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Ultrasonic Waveguides for Quench Detection in HTS Magnets

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High-temperature superconductors (HTS) are expected to have a major impact on the development of future particle accelerators and fusion energy systems. One of key challenges associated with HTS is a slow propagation of the normal zone that complicates early detection of thermal runaway (quench) in an HTS magnet using voltage-based techniques. Furthermore, fusion systems require field ramping rates up to several T/s under strong time-varying ac magnetic fields imposed on the conductor which makes voltage-based quench detection difficult or impractical. We propose an alternative non-voltage quench detection solution based upon monitoring mechanical stress wave propagation in a solid fiber-like flexible waveguide. The latter can be co-wound with the superconducting cable and carry acoustic wave over long distances. Acoustic waveguide technology allows for measuring local variation of strain or temperature in a way similar to optical fibers. However, unlike fiber-optic sensors, mechanical waveguides are constructed of robust materials and eliminate the need for expensive and complex signal receivers and data processing equipment. We will present our early developments in cryogenic acoustic waveguide technology, and discuss preliminary experiments conducted towards validating it for future use in practical HTS magnets.

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