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Numerical Study of Temperature Distribution within a Conduction-Cooled, MgB2 MRI Coil Segment

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Abstract gradients minimized in order to retain thermal and operating margin. We have used 3D finite element method (FEM) simulation in COMSOL Multiphysics software to calculate the temperature distribution both along the winding direction and across the cross-section of an MRI segment coil at its equilibrium operating temperature. We have also modelled the evolution of the thermal properties during cool-down from ambient temperature. The heat capacity and thermal conductivity along the wire as a functi Superconducting magnets used for MRI scanners need to keep temperature on of temperature for the composite wire was calculated using a rule of mixtures. However, the thermal conductivity within the wire cross section (x- and y-directions) was computed using a 2D FEM model (translationally invariant in z) for the composite wire. Based on this, a time-dependent model was built to calculate the coil temperature throughout the winding during cool-down in our test cryostat system. The model included a heat leak component to the coil current contacts via conduction through the current leads as well as a radiation component from the surfaces of the cryostat. A key result was that a coil temperature difference of 5 K was seen along the coil winding direction even at the steady state. A temperature difference of 4.2 K across the coil cross-sectional area was also seen, indicating an Ic difference of 10.5 A based on experimental measurements. Benefits and complications on the new designs including using thermal straps with higher thermal conductance as well employing thinner current leads were analyzed.

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