T$_C$SUH Bi-Weekly Seminar

Texas Center for Superconductivity at the University of Houston

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Simulation of Quench Propagation in YBCO 2G Conductors and Coils

ABSTRACT

Superconductors will play an important role in tomorrow's power systems by enabling the development of more efficient and more compact electrical systems. The unique properties of superconductors allow for current to flow with no resistive losses, however, different types of losses need to be considered in variable regimes and in some cases, thermal runaways (quench) can occur. Quench in superconductors is an electro-thermal instability induced when a local energy input exceeds a certain threshold. It can be created from a multitude of causes including defects in the material, lower critical current or external energy input. A typical local quench starts as a hot spot, creating a local resistive transition of the superconductor forcing the transport current to migrate to the resistive stabilization layer; the normal zone propagates along the winding. This phenomenon, very common in low temperature superconductors because the minimum quench energy is very low, is addressed by an active detection system monitoring voltages at different locations. Unfortunately, High Temperature Superconductors (HTS) exhibit very low normal zone propagation velocities (NZPV) making quench detection challenging using conventional voltage-based detection systems. A reliable and quench detection system is critical to the development of power applications of high temperature superconductivity and therefore quench propagation analysis needs to be part of any superconducting magnet design. The peak temperature during a quench strongly depends upon the magnet topology, type of superconductor, type of cooling system and operating temperature, and needs to be kept as low as possible.

The presentation deals with the simulation of quench propagation using finite element analysis at two different scales: in HTS coils with a global model and in tape conductors with an accurate geometry representation. The first model presented deals with the simulation of a HTS racetrack coil with a homogenized thermal model showing the propagation of the quench in three dimensions. The second model deals with a 2G tape in which all the layers are represented with high fidelity. The different simulation results are compared to experimental data.

BIO

Dr. Philippe Masson has been working in the area of electro-mechanical systems, power application of superconductivity and Multi-Physics Modeling since 1999. He received a Ph.D. in Electrical Engineering from the Université Henri Poincare, Nancy, France in 2002. He then spent 6 years at the FSU-Center for Advanced Power Systems in Tallahassee, FL, working on the development of high power density superconducting machine for aircraft propulsion as part of the NASA/DoD URETI on Aeropropulsion and Power and on numerical modeling of electro-thermal instabilities in superconductors for the U.S. Air Force Research Lab. At the same time, he was appointed by the FAMU-FSU College of Engineering as adjunct professor for the Department of Electrical Engineering. In 2009, he joined the Advanced Magnet Lab as Senior Scientist where he worked on superconducting motors and generators as well as resistive and superconducting magnets for high-energy physics and medical applications. In 2012, he joined the University of Houston as a faculty member of the Department of Mechanical Engineering and as a member of the Texas Center for Superconductivity. Dr. Masson was appointed to the Editorial board of IEEE Transactions on Applied Superconductivity and has been serving as Editor for Large Scale Applications since 2005. He joined the editorial board of the International Journal of Aerospace Engineering in 2009. He is a Senior Member of IEEE and AIAA and a member of the Cryogenic Society of America.

He received the "Outstanding Young Researcher Award" from NASA in 2007 and the Roger W. Boom Award from the Cryogenic Society of America in 2010. Dr. Masson has published over 35 journal papers and given more than 50 conference presentations in the area of Applied Superconductivity and MultiPhysics Modeling. He is a member of the program committee of the Applied Superconductivity Conference (ASC) since 2002 and has served as technical editor for ASC and the Magnet Technology conferences since 2002.

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