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Quench Dynamics testing and 3D modeling of VIPER HTS Cable

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VIPER cable is a high-current and high-field capable high temperature superconducting (HTS) cable designed by MIT and Commonwealth Fusion Systems (CFS) for large scale superconducting magnet system applications. The VIPER cable design is based on the high-temperature superconductor cable architecture known as Twisted Stacked Tape Conductor (TSTC) first proposed by Takayasu et al. [1]. Several VIPER cable prototypes (name Alpha, Bravo, Charlie, and Delta) were instrumented and tested at the SULTAN facility to qualify the mechanical strength, fatigue cycling, and quench stability at fusion-relevant conditions. This poster will cover the quench tests results and COMSOL simulation modelling of the VIPER Delta test campaign. The VIPER Delta cable was tested at fields up to 10.9T, currents up to 50 kA, and operating base temperatures ranging from 4.5 K to 20 K. Experimental results show quench propagation velocities (QPV) on the order of 0.1 m/s with QPV increasing with operating current and decreasing with operating temperature. 3D COMSOL models were created to simulate the quench dynamics, such as QPV changing with temperature, of the VIPER Delta cable at Sultan. The cryostability, quench temperature thresholds, and normal zone propagation will be simulated with the 3D COMSOL model and compared to experimental data. In addition, sensitivity studies will show how important accurate REBCO tape characterization (Ic vs. angle, temperature, and magnetic field), HTS stack assumptions, and cable material property data (thermal and electrical properties) translate to the accuracy of the model compared to experimental results.

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[1] M. Takayasu, et al., "HTS twisted stacked-tape cable conductor,"Supercond. Sci. Technol., 2011.

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