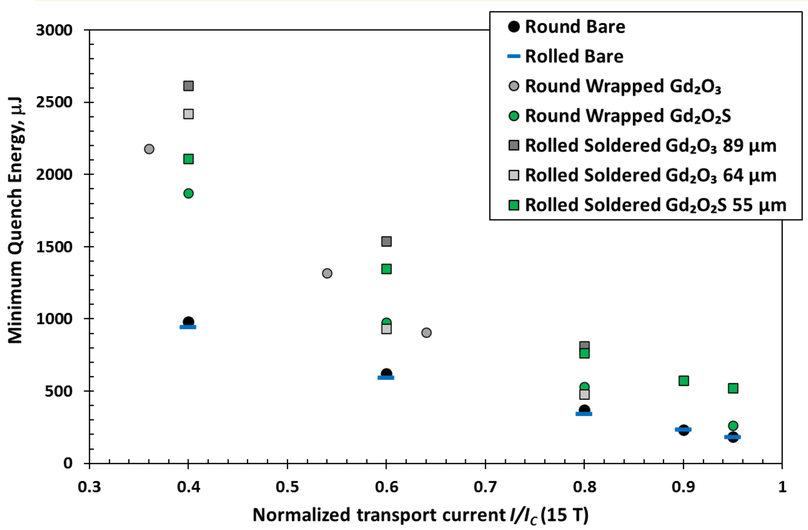
Heat pulse 200μs long is applied with varying amplitudes using 200V–1A Power Supply

EXPERIMENTAL SETUP

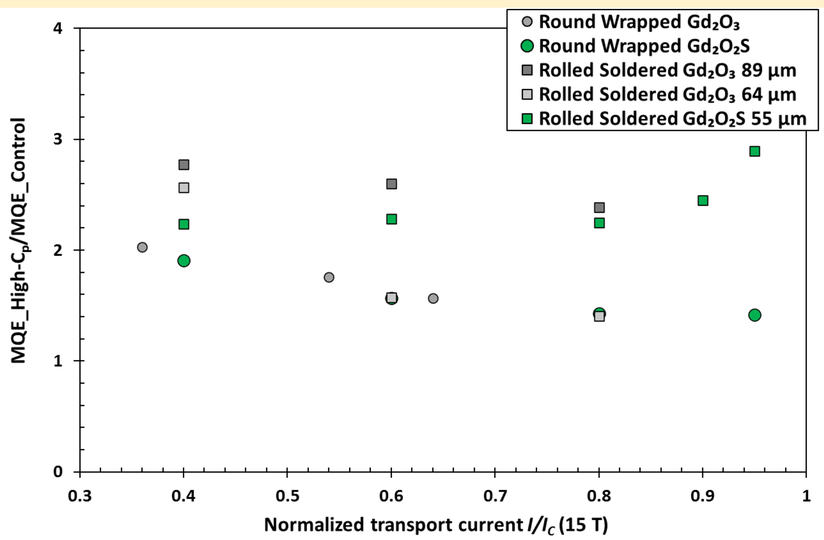


WK-09-125BT-350 Micro-Measurements strain gauge (4 mm x 1.5 mm) as 350 Ohm heater

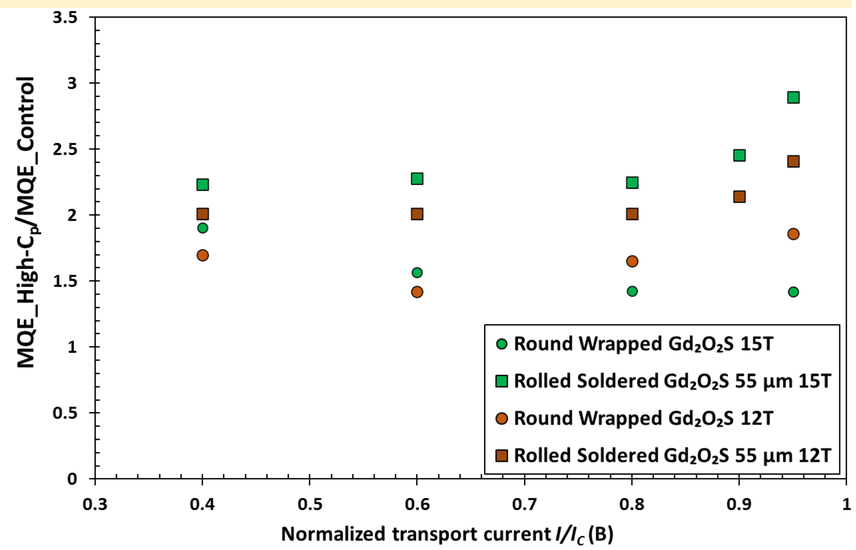
Results.



MQE (15T) vs. Current



MQE Gain (15T) vs. Current



MQE Gain (B) vs. Current