



Qualification of movement leading to quench in Nb₃Sn coils by means of induced voltage, quench antenna and vibration measurements

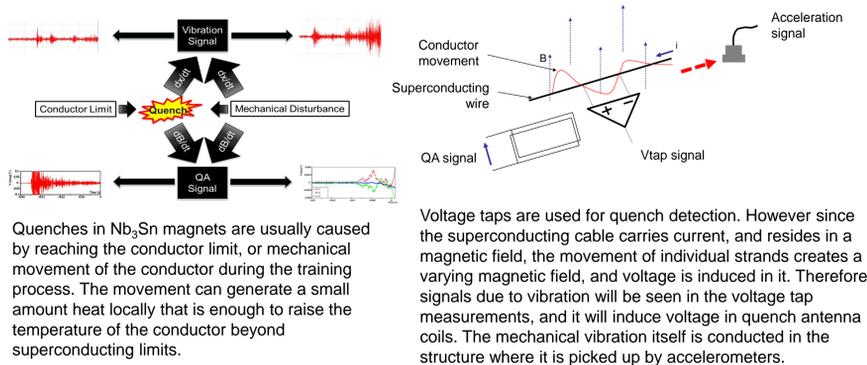
D. Turi, G. P. Willering, M. Bajko, H. Bajas, M. Guinchard, P. Grosclaude, F. Mangiarotti, E. de Matteis, M. Probst
CERN, Geneva, Switzerland

Abstract

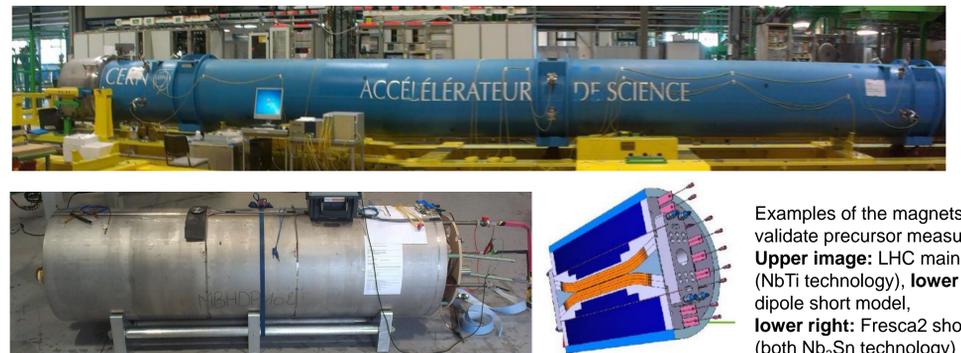
A general understanding of training quenches in Nb₃Sn superconducting coils is that they are predominantly caused by settling of the coil while increasing the force in the magnet during current ramp up. In most cases, voltage measurements show precursors that can indicate the magnitude of movement. Three types of movement detection methods were combined in recent tests of Nb₃Sn model magnets: direct voltage measurements, quench antenna and accelerometers. The accelerometer measurements can exclude the electrical origin of the precursors in voltage and quench antenna data, and allow to further investigate the frequency and amplitude spectrum of the vibrations.

Here we describe the test results of the three movement detection methods on state of the art Nb₃Sn model magnets and compare the results with those from NbTi magnets.

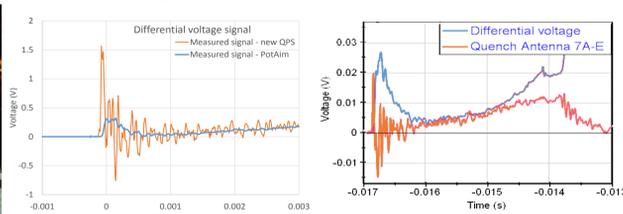
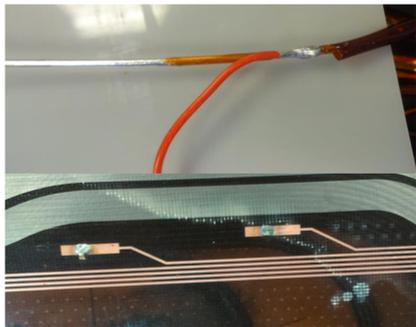
Basic principles



Magnets



Voltage taps



Quench antenna



Vibration measurement

PCB 351B41	PERFORMANCE
	Sensitivity (±10%)
	Measurement Range
	Frequency Range (±5%)
	Frequency Range (±10%)
	Resonant Frequency (±1 dB)
	Broadband Resolution
	Non-Linearity
	Transverse Sensitivity

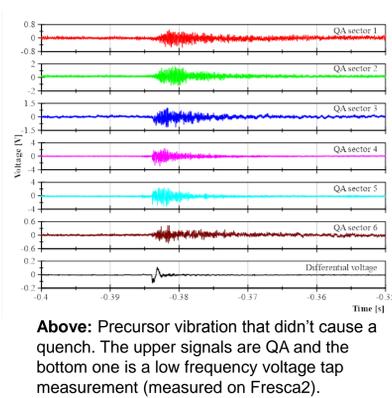
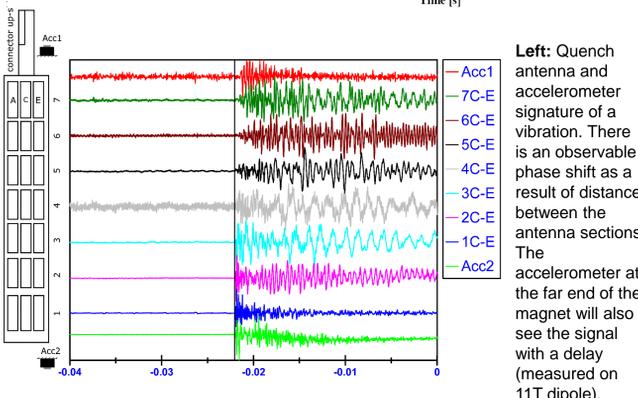
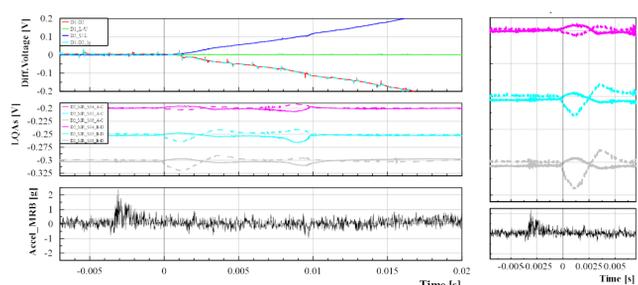
PCB 351B11	PERFORMANCE
	Sensitivity (±10%)
	Measurement Range
	Frequency Range (±5%)
	Frequency Range (±10%)
	Resonant Frequency (±1 dB)
	Broadband Resolution
	Non-Linearity
	Transverse Sensitivity

Left: two cryogenic models of accelerometers. There is a tradeoff between sensor bandwidth and sensitivity.

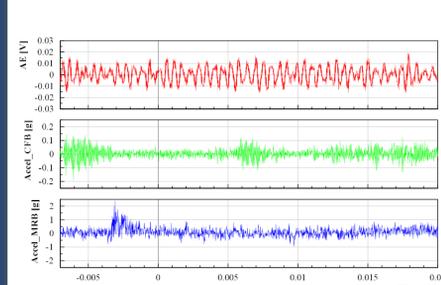
Right: Acoustic emission sensor (courtesy of M. Marchevsky at LBNL). AE sensors have much higher bandwidths than accelerometers, and are sensitive to surface waves instead of bulk waves.



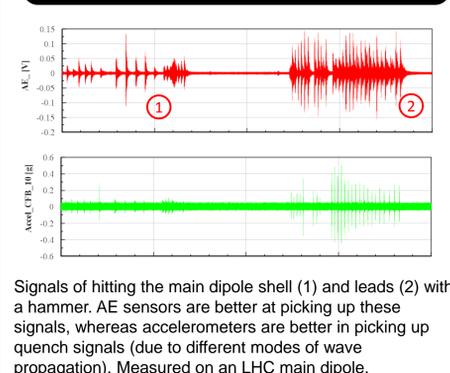
Quench precursor



Effect of position



Differences between AE and accelerometer



Conclusion

Precursors are not always present before a quench. If there are however, they can be picked up by quench antenna coils and accelerometers if they are located close enough to the source. These methods were validated simultaneously during quenches on an LHC main dipole, and vibrations were observed on Nb₃Sn magnets. Detailed tests on the 11T dipole will begin next month.

Acknowledgement

The authors would like to thank M. Marchevsky and his group at LBNL for lending us the acoustic emission sensor.