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Quench Detectors Sensing Second Sound Events Induced by SRF Cavities Thermomagnetic Breakdown in Superfluid Helium

The maximum RF surface magnetic field (BS) achieved with Superconducting RadioFrequency (SRF) bulk Nb cavities is often limited by anomalous losses due to Joule heating of normal-resistive defects embedded onto the RF surface. At high BS (e.g BS>50 mT), the defect temperature increases strongly with the field, leading to a thermal runaway of the cavity or quench. In the frame of a R&D program dedicated to the development of diagnostic tools for in situ detection and locating thermal quenches (thermo-magnetic breakdown) in SRF Cavities, IPN developed its first quench detectors, the so-called Oscillating Superleak Transducer (OST) and a cryogenic test stand for their calibration and full characterization in a saturated He II bath from T down to 1.6 K. Moreover, industrial low response time (« 1ms) resistive thermometers were also used for quench detection purpose tested and characterized. The test stand allows precise and controlled experimental simulation of SRF cavity quench using Joule heated pulsed sources. A Second Sound Resonator (SSR), with a pair of OST at its two extremities as thermal source and sensor respectively and housing both a low thermal capacity heater and a bolometer assembly was also developed. The first experimental data, with SSR operated in either a resonating mode with an AC excitation and/or in a shock wave mode and subjected to pulsed high heat flux, are reported. Finally OST detectors were successfully used for locating and characterizing quench sources in various bulk niobium SRF cavities at different RF resonating frequencies (e.g. quarter wave resonators of SPIRAL2 linac, spoke and elliptical cavities). In particular, we studied the quench dynamics and critical size of hot spot normal resistive area leading to SRF cavity quench.

Primary author: FOUAIDY, Mohammed (IPN Orsay)

Co-authors: Mr MARONI, Alain (Institut de Physique Nucléaire d'Orsay); Dr LONGUEVERGNE, David (Institut de Physique Nucléaire d'Orsay); Mr DUBOIS, Francis (Institut de Physique Nucléaire d'Orsay); Mr YANICHE, Jean-François (Institut de Physique Nucléaire d'Orsay); Mr POCHON, Olivier (Institut de Physique Nucléaire d' Orsay); Mr PLÉ, Raphael (Institut de Physique Nucléaire d'Orsay)

Presenter: FOUAIDY, Mohammed (IPN Orsay)

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