Advances in Practical REBCO HTS Magnet Design: Modeling, Validation, and Reliability

Matt Bristow,[1] Greg Brittles,[1] Rod Bateman[1], Manuel Pérez Pacheco,[1]*

[1]Tokamak Energy Magnetics (TEM), 173 Brook Dr, Milton, Abingdon OX14 4SD

High Temperature Superconductors (HTS), and particularly REBCO (Rare-Earth Barium Copper Oxide) conductors, are enabling a new generation of compact, fast-ramping, and quench-safe magnets. While their potential for disruptive use across multiple sectors is widely acknowledged, challenges remain in accurately modelling their electromagnetic behaviour and ensuring that simulations reliably predict performance in real systems.

This work reviews the advances we have achieved in simulation and modelling of REBCO HTS magnets, focusing on methods to capture quench dynamics [2] and screening current effects [1]. Emphasis is placed on the matching between modelled and experimentally measured responses, with results showing close correlation under dynamic operating conditions.

Representative examples of magnet prototypes are presented to illustrate validation of simulation models against experimental data, including demonstrations of fast-ramping operation**,** stable high-field generation**,** and their intrinsic quench safety**.**

By systematically comparing modelling outputs with real world measurements, TEM demonstrates its ability to provide robust, predictive simulation frameworks for REBCO HTS magnets. This builds confidence in the use of our modelling and simulation tools as a foundation for designing reliable, application-ready magnet systems.

References

1. V. Zermeño, F. Grilli, “Numerical modeling of superconductors for power applications,” *Superconductor Science and Technology*, 27(4): 044025, 2014. (screening currents)
2. K. Nakajima, et al., “Quench characteristics of REBCO coils under fast ramping fields,” *IEEE Transactions on Applied Superconductivity*, 31(5): 4600205, 2021. (quench dynamics)