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Field Quality Analysis in the HTS Dipole Insert-Magnet Feather M2 with the Finite Element Method

High temperature superconductors are a promising technology for future particle-physics accelerator magnets. They can help in overcoming the limitations and constraints in today's high-energy particle accelerators by allowing for higher magnetic fields. At the same time, accelerator magnets need to meet stringent requirements in terms of magnetic field quality. Superconductors made of HTS tapes show an inhomogeneous current distribution with respect to filamentary cables based on Nb-Ti or Nb3Sn, which is determined by the larger size and the particular geometry of the filament. Such behavior is detrimental for the magnetic field quality and could be a showstopper in the adoption of the HTS technology. For this reason, the design of future HTS magnets requires an accurate prediction of the electrodynamic phenomena in the conductors for the relevant operational conditions.
We present a 2D magnetoquasistatic simulation of the HTS Dipole Insert-Magnet Feather M2 [1]. The model relies on a formulation based on mixed potentials, implemented with the Finite Element Method. The model is validated for different temperatures against measurements from the magnet in a stand-alone configuration. The code is used to extend the results to the upgraded version of the magnet, which will be operated in a background field of 13.5 Tesla as an insert in the FRESCA2 superconducting dipole.

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References

[1] J. Van Nugteren, et al. "Powering of an HTS dipole insert-magnet operated standalone in helium gas between 5 and 85 K." SUST 31.6 (2018): 065002.

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