# QUENCH EXPERIMENTS ON $YBa_2Cu_3O_{7-\delta}$ COATED CONDUCTORS IN SELF FIELD

X. Wang (CAPS, Electrical and Computer Engineering, NHMFL/FSU); U.P. Trociewitz (NHMFL/FSU); J. Schwartz (NHMFL/FSU, Mechanical Engineering, CAPS)

## Introduction

High-$T_c$ superconducting magnets are not self-protected due to their low normal zone propagation velocity (NZPV) so active protection techniques are required [1,2]. Here, we report the minimum quench energy (MQE) and NZPV measured on YBCO coated conductors cryocooled to temperatures varying from 40 K to 77 K in self field.

## Experimental

A 4 mm wide, 180 mm long coated conductor sample was provided by IGC SuperPower Inc. The sample was fabricated using ion-beam-assisted deposition on Hastelloy C276 substrate. Atop the 100 µm thick Hastelloy layer is a 1 µm thick buffer layer, a 1.4 µm thick YBCO layer and a 3 µm thick Ag layer. The architecture is surrounded by 37 µm thick electroplated Cu stabilizer. A small W-shape heater was fixed on the YBCO facing side of the tape using alumina filled epoxy.

## Results and Discussion

The MQE is on the order of 1 J and increases when the transport current decreases because of reduced Joule heating during current sharing into the matrix (Fig. 1). The NZPV values are on the order of 10 mm/s (Fig. 2). As the transport current, $I_t$, and $I_t/I_c$ increase, the normal zone propagates more quickly and the MQE decreases, revealing that the sample is less stable. Higher NZPV is attractive as it helps preventing a magnet from localized overheating and damage; but a magnet operating at higher fraction of $I_c$ is also more sensitive to disturbances and easier to quench.

## Conclusions

Experimental results are reported on the MQE and the NZPV of a YBCO coated conductor as a function of temperature. Results show that this conductor architecture is more stable than similar architectures that are wider and have less Cu. When the propagation velocity is calculated using an adiabatic formula, values are two to three times higher than those measured are obtained. For fixed fraction of $I_c$ in the conductor, NZPV and MQE can be increased by decreasing the operation temperature and thus increasing the $I_c$ and transport current, which may be a viable approach for large magnets. Even so, as the NZPV is still on the order of 10 mm/s, other innovative protection techniques still need to be explored.

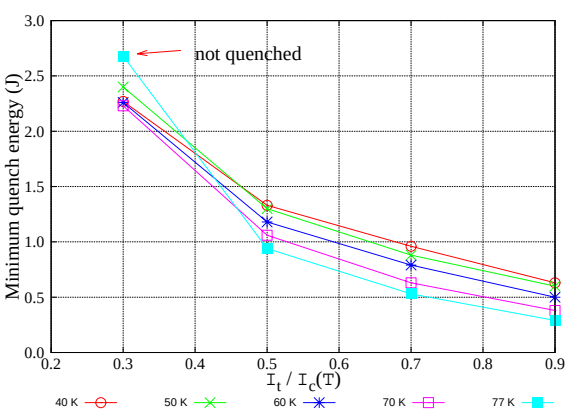


Fig. 1. MQE *vs.* transport current normalized to the end-to-end $I_c$ at each individual temperature.

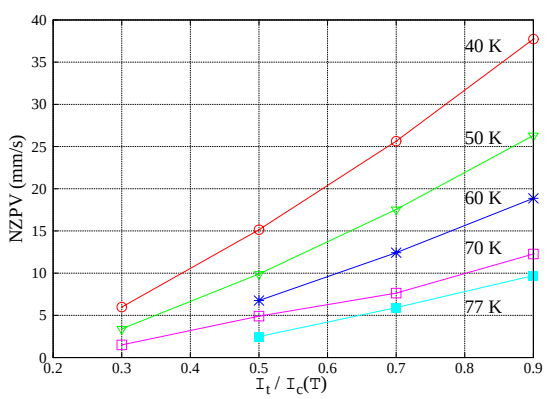


Fig. 2. NZPV *vs.* transport current normalized to the end-to-end $I_c$ at each individual temperature.

## Acknowledgements

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## References

[1] Oberly, C.E., et al., Advances in Cryogenic Engineering, 38B, 479 (1992).
[2] Iwasa, Y., *et al.*, Cryogenics, **43**, 303 (2003).