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Dynamic strain characteristics and responds in a LTS sextupole magnet during excitation and spontaneous quench

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The dynamic strain/stress characteristics and responds of a low temperature superconducting (LTS) sextupole magnet during excitation, pre and post spontaneous quench are investigated in the present work. The strains are measured by using a half-bridge circuit composed of a cryogenic strain gauge and dummy resistances. The strain gauges are directly embedded within the magnet structure, which are located between the superconducting windings and the stainless steel. A fast data acquisition system with wireless and a resolution of 1ms is used for the strain measurements of the SC magnet during excitation and spontaneous quench. The results show that the strong turbulence and high value of measured internal strains are always detected in advance compared to the transport current, magnetic field and temperature signals recorded when a spontaneous quench occurs. It indicates that the transient internal strain measured in the SC magnet can capture the quench feature timely. To better understand the dynamic strain histories in the SC magnet during the excitation, initial and post quench processes, a spectrum analysis of the measured strain signals is conducted. It is indicated that several spectral peaks are always observed at the onset of a quench. When the current is increased, the amplitudes of these spectral peaks for the pre quench are weakened and the corresponding frequencies are enhanced. The observations indicate that the accumulated disturbance energy from the deformation or movement of SC wires inside the magnet may be dominant for occurrence of a quench. By means of quench training, the movement inside of coils is gradually constrained resulting in the structural frequency being increased.

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